CONNECTED LEARNING SUMMIT

Create. Play. Mobilize.

Proceedings of the 2019 Connected Learning Summit

Edited by Jeremiah H. Kalir and Danielle Filipiak

The Proceedings of the 2019 Connected Learning Summit features research and presentations from the 2019 Connected Learning Summit, held at the University of California, Irvine in October 2019. The proceedings includes full research papers and abstracts for all other presentations.

Carnegie Mellon University
ETC Press

Proceedings of the 2019 Connected Learning Summit

Proceedings of the 2019 Connected Learning Summit

EDITED BY JEREMIAH H. KALIR AND DANIELLE FILIPIAK

CARNEGIE MELLON UNIVERSITY: ETC PRESS
PITTSBURGH, PA

Please cite as: Kalir, J. H., & Filipiak, D. (Eds). (2020). *Proceedings of the 2019 Connected Learning Summit* (Vol. 1). Pittsburgh, PA: ETC Press.

Print ISSN: 2642-3618
Digital ISSN: 2642-3626

Contents

From the Editors

Welcome to the *Proceedings of the 2019 Connected Learning Summit*.

It is our honor to share with you a proceedings that celebrates participatory, playful, and transformative learning. In 2018, the inaugural Connected Learning Summit gathered together the Digital Media and Learning Conference, the Games+Learning+Society Conference, and the Sandbox Summit to commence a new chapter of inspired inquiry and shared commitment to more equitable learning futures. In 2019, nearly 450 educators, scholars, designers, and leaders gathered at the University of California, Irvine—home of the Connected Learning Lab—for the second annual Connected Learning Summit. As evident throughout the pages of this proceedings, this community is successfully identifying and traversing new pathways for connected and creative learning that made a difference in the lives of youth, families, educators, and many others across diverse learning environments.

There were many highlights of the 2019 Connected Learning Summit, not all of which are captured in this proceedings. Notably, the summit began with a fireside chat hosted by Henry Jenkins and featuring youth activists Jessica Riestra and Justin Scott, who are leading social movements in their communities and had much to teach all attendees about tenacity, courage, and wisdom. We are also grateful for keynote presentations by sociologist and author Eve Ewing, as well as by game designer and researcher Tracy Fullerton; thank you for sharing with us your passions, incisive perspectives, and recommendations for educational change.

To publish a proceedings that features 175 sessions presented at the 2019 Connected Learning Summit requires a dedicated and skilled team. We would like to thank, first and foremost, everyone who joined us at UC Irvine and whose work is featured in these pages. The Connected Learning Summit Conference Committee—including Amon Millner, Constance Steinkuehler, Deborah Fields, Drew Davidson, Edgar Quintanilla, Emily Martin, Eric Klopfer, Fay Cobb Payton, Ira Fay, Justin Reich, Kim Jaxon, Mizuko Ito, Ricarose Roque, Sangita Shresthova, Scot Osterweil, Sam Dyson, and Kylie Peppler—has steadfastly supported the team that has produced these proceedings. And invaluable assistance was provided by Claudia Caro Sullivan and Jamieson Pond, from the Connected Learning Lab, as well as by Karen Bleske. Brad King at Carnegie Mellon University's ETC Press helped shepherd the proceedings toward publication.

If you find yourself inspired by these proceedings, please consider joining us at the 2020 Connected Learning Summit to be held July 29–31 at the Massachusetts Institute of Technology in Cambridge, Massachusetts.

On behalf of the proceedings team,

Remi Kalir and Danielle Filipiak

Co-Editors, *Proceedings of the 2019 Connected Learning Summit*

2019 CLS Reviewers

Jonathan Alexander
Craig Anderson
Zhen Bai
Anastasia Betts
Ayesha Bhimdiwala
Paige Boehmcke
Leslie Bondaryk
Scott Byrd
Christina Cantrill
Claudia Caro Sullivan
Monica Chan
Carol Cohen
Negin Dahya
Drew Davidson
Jonathan deHaan
Yao Du
Sam Dyson
Jason Engerman
Matthew Farber
Ira Fay
Deborah Fields
Deanna Gelosi
Tricia George
Kristin Gorski
Hao He
Sean Hickey
Kelly Hoffman
Christopher Holden
Theresa Horstman
Amy Hutchison
Mizuko Ito
Burcu Izci
Krithika Jagannath
Kim Jaxon
Bob Keeley
Anna Keune
Hanaa Khamis
Ben Kirshner
Eric Klopfer
Hillary Kolos
Yoonhee Lee
Grace Lin
Wenyi Lu
Jose Luis Mendoza
Emily Martin
Areej Mawasi
Caitlan Maxwell
Cherise McBride
Amon Millner
Elizabeth Mills
Patricia Monticello Kievlan
Katherine Moriwaki
Christine Moskell
Bonnie Mozer
Eduard Muntaner-Perich
Yumiko Murai
Brandon Muramatsu
Amanda Ochsner
Dan O'Reilly-Rowe
Scot Osterweil
Priyanka Parekh
Ahram Park
Melanie Parlette-Stewart
Fay Cobb Payton
Anthony Pellicone
Kylie Peppler
Judy Perry
Joy Pierce
Caroline Pitt
Kate Powers
Edgar Quintanilla
Denise Quintel
Matt Rafalow
Justin Reich
Carolina Rodeghiero
Ricarose Roque
Pati Ruiz
Beverly Santo
Denise Sauerteig
Mishael Sedas
Sangita Shresthova
Brian Smith
Laura Sparks
Constance Steinkuehler
Becky Stephenson
Felicia Sullivan
Jing Sun
Kristana Textor
Naomi Thompson
Melissa Vervinck
Justice Walker
David Wang
Hong-An Wu
Ann Yamamoto
Sherry Yi

Special Thanks

Karen Bleske, CLS Proceedings Principal Copy Editor

Jamieson Pond, Communications Manager, Connected Learning Lab and CLS Proceedings Data Analyst

Claudia Caro Sullivan, Assistant Director, University of California Humanities Research Institute and CLS Proceedings Executive Producer

PART I

RESEARCH PAPERS

1. Beyond Coding

Youth Creativity, Literacies, and Social Engagement in a Computer Programming Club

EARL AGUILERA

Abstract: As momentum builds around computer programming clubs and broader movements promoting "computer science (CS) for all," less work has explored the many other ways that young people are developing and demonstrating creative, multimodal literacy practices as well as social engagement in these CS-focused spaces. The purpose of this paper is to share insights into these issues, based on a study of 1 such "code club" situated in a public library in the Southwestern United States. Specifically, this paper presents an analysis of data collected over the course of a 10-week summer session of the code club (June 2017–August 2017). A total of 47 students aged 8–14 participated, which met twice a week with a library facilitator. As part of the study, I collected observational, artefactual, and audio-recorded data from each session and engaged in first- and second-cycle qualitative coding (Saldana, 2015) to identify the ways in which students drew on multimodal literacy practices as they navigated, interpreted, interrogated, and designed their learning experiences across virtual and face-to-face contexts (Serafini, 2012). Findings from this study suggest that a wide variety of creative practices can be observed while students engage with digital content, procedural literacies, and social contexts "beyond the screen." This paper contributes to the work of connected learning by providing additional evidence into the diverse and multidimensional learning practices that can occur within code clubs and similar environments, as well as the ways that teachers, parents, librarians, and other adults can support students engaging in these practices.

Introduction

As we can see in both the popular press and academic discourse, momentum has been building around computer programming clubs and broader movements promoting "computer science (CS) for all." (Balli, 2017; Fields, Giang, & Kafai, 2013). However, fewer efforts have explored the many other ways that young people are developing and demonstrating creative, multimodal literacy practices, as well as social engagement in these CS-focused, informal learning spaces. These "code clubs" are particularly interesting spaces in which to examine issues of connected learning, as debates about the value of computer programming as a career-unlocking skill are beginning to complicate discourses surrounding the CS4All movement (Futterman, 2015). Beyond these debates, however, questions about what actually occurs within the "buzzing, blooming confusion" of these informal learning experiences can provide important insights into the value of youth engagement in these spaces beyond learning how to program (Barab & Squire, 2016, p. 4). This paper takes up this challenge by offering an analysis of one such code club, highlighting the diverse, creative, and expressive literacies and social engagement practices demonstrated by participating students over the course of just a short span of time.

Specifically, the paper reports on a study examining the literacy practices demonstrated by students participating in a library code club. Broadening the analytical focus beyond computer programming, the study sought to address the following areas:

- The ways that participants' literacy practices appeared to engage aspects of multimodal digital media *content*;
- The ways that participants' literacy practices appeared to engage aspects of *procedurality*, including the

computational logics underlying various programming languages and tools; and
- The ways that participants' literacy practices appeared to engage broader issues of social *contexts* of the production, dissemination, and use of this digital media by wider audiences.

By framing the focus on the study in the context of literacies, this paper aims to contribute to an understanding of the diversity and complexity of youth engagement, learning, and socializing even in spaces that appear to have a more singular curricular focus.

Perspectives and Framing

The analysis shared in this paper is grounded in a perspective of literacy as a situated, sociocultural, and multimodal phenomenon (Rowsell, Kress, Pahl, & Street, 2013). Literacy is *situated* in that it involves cognitive capacities (e.g., decoding and processing written letters), social practices (e.g., reading in a classroom, as opposed to in the home), and material technologies (e.g., reading a physical or electronic book), but always within a specific context or situation: What counts as "being literate" has been demonstrated to vary across cultures, communities, and institutions (Mahiri, 2004). Literacy is *sociocultural* in that beyond the immediate situation (e.g., a child reading a book in a third-grade classroom), it is shaped by broader social, historical, cultural, economic, and ideological contexts (Street, 2006). Finally, literacy is *multimodal* in that beyond its linguistic dimension, it involves artifacts that use a variety of modes of communication—image, sound, gesture, and more—to represent and exchange social meanings (Serafini, 2012). Following this logic, the remainder of this paper will reframe the singular "literacy" in the plural, as *literacies*, in order to recognize the multiple ways of being and becoming literate that different people bring to different situations (The New London Group, 1996). In addition, this view allows us to expand the idea of *texts* as encompassing more than just words written on a page to more closely approximate a social-semiotic definition of a text as a material instantiation of these social exchanges of meaning.

Building on these foundations, this paper conceptualizes digital-age literacies across three overlapping and interconnected dimensions (Aguilera, Stewart, Mawasi, & Cortés, 2019). At the content dimension, we can highlight aspects of the multimodal content rendered "on the screens" that have become a ubiquitous part of our daily lives (Serafini, 2012). Within the procedural dimension, we can consider the technological rules operating "behind the screen" that constrain these digital literacy experiences, as well as the potential affordances that digital tools may lend to literacy learners (Golden, 2017; Murray, 1997). Finally, we can look "beyond the screen" at the contextual dimension of digital media technologies—particularly at the sites of production, dissemination, and use of these technologies for exchanging meaning (Rose, 2012). Such a multidimensional framing of these literacies is important for expanding our analytical perspectives on what "counts" as literacy in a digital age.

Method

The methodology and analytical approach in this study are guided by paradigms of naturalistic and interpretive inquiry, which emphasize the study of social phenomena, such as teaching and learning, through methods that attempt to preserve, rather than manipulate, contexts of study as they occur in "real-world" settings (Barab & Squire, 2016). Further, interpretive paradigms of inquiry seek to understand the perspectives of participants as they interact in their local

contexts; rather than attempting to present an "objective" analysis of findings, such studies are informed and shaped by the subjective experiences and socially constructed realities identified by participants (Erickson, 1986).

Context and Participants

This paper focuses on an analysis of data collected over the course of a 10-week summer session of the Code Club (June 2017–August 2017). A total of 47 students aged 8–14 participated in the summer Code Club, which met for two separate sessions (one group from 3 to 3:45 p.m., and one from 4:15 to 5 p.m.) on Thursday afternoons, along with a library facilitator. About 12 of the Code Club's participants identified as female (26%), with the remaining 35 students identifying as male (74%). Surveys administered during the Code Club sessions suggested that participants came from a wide range of schooling backgrounds, including local public school districts, charter schools, private schools, and homeschooled experiences. Surveys also indicated that participants had a wide variety of background experiences and interests outside of the Code Club. The study was conducted in an urban public library setting in a metropolitan area of the Southwestern United States. As the sole public library in its city, it serves 737,233 visitors each year. The library occupies a total of more than 100,000 square feet, and it includes one of the largest youth libraries in the United States. The observational data for this study were collected within this youth library, a space that included a youth computing area with 15 operating desktop computers. A donation to the library's program also provided 10 additional laptop computers, which the students used to varying degrees.

Data Sources and Collection Procedures

As part of a larger, yearlong study of the Code Club, I collected observational, survey, and audio-recorded data over the course of a 10-week summer session (June 1, 2017–August 4, 2017), as described below:

Observational data. The main source of observational data used in this study were postsession field notes that I composed after both Code Club sessions had ended, shortly after the closing of the library at 5 p.m., via audio-recording and subsequent transcription. These field notes contained a detailed narrative of my observations as a researcher/facilitator in the space.

Survey data. To better inform my understanding of students' backgrounds and individual experiences, I designed a brief survey for students that I administered during the early part of the summer sessions. The survey collected basic demographic information such as age and school attended, along with questions about prior Code Club experience, experiences with technology outside of Code Clubs, and engagement in Code Club activities outside of the scheduled time.

Audio-recorded data. To aid in the construction of post-observation field notes, I began collecting audio recordings from June 15, 2017, until the end of the session. While these recordings were not transcribed and coded for the purposes of this project, they helped inform the overall construction and analysis of the postsession field notes.

Qualitative Coding as Analytic Procedure

For the purposes of this study, the main analytical focus was on the post-observation field notes, as constructed by me and informed by in-session observations, survey data, and audio recordings. Following models proposed by Saldana

(2015), I engaged in first- and second-cycle qualitative coding to identify patterns and discrepancies that could inform an understanding of the ways that students engage in multidimensional literacy practices as part of their experience in a computer programming club. I used the NVivo software to upload and store revised copies of the field note transcriptions; apply, categorize, and manage codes; run "queries" for code frequency and cross-code references; and to generate and store analytical research memos throughout my process.

I began my first cycle of coding by generating and applying attribute codes to each set of field notes I analyzed. These codes named various attributes of each document, including time of generation, participants mentioned, and activities observed, and provided an overall "summary" of each field note document to assist me in the management of the broader analytical process.

Drawing on the conceptual framework previously outlined, I then engaged in a process of structural coding, defined as "a content-based or conceptual phrase representing a topic of inquiry to a segment of data to both code and categorize the data corpus" (Saldana, 2015, p. 83). In the case of this study, I generated and applied the codes of {On the Screen}, {Behind the Screen}, and {Beyond the Screen} across broad areas of the field notes to correspond to the content, procedural, and contextual dimensions of the conceptual framework.

Having generated structural codes to create an initial "mapping" of the field note observations and identifying sections to look into further, I moved toward second-cycle coding through *process coding* (Bogdan, 2012), which uses gerunds ("-ing" words) to connote action in the data. I developed and applied these codes to capture a sense of the different literacy practices that I observed and noted through observation. Process codes that I generated and applied to the data were drawn primarily from my own understanding of "traditional" and new media literacy literacies, as well as constructed from reviews of the literature and my own experience (conversations, course work, lectures, etc.).

During a second cycle of coding, I reorganized and reexamined the first-cycle codes I developed through a process referred to as *pattern coding*, so that I could move toward "a coherent metasynthesis of the data corpus" (Saldana, 2015, p. 208). Pattern codes, as Miles and Huberman (1994) describe them, are "explanatory or inferential codes, ones that identify an emergent theme, configuration, or explanation" (p. 69). In the case of this analysis, pattern codes were first generated and applied to the existing procedural codes rather than to the original field notes themselves. These codes were generated based on "families" of literacy practices (Luke & Freebody, 1999) that I identified as I reviewed and revised codes from the first-cycle processes. Thus, the codes {gamemaking}, {game-playing}, {game-modding}, and {watching videos about games} were grouped under the "meta-code" {Gaming}, which I later revised to the pattern code of {Big "G" Gaming Practices} (Gee, 2003).

Findings

In this paper, I have aimed to map a range of literacy practices and resources that students appeared to engage with in the Code Club beyond just growth in the skill of computer programming. Specifically, this study sought to address the following question: *In what ways do students engage in multidimensional literacy practices as part of their experience in a computer programming club*? Based on the qualitative coding process described above, I summarize findings that address this question across the three dimensions of the conceptual framework.

The Content Dimension: Media Creation, Remixing, and Sharing

Approaches to literacy development with new media have historically emphasized "receptive" (sometimes considered passive) competencies such as reading, listening to, or consuming media. However, in line with research across the field of connected learning, evidence from the present underscores the prevelance of "productive" (sometimes considered active) literacy practices, such as creating, remixing, and sharing media content. A field note entry from July 7, 2017, exemplifies such an entanglement of productive and receptive literacy practices. In the transcript that follows, I describe working with Hannah, a female focal participant aged 10 who attends a local charter school, on an original animation she is developing on the Scratch platform:

> Again, expressed being a little stuck in a project / not really sure what to do next / What I was suggesting to her / beyond trying to brainstorm new ideas for her project / was to look into other projects / and see what other people have created / to get some inspiration. / She did jump back into the Scratch gallery after that, //and viewed an animation. / I believe it was about some type of food, / and appeared engaged when I asked her about it / Not too long after that / jumped back into her own project, / again asking for a little bit of guidance with / sequences of actions and events in her animation//. (Post-observation recording, July 7, 2017)

Here, I interpreted Hannah's moving from "stuck" in an ideational phase of a project to "jumping back" as mediated by inspiration gained from exploring the animated work of others who have shared on the Scratch platform. Hannah's work on her animation exemplifies just one of the many ways that students demonstrated creative literacy practices within the Code Club. Other examples included practices I coded as {Digital Sprite Creation}, {Game "Modding"}, {Audio Production}, and {Reading and Writing Code}.

The Procedural Dimension: Big "G" Gaming as Exploratory Practice

Throughout my analytical process, I noted many instances in which students engaged with digital games, though not solely in the practice of playing them. Instead, students throughout the Code Club demonstrated what Gee (2003) referred to as Big "G" Gaming practices—experimenting with play styles, playing with the logics of computation, "hacking" premade tutorials toward personal preferences and goals—largely toward the goal of exploration. As positive as this seems, however, these practices also led to moments of difficulty for some students.

In one session, for example, 11-year-old and experienced Code Clubber Natasha expressed some frustration with a programming challenge as she played through the gamelike *CodeCombat* (2013) web application. Notes from one session described Natasha's interactions with the gamified tutorial:

> They described making sure to get out of the dungeon alive / and also attacking two particular monster characters / What the instructions did not specify was that // the monsters had to be attacked in relatively quick succession. / Otherwise, they would drain the player of his or her hit points / so they had a chance to complete the level. / And that's what Natasha was running into with her code / essentially she had the correct amount of attacks in a row with the first monster. / But for the second monster / there was a movement command that she had placed / between her two attacks, / Such that the second monster she ran into had a chance / to drain her character of all its hit points / before she could continue //. (Field notes, July 6, 2017)

In this case, Natasha's prior reliance on scripted tutorials promoted by Code Club facilitators proved less helpful than actually engaging in the practices of playful experimentation with game mechanics and outcomes. At the same time, by taking a solely play-focused stance, Natasha would miss out on opportunities to understand the programming languages

underlying these game mechanics. Only by engaging in discussions about a wide range of gaming practices would she and I later be able to develop solutions to this programming puzzle.

The Contextual Dimension: Navigating, Negotiating, and Connecting Learning Contexts

Finally, a third grouping of creative literacy practices reflected the ways that students *navigated* relationships with peers and adults, *negotiated* norms, rules, and expectations of the Code Club space, and *connected* with communities, peers, and resources beyond the physical and temporal boundaries of the Code Club.

Included within this dimension were the ways that Riri, a relative newcomer to the Code Club, took cues for how she spent her time, not from facilitators, but primarily from watching her brother, Luke, pursue his own interests (Field notes, July 13, 2017). Miles, a more experienced participant in the Code Club, once spent his entire session reviewing and commenting on the creations of peers in the online Scratch platform (Field notes, July 20, 2017). Finally, Colleen, a visiting international student, demonstrated her own engagement with the social contexts of literacy production by verbalizing doubts about the originality of her remix of a game called *Flappy Bird* (dotGears, 2013), as in her mind, "it wasn't my idea first" (Field notes, June 22, 2017).

In response to the overall question that guided this analysis, I found that students drew on literacy resources and practices in a wide range of ways across the dimensions of content, procedurality, and context. Among these practices were (a) the creation, remixing, and sharing of media, (b) the enactment of Big "G" Gaming practices as a means of exploration, and (c) the navigation, negotiation, and connecting of social learning contexts.

Discussion

Findings from this study suggest that despite the Code Club's stated focus on computer programming, a range of opportunities for creative literacy engagement beyond programming were taken up by participating students. This is, of course, not to diminish the importance of the complex literacy practices students engage in at the procedural dimension of computational media—reading and writing code, experimenting with the logics of computation, and encoding meaning through the manipulation rules and rule systems. Instead, these findings highlight the importance of expanding our lenses of analysis in these spaces to include how students are engaging simultaneously with *content*, *procedurality*, and the social *contexts* that are mutually constituted by sites of online content production, dissemination, and everyday use. This study contributes to the broader literature base underpinning connected learning by providing additional evidence into how youth literacy practices are can be enacted on, behind, and beyond the screen, and subsequently, the ways that teachers, parents, librarians, and other caring adults can support students developing creative literacy practices in a digital age.

References

Aguilera, E., Stewart, O. G., Mawasi, A., & Cortés, L. E. P. (2019). Seeing beyond the screen: A multidimensional framework for understanding digital-age literacies. In P. M. Sullivan, J. L. Lantz, & B. A. Sullivan (Eds.), *Handbook of research on integrating digital technology with literacy pedagogies* (pp. 1–31). Hershey, PA: IGI Global.

Balli, E. (2017, February 9). Library coding clubs prepare kids and teens for growing job market. *Cronkite News.* Retrieved from https://cronkitenews.azpbs.org/2017/02/09/library-coding-clubs-prepare-kids-teens-growing-job-market/

Barab, S. A., & Squire, K. (Eds.) (2016). Design-based research: Clarifying the terms. In S. A. Barab & K. Squire (Eds)., *A special issue of the Journal of the Learning Sciences* (pp. 1–14). New York, NY: Psychology Press.

Bogdan, R. (2012). *Qualitative research for education: An introduction to theories and methods*. New York, NY: Pearson Education.

CodeCombat. (2013). The most engaging way to learn computer science. *CodeCombat*. Retrieved from https://codecombat.com/

dotGears. (2013). *Flappy bird* [Video game]. Hanoi, Vietnam: .GEARS.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 119–161). New York, NY: MacMillan.

Futterman, L. (2015, September 22) Beyond the classroom: A look at both sides of the coding curriculum debate. *Miami Herald*. Retrieved from https://www.miamiherald.com/news/local/community/miami-dade/community-voices/article35749131.html

Fields, D. A., Giang, M., & Kafai, Y. B. (2013). Understanding collaborative practices in the Scratch online community: Patterns of participation among youth designers. In *To see the world and a grain of sand: Learning across levels of space, time, and scale: CSCL 2013 Conference Proceedings* (Vol. 1, pp. 200–207). Madison, Wisconsin.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy.* New York, NY: Palgrave.

Golden, N. A. (2017). Critical digital literacies across scales and beneath the screen. *Educational Media International*, 54(4), 373–387.

Luke, A., & Freebody, P. (1999). A map of possible practices: Further notes on the four resources model. *Practically Primary*, 4(2), 5–8.

Mahiri, J. (2004). *What they don't learn in school: Literacy in the lives of urban youth.* New York, NY: Peter Lang.

Miles, M. B., & Huberman, M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage.

Murray, J. H. (1997). *Hamlet on the holodeck: The future of narrative in cyberspace*. Cambridge, MA: The MIT Press.

Rose, G. (2012). *Visual methodologies: An introduction to researching with visual materials*. Thousand Oaks, CA: Sage.

Rowsell, J., Kress, G., Pahl, K., & Street, B. (2013). The social practice of multimodal reading: A new literacy studies-multimodal perspective on reading. In D. E. Alvermann, N. J. Unrau, & R. B. Ruddell (Eds.),*Theoretical models and processes of reading* (6th ed.; pp. 1182–1207). Newark, DE: International Reading Association.

Saldana, J. (2015). *The coding manual for qualitative researchers*. London, UK: Sage.

Serafini, F. (2012). Reading multimodal texts in the 21st century. *Research in the Schools: A Nationally Refereed Journal Sponsored by the Mid-South Educational Research Association and the University of Alabama*, 19(1), 26–32.

Street, B. V. (2006). Autonomous and ideological models of literacy: Approaches from New Literacy Studies. *Media Anthropology Network*, *17*, 1–15.

The New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review*, 66(1), 60–93.

2. Professional Identity in the Library

A Case Study of Youth Services Professionals in an Urban Public Library System

SHARON COLVIN, PETER WARDRIP, AND THOMAS AKIVA

Abstract: Public libraries have historically been seen as warehouses for resources with library staff to help search. This is reflected in formal library education, which emphasizes organizing and searching skills. However, libraries have evolved to become community spaces that house makerspaces, social groups, music events, and job fairs. Libraries meet the needs of their communities as spaces for socializing, exploring, and learning. Library staff are at the crux of the tension between an old model of quiet individual learning and the new model of social and collaborative learning. This case study attempts to understand how this tension plays out in an urban library system. We interviewed 16 youth services library staff as well as 2 administrative supervisors using a new, meme-based tool for eliciting conversation around these tensions. Library staff feel pressure from the community to provide access to electronic resources while keeping youth quiet and pressure from the library to meet externally defined goals such as workforce readiness and academic proficiency. At the same time, the staff see inherent value in connecting with and building relationships with youth. The resulting tension is associated with feelings of being overwhelmed, overworked, and burned out. Looking forward, it seems that public libraries such as this could benefit from a facilitated learning model that values relationships as part of the collaborative and active learning process. Focusing on relationships as the crux of the work may help alleviate some tensions that staff experience.

Literature Review

American public libraries have been cultural fixtures since Benjamin Franklin opened the first one in 1833 (Brady & Abbott, 2015). Though rarely considered part of the educational system, they have evolved from membership-based, privately funded reading rooms (Brady & Abbott, 2015) to dynamic spaces for lifelong learning (Willett, 2016), advocacy, and social justice (American Library Association, 2017). The combination of steady cultural support and flexible services make public libraries some of the best, most responsive spaces for out-of-school learning.

Public libraries, in general, are moving away from an old model of information gatekeeper to a new model of education, community engagement, and facilitation (Lankes, 2011). This is illustrated by the introduction of library learning centers and makerspaces, which are spaces for hands-on STEM exploration. In turn, the job of librarians, especially youth services librarians, has changed from information organization and retrieval to informal education and facilitation. Interestingly, the American Library Association requirements for formal library education have not evolved as quickly as the services (American Library Association, 2015). Public library staff are neither trained nor recognized as youth workers but they are similar in many ways. Youth services staff face all of the same issues as youth workers: low pay, part-time hours, isolated training, and lack of legitimization (Yohalem & Pittman, 2006). Not only that, but public libraries provide many features of positive development, including psychological safety, structure, supportive adults, opportunities for belonging and skill building, and community engagement (Mahoney, Larson, Eccles, & Lord, 2005). The public libraries of today strive to support all youth in formal and informal programming. Like other youth workers, they create safe spaces for young people to learn, socialize, and connect with each other.

Youth service librarians tend to be trained to be resource providers—they connect youth with information, people, organizations, or other resources. This is especially true in formal Library Science programs. Recently, the vision of

youth librarians has changed: "Libraries used to be grocery stores. Now we need to be kitchens" (Braun, Hartman, Hughes-Hassell, Kumasi, & Yoke, 2014, p. 4). Competencies and trainings have encouraged librarians to learn to use and connect people with tools that they can leverage to pursue their own interests (Braun, Cooke, Lyons, Ryan, & Yoke, 2018). This kind of interest-based programming and connected learning requires getting to know youth and communities very well. However, facilitation and teaching are missing from the expectations and competencies.

State and national agencies regularly publish competencies for youth services library staff. *The Future of Library Services for and With Teens: A Call to Action* outlines a new direction for teen services (Braun et al., 2014). This policy document calls for teen services staff to be facilitators, educators, connectors, and partners. One of the goals is explained as "to change the lives of teens and provide them with a brighter future" (Braun et al., 2014, p. 31). This document very clearly encourages library staff to connect with teens and help facilitate their learning. It is interesting that they describe the historical audience as "teens who are readers and users of the physical school or public library space, especially teens who use the library for homework and leisure reading" (Braun et al., 2014, p. 15), which reflects the view that the library is about "stuff." This description calls to mind an image of a library that provides a quiet space and books, but not much more. In contrast, the vision for the future audience is "teens who view the school or public library as a community space" (Braun et al., 2014, p. 15). This is a very different vision for the space. Community spaces rely heavily on staff to create an open and inviting space. They have tools, but their purpose is more complex than simply providing books and a quiet space to read.

Theoretical Frame

Professional identity is an important part of an employee's identity. Some people may identify strongly with their occupation and/or organization and some may not. Professional identity is affected by social structures, economic opportunities, expectations, relationships, and salience of the work (Skorikov & Vondracek, 2011). If an organization meshes with the other facets of an individual's identity, the organization can provide valuable motivational factors. If, however, the organization clashes with the identity of the employee, this can create stress and lack of loyalty (Haslam & Ellemers, 2011). Identification with the organization can indicate that the employee sees it as a key element of their identity. When people are in a place to make occupational choices, their motivational tendencies can affect the way that they see their work. Those who are intrinsically motivated can see their work as a calling or a career while those who are extrinsically motivated tend to see their work as a set of tasks or as a way to move up in society (Skorikov & Vondracek, 2011). It is likely that libraries attract both types of people. Intrinsically motivated people look beyond the traditionally low library salaries and see their work as a way to help society at large while extrinsically motivated people see their work as a means to a paycheck or to gain skills for future employment.

Youth services are an example of library services that take an open-system perspective (R. W. Scott & Davis, 2007). Similar to those described in Lounsbury and Pollack (2016), the services of libraries have gone from being isolated and unidirectional information centers to spaces for learning and exploration. The environment places pressure on public libraries, especially in the case of young people. Stakeholders include politicians, parents, caretakers, funders, and the teens themselves. Librarians have tried to accommodate this by addressing many aspects of the larger field of Youth Services (W. R. Scott, Deschenes, Hopkins, Newman, & McLaughlin, 2006). Library services have been repackaged to meet the pressures of the larger educational field in an effort to normalize library programming (Lounsbury & Pollack, 2016).

Method

The library system in this case study has 17 branch locations within a medium-sized Rust Belt city in the United States. Using typical case sampling (see Patton, 2014), we engaged 17 youth services staff (eight Teen Services, five Children's Services, and four both) from 14 branches in the library system. All staff were full time except one, but her data were included because she had substantial experience in the position and could speak to the research questions. Ten of the participants held a master's in Library Science degree. Two of the participants had outreach responsibilities that required travel to organizations within the community. The newest member of the staff had been there only one year and the most senior had been working for the library system for 17 years. Most of the participants had been working in the library system between two and six years. In addition, the Teen Services coordinator was interviewed twice to gain organizational insight. All interviews took place between Fall 2017 and Fall 2018. All participant were given a $20 gift card as thanks for their participation.

Each participant was interviewed using a semistructured interview protocol that took approximately 60 minutes. Interview topics included participants' education, training, experience, tenure at the library system, and the types of work they do with youth. Interviews included a meme-based activity, an exercise that required the participant to describe his or her work from the perspectives of various stakeholders. This exercise, modeled after a popular Internet meme, served as an elicitation device for the interview and also produced an artifact to analyze. After seeing an example from another field (teaching), participants were encouraged to draw or write their responses. The activity afforded contrasting perspectives to emerge in the library staff's description of their work as informal educators.

Analysis

For the purposes of this analysis, we focused on five questions from the interview prompts: What does the community think you do? What do library patrons think you do? What do you think you do? What do you actually do? Do you think of yourself as an educator? We analyzed the artifacts produced in the meme exercise in tandem with interviewer notes and interview transcripts. We used Dedoose mixed-methods analysis software to identify emergent codes. Two authors reviewed and agreed on all codes before proceeding to analysis.

The emergent themes in the analysis were: books, resources, quiet, behavior management, relationship with youth, technology support, and fun. These themes were collapsed into two large categories that came up in repeatedly in the interviews: relationships and resources. In addition, staff described the expectation that the library should be silent and the organizational work they needed to do. The following are the major themes that emerged from the data:

- Relationship Based—Working relationships with teens and patrons, mentoring, creating a safe space, youth engagement;
- Silent—Quiet, reads books all day, behavior management, babysitter, obsolete;
- Resource Based—Organizing, finding and recommending books, fixing computers and equipment, using new digital tools, answering questions;
- Organization Based—Management, committee work, paperwork, reports;
- Burnout—Multitask, overwhelmed, doing everything.

Findings

Expectations from the community and patrons seemed to fall squarely into the Silent and Resource-Based themes. Participants felt pressure to be closely tied to resources and to maintain a quiet and on-demand presence. This was a source of frustration when those expectations were also placed on the youth who were using the space. Of the 17 respondents, 9 stated that the community thought that they were silent and 14 stated that the community thought of them as resource based. None of the participants mentioned relationships when describing what the community thought they did.

The library staff expressed strong feelings about the expectations from the community. The overwhelming response was that the library was expected to be quiet, but the reasons for this quiet were varied. Staff explained that the community saw them as "doing book things" but also as "providing access." This theme of providing resources on demand was consistent throughout the interviews. Along with the expectation of resources was the assumption that libraries were disappearing with the advent of the Internet. One of the most interesting themes was that the community expected library staff to keep kids quiet. "They don't want to deal with the kids" but they expect them to be quiet and out of the way. This misunderstanding of youth services and of youth in general was a source of frustration for staff.

Library staff expressed a slightly different expectation from actual library patrons. Staff thought that they were expected to provide resources for everything from books to computer support and digital media assistance. All 17 participants stated that library patrons thought they were resource based. Only two said that they thought library patrons thought of them as engaging in relationship work. One staff member explained that young people saw him as "Walmart! On-demand fun." There was more talk of connection and relationships in reference to people who used the library. One respondent explained that library patrons saw him as a "cross between a postal carrier and a bartender." He listened to patrons' stories, heard their complaints, and delivered resources. While relationships were not placed at the center of these expectations, they were more present than with those in the general community.

In contrast, responses to "What I think I do" reflected more relationship-based work. Thirteen of the participants thought that they engaged in relationship-based work. Ten participants said that they did resource-based work. Staff see themselves as mentors and as facilitators of active, engaged learning and collaboration as well as resource brokers. Library staff consistently described their jobs in terms of relationships and learning. One staff member described her job as being a "quiet catalyst. And when the teens open up, it's like they tell you all kinds of things about their lives. And then some of those relationships, they just know that somebody cares." One staff member's view of his job was as amplifying youth voice. Another participant wanted to support teens and change the world in the process. Staff really focused on connecting with and learning about the youth in the community. There was some mention of resources, but they were mainly couched in the desire to enhance the experience of youth rather than a one-way transfer of knowledge.

The question about "What I actually do" yielded mixed responses. Fourteen of the respondents described their work as research based and only five described their work as relationship based. Many of the staff stated that they did everything, multitasked, balanced priorities, and five of them were coded as burned out. One staff member explained that she was "running everywhere all the time; putting out fires." The emotion attached to their responses reflected a sense of being completely overwhelmed.

Interviewees' responses to whether or not they identified as educators were mixed. Thirteen responded affirmatively, but several struggled with the semantics. Eight of the participants qualified their responses. One staff member explained that she felt "more social worker than educator, but definitely educator. … I would say the social worker part of you is like working on the more base needs whereas an educator is the next step up." Staff struggled with the idea that relationships and education could coexist in their position.

In order to better understand the context of this library system, we interviewed the Teen Services coordinator, who, along with the Children's Service coordinator, provides onboard training and mentorship to youth services staff in all 18 branches. She described the strategic plan that has been in place for the last five years. The emphasis is on "interest-based learning," which involves encouraging young people to pursue interests and to acquire skills and knowledge to reach mastery, feel independent, and gain career skills. Under this plan, the library is to be a space for informal learning for anyone at any time. The plan emphasizes cultivation of interests through introduction of tools and resources such as sewing machines, 3D printers, robotics, and cameras. These activities are not necessarily directly tied to programs but are instead available at any time for use and skill improvement through a formal badge system. Staff award badges for mastery and often give additional privileges such as unsupervised tool use and the ability to take equipment home. There is an emphasis on youth services staff being mentors to youth, but this mentorship seems very much tied to interest and skill development. The emphasis is less on social-emotional skills and more on "practical" skill acquisition. The professional development available to youth services staff revolves around skill building. This institutional view is a mix of both the individualistic and facilitated models of learning.

Discussion

This paper is a case study of one urban library system. It is clear that the staff are interested in connecting with the youth in their communities, but it is unclear how the library system supports such work. What is clear is that there is a tension between expectations and the actual work done in the library.

Outside stakeholders, as represented by the community, seem to disregard the work in the library and to expect an old-fashioned quiet space full of books. This is in stark contrast with the multitasking and burnout of the actual work done in the library. In the context of professional identity theory (Brown, 2015), there seems to be a friction between expectations, workload, and identity that is causing tension and burnout.

The tool used in this study contrasted several perspectives/stakeholders' idea of library work. The community is the furthest from the actual work so it follows that its perspective would be the most old fashioned and obsolete. Library staff feel that they are disregarded and even disrespected by this group. Unfortunately, the community is a stakeholder in a public library and can put pressure and expectations on the work done. Library patrons, those who use the library, are somewhat closer to the library work but the staff still felt that they saw their work as incomplete. Respondents described patrons as seeing their work as book and resource based. Thus, the public is not seeing the actual complex work of the library. Again, patrons are stakeholders and can put enormous pressure on the work that is done in their community.

The question about "What do you think you do" seems to be the most idealistic of all the prompts. It may or may not be as realistic as "What the library patrons think I do." Interestingly, this prompt yielded the most discussion of relationships, connecting with youth, and creating safe spaces, which is exactly what library policy documents are supporting (Braun et al., 2014).

The "What do you actually do" prompt seemed to reflect that staff are juggling the expectations of stakeholders and their own wishes for their job. This friction may be leading to the burnout that is reflected in their responses. Those staff members whose identities are closely tied to their work may be experiencing discord because their actual work is quite different from their idealized job. It seems that even when staff are not multitasking, they are sacrificing the ideal part of their job in favor of resource brokering and organizational work.

Interestingly, many of the participants thought of themselves as educators, at least in part. Many of them qualified their educator identities with their lack of formal education and curriculum experience. This may be a reflection of the

tension between traditional book-based education and the more informal relationship-based work that is reflected in our findings.

When we put together our findings with the interview with the Teen Services coordinator, the tension becomes even clearer. The library system is very focused on tools and on learning to use new technology. While there is a new interest in training staff to be mentors, those trainings seem to fall to the side when there are resources to learn about, tools to master, and procedures to follow.

Conclusion

Library staff, especially those who work with youth, are facing a strong shift in expectations and pressures in their work. Library work is traditionally resource based and the social expectations reflect an old-fashioned view of a book-based library. Unfortunately, there seems to be an assumption that libraries have not kept up with technology and are therefore obsolete. This pressure to meet resource needs of the community flies in the face of staff job expectations as well as the policy recommendations put forth by professional organizations.

The resource- and relationship-based work that library staff describe is very similar to that which is done in afterschool programs. There is tremendous pressure to prepare youth for the workforce, to please local and state government expectations, and to appease grantors interested in educational initiatives such as literacy and STEM. These educational goals create an environment focused on goals and outcomes and pulls attention away from relationships and toward the resources available in the library. As part of the field of informal educators, library staff feel pressures to be everything to everyone. Unfortunately, like afterschool workers, they are trained neither to facilitate learning nor to balance the expectations of disparate stakeholders.

In order to ease the tension demonstrated in this case study, we recommend stronger training programs to help library staff learn to facilitate learning and incorporate relationship building into their educational outcomes. This relationship-based work will enhance the experience for the youth and help them learn and grow (Li & Julian, 2012). Focusing on relationships could help staff align their work with their expectations and feel more at ease with their work.

This study is reflective of only one well-resourced library system. It is concerning, though, because less well-resourced systems may struggle even more with less training and fewer staff. Local training and support may not be enough to help staff evolve along with library services. State and national organizations may need to step in.

References

American Library Association. (2015). *Standards for accreditation of master's programs in Library and Information Studies.* Retrieved from http://www.ala.org/accreditedprograms/sites/ala.org.accreditedprograms/files/content/standards/Standards_2015_adopted_02-02-15.pdf

American Library Association. (2017). *American Library Association: About* ALA. Retrieved from http://www.ala.org/aboutala/

Brady, H., & Abbott, F. (2015). A *history of U.S. public libraries.* Retrieved from https://dp.la/exhibitions/exhibits/show/history-us-public-libraries

Braun, L. W., Cooke, N. A., Lyons, D., Ryan, S., & Yoke, B. (2018). *Transforming library services for and with teens through continuing education*. Retrieved from http://www.ala.org/yalsa/national-forum-transforming-teen-services-through-continuing-education

Braun, L. W., Hartman, M. L., Hughes-Hassell, S., Kumasi, K., & Yoke, B. (2014). *The future of library services for and with teens: A call to action*. Retrieved from http://www.ala.org/yaforum/sites/ala.org.yaforum/files/content/YALSA_nationalforum_Final_web_0.pdf

Brown, A. D. (2015). Identities and identity work in organizations. *International Journal of Management Reviews*, *17*(1), 20–40. https://doi.org/10.1111/ijmr.12035

Haslam, S. A., & Ellemers, N. (2011). Identity processes in organizations. In S. J. Schwartz, K. Luyckx, & V. L. Vignoles (Eds.), *Handbook of identity theory and research* (pp. 715–744). New York, NY: Springer.

Lankes, R. D. (2011). *The atlas of new librarianship*. Cambridge, MA: The MIT Press.

Li, J., & Julian, M. M. (2012). Developmental relationships as the active ingredient: A unifying working hypothesis of "what works" across intervention settings. *American Journal of Orthopsychiatry*, *82*(2), 157–166. https://doi.org/10.1111/j.1939-0025.2012.01151.x

Lounsbury, M., & Pollack, S. (2016). Institutionalizing civic engagement : Shifting logics and the cultural repackaging of service-learning in US higher education. *Organization*, *8*(2), 319–339. https://doi.org/10.1177/1350508401082016

Mahoney, J. L., Larson, R. W., Eccles, J. S., & Lord, H. (2005). Organized activities as development contexts for children and adolescents. In J. L. Mahoney, R. W. Larson, J. S. Eccles, & H. Lord (Eds.), *Organized activities as contexts of development: Extracurricular activities, after-school and community programs* (pp. 3–22). Retrieved from http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2005-01368-001&site=ehost-live&scope=site

Patton, M. Q. (2014). *Qualitative evaluation and research methods: Integrating theory and practice*. Thousand Oaks, CA: Sage.

Scott, R. W., & Davis, G. F. (2007). *Organizations and organizing: Rational, natural, and open system perspectives*. Upper Saddle River, NJ: Pearson Education.

Scott, W. R., Deschenes, S., Hopkins, K., Newman, A., & McLaughlin, M. (2006). Advocacy organizations and the field of youth services: Ongoing efforts to restructure a field. *Nonprofit and Voluntary Sector Quarterly*, *35*(4), 691–714. https://doi.org/10.1177/0899764006289772

Skorikov, V. B., & Vondracek, F. W. (2011). Occupational identity. In S. J. Schwartz, K. Luyckx, & V. L. Vignoles (Eds.), *Handbook of identity theory and research* (pp. 693–714). New York, NY: Springer. https://doi.org/10.1007/978-1-4419-7988-9

Willett, R. (2016). Making, makers, and makerspaces: A discourse analysis of professional journal articles and blog posts about makerspaces in public libraries. *The Library Quarterly*, *86*(3), 313–329. https://doi.org/10.1086/686676

Yohalem, N., & Pittman, K. (2006). *Putting youth work on the map: Key findings and implications from two major workforce studies*. Retrieved from http://dev.forumfyi.org/files/YouthWorkOnTheMap.pdf

3. Election Lab

A Computer Board Game Where STEM Meets Civics

STUART CRILEY AND JASMINKA CRILEY

Abstract: *Election Lab* combines math and civics in a game-based learning platform for middle and high school students. It opens the eyes of learners to the hidden but strategic role of STEM professionals in increasingly data-driven presidential campaigns. The games present learners with 1 of several actual election scenarios from recent history—from landslides to very tight races. The game design is a hybrid of a board game and computer, leveraging advantages of both formats. The physical board game uses large, high-resolution electoral maps and manipulatives; provides a hands-on experience; and increases accessibility for English language learners and others who may not benefit from traditional presentations of math concepts. The accompanying computer speeds up play with an interactive display that updates after each state battle; automatically calculates the electoral vote totals for each candidate; and most important, captures gameplay data for later statistical analysis and discussion. The result is a novel informal learning program that uses math to understand strategies used in elections, and that uses data generated from gameplay to allow learners to think like statisticians. Elections come alive when they are played, driving history learning. Finally, experiencing an election from the point of view of a campaign strategist and understanding the convoluted mechanics of the Electoral College firsthand will engage future voters, especially for populations that have historically low voter participation.

Introduction

Participatory democracy depends upon an informed, engaged, and scientifically literate electorate. This cross-disciplinary learning game uses STEM to explore a civic issue of great importance: how we choose the next president. Unfortunately, many Americans understand this process poorly, and civic engagement remains a challenge.

The Electoral College

Our system of selecting the president of the United States is second only to choosing the next Dalai Lama for its oddity ("Reincarnation," The Dalai Lama, 2019). The international press is justifiably baffled (*Japan Times* [Drew], 2016; *Le Monde*, 2016; *Süddeutsche Zeitung*, 2016; *The Economist*, 2012;). But our familiarity with the system has robbed it of its strangeness: When it is explained to students, much of the instruction time is spent simply explaining the mechanics (Herczog, Kidwell, & Croddy, 2011). Yet every four years, despite the best efforts at civic education, the search term "Electoral College" spikes each day after Election Day (Figure 1).

Keeping up with current events is not always helpful, either. Increased fragmentation of news sources has offered more choice when consuming news while increasing the hazard of being less informed (Cassino & Woolley, 2012)—at the same time boosting a false sense of confidence in being well informed (NORC, 2016). In an election year, journalists often report from so-called "swing states" without explaining why these states are different, or why they are important. Political pundits are even worse: Their predictions turn out to be no better than chance (Silver, 2012).

The reason the Electoral College is both uninteresting and difficult to understand, the authors believe, is that it takes mathematics to understand the insights. But mathematics is most often taught in another classroom, and the mathematics that is taught there has been (until very recently) largely devoted to computation—not mathematical thinking. The good news is that these circumstances are changing for the better. Data literacy has been identified as a critical skill for 21st-century workers, and data literacy has been endorsed by the American Library Association (2013) as well as the National Council for the Social Studies (NCSS; 2018). But the challenge is implementation: Social studies and history teachers are not typically required to take mathematics beyond their freshman year (CSULB, 2019; Columbia University Teachers College, 2019), and data literacy is a relatively new course in graduate education programs for teacher certification (GVSU, 2019).

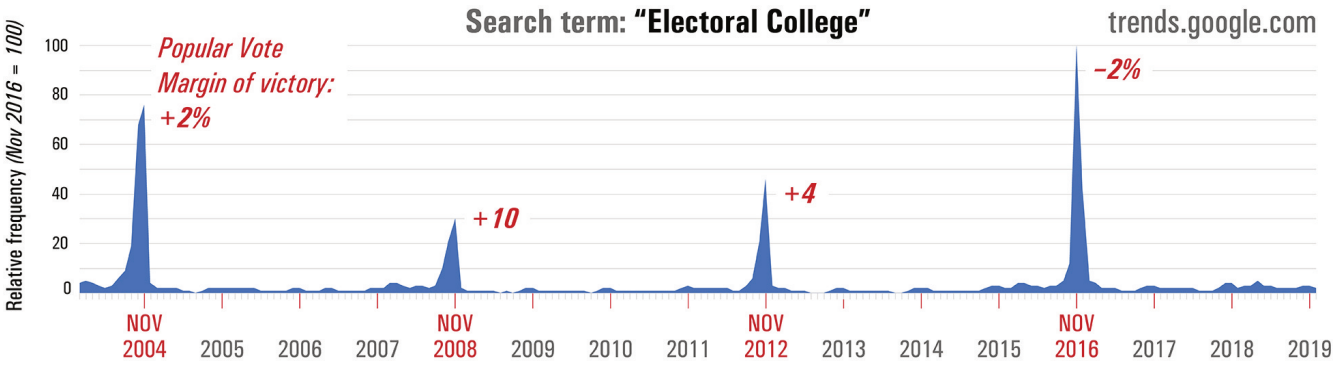

Figure 1. Americans still struggle to understand the Electoral College. Results from Google Trends for the search term "Electoral College" are plotted from 2004 to 2019. Notice the periodicity that peaks in November every election year. The height of the peak is inversely proportional to the margin of victory by popular vote: The closer the margin, the greater the number of searches.

American Achievement Gap in Mathematics

Global economic competition has placed even greater pressure on our education system, but American student performance on the National Assessment of Educational Progress for eighth-grade math has not improved since 2007 (NAEP, 2017). When compared to other nations, the United States has consistently ranked below the OECD mean in math (PISA, 2018). Student understanding of math concepts, especially where and how to apply them appropriately to novel situations, has been particularly difficult to teach. As more data migrate online, both in quality and in volume, data literacy has become an increasingly crucial skill in science, industry, and government.

Mock Elections: An Imperfect Means to Improve Civic Engagement and Voter Participation

In election years, public schools across the country conduct mock elections during classroom time, with students voting for the candidates on a mock ballot, in an effort to instill in them the virtues of participatory democracy (nationalmockelection.org, 2014). While the goal is laudable, in reality students often go through the motions of voting without developing a firm understanding of our electoral process.

Methods

Election Lab was developed as a cross-disciplinary learning-game platform that combines STEM and civics: It uses math to elucidate a complex yet very important electoral process, the election of our president. It addresses an educational need for more mathematical rigor and data literacy in social science teaching for K-12 (Cobb & Moore, 1997; Steen, 1999; Vahey et al., 2010).

To improve future voter engagement, *Election Lab* flips the traditional perspective from *voter* to *campaigner*, allowing players to see the electoral map as the campaigns see it. They are given an authentic role to play (D. A. Kolb, 2014; Y. A. Kolb & D. A. Kolb, 2009; Shaffer, 2005): Create and implement a strategy that places their limited campaign resources on enough states to win the presidency. Moreover, this strategy is tested, head-to-head, against a competing campaign. To ensure that this learning game can fit within a classroom period, playing time was designed to last 25 minutes. As a computer hybrid game, *Election Lab* removes the biggest source of friction for traditional strategy board games: cumbersome setup, complicated mechanics, and tedious bookkeeping.

The Setting

With just a few weeks before the presidential election, players take on the role of campaign strategists. Most states are already firmly in one camp or the other, leaving a handful of states still in play: *the swing states*. Players must win enough of these swing states and their electoral votes for victory in the election.

The Physical Game Board

Eight election years were chosen, to provide a range of electoral scenarios, from closely contested to landslide (1860, 1876, 1960, 1988, 2000, 2012, 2016, and 2020). For each election year, the electoral map reflects the actual polling numbers for each state (Figure 2). Red states are firmly Republican, blue states are firmly Democratic; in contrast, white states can be won by either side. Where robust polling data was not available, the final election results were used: States won by >5% by either side are colored for that campaign. State results that were close (within ~5%) are colored white. Players must decide how to deploy their *limited campaign resources*, *represented by game pieces*, to win the states still in play.

Figure 2. The game board setup with partition (left) and ready to play (right).

Furthermore, these deployments are done in secret, hidden from the other campaign by a removable partition. Once both campaigns are finished with their setup, the partition is removed, and the campaigns battle, state by state, to determine the winner. The game pieces themselves translate into the number of dice each team can roll. More pieces mean more chances at winning, but having more dice to roll than the other team does not guarantee victory. *Dice represent imperfect polling in any election* and the difference between projected and actual votes.

Companion Computer to Display the Interactive Map

Players share a Chromebook or other device that is open to a map that tallies the electoral votes after each state is won. This web-based map also serves an important external check to keep track of which states still need to be played, because pilot testing has shown that teams occasionally forget to remove pieces from a state after it is won or lost. As groups use the web-based map, the results are recorded to a group file that the instructors can display. These group data are a starting point for the discussion that follows.

Results

From 2016 to 2018, *Election Lab* has been played by students (N = 517), teachers (N = 62), administrators (N = 21), and parents (N = 40). Feedback has been overwhelmingly positive: students rated the game highly; social studies teachers liked the ability of the game to bring history alive; math teachers liked using the gameplay data, bringing statistics and probability alive. Administrators recognized the civic value of engaging future voters. And parents who played the game with their children at home found a way to connect with them around math and civics, learning about both in the process.

Pilot testing with 25 middle school students in 2016 revealed the length of the game was: *too short* (8%), *too long* (20%), and *just right* (72%); 88% would play the game again. Early feedback from players was crucial in developing a fast-paced game that was easy to play but hard to master. Rules were adjusted to account for edge cases. A second round of testing with a larger group of eighth-grade students (n = 208) dramatically improved ratings for how much fun players had: 43% rated the game *very good* or *excellent* in pilot testing, while 82% rated the game *very good* or *excellent* in the second round.

Gameplay Data

When students play the election games, they generate two kinds of data that are available for group analysis and discussion:

1. The initial positions staked out by each campaign;
2. The final results for each swing state.

The initial positions reveal the strategic choices made by the teams. Players must distribute their resources (24 pieces) from 10 to 20 swing states, depending on the election year. The states themselves are worth electoral votes ranging from 3 to 47. A first-order optimal strategy would be to allocate more game pieces on the more valuable states. Indeed, this is what most teams do:

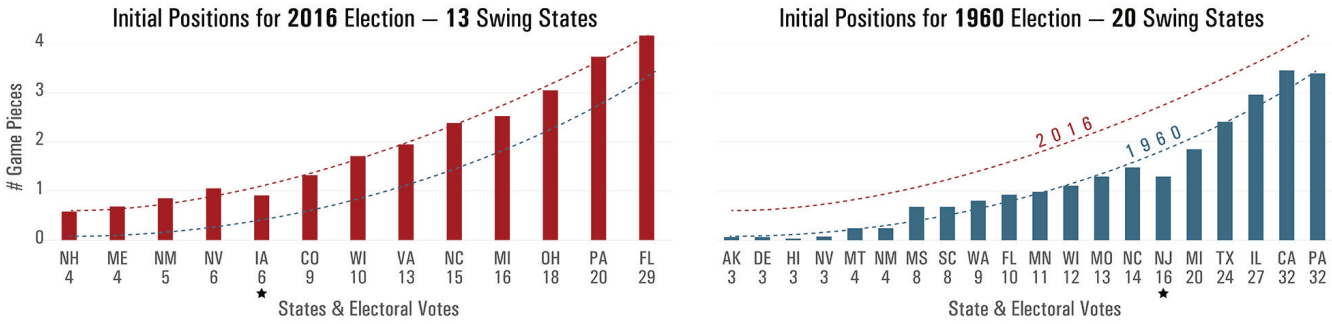

Figure 3. Data of initial positions for 2016 and 1960.

Players tend to place more pieces on more valuable states (see Figure 3). But differences in the strategies between 2016 (13 swing states) and 1960 (20 swing states) emerge upon closer inspection. Because the same number of game pieces are distributed across more swing states in 1960, students must spread their resources more thinly. Most players for the 1960 election abandoned several states, while only half the players did so for 2016. Iowa (IA) and New Jersey (NJ) are marked with a star because players placed fewer resources than one would expect based on the trend.

In 2016, Nevada (NV) has just as many electoral votes as Iowa, but it received more game pieces, probably because it is larger (and more easily seen on the map). Likewise, in 1960, New Jersey is underrepresented with game pieces, probably because this small but valuable state is easy to overlook.

More sophisticated strategies begin to evolve as students gain experience against more opponents and in different election years. Indeed, these results led to creation of the exercises shown in Figure 5: A gradually weighted strategy can be beaten by a more aggressively weighted strategy. History provides some evidence that this evolved strategy was successfully used: In 1960, Nixon visited all 50 states during the campaign, while Kennedy focused on important swing states. And in 2016, Trump visited states in the Rust Belt he needed for victory, while Clinton, confident that the "blue wall" would hold, spent precious time visiting states that were only marginally in play.

Statistics Analysis

Students struggle to master statistics, in part because they do not have a personal connection with the data (Konold & Higgins 2003), or because they struggle to place individual results in context. Language barriers create additional challenges when statistical scenarios are commonly presented as word problems. In stark contrast, *Election Lab*, by virtue of its computer-board game hybrid design, uses gameplay data as raw material for a mini-statistics lab.

Data display/dot plots/histograms. Students make the transition from the game board to data in several small steps (see Figure 4). The pieces themselves are round and amenable to representation as dot plots. Transitioning to a histogram is a natural progression, because the game interface encourages them to think in these terms:

1. The physical game is shown with red pieces placed on the 1876 map.
2. Then the on-screen representation of the game is shown, with the red pieces.
3. Users can set the number of pieces with a User Interface that has (+) and (−) buttons for each state. The number of pieces that are placed is depicted as a series of red dots, also known as a dot plot. It is a building block for further ways of displaying and analyzing data.

4. Removing the dots, and we have a bar chart of the values, also known as a histogram.

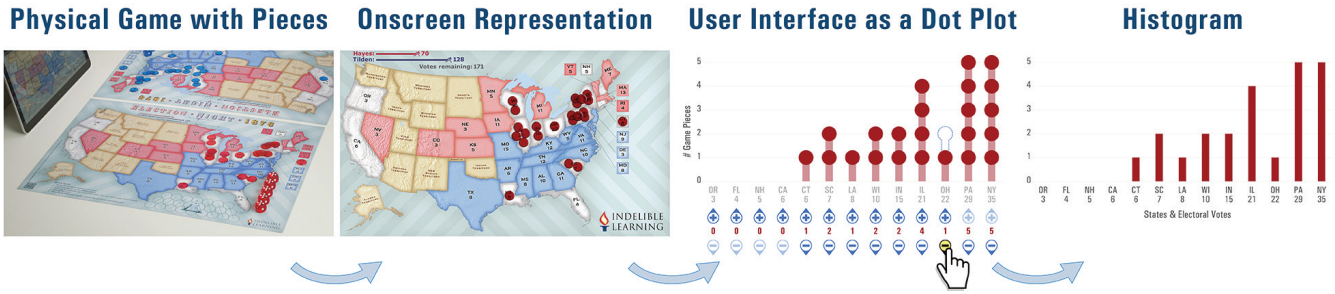

Figure 4. Migrating students from physical placement of pieces on a map to data plots.

Once at the histogram level, players start seeing the game from this dashboard indicator. They can compare other games from other players. Each is a plot of opening strategies, as shown in Figure 5.

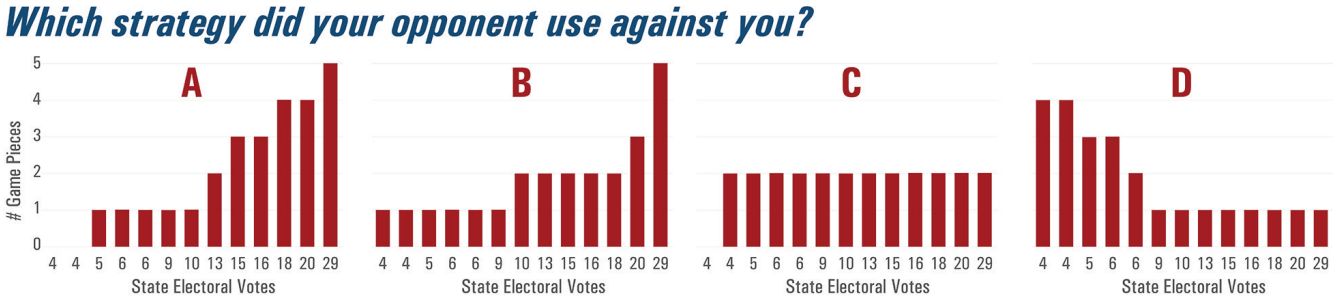

Figure 5. A sample of the postgame analysis.

Players who are accustomed to seeing the initial positions displayed as a histogram can then learn to recognize patterns of the different strategies. In Figure 5, states are plotted from least to greatest electoral votes. Strategy *A* is heavily weighted toward the high-value states and is forced to abandon the two low-value states. *B* is also weighted, but it ensures every state has at least one piece. *C* is a flat strategy. *D* is a nonsensical strategy that wastes resources on low-value states.

Each game played is a discrete event felt palpably by the students who participated in it. A losing strategy may have been ineffective because the opponent was better at deploying resources. Or it may have been due to bad luck. Knowing which explanation is more likely requires understanding *expected value*, shown in Figure 6.

Figure 6. Using game strategies and simulated games to explore expected value.

In this exercise, students are given the opportunity to peek at the opponent's strategy (in this case, Blue's strategy, played by the computer). They are challenged with setting a strategy that would be expected to beat it. Then the computer runs 1 million simulated games and tallies the results. This example is from the 2016 election, in which Blue has placed most of his pieces on the three biggest swing states, Ohio, Pennsylvania, and Florida. The player can beat this strategy by placing individual pieces on the states abandoned by Blue, and abandoning Ohio. The expected value for Red's strategy is 89.97, exceeding the 79 electoral votes needed to win.

Civics Analysis

By playing the game, students gain first-hand experience of the strategic challenges that the historical campaigns faced. Since the game works within the rules of the Electoral College, it closely reflects the mechanism by which campaigns win.

- Players for Governor Romney in 2012 quickly realize how important Florida and Ohio were to his campaign.
- After playing the election of 1860, players can easily determine whether Southern and Northern Democrats could have beaten Lincoln had they united under a single nominee.
- In 1960, the electoral map was unusually broad: 20 swing states were in play. Despite Nixon's built-in advantage at the start of the game, Kennedy still has many paths to victory. In the actual election, Kennedy deployed a shrewd swing-state strategy that was superior to Nixon's.

This first-hand experience is an essential tool of engagement. Students are genuinely curious about the candidates and the actual outcomes once they have played these roles themselves.

- From the game map, they know which states were up for grabs.
- When shown the resulting electoral map from the actual election, they immediately make comparisons to the final state of the map for their game.
- By seeing the electoral map at the start of the game, and playing to win, they know which states were important.

Playing the games creates a sense of surprise. As the results from all the games played in the class are compared, they get a sense of how likely or unlikely the historical outcome was.

- In 1876, 1960, 2000, and 2016, the historical outcomes were unexpected.
- And in the game, Tilden, Nixon, Gore, and Clinton start with varying leads over their opponents, with slight to great probabilities of winning.
- All four candidates lost in the actual elections.

Discussion of *which* states were won by successful campaigns easily turns to *how*.

- Which messages resonated with Southern voters in 1960?
- How could Kennedy diffuse Nixon's obvious advantage in foreign policy experience? Did Dukakis have the same challenge with Bush in 1988?
- In 1860, how circumspect did Lincoln need to be about abolishing slavery during his campaign?
- Would it have mattered for the election, or was he thinking ahead about holding the fracturing nation together?

Discussion

This project applies statistics and probability content standards to develop a cross-disciplinary, data-driven course on civics. The program uses game-based learning to provide immersive simulations of actual election scenarios and invites students to build conceptual models of these elections, and then to test them against other teams in head-to-head contests (just as in real elections). By using statistics, probability, and mathematical practices in a game-based learning environment, students can engage in constructive struggle to master these skills in an environment that rewards persistence and is forgiving of failure. Games also allow wider access to students who do not consider themselves good at math, or who may struggle with language or text presentations of math problems. Data generated from the games themselves allow quick and easy comparisons of many trials, visually displayed, and are amenable to statistical analysis and group discussion. Moreover, students are genuinely curious about an election year they have just played, providing the perfect setting for a social sciences teacher to provide historical context. Overall, it is a positive, powerful first experience with elections for future voters.

References

American Library Association. (2013, June 18). ALA Task Force releases digital literacy recommendations. *ALANews.* Retrieved from http://www.ala.org/news/press-releases/2013/06/ala-task-force-releases-digital-literacy-recommendations

Cassino, D., & Woolley, P. (2012). What you know depends on what you watch: Current events knowledge across popular news sources. *Public Mind Poll.* Teaneck, NJ: Fairleigh Dickinson University. Retrieved from http://publicmind.fdu.edu/2012/confirmed/final.pdf

Cobb, G., & Moore, D. (1997). Mathematics, statistics, and teaching. *American Mathematical Monthly*, 104, 801–823.

Columbia University Teachers College. (2019). *Application requirements.* Retrieved from https://www.tc.columbia.edu/arts-and-humanities/social-studies-education/

CSULB (California State University, Long Beach). (2019). *Basic skills requirement.* Retrieved from https://edit.csulb.edu/college-of-education/teacher-preparation-advising-center-tpac/basic-skills-requirement.

Drew, E. (2016, August 29). Understanding America's Electoral College. *Japan Times*. Retrieved from https://www.japantimes.co.jp/opinion/2016/08/09/commentary/world-commentary/understanding-americas-electoral-college/

GVSU (Grand Valley State University). (2019). SST 311—Data literacy for social studies teachers. *Grand Valley State University 2019–2020 undergraduate and graduate catalog.* Retrieved from https://www.gvsu.edu/catalog/course/sst-311.htm

Herczog, M. M., Kidwell, F. L., & Croddy, M. (2011). *Preparing students for college, career, and citizenship: A California guide to align civic education and the common core state standards for English language arts and literacy in history/social studies, science and technical subjects.* Los Angeles, CA: Los Angeles County Office of Education.

Kolb, D. A. (2104). *Experiential learning: Experience as the source of learning and development* (2nd ed.). Upper Saddle River, NJ: Pearson Education.

Kolb, Y. A., & Kolb, D. A. (2009). The learning way: Meta-cognitive aspects of experiential learning. *Simulation & Gaming*, 40(3), 297–327. https://doi.org/10.1177/1046878108325713

Konold, C., & Higgins, T. L. (2003). Reasoning about data. In J. Kilpatrick, W. G. Martin, & D. Schifter (Eds.), *A research companion to principles and standards for school mathematics* (pp. 193–215). Reston, VA: National Council of Teachers of Mathematics.

Le Monde. (2016, November 1). The electors in the United States, how does it work? [French]. Retrieved from https://www.lemonde.fr/les-decodeurs/article/2016/11/01/elections-americaines-les-grands-electeurs-comment-ca-marche_5023509_4355770.html

NAEP (National Assessment of Educational Progress). (2017). Mathematics report card, 8th grade. Retrieved from https://www.nationsreportcard.gov/math_2017/nation/achievement?grade=8

National Council for the Social Studies (NCSS). (2018). *Programs and projects endorsed by NCSS*. Retrieved from https://www.socialstudies.org/about/endorsements/endorsed_programs

nationalmockelection.org. (2014). *How to do it: A guide to the National Student/Parent Mock Election*. Retrieved from http://nationalmockelection.org/wp-content/uploads/2014/09/howtodoit.pdf

NORC. (2016). *How Americans navigate the modern information environment: A study commemorating the 75th anniversary of NORC at the University of Chicago*. Retrieved from http://www.norc.org/PDFs/75th%20Anniversary%20Research%20Project.pdf

PISA (Programme for International Student Assessment). (2018). *OECD, PISA 2018 database, Tables I. B1.10, I. B1.11 and I. B1.12*. Retrieved from http://www.oecd.org/pisa/data/2018database/

Shaffer, D. W. (2005). Epistemic games. *Innovate: Journal of Online Education* 1(6), Article 2. Retrieved from https://nsuworks.nova.edu/innovate/vol1/iss6/2

Silver, N. (2012). *The signal and the noise*. New York, NY: Penguin.

Steen, L. A. (1999) Numeracy: The new literacy for a data-drenched society. *Educational Leadership*, 57(2) 8–13.

Süddeutsche Zeitung. (2016). Trump's last hurdle–7 facts about the "electoral college" [German]. Retrieved from https://www.sueddeutsche.de/politik/us-wahl-7-fakten-ueber-das-electoral-college-1.3298075

The Dalai Lama. (2019). *Biography and daily life: Reincarnation*. Retrieved from https://www.dalailama.com/the-dalai-lama/biography-and-daily-life/reincarnation

The Economist. (2012, May 9). How America really chooses its president. Retrieved from http://www.economist.com/blogs/graphicdetail/2012/05/daily-chart-5

Vahey, P., Rafanan, K., Swan, K., van 't Hooft, M. A., Kratcoski, A., Stanford, T., & Patton, C. (2010). *Thinking with data: A cross-disciplinary approach to teaching data literacy and proportionality*. Paper presented at the Annual Conference of the American Educational Research Association. doi:10.1007/s10649-012-9392-z

4. Using Connected Learning Design Principles to Further Co-Create a Critical Speech Therapy Game

JARED DUVAL, ELENA MÁRQUEZ SEGURA, ELIZABETH GOLDMAN, SU-HUA WANG, AND SRI KURNIAWAN

Abstract: Therapy can be costly, time consuming, repetitive, and difficult. Games have the power to teach transferable skills, can turn repetitive tasks into engaging mechanics, have been proven to be effective at delivering various forms of therapy, and can be deployed at large scales. Therapy games represent fertile ground for connected learning. In this work, we collaborate with 7 children with corrected cleft palate aged 2–10 and their parents during their yearly visit to UC Davis Medical center to co-create and evaluate *SpokeIt*, a speech therapy game. Each of these children comes from low socioeconomic statuses with limited access to speech therapy and would benefit from the amplified opportunities of new media in connected learning. Throughout the study, we ran multiple cascading participatory design sessions using design principles of connected learning, which culminated in the design of 2 new medium-fidelity prototypes presented in this paper.

Introduction

In 2012, nearly 8% of children aged 3–17 in the United States had a communication disorder, and younger children, boys, and non-Hispanic white children were more likely than other children to receive an intervention service for their disorder (National Center for Health Statistics, 2015). Correcting speech is an important issue because children with speech impairments have high risks of behavioral problems and increased symptoms of depression (Hunt, Burden, Hepper, Stevenson, & Johnston, 2007). They show more deficits in social and academic competencies, score higher for social problems (Feragen, Kvalem, Rumsey, & Borge, 2010), and are more likely to be teased in social settings (Hunt et al., 2007). These are serious consequences for a skill that can be improved (Aten, Caligiuri, & Holland, 1982; Johnson & Pring, 1990; Robertson & Thomson, 1984). Even those who undergo corrective surgery tend to display a delay in scholarship, have a lower income, marry later in life, and become independent from their parents significantly later (Sousa, Devare, & Ghanshani, 2009). After surgery, practice and support are the keys to improving speech (Cicerone et al., 2005). While speech-language pathologists (SLPs) employ many engaging games (Mashima & Doarn, 2008), progress in speech is often slow or lost at home because speech practice at home is usually hindered by a lack of intrinsic motivation that is due to the tedious and repetitive idiosyncratic nature of traditional speech therapy curriculums (Aten et al., 1982). Parents also experience significant difficulties in prompting their children to complete speech exercises at home, especially if they are very young (Miesenberger, Klaus, Zagler, & Karshmer, 2010).

Speech therapy games could help children practice at home and expedite their recovery (Rubin, 2017). Games have the potential to turn repetition, such as repeating words in speech therapy, into an element that is recognized as useful for progress in the game (Kaufman, 2010). Literature has shown that games are an effective educational intervention and medium to convey and support feelings of self-efficacy because of the immersive and pervasive virtual environment and that they have been shown to work effectively as educational interventions (Gee, 2005). Games have demonstrated the ability to teach while providing a motivating and interactive environment (Virvou, Katsionis, & Manos, 2005), are effective with children (Rosas et al., 2003), and can be as effective as face-to-face instruction (Randel, Morris, Wetzel, & Whitehill, 1992). A variety of serious games for health have been documented to be useful for their target populations, and they are wide ranging in their platforms, health outcomes, and target populations, from an exergame to help blind children with balance (Morelli, Lieberman, Foley, & Folmer, 2014) to embodied persuasive games for adults in

wheelchairs (Gerling, Hicks, Kalyn, Evans, & Linehan, 2016) to mobile games for motivating tobacco-free life in early adolescence (Parisod et al., 2017).

Background

*SpokeIt i*s a speech therapy game equipped with a critical speech-recognition system capable of "hearing" many common speech errors. SpokeIt contains numerous minigames that target specific types of speech therapy, such as rhythm and articulation, that fit within an overarching narrative. *SpokeIt*'s narrative, mechanics, and characters were iteratively co-designed and presented in our previous works (J. Duval, 2017; J. S. Duval, Márquez Segura, & Kurniawan, 2018).

Method

We visited our collaborators at UC Davis Medical Center, where children with corrected cleft are assessed by different medical experts, including speech pathologists, behavioral therapists, plastic surgeons, sleep therapists, dentists, and so forth. We were invited to take part in a "clinical day," in which patients are assigned to a room while a variety of doctors rotate in and out to see each patient. Per request of the speech language pathologist and to minimize interference with the doctors' rotations, we designed co-creation sessions that lasted 10 minutes and which would be conducted during "gaps" when no medical professionals were present in the patient's assigned room. Seven children participated in our study; their ages ranged from 2 years, 7 months to 10 years, 9 months (M = 6 years, 1 month, SD = 3 years, 6 months). They were accompanied by their parent(s), who observed them play and were also interviewed. We also interviewed two speech language pathologists. In all, we collected data on seven children, seven parents, and two speech language pathologists.

Connected Learning Design Principles for Meaningful Co-Creation

Figure 1. Design probes used for cascading participatory design sessions.

Everything Is Interconnected

In order to come up with play scenarios, children were provided with tangible co-design probes, toys, and props (see Figure 1). The tangible representations of our characters connected the play session to the *SpokeIt* universe. The animal flash cards and word flash cards were chosen because they are rated as developmentally appropriate words for ages 3 and higher. The letter and number magnets were useful random character or number generators. The stickers were a gift to the children for participating. At the beginning of the session, we played *SpokeIt*'s cinematic on a laptop to remind participants of the story and to help them connect the virtual and tangible characters. Next, children were presented with the rest of the tangible co-design probes to create and play game scenarios. Between sessions, we created medium-fidelity prototypes of these play scenarios in Adobe XD. We then had the following participants play and critique the Adobe XD prototypes so that each design was tested and iterated with subsequent participants, hence cascading participatory design sessions.

Learning Happens by Doing

To inspire them, they were asked first to play either a play scenario we had prepared or one that a previous child had proposed. Children were encouraged to iterate these scenarios, changing the rules, objects used, and so forth, and to play the new scenario. For example, if a game required them to repeat a word X number of times, where X is a number magnet pulled from a container, we asked that they physically draw a number and repeat the word that many times.

Challenge Is Constant

In the latter cascading co-creation sessions, the children played scenarios that had already been mocked up in Adobe XD. Facilitators presented the iPad with the prototype running and read the written instructions out loud to the children. Using Wizard of Oz techniques (Dow et al., 2005; Fraser & Gilbert, 1991), facilitators took the role of the speech-recognition system and the narrator. They would clarify instructions, give helpful hints, and provide feedback when necessary as the game would do when it is finished. We took note of when they were engaged, which design elements the child seemed to enjoy the most, and when the child needed more support.

Anyone Can Participate

After they played the previously made designs, we invited children to come up with another play scenario using the tangible probes. The facilitator helped the children polish it with questions such as: What happens next? How do they do that? What do they need to say to help? The facilitator reminded players that all of the challenges should require speech. Once the play scenario was concluded, the child played it once or twice with the help of the facilitators. Last, the children were asked general questions about the play scenario, such as: What do you like the most about this game? Why? What do you like the least? Would you like playing this game at home? They were also asked which game of those they had played they liked the most. At the end of the session, the child chose a game character sticker to take home as a souvenir.

Designs

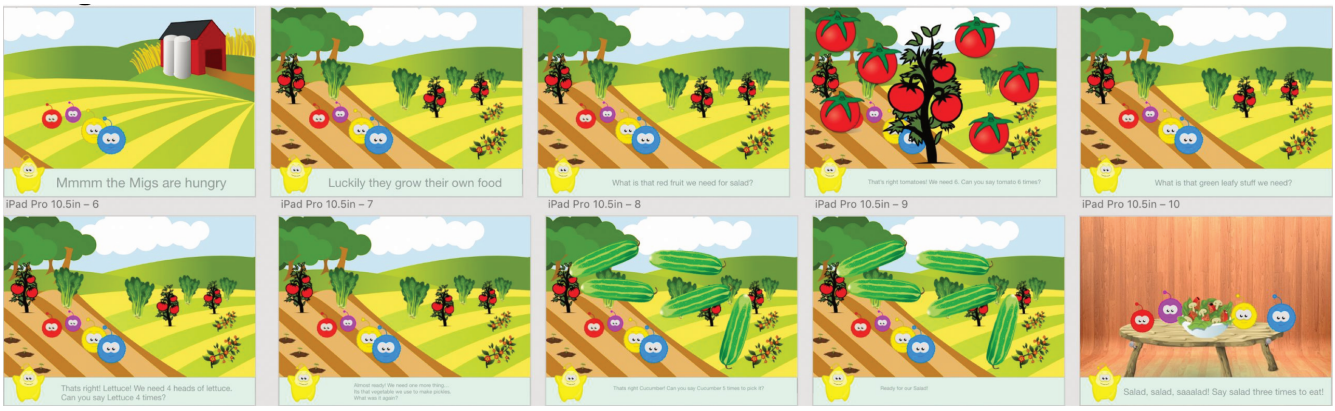

Figure 2. Adobe XD medium-fidelity prototype of farm-to-table minigame rapidly developed during gaps.

The first design (see Figure 2) is a farm-to-table minigame in which players cultivate the crops needed to make a salad. In this minigame, players pick the various fruits and vegetables by saying the name of the vegetable. If the salad requires five tomatoes, they would say *tomato* five times. During the Wizard of Oz Adobe XD playtests, we gained valuable knowledge about how we naturally support children and ideas on how this should be incorporated into the final product: It helps to repeat the same directions but worded in different ways. Different children can complete the same challenge in various directions. Silence and numerous incorrect attempts indicate confusion. We found the magic number to be

that three seconds of silence or three incorrect attempts in a row indicate the child might need support. If there is a list of items required, it helps to provide example solutions. The game should ask the children if they need help when they might be struggling. Sometimes they need more time to complete the task or a few more tries. We also found that children enjoy silly euphonious words such as *pickle*, which may be more challenging to guess but are more rewarding because they are fun to say.

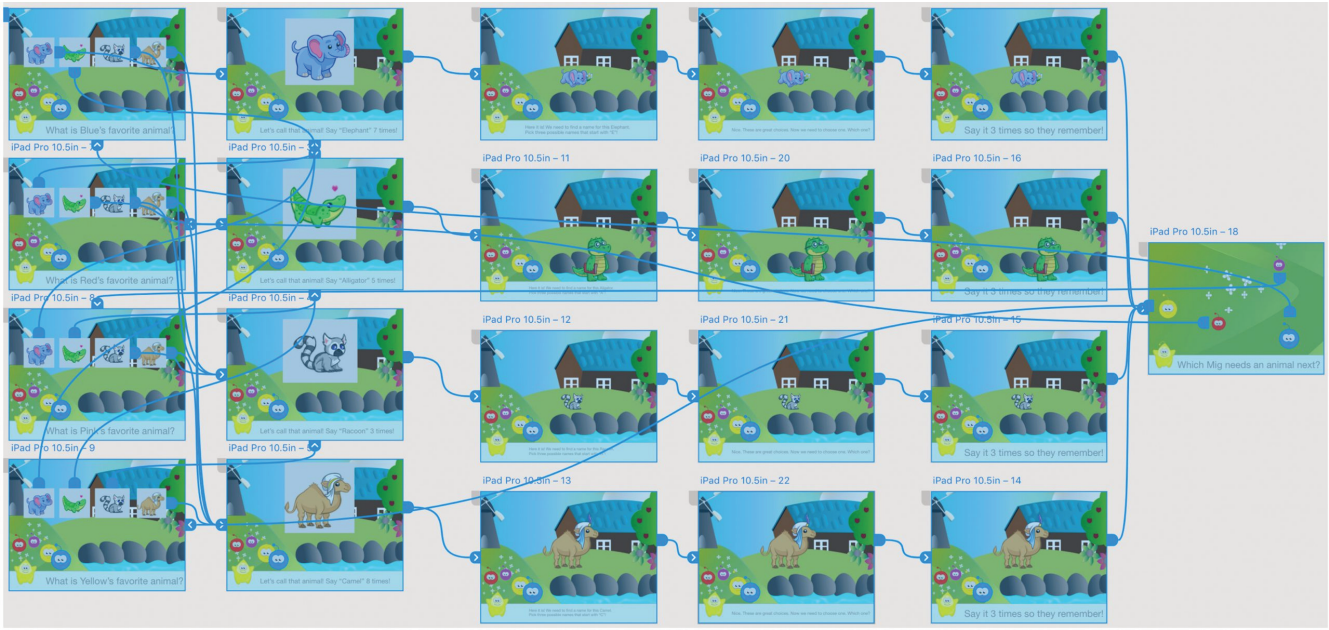

Figure 3. Adobe XD medium-fidelity prototype of farm animals minigame rapidly developed during gaps.

The second design (see Figure 3) started as a predesigned scenario to spur creativity. However, the children enjoyed playing it and iterating on it, so we decided to mock it up in Adobe XD on the scene. The characters were at a farm with no animals. To bring an animal to the farm, the child needed to say the animal's name and the sound that the animal makes. To give the animal a name, the child needed to say a name that started with the same sound as the type of animal. At this point, the facilitator asked the child to pick a number card out of a box randomly. "[X] times! You need to say their name [X] times, so they remember it." When the child calls the [animal] [X] times, that animal's card is turned over. The same process is repeated with the three other animals.

Discussion

In this paper, we present a novel co-design method that emerged out of the constraints and possibilities of our testing environment: a tight fast-paced cascading co-design protocol featuring play, tangibles, on-scene medium-fidelity prototyping, Wizard of Oz techniques, and continued iteration of designs using the design principles of connected learning.

Learning Happens by Doing

We found two aspects essential: First, a warm-up scenario is helpful so that children understand what they need to create, and second, having tangible play props. The character props allowed children to immerse themselves in the universe and come up with interesting play scenarios. Children liked these tangible characters (even wanted to keep them), held onto them, played with them, and felt comfortable using them to make new games.

Challenge Is Constant

The props directly influenced emerging games, which is why choosing appropriate props was extremely important. We used wooden magnets to act as random letters and number generators, age-appropriate flash cards to prompt words that need to be spoken, and tangible felted characters crafted to look like the characters in the game. The props directly influence resulting designs, so if the facilitators are not careful with these choices, the emerging play may be constrained by rules that do not fit goals. It can be challenging to redirect focus and play to the goals of the session. Our probes, especially the flash cards, helped keep play constrained to using speech. Because children had already played the game, they understood the constraints of the *SpokeIt* universe. It helps to define the play space clearly.

Anyone Can Participate

Co-creating a game—even if it is a sketch of a play scenario—is challenging, and even more so if the co-creators do not have a background in game design and are children(!). However, children are experts in make-believe, and crafting a magic circle comes naturally to them. The challenge is crafting "the right circle," one that can help them in their therapy.

Everything Is Interconnected

We used breaks between sessions to create on-scene medium-fidelity interactive prototypes based on games children made with our tangible probes. This meant valuable design knowledge was not lost to time because it was made immediately after sessions. Each design could be iterated multiple times in the day, with multiple children, in a medium-fidelity environment (Adobe XD). Children evaluated other children's designs, which gave insights into which features were essential to multiple children versus just the child who made the game.

References

Aten, J. L., Caligiuri, M. P., & Holland, A. L. (1982). The efficacy of functional communication therapy for chronic aphasic patients. *Journal of Speech and Hearing Disorders*, 47(1), 93–96.

Cicerone, K. D., Dahlberg, C., Malec, J. F., Langenbahn, D. M., Felicetti, T., Kneipp, S., … Catanese. (2005). Evidence-based cognitive rehabilitation: Updated review of the literature from 1998 through 2002. *Archives of Physical Medicine and Rehabilitation*, 86(8), 1681–1692.

Dow, S., MacIntyre, B., Lee, J., Oezbek, C., Bolter, J. D., & Gandy, M. (2005). Wizard of Oz support throughout an iterative design process. *IEEE Pervasive Computing*, 4(4), 18–26.

Duval, J. (2017). A mobile game system for improving the speech therapy experience. In *Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services* (p. 72). New York, NY: ACM.

Duval, J. S., Márquez Segura, E., & Kurniawan, S. (2018). SpokeIt: A co-created speech therapy experience. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems* (p. D501). New York, NY: ACM.

Feragen, K. B., Kvalem, I. L., Rumsey, N., & Borge, A. I. (2010). Adolescents with and without a facial difference: The role of friendships and social acceptance in perceptions of appearance and emotional resilience. *Body Image*, 7(4), 271–279.

Fraser, N. M., & Gilbert, G. N. (1991). Simulating speech systems. *Computer Speech & Language*, 5(1), 81–99.

Gee, J. P. (2005). Learning by design: Good video games as learning machines. *E-Learning and Digital Media*, 2(1), 5–16.

Gerling, K., Hicks, K., Kalyn, M., Evans, A., & Linehan, C. (2016). Designing movement-based play with young people using powered wheelchairs. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 4447–4458). New York, NY: ACM.

Hunt, D. O., Burden, D. D., Hepper, D. P., Stevenson, D. M., & Johnston, D. C. (2007). Parent reports of the psychosocial functioning of children with cleft lip and/or palate. *The Cleft Palate-Craniofacial Journal*, 44(3), 304–311. https://doi.org/10.1597/05-205

Johnson, J. A., & Pring, T. R. (1990). Speech therapy and Parkinson's disease: A review and further data. *British Journal of Disorders of Communication*, 25(2), 183–194.

Kaufman, D. (2010). *Educational gameplay and simulation environments: Case studies and lessons learned.* Hershey, PA: IGI Global.

Mashima, P. A., & Doarn, C. R. (2008). Overview of telehealth activities in speech-language pathology. *Telemedicine and E-Health*, 14(10), 1101–1117.

Miesenberger, K., Klaus, J., Zagler, W., & Karshmer, A. (Eds.). (2010). *Computers helping people with special needs. 12th International Conference, ICCHP 2010, Vienna, Austria, July 14-16, 2010 Proceedings, Part II*. Germany: Springer Berlin Heidelberg. Retrieved from https://books.google.com/books?id=jIbX8RXAf7UC

Morelli, T., Lieberman, L., Foley, J., & Folmer, E. (2014). An exergame to improve balance in children who are blind. In *Proceedings of the 9th International Conference on the Foundations of Digital Games.* Retrieved from http://www.fdg2014.org/papers/fdg2014_wip_13.pdf

National Center for Health Statistics. (2015). Communication disorders and use of intervention services among children aged 3–17 years: United States, 2012. Retrieved from https://www.cdc.gov/nchs/products/databriefs/db205.htm

Parisod, H., Pakarinen, A., Axelin, A., Danielsson-Ojala, R., Smed, J., & Salanterä, S. (2017). Designing a health-game intervention supporting health literacy and a tobacco-free life in early adolescence. *Games for Health Journal*, 6(4), 187-199.

Randel, J. M., Morris, B. A., Wetzel, C. D., & Whitehill, B. V. (1992). The effectiveness of games for educational purposes: A review of recent research. *Simulation & Gaming*, 23(3), 261–276.

Robertson, S. J., & Thomson, F. (1984). Speech therapy in Parkinson's disease: A study of the efficacy and long term effects of intensive treatment. *International Journal of Language & Communication Disorders*, 19(3), 213–224.

Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., … Salinas. (2003). Beyond Nintendo: Design and assessment of educational video games for first and second grade students. *Computers & Education*, 40(1), 71–94.

Rubin, Z. (2017). *Development and evaluation of software tools for speech therapy* (Doctoral dissertation). University of California, Santa Cruz.

Sousa, A. D., Devare, S., & Ghanshani, J. (2009). Psychological issues in cleft lip and cleft palate. *Journal of Indian Association of Pediatric Surgeons*, 14(2), 55–58. https://doi.org/10.4103/0971-9261.55152

Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Educational Technology & Society*, 8(2), 54–65.

5. "I'm Teaching This for the Culture!"

Reexamining the Ideological Tensions and Institutional Constraints of Teaching Hip-Hop–Based Music Education Within the Formal Classroom

JABARI M. EVANS

Abstract: Hip-hop–based education, the usage of hip-hop practices and pedagogy in urban classrooms, has been argued by many researchers as very beneficial to understanding how to improve the educational disparities of urban youth in low-income environments. However, if public school systems are unaccepting of the "organic" and unstructured nature of hip-hop culture (language, style, dress, and its resistance to the status quo), how can hip-hop practices be used substantially within the classroom? This paper examines the constraints and ideological conflict when teaching hip-hop music production in the formal music classroom. Focusing on pedagogical work of the teaching artists within a school-based hip-hop music program in an urban school district, this article uses in-depth interviews with five teaching artists/facilitators working within a hip-hop–based music education program in Chicago. By using the narratives of these teachers as units of analysis, qualitative methods were used to examine how teaching artists overcame the ideological conflicts of their host institutions during the implementation of the program's curriculum. Overall, this case study reveals how administrative expectations (or lack thereof) for hip-hop's utility in the classroom greatly influences how the learning in hip-hop programs is, or is not, taking place. The findings suggest that school administrators, teachers, and other staff members could stand to take a more concerted interest in understanding the complexity of the artistic processes involved in rap music making as well as the culture attached to it if they sincerely want hip-hop pedagogy to be effective in their schools.

Background and Introduction

Hip-hop culture has continually been identified by media scholars as the dominant voice of youth culture (Forman & Neal, 2004). Rap music, the most performative and visible product of the culture, is a global phenomenon and a billion-dollar industry that influences the ways in which youth form their identity, connect with their peers, and make meaning of the world around them. For the last 20 years, several scholars have written extensively about the benefits of hip-hop–based education (HHBE) programs in formal learning environments (see Petchauer, 2009). In creating frameworks that explain its course of action or preferred approach, empirical research has consistently linked HHBE to critical pedagogy (Akom, 2009) and culturally relevant pedagogy (Ladson-Billings, 1995), identifying HHBE as a great means to teaching social justice or youth activism by addressing dominant issues of race, racism, and oppression in the lived experience of African American students. Many scholars have claimed that hip-hop pedagogy offers an education in which learners can work toward their desired aspirations via mediums that are familiar to them and build upon their already acquired knowledge (Emdin, 2016; Hill & Petchauer, 2013). Numerous scholars have also produced evidence that suggests the power of hip-hop–themed media interventions to drive self-empowerment and academic efficacy with underperforming students (Dimitriadis, 2001; Forman, 2002; Hill, 2009; Ibrahim, 1999; Stovall, 2006; Thibeault, 2010). These studies have almost exclusively focused on the positive socioemotional outcomes of the students, expanded on theories of linguistics, and emphasized an ability of HHBE to help instructors build rapport/trust within their classrooms (see Petchauer, 2009). However, several book projects (Desai, 2010; Emdin & Adjapong, 2018; Fisher, 2007; Hill, 2009; Low, 2011; Seidel, 2011; Watkins & Cho, 2018) have provided models of how we might begin to reconceptualize the purpose of public education and develop hip-hop pedagogies with a more critical, liberatory lens.

This study aimed to address those concerns by exploring the narratives of teaching artists employed by a hip-hop–based education program that is being piloted in Chicago elementary schools. Through use of several informal conversations, field notes from in-class observations, as well as transcriptions of four semistructured interviews, this paper explores the ideological tensions of teaching hip-hop music making as a formal school subject. The primary aim of this paper is to elaborate on the tensions and constraints faced by the teaching artists with the integration of hip-hop into the formal learning environment.

In the following sections of this paper, I suggest that while school administrators generally believe that this type of class offering is based in the cultural-linguistic reality of their students, teaching artists often feel their instructional freedom is marginalized within the academic spaces they serve. In investigating how teachers mitigate these obstacles and approach school music from a hip-hop cultural perspective, this examination is guided by the following general research questions:

1. What are the creative constraints to inserting hip-hop–making practices in formal academic spaces?
2. Do teaching artists still encourage hip-hop music as free creativity or are there constraints placed on their students' music compositions because of the setting? If so, how do they balance this?
3. How do teaching artists negotiate their real-life experiences in hip-hop with meeting the demands of the academic institutions that employ them?

Along the same lines, I previously have suggested that hip-hop composition in academic spaces could be a form of new media literacy that is useful to African American youth for cultivating skills in analyzing media codes and conventions; in abilities to criticize stereotypes, dominant values, and ideologies; and in competencies to interpret the multiple meanings and messages generated by all media texts (Evans, 2019). The findings of that study suggest that HHBE, as a media literacy intervention, could (and should) be used with its listeners to help them to discriminate and evaluate media content, to critically dissect media forms, to investigate media effects and uses, to use media intelligently, and to gain skills to construct their own alternative media. Even so, this can occur only if schools seriously invest in supporting curricula to empower students to practice media literacy—which means thinking critically about the social function of digital media and implications of technological advancements.

Ultimately, I argue in this study that implementation of hip-hop music in elementary education, inasmuch as it takes place in classrooms and is mediated by codified and standardized pedagogical material, involves new challenges and paradoxes for teachers and students, who strive to inform their creative labor and teaching by the traditions, ideologies, and ideals—whether real or imagined—of the music.

Case Study: Background and Corpus of the Data

As the third-largest city in the United States, Chicago is home base to a vast array of arts and cultural institutions, universities and scientific organizations, and many vibrant and diverse cultures. It is also a city that is well documented as having many racial, economic, and political tensions. Chicago's racial/ethnic and economic inequities have a long-standing history and have been characterized as "pervasive, persistent, and consequential" (Hendricks, Lewis, Arenas, & Lewis, 2017, p. 16). Poverty is concentrated on the south and west sides of the city, which are also the areas with the highest concentrations of Black or African American and Hispanic populations (Bloch, Cox, & Giratikanon, 2015).

Between 2016 and 2019, I studied the impact of hip-hop–based education within elementary schools on what the popular press has deemed some of Chicago's poorest communities on the south and west sides. According to Chicago Public Schools' (CPS's) *State of the Arts Education Report*, of the 23 school districts in those communities, at least 50% of the principals in 22 of those districts stated that their students would like to have more programs teaching Hip-Hop

Composition, Deejaying, and Spoken Word in their school curriculums (Ingenuity, 2019). Additionally in 10 of those districts, hip-hop was the top requested type of programming by students in their survey responses.

In this article, I am examining a program seeking to fill that void: Foundations of Music's Songwriting and Production (SWP) program. The sponsor of the program, Foundations of Music, is an arts-oriented nonprofit organization in Chicago that aims to deliver culturally relevant arts education to Chicago students in elementary and middle schools. Using a research-based curriculum, teaching artists work with partner schools and communities to foster student connections to music, the arts, and the world around them. Its programs aim to ignite curiosity, develop skills, and promote social-emotional growth. Foundations of Music now reaches more than 5,000 students in nearly 40 schools.

Foundations of Music's SWP program introduces students aged 10-14 years to both the process of writing original rap/hip-hop songs and the technology used to produce them. SWP participants create within a pre-production and recording setup in the classroom with trained teaching artists who travel to the school and set up mobile workstations for the students to record music. Following a project-based learning model, the program's final objective is that the class participants will collaborate to write, produce, record, and mix three original songs over 10 weeks. The data I am drawing from are informed by two components: field notes from participant observations and in-depth interviews. Overall, I conducted more than 250 hours of classroom observation and completed five in-depth interviews with teaching artists. During this time, I logged 83 written entries on a word-processing application on my cellular phone, compiling almost 150 pages of field notes pertaining to the teaching strategies and curriculum fidelity employed within the program.

Methods and Analysis

As the lone researcher on this study, I transcribed my field notes and interview tapes (verbatim) to a word processor and coded them using ATLAS.ti software. As I employed a grounded-theory approach (Glaser & Strauss, 1967), concepts and categories emerged in the process of doing my fieldwork and inductive coding. Early on in my observations, I was primarily trying to look for ways in which the program enhanced typical academic achievement measurement outcomes such as test scores. However, that focus was a "dead end" and led me to seeing occupational identity as a key independent variable related to the SWP program. However, as the study evolved out of the field into the analysis process, the theme of teacher artists' having ongoing negotiation between structure and uncertainty in temporal dimensions became salient in my theoretical memos. Recognizing each 10-week class sequence as a cohort and a unique study of analysis, I returned to the field to collect data relevant to my insight, and then I decided to ask clarifying questions to teaching artists and other key stakeholders in semistructured interviews to connect emerging insights across multiple data sources (e.g., MP3 files, photographs, and lyric journals).

While field notes largely captured the picture of teaching and learning practices in the SWP program, interviews deepened insight into how teaching artists actively played with the literacy standards set forth by their host administrators: Common Core Standards set forth by the State of Illinois Board of Education. Data within these field notes were marked with parent themes that reflected three operational levels at which the program appeared to cause tension for teacher implementation: school culture, student learning goals, and teacher pedagogical approach. I then revisited my data and refined subcategories of the theoretical codes into three points of tension: Structure versus Uncertainty, Craft versus Art, and Street Authenticity versus School Conformity. Each of these themes addressed separate research questions in my inquiry and data from each field note made up one cumulative case study.

Case-based qualitative methods are useful in revealing complex processes that unfold through time (Yin, 2013).This investigation is a holistic multiple case study (Yin, 2009). Holistic case studies, which value and investigate the contexts in which cases exist, can blur the lines between case study and ethnography. Although they might constrain generalizability, they are situated for analyzing social phenomena that are previously unknown or understudied (Glaser

& Strauss, 1967; Lofland & Lofland, 1995; Small, 2009). Though the SWP program and its teaching artists who were chosen for this study were convenient to the researcher, they have an unusual presence within an urban public school system and display an unusual case, one that can drive the ability for researchers to observe the complex creative and learning processes that are needed for further study of hip-hop pedagogy.

There was no incentive for interviewed or observed participants. Study procedures were approved by the Institutional Review Board at the sponsoring institution of the researcher. Finally, pseudonyms were assigned to all teachers observed in this study to preserve their anonymity. Additionally, pseudonyms were given for the names of the schools and any information regarding their exact location. In the following sections of this paper I will discuss the findings of my interviews and unstructured conversations with three of the SWP program's teaching adult facilitators (Supa, Malcolm, and Jerry) as they actively helped their students in hip-hop–making practices.

The SWP Classroom, Defined

The class structure and processes of the SWP program sessions that I observed looked much different from one might expect in the typical didactic music classroom. At a basic time-structure level, SWP classes were generally broken up into three sections: The first part of the class (25 minutes) was used to lead students through a five-minute lecture and 20 minutes of writing time to develop and refine lyrics and vocal and performance exercises to gain confidence and poise when presenting one's work, and the second part of the class (25 minutes) was used to provide students a structured free time to work on their individual projects with the recording technology and music-production software. For the final 10 minutes of the course, students were given the opportunity to learn how to constructively critique their work, as well as that of their peers.

In terms of content of the curriculum, the course's group discussion prompts and lesson themes were designed and guided with reference to James Peterson's (2013) four educational elements of hip-hop, which were created to understand the components that underwrite many initiatives that bring hip-hop culture into the classroom but most important, classrooms needing principles centered on composition. These elements were also keyed upon by the program founders to teaching artists because they have been widely described in the scholarly literature as the driving sensibilities, mindsets, and approaches embedded in the hip-hop aesthetic form (Petchauer, 2009). These elements are defined as follows:

1. Knowledge—Understanding of popular culture, current events, and various media that they regularly interact with;
2. Consciousness—Debating over the contents of the music they listen to and/or admire, articulating space and place and/or providing sociopolitical commentary;
3. Search and Discovery—Development of new musical skills and sensibilities; additionally, actively seeking resources that will build skills and sensibilities that directly relate to their individual project;
4. Participation—Active contribution to class projects and/or day-to-day class discussions that allow students to hone their critical thinking and develop knowledge of composition.

Additionally, a major component differentiating the SWP class process was that all workshops purposely would begin and end with youth participant voices rather than with the voice of the teaching artist. This was designed so that the students would feel empowered and safe to set the "tone" in the classroom. At the start of a workshop, this can take the form of a "check-in," in which participants introduce themselves and declare how they are feeling and what they want to accomplish that day. Often, SWP classes started with a wall-write, which was when participants had to respond to a prompt written on a dry-erase board hanging on the wall—such as "What does it mean to be from the hood?" and then brainstorming about the question to start the songwriting process.

Summary and Discussion of Findings

Interviewees suggested that hip-hop is a tool to teach youth of color to solve problems and that it is not the solution itself. Fieldwork in this study illuminates that developing any type of future-ready curriculum or SWP-like program requires future-ready administration to properly invest (financially and with instructor development) in its implementation. Though the teaching artists in this study often went above and beyond in the name of their students' academic and professional success, their interviews revealed much frustration and disillusionment about how their work was valued in the academic space. Evidence presented in this study also shows that formal and informal learning strategies act in a dialectic way, which indicates that rap musicians combine formal and informal learning strategies in their practice of musical learning (Söderman & Folkestad, 2010).

The findings of this study suggest that simplistic and stereotypical misgivings about students and their attachment to hip-hop culture still exist and greatly influence the ways in which hip-hop is delivered in the classroom. In this paper, I suggest that the unstructured systems of hip-hop music making are hardly conducive to the standardized evaluation normally appreciated by parents and administrators. In reflecting on the ways in which these teaching artists seek to combat meeting the demands of their school's learning cultures, I saw three major themes emerge through the course of this exploration: (a) reframing curriculum outcomes to match those related to standardized tests, (b) focusing on hip-hop's craft and professionalism as a form of vocational training, and (c) reality pedagogy—challenging the status quo, doing what is necessary to give students freedom of expression, even if it means ignoring school rules.

During the course of this study, I have found that many teachers and school administrators carry an implicit bias about hip-hop as deviant, disruptive, and counter to academic achievement and ideal school culture. The reason is that they believe hip-hop is meant to be improvisational, interest-driven, and self-expressive. Thus teachers of this kind of music education must adjust their curricula to the tenor of each and every class that they teach and every student that they teach. The current case study suggests to me that hip-hop can lead to its greatest gains in education by our seeing its vocational value in the future of today's youth.

Whether we are talking about engineering, business, advertising, marketing, social media, entrepreneurship, or any form of creative labor, rap music as a practice has the capabilities to develop at-promise youth into engaged citizens in modern society. Unfortunately, the uncertainty that interest-driven media-making brings during academic class time often does not fit with the way public school teachers are typically assessed for job performance. Additionally, those administrators who have the ability to change the typical imperatives that are allowed and expected in primary school spaces reported being overwhelmed by constant demands to directly connect all in-school activities to improving test scores.

Nonetheless, hip-hop scenes can (and should) be recognized by scholars and stakeholders as a legitimate site of labor for urban youth of color. Since opportunities are not always available to men of color in the formal labor market, many are distrustful of that system and opt to participate in more entrepreneurial endeavors. This allows them to control their image, create and promote their personal narrative, maintain individuality, and find a sense of self-worth and belonging in something positive. The basic assumptions of this study are that music education could easily be reoriented to fit the "post-performance" digitized forms of today's popular music and that this, in turn, should reorient how we evaluate the goals, missions, and values of music education. However, my findings suggest that this can be done only if educators are allowed to sincerely be responsive to young people's interests and ingenuity. The educators in this study have sought vigorously to find ways to connect hip-hop music production/composition to concrete skills and opportunities in the modern labor market. Even so, all subjects in this study indicated that their instruction lost its transformative potential when school administrators made demands for more structure, requesting that the lessons teach technical skills that might reproduce hegemonic representations.

The findings of this study suggest that while hip-hop can (and should) be recognized as a legitimate site of labor for urban youth of color, many administrators have erroneously attributed how youth of color "put culture to work" in hip-hop as devoid of work ethic, ingenuity, or savvy. What many might regard as play is actually work in the field of hip-hop. Framing youth engagement with cultural practices as work reframes them as cultural producers who shape and control their environments with subcultural capital that they possess. Such an acknowledgment is truly the difference between academic "buy-in" and disengagement. For this reason, I recommend that urban school districts examine the degree to which hip-hop is addressed in their teacher- and leadership-development curriculum. For those of us who recognize the power of hip-hop, it is simply unacceptable that urban educators are unfamiliar with the significance of this culture's impact on young people and on the world. Denying or overlooking its impact is both short-sighted and unjust.

References

Akom, A. A. (2009). Critical hip-hop pedagogy as a form of liberatory praxis. *Equity & Excellence in Education*, *42*(1), 52–66.

Bloch, M., Cox, A., & Giratikanon, T. (2015, July 8). Mapping segregation: New government rules will require all cities and towns receiving federal housing funds to assess patterns of segregation. *The New York Times.* Retrieved from https://www.nytimes.com/interactive/2015/07/08/us/census-race-map.html

Desai, S. R. (2010). *Emancipate yourself from mental slavery/None but ourselves can free our minds: Spoken word as a site/sight of resistance, reflection and rediscovery* (Doctoral dissertation). University of California, Los Angeles.

Dimitriadis, G. (2001). *Performing identity/performing culture: Hip-hop as text, pedagogy, and lived practice* (Revised ed.). In C. McCarthy & A. N. Valdivia (Series Eds.): Intersections in Communications and Culture (Vol. 1). New York, NY: Peter Lang.

Emdin, C. (2016). *For White folks who teach in the hood … and the rest of y'all too: Reality pedagogy and urban education.* Boston, MA: Beacon Press.

Emdin, C., & Adjapong, E. S. (Eds.). (2018). *#HipHopEd: The compilation on hip-hop education: Volume 1: Hip-hop as education, philosophy, and practice.* Leiden, The Netherlands: BRILL/Sense.

Evans, J. M. (2019)."Deeper than rap": Cultivating racial identity and critical voices through hip-hop recording practices in the music classroom. *Journal of Media Literacy Education*, *11*(3), 20–36. doi:10.23860/JMLE-2019-11-3-3

Fisher, M. T. (2007). *Writing in rhythm: Spoken word poetry in urban classrooms.* New York, NY: Teachers College Press.

Forman, M. (2002). "Keeping it real"?: African youth identities and hip hop. *Critical Studies*, *19*, 101–132.

Forman, M., & Neal, M. A. (2004). Hip-hop am Main, rappin' on the Tyne: Hip-hop culture as a local construct in two European cities. In M. Forman & M. A. Neal (Eds)., *That's the joint! The hip-hop studies reader* (pp. 219–246). New York, NY: Routledge.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative theory.* New Brunswick, NJ: Aldine Transaction.

Hendricks, K., Lewis, A. E., Arenas, I., & Lewis, D. G.. (2017). *A tale of three cities: The state of racial justice in Chicago.* Chicago: Institute for Research on Race & Public Policy at the University of Illinois at Chicago.

Hill, M. L. (2009). *Beats, rhymes, and classroom life: Hip-hop pedagogy and the politics of identity*. New York, NY: Teachers College Press.

Hill, M. L., & Petchauer, E. (2013). *Schooling hip-hop: Expanding hip-hop based education across the curriculum.* New York, NY: Teachers College Press.

Ingenuity. (2019). *State of the arts arts education in the Chicago Public Schools. A survey.* Retrieved from https://www.ingenuity-inc.org/data-research/state-of-the-arts/

Ibrahim, A. E. K. M. (1999). Becoming black: Rap and hip-hop, race, gender, identity, and the politics of ESL learning. *TESOL Quarterly*, *33*(3), 349–369.

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory Into Practice*, *34*(3), 159–165.

Lofland, J., & Lofland, L. (1995). *Analyzing social settings.* Belmont, CA: Wadsworth.

Low, B. (2011). *Slam school: Learning through conflict in the hip-hop and spoken word classroom*. Palo Alto, CA: Stanford University Press.

Petchauer, E. (2009). Framing and reviewing hip-hop educational research. *Review of Educational Research*, *79*(2), 946–978.

Peterson, J. B. (2013). Rewriting the remix: College composition and the educational elements of hip-hop. In M. L. Hill & E. Petchauer (Eds.), *Schooling hip-hop: Expanding hip-hop based education across the curriculum*, 47-65. New York, NY: Teachers College Press.

Seidel, S. (2011). *Hip-hop genius: Remixing high school education.* Lanham, MD: Rowman & Littlefield Education.

Small, M. L. (2009). How many cases do I need?' On science and the logic of case selection in field-based research. *Ethnography*, *10*(1), 5–38.

Söderman, J., & Folkestad, G. (2004). How hip-hop musicians learn: Strategies in informal creative music making. *Music Education Research*, *6*(3), 313–326.

Stovall, D. (2006). We can relate: Hip-hop culture, critical pedagogy, and the secondary classroom. *Urban Education*, *41*(6), 585–602.

Thibeault, M. D. (2010). Hip-hop, digital media, and the changing face of music education. *General Music Today*, *24*(1), 46–49.

Watkins, S. C., & Cho, A. (2018). *The digital edge: How black and Latino youth navigate digital inequality*. New York, NY: NYU Press.

Yin, R. K. (2009). *Case study research: Design and methods (Applied social research methods).* London, UK, and Singapore: Sage.

Yin, R. K. (2013). Validity and generalization in future case study evaluations. *Evaluation*, *19*(3), 321–332.

6. Interests, Relationships, and Opportunities Within the 2018 Global Minecraft Mentor Program

MATTHEW FARBER AND MIA KIM WILLIAMS

Abstract: *Minecraft: Education Edition* (Microsoft, 2016) has become a critical tool for learning for many classrooms, connecting students and teachers in game-based activity (Dikkers, 2015; Kafai & Burke, 2016). On the *Minecraft: Education Edition* website, a teacher can connect with mentors, review shared lessons, and download maps of generated worlds. In 2017 Microsoft Education launched the Global Minecraft Mentor Program to support teaching, learning, and innovation with the game. This research explores and describes this mentor space from the perspective of the participants. It seeks to understand the experiences of mentors within this space, entry points to onboard teachers who have little or no background in adapting *Minecraft: Education Edition* to their classrooms, and the extent to which connected learning principles manifest in the mentoring space. Research followed an explanatory sequential mixed-method design. The 2 phases of data collection in this study begin with quantitative data collection and analysis; the quantitative findings will inform the development and deployment of the qualitative data collection and analysis (Creswell, 2015). Data included survey responses, interview responses, artifacts provided by interview participants, and artifacts related to the Global Minecraft Mentor Program website.

Introduction

Passionate teachers have adopted the video game *Minecraft* into a variety of classroom disciplines (Dikkers, 2015; Kafai & Burke, 2016). An open-environment sandbox of interactive virtual building blocks, "like typing paper, [*Minecraft*] can be used to represent ideas effectively and in a 3D space" (Dikkers, 2015, p. 101). As a teaching tool, *Minecraft* has become more pervasive in classrooms around the world (Dikkers, 2015; Ito et al., 2019; Kafai & Burke, 2016). *Minecraft* is a game that can be played in two distinct modes: Survival Mode, in which players collect and manage resources with the goal of surviving in a sometimes-dangerous virtual world (Dikkers, 2015), and Creative Mode, which is constructionist in nature, as players are afforded unlimited resources with which to build and create (Kafai & Burke, 2016). Both of these game modes can engage players in creativity, innovative thinking, and problem-solving abilities, while at the same time teaching necessary content and skill knowledge (e.g., Butler, Brown, & Críosta, 2016; Qian & Clark, 2016).

To support teachers' best practice in using *Minecraft*, Microsoft Education launched a mentor community known as the Global Minecraft Mentor Program in 2017. (Microsoft had purchased *Minecraft* in 2014 and then published an educational modification, *Minecraft: Education Edition*, in 2016.) The Global Minecraft Mentor Program is a competitive program that pairs teacher experts with new community members and features several entry points to onboard teachers who have little or no background in adapting *Minecraft* to their classrooms ("2018 Global Minecraft Mentor Program," 2018). For instance, on the *Minecraft: Education Edition* website, a teacher can connect with mentors, adapt shared lesson plans, and download maps of mentor-published worlds (e.g., a map set in ancient Egypt).

Much of the research and literature around classroom game-based learning practices has pertained to teacher attitudes about games and learning (e.g., Fishman, Plass, Riconscente, Snider, & Tsai, 2014), learning outcomes from game play (e.g., Anderson, Dalsen, Kumar, Berland, & Steinkuehler, 2018), and game-based assessment strategies (e.g., Kim, Shute, & Ventura, 2013; Shute, Moore, & Wang, 2015). However, there is a deficit of literature that describes how game-based learning teacher educators peer-mentor one another, particularly in online spaces. In this paper, the experiences of

mentors within the 2018 cohort of the Global Minecraft Mentor Program are explored. The Microsoft's Global Minecraft Mentor program in 2018 included 341 educators from 70 countries ("2018 Global Minecraft Mentor Program," 2018). This paper explores and describes this mentor space from the perspective of the participants. We sought to examine how those mentors interacted and peer-mentored one another in this affinity space, guided by the following research question:

- What are the lived experiences of mentors within the 2018 Global Minecraft Mentor Program?

Theoretical Framework

This study sought to understand the lived experiences of an affinity group of the 2018 Global Minecraft Mentors. The theoretical foundation for this study was built on the principles of connected learning, a framework that includes three learning principles—academically oriented, interest-powered, and peer supported; and three design principles—production-centered, openly networked, and shared purpose (Ito et al., 2013). The principles of connected learning stem from interest-driven and peer-supported practices that can occur in school, but more typically are found informally outside of school such as in online communities of practice (Ito et al., 2013). Connected learning harnesses digital media learning "to more easily link home, school, community and peer contexts of learning; support peer and intergenerational connections based on shared interests; and create more connections with non-dominant youth, drawing from capacities of diverse communities" (Ito et al., 2013, p. 4). Connected learning can increase youth's "access to knowledge, providing timely feedback and individualized learning experiences, and connecting youth to a network of individuals who have expertise in an area of shared interest" (Davis & Fullerton, 2016, p. 98).

As Garcia (2014) observed, connected learning historically focuses on youth in out-of-school settings, yet "the principles of connected learning (e.g., it is interest-driven and collaborative) apply to teachers, as well as their students" (pp. 5–6). For example, pedagogy at the Quest to Learn public school in New York City is guided by the principles of connected learning, as well as a "game-like" teaching philosophy (Ito et al., 2013, p. 35). Quest to Learn has evolved to include student game production in its approach to connected learning, which is production-centered (Kafai & Burke, 2016).

Connected Teaching

Members in online communities of practice can provide or get access to both informal and formal knowledge, learn to problem solve, collaborate, communicate, discuss important topics, and explore ideas (Wenger, White, & Smith, 2012). A community includes collaboration with people who share similar passions and believe in the overall mission (Kraut & Resnick, 2011). Participants who "have existing social ties to be members of the community increase their bonds-based commitment to the community" (Kraut & Resnick, 2011, p. 89). The purpose of the community of practice is to share ideas, whereas an affinity space is slightly different, as it focuses on the "space" where community members meet; communities of practice pertain to group affiliation (Gee, 2005).

Educators who meet and peer-mentor one another in affinity spaces are a form of teacher professional learning (Baker-Doyle, 2017; Cantrill, Smith, West-Puckett, & Zamora, 2016). Teachers who adopt novel teaching approaches such as game-based learning may not necessarily be co-located in the same school building and may be temporally separated; therefore, they may join and participate in online communities of practice, which are learning spaces where members learn "from and with each other" (Wenger et al., 2012, p. 7). For example, in a connected learning massive open online course (CLMOOC), teachers met online to discuss and develop pedagogy around the remix of digital media (Cantrill et

al., 2016). In this context, remix became the "shared language for playful democratic learning wherein meaning was made in the act of remixing among peers" (Cantrill et al., 2016, pp. 14–15).

Both Twitter and Facebook are examples of social media platforms that are also online affinity spaces where a system of apprenticeships enable members to cement relationships (Baker-Doyle, 2017; Wenger et al., 2012). Teachers have self-organized on these platforms into what is known as personal (sometimes called professional) learning networks (PLNs), which are an "egocentric (personalized) network of people and groups that an individual trusts and connects with online and offline" (Baker-Doyle, 2017, p. 76). In PLNs teachers may engage in peer-to-peer co-learning on topics that speak to specific proclivities, affinities, or shared teacher interests. PLNs enable "educators to forge, and move towards, new conceptions of their professional identities. Despite some vague and teacher-centered answers, many other teachers were able to extend the benefits from and in PLNs to their students in numerous ways" (Carpenter, Krutka, & Trust, 2016, p. 31).

Affinity spaces center on the notion that interest-driven engagement is key to learning, whether formal or informal, online or face-to-face. While this connection has not previously been studied in depth, research suggests that when a teacher intentionally decides to teach with games, it may be because he or she has a proclivity to play games. Takeuchi and Vaala's (2014) report on levels of proficiency of teachers who taught with games indicated 82% of surveyed teachers were self-described game players, and 78% of that group taught with games (n = 694; Takeuchi & Vaala, 2014). Takeuchi and Vaala (2014) stratified the groups of teachers, further sorting game-using teacher participants as "dabblers" or "naturals." Non-game-using teachers were not totally resistant to teaching with games; however, the percentage that used games to teach was smaller, at 55% (Takeuchi & Vaala, 2014). Thus, Takeuchi and Vaala's (2014) findings suggest that a teacher who has experience playing video games may be more apt to teach with them.

Methodology

This research followed an explanatory sequential mixed-method design. The two phases of data collection in this study bega with quantitative data collection and analysis; the quantitative findings informed the development and deployment of the second phase of qualitative data collection and analysis (Creswell, 2015). Data included survey responses, interview responses, artifacts provided by interview participants, and artifacts related to the Global Minecraft Mentor Program website.

Data Collection

Theoretical sampling was used to study "incidents, slices of life, time periods, or people on the basis of their potential manifestation or representation of important theoretical constructs" (Patton, 2001, p. 238). This type of sampling is built upon the seminal work of Glaser and Strauss (1967) pertaining to the discovery of grounded theory. Potential participants were contacted through email addresses that were obtained from Microsoft Education's program officer. The target population of this study were the 2018 cohort members of the Global Minecraft Mentor Program.

Phase 1. An online survey was administered using the researchers' password-protected account in Qualtrics, beginning on April 16, 2018, and concluding on May 21, 2018. The call to participate was initially posted privately to Global Minecraft mentors, shared by Microsoft's manager of Minecraft Education. Interested participants were directed to the consent form and the online survey. The consent form was the first segment of the survey and only people who agreed to participate were directed to the survey questions. Participants were asked to answer both close-ended questions and

open-ended questions about their experiences in the mentorship program, their collaborative learning knowledge, and demographic information. There was participant attrition, with 35 beginning the survey, and 28 completing it.

Phase 2. Interview questions were developed based on the findings of the qualitative phase of the research. Of the 24 of the 28 survey participants who agreed to participate in the qualitative phase, 14 participated in a semistructured interview. Interviews, which took from 45 minutes to one hour to conduct, took place synchronously using Zoom video conferencing; the interview phase began on September 12, 2018, and concluded on October 3, 2018. During the interview, the participants responded to questions about their experience in the Global Minecraft Mentor Program. Artifacts related to the teaching before and after *Minecraft* integration, such as participants' lesson plans, social media shares and public blog posts, and assignment instruction documents, were also collected from the interviewees. Interviews were then transcribed before data analysis and shared with the participants to ensure trustworthiness through a member-check process.

Data Analysis

The qualitative strand of this mixed-method research uses data analysis procedures consistent with an interpretivist model of qualitative research. Software was selected and used to create memos, code, sort, and analyze transcripts from the structured interviews, as well as the responses to the open-ended student survey questions. Memos and coded data were reviewed to make comparisons about the participant responses. Analysis of qualitative data also included use of the constant-comparative method of coding, which affords flexibility to focus on data before analyzing and making sense of the observed phenomena (Charmaz, 2014).

The qualitative strand of this mixed-method research used data analysis procedures consistent with an interpretivist model of qualitative research. Using a constant-comparative analysis of the data being collected (Strauss & Corbin, 1998), artifacts, screen shots, and process notes were read as they were collected and again at the end of the data collection period. The three-step process of open coding, axial coding, and selected coding as described by Strauss and Corbin (1998) was conducted to construct assertions and understand the relationships among sets of data. The quantitative survey data was analyzed using appropriate descriptive statistics. Descriptive statistics were also used to summarize demographic data.

Preliminary Findings

While the 2018 cohort of the Global Minecraft Mentor program included 341 educators from 70 countries, participants represented 10.3% of that population in Phase 1 of data collection. There was further attrition in the second phase, the semistructured interviews. The findings herein may not represent the entire population, and we are not suggesting that these results can be statistically generalizable.

Of the surveyed participants (N = 35), 68.57% self-reported themselves as teachers; 5.71% as school administrators; 8.57% as consultants; and 17.14% selecting "other" as their role in education. No participant identified as a school librarian, higher education faculty, or as corporate. Fifteen participants were based in the United States, and three were in Canada. As this is the Global Minecraft Mentor Program, other responses included a participant from Israel, as well as Hong Kong, New Zealand, India, Italy, Mexico, South Korea, and Russia. These were generally seasoned educators, with a minimum of three years of teaching experience and a maximum of 25 years. Of N = 35, 17.14% reported teaching with *Minecraft* for more than five years; 42.86% self-described their expertise as intermediate, while 17.14% stated that they considered themselves to be beginners, and 14.29% as expert users.

In addition to other versions of *Minecraft* available in the market (e.g., the mobile version, the commercial off-the-shelf edition), all respondents (N = 34) of the question regarding game edition reported using *Minecraft: Education Edition.*

Growing Pains in a Peer-Supported Community

The first year of the Global Minecraft Mentor Program consisted of 60 educators; Year 2 exceeds 300 members. Some frustrations were expressed to the researchers in the semistructured interview phase of data collection regarding the differences between Years 1 and 2. The significant increase of mentors in the community within the short timeframe created divisions among the mentors. Those who have shared experiences or similar experience levels with *Minecraft: Education Edition* would talk among themselves within the online community.

> But what we are now in Teams is growing into its shoes and becoming quite big. … It's a bit like old friends talking to each other and it felt like expert people just having conversation amongst themselves. So, the second year with the expanded numbers has really made it multinational so you know what people from all over the world who are leaders in their countries are popping up and commenting and speaking and sharing and it is really getting a more global sense in its current expanded version because I think in the first year was like 60 something in the second year there's over 300. (Participant C1)

> When it was a smaller community it was a lot easier to really stay involved and engage with the rest of the mentors. Now it's definitely lost that part. So, I feel like it's a little more challenging to stay really connected as part of that mentor community. (Participant T1)

Transition from Slack as an asynchronous communication channel to Microsoft's proprietary Teams application was a challenge for the original mentors. However, it held value for those who entered the program in 2018. "Like, in the Teams group there are subgroups where people have specific interests and passions and like mindedness," Participant T1 explains about their ability to connect with other mentors doing similar projects.

Experienced mentors commented on the overload and irrelevance of information. "some people would post questions about basic stuff like installing the software" (Participant M1). Mentors who had less experience with *Minecraft: Education Edition* commented on the value of the interactions, quick responses, and the ability to join specific conversations about one topic.

Peer Support Within Mentors

All of the interview participants talked about their mentoring activities with excitement. Their passion for sharing *Minecraft* and active learning gave testament to why they are mentors in this program.

> It was kind of interesting to me that Minecraft hadn't quite made it to India. I don't know that she originally knew what she was seeking mentorship in, but she was very excited. Her students when I started showing her some things in Minecraft, they did start to use it. She changed what she was teaching and I Interacted with her students too. She was getting into it and her class- they would share some things that they were doing and that was very exciting to see them come from just being this totally new thing to something that they really saw value in and were able to embrace a way of learning. Then there were others, you know a lot of times the mentoring came in the form of a school district that had decided to let a teacher use it. So, I mentored teachers that wanted to get started and didn't really know where to start. (Participant T1)

A majority of mentors engage with their own play in *Minecraft*; of respondents (n = 31), 77.42% strongly agreed that they were self-initiated learners. Approximately half of these respondents have engaged in learning about teaching and/or *Minecraft* in informal settings (e.g., afterschool program, museums, Internet). Just over two thirds of respondents strongly agreed that their passion for *Minecraft* increased because of participation in the community. This supports interest-driven and shared-purpose principles of connected learning. The Minecraft Global Mentor Program created a space for mentors, who might have been the only one they knew integrating *Minecraft*, to support each other through the interest-driven opportunities it afforded by creating a space for mentors to come together.

Conclusions and Next Steps

Peer-supported, interest-powered, and academically oriented learning are principles of connected learning, and they were evident in our findings from respondents from the 2018 Global Minecraft Mentor Program. Broadly speaking, these teachers also shared a similar pedagogical approach to implementing game-based learning in their classrooms. Some participants differentiated themselves as part of a "core group" of mentors in the community as a whole. A few were in the original pilot of five mentors (this preceded Cohort 1, in 2016). Regardless, Microsoft is a corporation and *Minecraft* is a product. The purpose of the mentor community might be to onboard new teachers, or it can be to connect large networks globally. Participants identified both frustrations and benefits of the mentor community and asynchronous collaboration space, Teams. It is notable that the growth of the program from 60 to more than 300 mentors embraced global collaboration. There was a sense that some mentors felt ownership in the program. This could also be a catalyst for collaboration and growth of the program, but it might also be detrimental to the community as a whole if an in-group and out-group mentality fully develops; it was expressed by some participants through their frustrations or affordances of the mentor group. This research gives insight into the program and experiences of the mentors in a community that may have scaled too quickly. Nonetheless, these growing pains can be harnessed as opportunities for the program to improve in future iterations.

References

2018 Global Minecraft Mentor Program. (2018, February 23). Retrieved from https://education.minecraft.net/blog/2018-global-minecraft-mentor-program-launches-with-over-300-educators/

Anderson, C. G., Dalsen, J., Kumar, V., Berland, M., & Steinkuehler, C. (2018). Failing up: How failure in a game environment promotes learning through discourse. *Thinking Skills and Creativity*, 30, 135–144. doi:10.1016/j.tsc.2018.03.002

Baker-Doyle, K. (2017). *Transformative teachers: Teacher leadership and learning in a connected world.* Cambridge, MA: Harvard Education Press.

Butler, D., Brown, M., & Críosta, G. M. (2016). *Telling the story of MindRising: Minecraft, mindfulness and meaningful learning.* International Association for Development of the Information Society. Retrieved from https://eric.ed.gov/?id=ED571584

Cantrill, C., Smith, A., West-Puckett, S., & Zamora, M. (2016). Remix as professional learning: Educators' iterative literacy practice in CLMOOC. *Education Sciences*, 6, 1–12. doi:10.3390/educsci6010012

Carpenter, J. P., Krutka, D. G., & Trust, T. (2016). 'Together we are better': Professional learning networks for teachers. *Computers & Education*. 102, 15–34.

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). London, UK: Sage.

Creswell, J. W. (2015). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage.

Davis, K., & Fullerton, S. (2016). Connected learning in and after school: Exploring technology's role in the learning experiences of diverse high school students. *Information Society*, 32(2), 98–116. doi:10.1080/01972243.2016.1130498

Dikkers, S. (2015). *TeacherCraft: How teachers learn to use* Minecraft *in their classrooms.* Pittsburgh, PA: ETC Press.

Fishman, B., Plass, J., Riconscente, M., Snider, R., & Tsai, T. (2014). Empowering educators: Supporting student progress in the classroom with digital games: A national survey. Ann Arbor, MI: University of Michigan.

Garcia, A. (Ed.). (2014). *Teaching in the connected learning classroom.* Irvine, CA: Digital Media and Learning Research Hub.

Gee, J. (2005). Semiotic social spaces and affinity spaces. In D. Barton and K. Tusting (Eds.), *Beyond communities of practice* (pp. 214–232). Cambridge, MA: Cambridge University Press.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Chicago, IL: Aldine.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., … Watkins, S. C. (2013). *Connected learning: An agenda for research and design.* Irvine, CA: Digital Media and Learning Research Hub.

Ito, M., Martin, C., Pfister, R.C., Rafalow, M. H., Salen, K., & Wortman, A. (2019). *Affinity online: How connection and shared interest fuel learning*. New York, NY: NYU Press.

Kafai, Y. B., & Burke, Q. (2016). *Connected gaming: What making video games can teach us about learning and literacy.* Cambridge, MA: The MIT Press.

Kim, Y. J., Shute, V. J., & Ventura, M. (2013). Assessment and learning of qualitative physics in Newton's playground. *The Journal of Educational Research*, 106, 423–430.

Kraut, R., & Resnick, P. (2011). *Evidence-based social design: Mining the social sciences to build online communities.* Cambridge, MA: The MIT Press.

Microsoft. (2016). *Minecraft: Education edition* [Video game]. Microsoft.

Patton, M. Q. (2001). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.

Qian, M., & Clark, K. R. (2016). Game-based learning and 21st century skills: A review of recent research. *Computers in Human Behavior*, 63, 50-58. doi:10.1016/j.chb.2016.05.023

Shute, V. J., Moore, G. R., & Wang, L. (2015). Measuring problem solving skills in Plants vs. Zombies 2.

In *Proceedings of the 8th International Conference on Educational Data Mining* (pp. 428–431). Madrid, Spain.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research techniques and procedures for developing grounded theory.* Thousand Oaks, CA: Sage.

Takeuchi, L. M., & Vaala, S. (2014). *Level up learning: A national survey on teaching with digital games*. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop.

Wenger, E., White, N., & Smith, J. D. (2012). *Digital habitats: Stewarding technology for communities.* Portland, OR: CPsquare

Acknowledgments

Meenoo Rami and the team at Microsoft Education.

7. Gameplay and Game Design to Enhance Design Thinking in Entrepreneurship Education

WILIAN GATTI JR. AND BEAUMIE KIM

Abstract: In this conceptual paper, we present a contribution to game-based learning and design thinking, which translates to teaching and learning practices. We have designed a pedagogical intervention based on a board game to engage learners and mediate the design thinking learning process in entrepreneurship education. We draw upon the idea that entrepreneurial activity is intrinsically related to designers' work. The idea of entrepreneurs as designers requires a change in the way business schools handle design thinking, and in particular, its cognitive aspect. Our intervention will allow us to examine learners' rationality in design thinking by taking 3 distinctive roles. In the first role, students as gamers will employ their cognition to design and execute their strategy to overcome their opponents, considering a general approach and emergent strategies that will arise from changes in the economic scenario and his/her competitors' decisions. Then, after students have played the game, they will role-play as designers, working in groups to redesign the played game. In the last role, students as potential entrepreneurs, we will see how learners design a business model that encompasses the product (the game), the technology applied to it, and the customers' desire. By combining the 3 roles, it is possible to analyze the design thinking development and cognition involved and the impact of the intervention on students' comprehension of entrepreneurship. Our pedagogical intervention can be positioned as a mediational artifact that supports reflection and analysis with expected positive outcomes for both deep learning and engagement.

Introduction

Entrepreneurs think and act as designers; both are motivated to create something for a purpose. Designers and entrepreneurs lead innovation trends in products, services, processes, and business models (Garbuio, Lovallo, Dong, Lin, & Tschang, 2018), designing artifacts and solving problems that challenge established technological regimes. A technological regime embodies the cognitive routines that drive a community of practitioners in their research and development (R&D) projects, leading engineers and designers to look in particular directions rather than in others (Geels, 2005).

However, the idea that entrepreneurs perform as designers requires a change in the way business schools handle design thinking, and in particular, its cognitive aspect. In this sense, before a student can deal with a "design tool" (e.g., business model canvas), she/he first needs to know how to use that tool, not necessarily the steps to reach the final result, but the rationality needed to exploit the tool. To use a metaphor, it seems that in the current entrepreneurial learning setting, students with no or little math literacy are users of electronic spreadsheets. Though this context can be improved. We need to go beyond the surface learning in which students are just following the steps to understand how to perform a task. We should reach the deep learning approach in which the student comprehends the meaning of the task and its intentional content, which allows him/her to achieve better results (Marton & Säljö, 1976).

With this goal in mind, we report in this paper a teaching and learning design to entrepreneurship education (EE) grounded in game-based learning (GBL) and design thinking. We have designed an experiential learning activity that embodied gameplay and game design to engage learners and mediate the design thinking learning process. Applying a board game as our mediational tool (Wertsch, 1998), we propose three interrelated learning experiences called

play, *design*, and *make stages*. In the first stage, the students play a board game designed to provide an introductory experience in entrepreneurship. At this stage, they build their knowledge of game mechanics and market rules to work with at the design stage. Designed for this learning activity specifically, by playing the game, students are allowed to create and execute a strategic plan to attempt to win the game. In the second step, the students are invited to redesign the game they just played and to apply various other perspectives to the original game. They are also encouraged to use analogical reasoning to identify real market mechanisms and elements and use and adapt them to their design. Finally, in the make stage, the students are asked to produce and market their redesigned games and present them in the form of a project. For the last step, the students are expected to use abductive reasoning to analyze the board game market to develop a new business model and validate their design and business solutions. At this point, we would be able to identify and compare the cognitive aspects related to design employed in the rational strategy used to win and redesign the game and also formulate the business model. The combination of all three activities makes the incorporation of design thinking in EE through design cognition possible.

Our proposal does not intend to substitute any established form of teaching and learning in EE, such as studying business cases and developing business plans, since we support the idea that effective entrepreneurs learn from multiple sources (Smilor, 1997).

Background

Business games and simulations have been used to provide learning opportunities in business since the 1930s in Europe (Faria, Hutchinson, Wellington, & Gold, 2009) and the 1950s in North America (Avedon & Sutton-Smith, 1971; Faria et al., 2009). Games are considered an important tool in education to foster student engagement (Jabbar & Felicia, 2015).

Games can be defined as "a system in which players engage in an artificial conflict, defined by rules that results in a quantifiable outcome" (Salen & Zimmerman, 2004, p. 80). Games embody the vision of "reflectively exploring phenomena, testing hypotheses and constructing objects" (Kiili, 2005, p. 14).

Although there is no consensus in the literature on the effectiveness of games and simulations as learning tools (Hays, 2005; Steinkuehler & Squire, 2014), previous research has shown their benefits in supporting student engagement (Boyle, Connolly, Hainey, & Boyle, 2012; Jabbar & Felicia, 2015) and productive student learning with good results (Clark, Tanner-Smith, & Killingsworth, 2016; Vandercruysse, Vandewaetere, & Clarebout, 2012). Gameplay is associated with learning and retention through changes in cognitive processes (Wouters, Van Nimwegen, Van Oostendorp, & Van der Spek, 2013) promoting creativity, concentration, problem solving, and enhancing the ability to process information (Sardone & Devlin-Scherer, 2016).

Even though most of the current literature on GBL emphasizes digital games, board games have persisted at homes and in schools for recreation and learning (Kwok, 2017; Sardone & Devlin-Scherer, 2016). They have been used to address many different topics, such as climate policy (Castronova & Knowles, 2015), history (Hoy, 2018), English, math, and biology (Crocco, Offenholley, & Hernandez, 2016), numerical knowledge (Ramani, Siegler, & Hitti, 2012), e-commerce (Robert & Richard, 2002), knowledge management (Taspinar, Schmidt, & Schuhbauer, 2016), accounting, finance, and marketing (Hergeth & Jones, 2003), and entrepreneurship (Fox, Pittaway, & Uzuegbunam, 2018). Furthermore, board games provide an immersive learning experience and contribute to socialization opportunities in class (Gonzalo-Iglesia, Lozano-Monterrubio, & Prades-Tena, 2018).

Games are models of systems (Kim & Bastani, 2017) and systems themselves (Fullerton, 2008). Understanding games as systems makes game design a promising learning tool for complex contexts such as entrepreneurship through a new way to construct knowledge (Kafai, 2006). Game design as a pedagogical strategy is related to design and/or

programming games that support learning objectives such as coding concepts, design literacy or design thinking, critical thinking, systems thinking, and problem solving (Kim & Bastani, 2017; Martins & Oliveira, 2018).

The use of game design as a pedagogical approach has increased, mainly with the use of computers in classrooms and the popularization of block programming tools such as Scratch, launched in 2007 (Resnick et al., 2009). However, board games encompass cheaper opportunities for design and are a real social practice, not just during the design activity but also during gameplay sessions. Nevertheless, just a small number of studies report the use of board game design in the classroom. Most of them are related to teachers' adaptation/modification of commercial games or custom-built games applied in their courses (Castronova & Knowles, 2015; Hoy, 2018; Sánchez, Parra, Marcela, & Vásquez, 2017). As an educational intervention, board game design was discussed by Kim and Bastani (2017), who showed that eighth grade students designed their own board and card games, mixing different disciplines to integrate multiple sources of knowledge (transdisciplinary approach) in science, technology, engineering, art, and math (STEAM) education.

Our Game Design

Our game, *Entrepreneurial Thinking*, is played taking turns where each turn represents one month. In each turn, a player makes up to four decisions to respond to market demands, ensure profitability, and outperform competitors. After 24 turns, the player who has the highest assets (after paying all his/her debts) wins the game. Player decisions are related to investment, marketing strategy, knowledge management, management, production system, selling, distribution system, and negotiations. As in real life, markets change according to economic events and entrepreneurs have to adapt their strategies according to the new context.

The market is represented on a main board (Figure 1), where players perform marketing research to gather information related to customers' expectations concerning product quality and price. This main board represents two provinces in Canada with cities connected by roads. Besides the customers' expectations, each city has a price for construction. Players have the possibility to build their offices, factories, and warehouses or contract a third-party logistics. These installations are essential to support company management, production, and distribution.

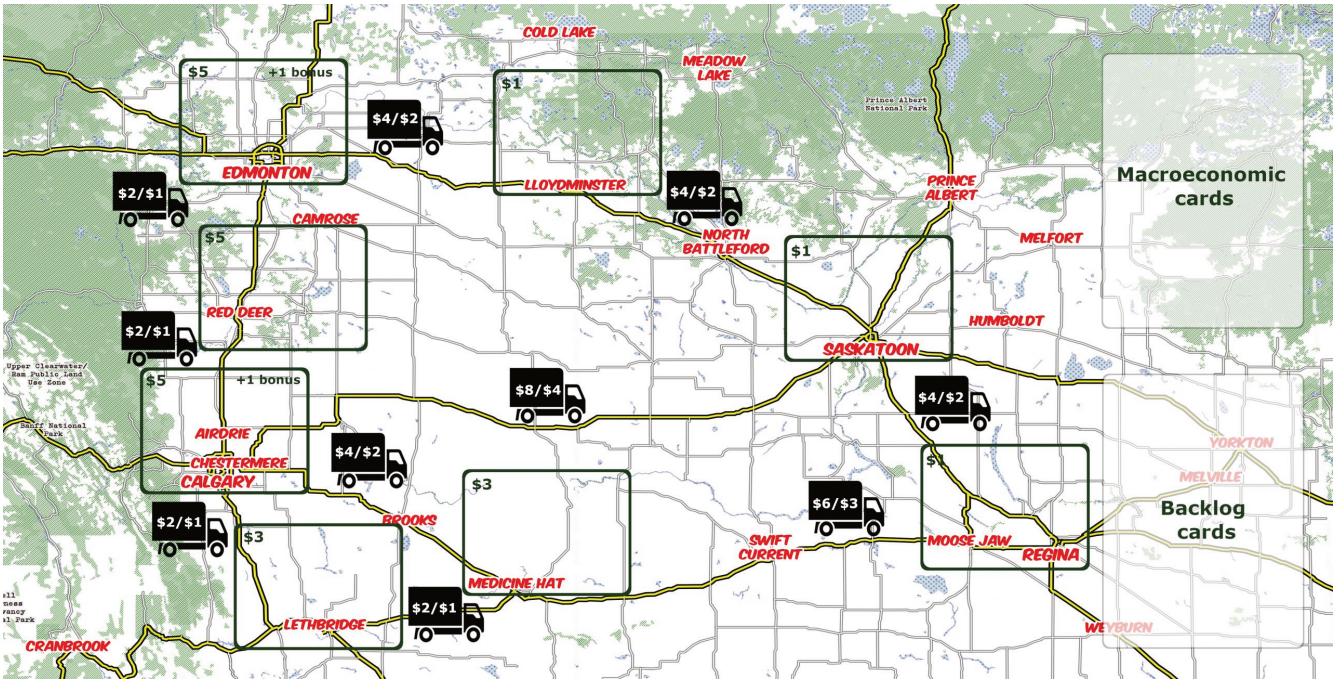

Figure 1. Main board.

A personal board represents the player's company (Figure 2). The company evolves based on the player's strategy, investment capacity, and managers hired. Hiring managers is a critical aspect of the game. To reach better performance, players need to hire executives to help them. Managers such as supply chain managers allow companies to perform better in distribution and finance executives help in the pricing process. Performing all these different roles through this game mechanic, the players act as active problem solvers experiencing the consequences of their choices (Barab et al., 2010) at the same time that they reflect on the importance of teamwork.

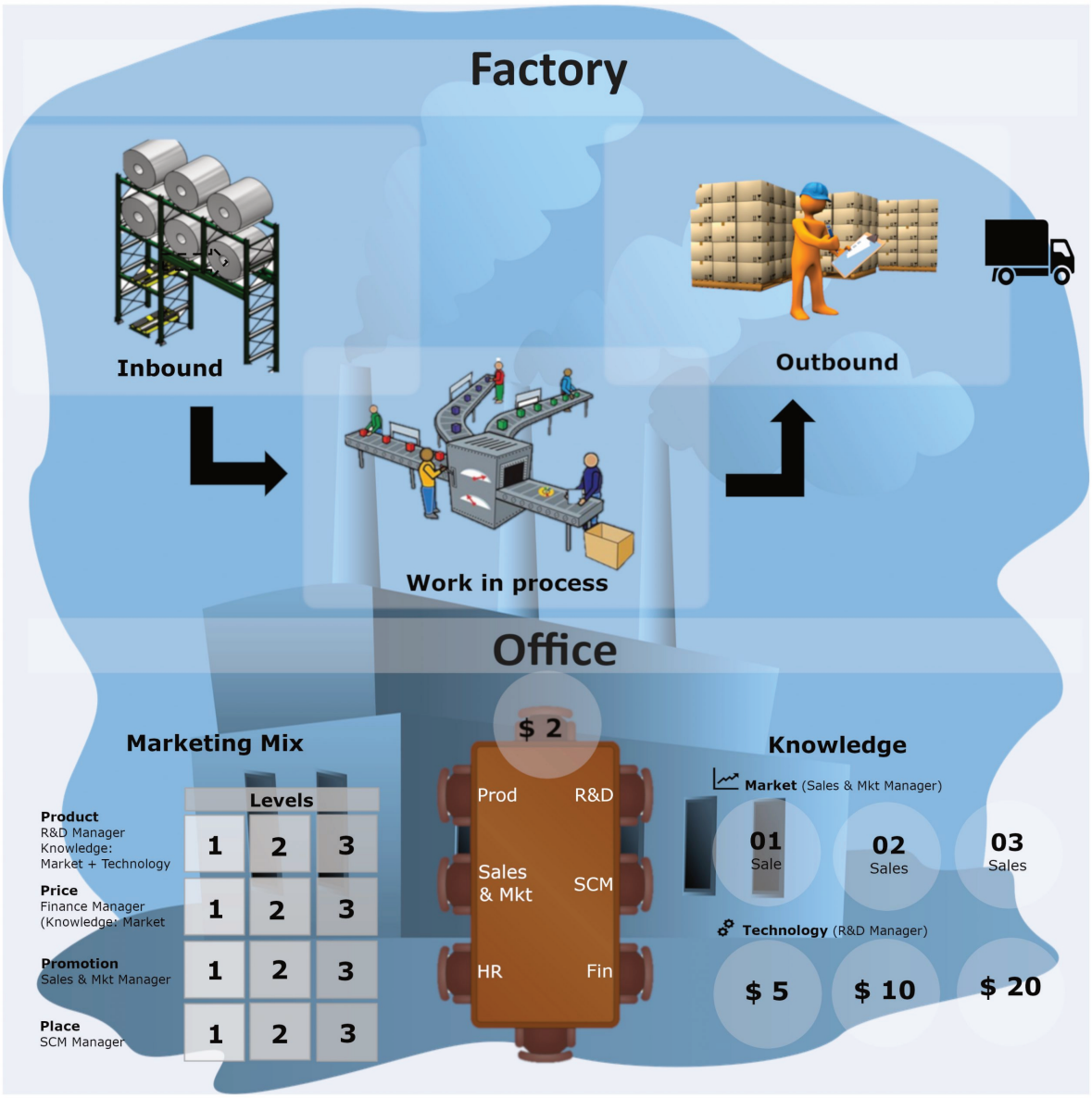

Figure 2. Player's board.

On his or her own board, the player also runs the production system by buying raw material, performing the production itself, and sending the final products to the warehouse, respecting the time needed to perform all these processes. The design of the game pursued a model that strikes a balance concerning playability and learning objectives. In this sense, our game was designed to integrate game structure, learning objectives, and gameplay enjoyment (Plass, Homer, Kinzer, Frye, & Perlin, 2011).

Intervention

In our pedagogical intervention, the students will perform different roles. In each role, the students are immersed in a system with more than one layer. Therefore, the cognitive aspects of design thinking are employed by the students to deal with the elements embedded in each layer and to integrate the different layers to form a meaningful system.

In the first stage, play, students will employ their cognition to design and execute their strategy to overcome their opponents, considering a general approach and emergent strategies that will arise from changes in the economic scenario and his/her competitors' decisions. They must integrate multiple layers, such as the elements of the game (components, mechanics, rules), their assumptions about how to run a business, and the opponents' strategy. Then, after students have played the game, the learners will role-play as designers, working in groups to redesign the played game and to integrate in one layer––the game itself, in the second layer––the relationship between the game and the players, in the third layer––the design team relationship, and in the fourth layer––their beliefs about the game, the game design, and the real business environment. In the last stage of the intervention, the make stage, we will see how the students design a business model that encompasses the product (the game), the technology applied, and the customers' desire. Three complex layers were integrated into one comprehensive system. By combining the three stages, it is possible to analyze the design thinking development and the impact of the intervention in students' comprehension of entrepreneurship.

The intervention described here is offered as opportunities for mediational action in EE but also offers challenges for educators. Garbuio et al. (2018) argued that students who are accustomed to more traditional approaches tend to resist new pedagogies because of uncertainty, messiness, and highly qualitative, real-world aspects that they embody. In turn, Günzel-Jensen and Robinson (2017) examined the barriers to adopting other methodologies considered innovative in EE. New pedagogical approaches go against the right versus wrong–answer dichotomy that permeates students' academic vision, at which the most significant accomplishment is to pass exams. This narrow vision focused on exams also leads to a lack of commitment to entrepreneurship projects that do not contribute/translate to success on exams. In addition, students are not able to reflect on their skills regarding what is essential to becoming an entrepreneur as well as gain little experience on how to create or evaluate business opportunities. Most of the new pedagogies are performed in groups; however, working in groups, students tend to hold back their opinions in order to arrive at collective decision making, which reveals a lack of self-knowledge about their role in a team. Finally, instructors have to legitimize themselves in the learning process as experts in venture creation and also as practitioners with experience in entrepreneurship. Günzel-Jensen and Robinson (2017) also clarified that instructors' legitimacy is essential to keeping students engaged.

It seems that novice teachers will face difficulties experiencing the process proposed here. Experience in dealing with students' frustrations and expectations is one of the essential requirements for instructors to perform well on the implantation of this approach in EE based on design cognition.

Conclusion

In this paper, we draw upon the idea that entrepreneurial activity is intrinsically related to designers' work. Based on that, we support the argument that a reinterpretation of design thinking in teaching and learning practices in EE is needed, mainly when we consider learning contexts with young and undergraduate students who have either no, or very limited, business experience. We build on Garbuio et al.'s (2018) argument that we should teach cognition as explicit content instead of as tools and processes that arise as a pedagogical perspective. Oxman (2001) has also made the same

claim, describing the necessity to reorient design education to a cognition-based approach rather than the production of design artifacts.

We acknowledge the importance of design cognition in the pedagogical practice of EE. However, design cognition will not replace the current EE pedagogy. As such, this paper attempts to present a complementary approach that would bring the essential cognitive tools necessary for instructors and students to creatively work the teaching-learning process aimed to create business opportunities.

In this conceptual paper, we present a contribution to GBL and design thinking, which translates to teaching and learning practices. Through different roles, students will perform design activities with the same subject and artifact but embedded in different systems interacting with distinctive elements. The result will promote a new understanding––based on cognition instead of a process––of design thinking in teaching and learning EE context.

Previous studies (Clark et al., 2016; Denner, Werner, Campe, & Ortiz, 2014; Jabbar & Felicia, 2015) have shown that specific characteristics of games (e.g., mechanics and aesthetics) support better learning and engagement. Our proposal hopes to contribute to the existing literature looking at how game mechanics and other game features contribute to enhancing particular aspects of design cognition, most of which will inform relevant game design attributes to EE. This is relevant as it will not only improve our own design but support future game design in the same field. Moreover, our findings will contribute to the literature in the field, since most of the current research is focused on digital games despite the revival of board games in the game market.

Our proposal also hopes to contribute to deep learning in EE, which is related to reflection (Neck & Greene, 2011). Our pedagogical intervention can overcome the logic of immediacy and urgency, supporting opportunities for reflection and analysis with expected positive outcomes for both deep learning and engagement. Furthermore, our intervention is design oriented, which requires an active learning posture and the synthesis of multiples sources of knowledge. Identifying and understanding which design aspects from our intervention support deep learning will be a contribution to future designs in EE.

References

Avedon, E. M., & Sutton-Smith, B. (1971). *The study of games*. New York, NY: John Wiley & Sons.

Barab, S. a., Dodge, T., Ingram-Goble, A., Pettyjohn, P., Peppler, K., Volk, C., & Solomou, M. (2010). Pedagogical dramas and transformational play: Narratively rich games for learning. *Mind, Culture, and Activity*, 17(3), 235–264. https://doi.org/10.1080/10749030903437228

Boyle, E., Connolly, T. M., Hainey, T., & Boyle, J. M. (2012). Engagement in digital entertainment games: A systematic review. *Computers in Human Behavior*, 28(3), 771–780. https://doi.org/10.1016/j.chb.2011.11.020

Castronova, E., & Knowles, I. (2015). Modding board games into serious games: The case of Climate Policy. *International Journal of Serious Games*, 2(3), 41–62. https://doi.org/dx.doi.org/10.17083/ijsg.v2i3.77

Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. *Review of Educational Research*, 86(1), 79–122. https://doi.org/10.3102/0034654315582065

Crocco, F., Offenholley, K., & Hernandez, C. (2016). A proof-of-concept study of game-based learning in higher education. *Simulation and Gaming*, 47(4), 403–422. https://doi.org/10.1177/1046878116632484

Denner, J., Werner, L., Campe, S., & Ortiz, E. (2014). Using game mechanics to measure what students learn from programming games. *International Journal of Game-Based Learning*, 4(3), 13–22. https://doi.org/10.4018/ijgbl.2014070102

Faria, A. J., Hutchinson, D., Wellington, W. J., & Gold, S. (2009). Developments in business gaming: A review of the past 40 years. *Simulation & Gaming*, 40(4), 464–487. https://doi.org/10.1177/1046878108327585

Fox, J., Pittaway, L., & Uzuegbunam, I. (2018). Simulations in entrepreneurship education: Serious games and learning through play. *Entrepreneurship Education and Pedagogy*, 1(1), 61–89. https://doi.org/10.1177/2515127417737285

Fullerton, T. (2008). *Game design workshop: A playcentric approach to creating innovative games* (2nd ed.). Burlington, MA: Morgan Kaufmann.

Garbuio, M., Lovallo, D., Dong, A., Lin, N., & Tschang, T. (2018). Demystifying the genius of entrepreneurship: How design cognition can help create the next generation of entrepreneurs. *Academy of Management Learning & Education*, 17(1), 41–61. https://doi.org/10.5465/amle.2016.0040

Geels, F. W. (2005). The dynamics of transitions in socio-technical systems: A multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). *Technology Analysis & Strategic Management*, 17(4), 445–476. https://doi.org/10.1080/09537320500357319

Gonzalo-Iglesia, J. L., Lozano-Monterrubio, N., & Prades-Tena, J. (2018). The usage of game-based learning in university education. How to motivate and foster creativity among adult students through board games. In *Proceedings of Play2Learn* (pp. 67–84). Lisbon, Portugal. Retrieved from http://gamilearning.ulusofona.pt/play2learn-2018-proceedings/

Günzel-Jensen, F., & Robinson, S. (2017). Effectuation in the undergraduate classroom: Three barriers to entrepreneurial learning. *Education + Training*, 59(7/8), 780–796. https://doi.org/10.1108/ET-03-2016-0049

Hays, R. T. (2005). *The effectiveness of instructional games: A literature review and discussion*. Orlando, FL: Naval Air Warfare Center Training Systems Division. Retrieved from https://apps.dtic.mil/dtic/tr/fulltext/u2/a441935.pdf

Hergeth, H. H., & Jones, M. R. (2003). Board games and teaching textile marketing and finance. *Developments in Business Simulation and Experiential Learning*, 30, 126–130.

Hoy, B. (2018). Teaching history with custom-built board games. *Simulation & Gaming*, 49(2), 115–133. https://doi.org/10.1177/1046878118763624

Jabbar, A. I. A., & Felicia, P. (2015). Gameplay engagement and learning in game-based learning: A systematic review. *Review of Educational Research*, 85(4), 1–40. https://doi.org/10.3102/0034654315577210

Kafai, Y. B. (2006). Playing and making games for learning: Instructionist and constructionist perspectives for game studies. *Games and Culture*, 1(1), 36–40. https://doi.org/10.1177/1555412005281767

Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. *Internet and Higher Education*, 8(1), 13–24. https://doi.org/10.1016/j.iheduc.2004.12.001

Kim, B., & Bastani, R. (2017). Students as game designers: Transdisciplinary approach to STEAM education. *Alberta Science Education Journal* (ASEJ), 45(1), 45–53.

Kwok, R. (2017). Game on. *Nature*, 547, 369–371. https://doi.org/10.1038/nj7663-369a

Martins, A., & Oliveira, L. (2018). Educational video game design by 8th graders: Investigating processes and outcomes. In *Proceedings of 12th European Conference on Game-Based Learning* (pp. 379–387). Sophia-Antipolis, France: ACPI.

Marton, F., & Säljö, R. (1976). On qualitative differences in learning: I—Outcome and process. *British Journal of Educational Psychology*, 46, 4–11. https://doi.org/10.1111/j.2044-8279.1976.tb02980.x

Neck, H. M., & Greene, P. G. (2011). Entrepreneurship education: Known worlds and frontiers. *Journal of Small Business Management*, 49(1), 55–70. https://doi.org/10.1111/j.1540-627X.2010.00314.x

Oxman, R. (2001). The mind in design: A conceptual framework for cognition in design education. In C. M. Eastman, W. M. McCracken, & W. C. Newstetter (Eds.), *Design knowing and learning: Cognition in design education* (pp. 269–295). Kidlington, UK: Elsevier. https://doi.org/10.1016/B978-008043868-9/50012-7

Plass, J. L., Homer, B. D., Kinzer, C., Frye, J., & Perlin, K. (2011). *Learning mechanics and assessment mechanics for games for learning* (White paper # 01/2011). New York, NY: Institute for Games for Learning. https://doi.org/10.13140/2.1.3127.1201

Ramani, G. B., Siegler, R. S., & Hitti, A. (2012). Taking it to the classroom: Number board games as a small group learning activity. *Journal of Educational Psychology*, 104(3), 661–672. https://doi.org/10.1037/a0028995

Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., … Kafai, Y. (2009). Scratch: Programming for all. *Communications of the ACM*, 52, 60–67. https://doi.org/10.1145/1592761.1592779

Robert, G., & Richard, D. (2002). The E-Commerce GameTM: A strategic business board game. *Developments in Business Simulation and Experiential Learning*, 29, 195–207.

Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge, MA: The MIT Press.

Sánchez, J. S., Parra, J. D., Marcela, L., & Vásquez, L. (2017). Design of a game to make decisions under pressure. *Developments in Business Simulation and Experiential Learning*, 44, 189–195.

Sardone, N. B., & Devlin-Scherer, R. (2016). Let the (board) games begin: Creative ways to enhance teaching and learning. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 89(6), 215–222. https://doi.org/10.1080/00098655.2016.1214473

Smilor, R. W. (1997). Entrepreneurship reflections on a subversive activity. *Journal of Business Venturing*, 12(5), 341–346. https://doi.org/10.1016/S0883-9026(97)00008-6

Steinkuehler, C., & Squire, K. (2014). Videogames and learning. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (2nd ed.). New York, NY: Cambridge University Press.

Taspinar, B., Schmidt, W., & Schuhbauer, H. (2016). Gamification in education: A board game approach to knowledge acquisition. *Procedia Computer Science*, 99(October), 101–116. https://doi.org/10.1016/j.procs.2016.09.104

Vandercruysse, S., Vandewaetere, M., & Clarebout, G. (2012). Game-based learning: A review on the effectiveness of educational games. In M. M. Cruz-Cunha (Ed.), *Handbook of research on serious games as educational, business and research tools* (pp. 628–647). Hershey, PA: IGI Global. https://doi.org/10.4018/978-1-4666-0149-9.ch032

Wertsch, J. (1998). *Mind as action*. New York, NY: Oxford University Press.

Wouters, P., Van Nimwegen, C., Van Oostendorp, H., & Van der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, 105(2), 249–265. https://doi.org/10.1037/a0031311

8. Are Your Students 'Slack'ers?

Using Cloud-Based Communication to Elicit Peer and Instructor Feedback

JASON R. HARRON, RYAN MYERS, AND JOAN E. HUGHES

Abstract: Slack is a popular cloud-based communication tool that is increasingly being used for collaborative learning in higher education. This study found that Slack was a viable tool for eliciting peer and instructor feedback as part of a face-to-face interdisciplinary project-based course. Students elicited feedback by directly requesting it from either their peers or instructors. Feedback was also provided via unsolicited advice or recommendations. Positive affirmations from both peers and instructors were the most common form of feedback. Slack provided a space outside of the learning-management system (LMS) where students could post photo and video updates about their project while engaging in (a)synchronous communication. Members of the Slack learning community were able to participate at their own pace and could choose whether they wanted to reply outside of traditional working hours.

Introduction

The use of learning-management systems (LMS), such as Blackboard and Canvas, have become the norm in facilitating face-to-face, blended, and online learning in higher education. These platforms provide a digital space for online collaboration where instructors can deliver course content, communicate with students, track their progress, and manage grades. However, "LMS are owned by companies that tightly control their platforms, making it difficult to expand the feature sets and integrate external resources in ways that best align with evolving institutional needs and pedagogies" (Adams Becker et al., 2017, p. 44). As a result, many faculty and students are accessing tools and apps that are not integrated within the LMS. This is especially true for project-based courses, in which students are often left to manage their own communication, file management, project roles, and schedules. Since these external tools and apps are not incorporated into the existing LMS, it makes it difficult for both instructors and peers to provide timely and constructive feedback.

The Role of Feedback in Collaborative Learning

Feedback is an essential part of collaboration since social interactions help to facilitate the co-construction of knowledge (Lipponen, 2002). As such, participants in learning communities mutually depend on each other in order to build shared understandings. This process of knowledge building can be supported by software platforms that serve as knowledge-building environments (KBE), where participants can create new meanings through social collaboration in order to resolve personal understandings (Stahl, 2000). LMS have the capability to serve as KBE, since their social tools provide a platform where knowledge can be co-constructed through dialogue and feedback while also maintaining a record of student learning.

Resta and Lee (2010) believe that both individual and group accountability are essential for successful online collaboration. Their research shows that while peer assessment can lead to a satisfying experience that ultimately deepens student learning, it can also hamper student learning if peers lack the expertise needed to give proper feedback.

Peer feedback is also impacted by the amount of group or team building that takes place in the community (Resta & Lee, 2010). As such, the social pressures of the community directly affect how comfortable students are with providing suggestions when work does not meet both individual and shared expectations.

Current LMS provide opportunities for both students and instructors to offer feedback. For example, the Canvas LMS has the option for instructors to create electronic assignments that students submit online and which are then graded by the instructor or through peer review. This can be done through comments and rubrics, and students in turn can respond to comments to create an electronic dialogue with the instructor. Similarly, the discussion feature in Canvas provides a forum where both students and instructors can pose questions, reply to each other's posts, and provide feedback. However, these affordances are lost once students begin to engage in online collaboration with tools and apps that are not built into the LMS. With the increased use of external tools and apps in mind, we turn our attention to Slack—a cloud-based communication tool that has been popular in the workplace, which "also holds compelling implications for collaborative learning" (Adams Becker et al., 2017, p. 44).

What Is Slack?

Slack, which was released in 2014, was originally developed as an internal collaboration tool for a gaming company (Anderson, 2016). Unlike most real-time messaging platforms that have interfaces designed only for mobile devices, Slack is designed to be fully functional on computers, tablets, and smartphones. The platform has adopted several social media conventions such as the use of hashtags (#) for topics and channels, the *at* sign (@) for direct messaging another user, and emojis to "like" a post (Anderson, 2016). The design of Slack centers around the use of teams in a virtual shared workspace. Team members can join a workspace through an invitation sent to their email address. Upon the creation of a new Slack workspace, channels called #general and #random are automatically generated. Team members may add new channels that are public to all members or limited to specific team members via private invitation. The use of multiple channels provides a "right place" for conversations to happen (McCracken, 2015). The tool also integrates external apps for file management and allows for the embedding of multimedia.

Slack as a Collaborative Learning Tool in Higher Education

The emerging research involving Slack has involved both blended and online learning environments. Altebarmakian and Alterman (2017) used Slack to communicate as part of a blended course on computer-supported learning. They found that students enrolled in the course used Slack to create channels and manage to-do lists; however, communication between peers was often superficial with comments that did not warrant a response. Sabin and Olive (2018) used Slack with an online course as a platform to improve communication between instructors and peers while also delivering diverse and dynamic course content. They found that about one third of the students were enthusiastic about using Slack and that the instructors perceived Slack as enriching their online teaching and interactions with students. However, the authors recommend that instructors adopt active and social learning frameworks in order to improve communication and collaboration, as well as building more meaningful social relationships among students.

As part of a case study, Tuhkala and Karkkainen (2018) investigated how Slack could support peer interactions in a master's thesis seminar course. All out-of-class communication took place via Slack, with students completing questionnaires at the end of the course. Results showed that students perceived Slack as easy to use, provided a relaxed environment when asking for assistance, and that participants had high intentions to use Slack in the future. However, students expressed frustration at being asked to use different communication tools in different courses. Zhang, Meng, Ordóñez de Pablos, and Sun (2019) used surveys and structural equation modeling to measure students' mutual trust,

social influence, and reward valence in connection to teamwork engagement as part of an eight-week postgraduate business course in China. Results showed that group members engaged more in Slack when they perceived mutual trust among their group members, and that the social influence of both fellow group members and the instructor had a positive effect on engagement. Furthermore, teamwork engagement had a positive effect on personal success.

Research Question

Although these studies are useful in developing a better understanding of how both students and instructors perceive the use of Slack as a communication and collaboration tool, there is a lack of research that examines the dialogue that takes place when providing both peer and instructor feedback via Slack. As such, this paper seeks to answer the research question: How is peer and instructor feedback elicited using a cloud-based communication tool, such as Slack?

Theoretical Framework

The connected learning framework is a theoretical framework that recognizes that learning is "socially embedded, interest-driven, and oriented toward educational, economic, or political opportunity" (Ito et al., 2013, p. 4). Connected learning is framed around three learning principles, which include: (a) Everyday exchanges of sharing and giving feedback are *peer-supported*; (b) learning becomes *interest-powered* when the subject is of both personal interest and relevant; and (c) that learning is *academically oriented* when learners can engage in social, civic, or career engagement. Furthermore, this framework espouses that the learning experience should follow three design principles, which include: (a) The use of digital tools should be *production-centered* in that learners actively create and experiment with content; (b) the design should be around a *shared purpose* made up of common goals and interests; and (c) the design should be *openly networked* where "online platforms and digital tools can make learning resources abundant, accessible, and visible across all learner settings" (Ito et al., 2013, p. 12).

The collaborative nature of Slack has allowed it to become an online platform that exemplifies both the design and learning principles of the connected learning framework. With its roots in workplace collaboration, Slack thrives as a production-centered space where animated GIFs, photos, and videos are easily uploaded and shared with peers. The ability to add channels makes it possible to customize the workspace, where members can still engage in the #random water cooler conversations while also remaining academically oriented and interest-powered while communicating in their team channel. In addition, the openly networked abilities of the platform allow for peer support to thrive, providing a space where students can elicit feedback from both their peers and instructors.

Methods

In the section below we outline the participants, how they were recruited, and how Slack data were both collected and analyzed in this study.

Participants

Participants included 23 undergraduate students and two instructors who used Slack as their primary communication tool for a face-to-face interdisciplinary project-based course focused on creating practical movie special effects (i.e., physical effects without the use of computer-generated images). This 14-week course took place at a large research institution in the United States during the fall of 2018. The instructors actively recruited students from multiple colleges to create a diverse interdisciplinary cohort. Participants' majors included Engineering (7), Theatre and Dance (7), Arts, Entertainment, and Technology (4), Radio, Television, and Film (3), Studio Art (1), and a double major in French and Design Arts and Media (1). Of the student participants, 12 were female and 11 were male. One male instructor had 15 years' experience in technical theater design and one female instructor had 25 years in scenic design.

Recruitment for the Study

Recruitment for the study was done during the first physical meeting of the course. The instructors were asked to leave the room during student recruitment. All 23 undergraduate students consented to participate in the study. Undergraduate participants were offered $50 cash compensation as part of a larger study for the first author's dissertation. The two instructors were approached outside of class hours for their consent to participate in the study. The instructors were not offered any cash compensation for participation and were not informed of which students consented to the study.

Data Collection

Slack data collection began during the second week of the course. The instructors renamed the default #general channel to #announcements, left #random unaltered, and added #questions about four weeks into the course. Students created three additional channels for sharing resources, arranging a visit to a haunted house, and organizing an end-of-semester holiday party. In total, there were 11,428 messages consisting of 6,323 public channels messages and 5,105 private direct messages. Over 5.9GB of files were posted, comprising primarily photos and video. This course used the free version of Slack, which limits users to seeing the 10,000 most recent messages and limits storage to 5.0GB. All messages were backed up once a week using Slack's export tool and multimedia were manually downloaded to ensure no data were lost once the message and storage threshold were crossed.

Data Analysis

Slack export files for each channel were parsed into a spreadsheet that the authors could access remotely via Google Sheets. Following the guidelines for open-thematic coding (Miles, Huberman, & Saldaña, 2013), the first and second author coded the first 200 messages from the channel #team1 to create a codebook including the name of the code, definition, inclusion criteria, exclusion criteria, and an example. To ensure interrater reliability (IRR), the authors engaged in constant comparison (Creswell, 2014), in which codes were compared and negotiated until there was agreement based on the criteria of the codebook. If new codes were added to the codebook all previous messages were reviewed and modified if needed. Over two months, the researchers compared a total of 2,141 messages at a rate of about 300 per week. Because of the size of the corpus, coding was limited to public channels, student-generated channels, and two of the seven team channels. Team channels ranged from 153 to 1,291 messages with a mean of 773. #team1 and

#team2 were selected since they represented moderate-use cases with 578 and 649 messages each. In total, 2,141 of the 6,323 messages were coded for this study, representing over one third of the entire Slack data corpus (33.86%).

Results

In the section below we describe the results about eliciting peer and instructor feedback via cloud-based communication. Our results found that feedback came in five different categories: (a) student requesting feedback from peers, (b) student requesting feedback from instructor, (c) unsolicited peer feedback, (d) unsolicited instructor feedback, and (e) peer and instructor affirmations.

Time	Person	Message
15:25:22	Student 1	<@Student 2> can you give the design brief a once over. I believe everything is finished but I want to make sure you have a chance to look it over before we ask for <Instructor 2> and <Instructor 1> for feedback
16:18:16	Student 2	Sorry just saw you message I can look at it right now *Student 1 reacted with* 👍 1
16:18:34 16:37:56	Student 2 Student 2	Also I will see what I can do <@Student 1> <@Student 1> <@Student 3> I made some edits and withheld from approval so you guys can review and approve if you agree. I mostly made edits to try to get our brief down to one page. I think it's important that our design brief is concise. If you could look at my suggested edits that would be great. Whether approved or not I think it will be good to send to <Instructor 1> and <Instructor 2> once you have reviewed the edits 👍 *[:Thumbs-up: in message]* *Instructor 1 reacted with* 👍 1
16:39:54	Instructor 1	Concise is good. Love one pagers. *Student 2 reacted with* 👍 1 *Instructor 2 reacted with* ❤️ 1

Table 1. Example of student requesting feedback from peers.

The first form of eliciting feedback came through direct requests from students to their peers (see Table 1). One example is requesting peers to review or edit documents stored remotely. As seen in the example in Table 1, students could perform peer review asynchronously and provide each other with updates when tasks were complete. Peers responded in both text and reaction emojis, and using the *at* sign (@) allowed students to directly message their peers and instructors. Of note in this example, dialogue shifted from asynchronous to synchronous feedback as the exchange progressed.

The second form of eliciting feedback came through direct requests from students to their instructors (see Table 2). In the example in Table 2, a student is requesting feedback about the movie demo reel two days before its final presentation. Of note in this example are both the time at which the dialogue took place and the length of the instructor's response. This exchange happened around 11 p.m. on a Saturday night, which represents an outlier in the data corpus. In addition, this example demonstrates that feedback via Slack can be as detailed as an email response.

Time	Person	Message
22:38:43	Student 3	I just uploaded a draft of our demo reel to our box folder. <@Instructor 1> I know its late but do you think you'll have time to give us feedback by tomorrow? I was trying to finish it this afternoon but we had a hard drive crisis 😬 *[:grimacing:]*
23:11:27	Instructor 1	This is so good your guys. I like ho you used your story boards. And the music is great! All my comments are little tweaks. Mostly I think could cut between 20 and 30 seconds out of this to pick up the pace. For example at 0:36 you say your were the pitcher and then go on to describe what a pitch is. I would cut that. 1:13 there are some mumbles about fabrication that could be cut. [...]

Note. [...] is used to represent 14 lines of text that were omitted due to space.

Table 2. Example of student requesting feedback from instructor.

Time	Person	Message
16:05:52	Student 1	Look how mesmerizing this is [Video clip of animated OLED eyeball] *Student 2 and 3 reacted with* ❤️ 2 *Student 2 also reacted with* 1
23:49:37	Instructor 1	Oh! That is crazy cool!
8:36:38	Instructor 2	This is AMAZING!!!! Such fine work team <#team2> 👏👏👏👏👏 *[:clap:]*
10:25:25	Instructor 1	I just realized shouldn't the iris get smaller when exposed to more light?
10:26:24	Student 1	I noticed that too. I should be able to fix that by just reversing the min and max value. Haven't tried it yet though

Table 3. Example of unsolicited instructor feedback.

The third form of eliciting feedback came through unsolicited responses from the instructors (see Table 3). In the example in Table 3, Student 1 posts a video update of the group project, which features an animated eye on an OLED display–powered single-board microprocessor. This dialogue begins with reaction emojis from peers, followed by an affirmation from Instructor 1 (note again the time of the instructor's response). This dialogue continues the next day with Instructor 2 also providing an affirmation. This example is unique because the exchange does not terminate with the affirmation, but leads to a critical piece of feedback from Instructor 1.

Person	Message
Student 4 Student 4	First print failed trying again with rafts Second print failed
Student 5	Are you printing supports?
Student 4 Student 4	It won't even get to the supports The clippy part of each finger is so thin it peels up and clumps
Student 5 Student 5	Hmmmm You're printing pla?
Student 4	Yup
Student 5 Student 5	Is the bed heated? Other than that I'd ask if you can use hairspray or something to make it stick

Table 4. Example of unsolicited peer feedback.

The fourth form of eliciting feedback came through unsolicited responses from peers (see Table 4). In the example in Table 4, Student 4 is providing real-time updates about multiple 3D print jobs that are failing. Student 5 interjects with questions in an attempt to help troubleshoot the issues. The dialogue terminates with unsolicited feedback with a suggestion about using hairspray to adhere filament to the print bed. From an interdisciplinary stance, this exchange is of interest since it involves a theater and dance major with experience in 3D printing remotely assisting a mechanical engineer in the troubleshooting process.

Time	Person	Message
11:29:40	Student 5	This is a test with some silver spray paint I have- thoughts? [Photo of the paint sample on a piece of foam]
11:29:59	Student 4	I think it looks good
11:37:16 12:23:06	Student 5 Student 5	About to paint! [Photo of unpainted project] Painting! [Photo of painted project]
12:29:45	Instructor 1	Cuuuuuuute!
13:14:58	Student 5	[Photo of painted project]
13:15:32	Student 4	Wow that looks great

Table 5. Example of peer and instructor affirmation in response to project updates.

The fifth form of eliciting feedback came through peer and instructor affirmations (see Table 5). In the example in Table 5, Student 4 post photos of paint samples on a piece of foam before applying the paint to the project. After Student 4 receives positive feedback from Student 5, she begins to post updates about the painting progress. After these updates, both Instructor 1 and Student 5 respond with affirmations that are positive in nature but do not constitute as substantial

feedback. This replicates the findings from our literature review, which found communication was often superficial via Slack.

Discussion

Based on our findings, using Slack provided an additional space outside of the LMS where students and instructors could engage in casual conversation while still providing both peer and instructor feedback. The (a)synchronous affordances of Slack allowed for communication to flow at a causal pace, proved more timely than scheduling in-person meetings, and replaced the need for lengthy email exchanges. While face-to-face communications terminates at the end of the meeting, Slack conversation can span several hours or even days, which allows members of the community to participate at their own pace.

Since the platform is available 24/7, it is up to both students and instructors to decide when they choose to interact via Slack. Instructors teaching with Slack may choose to set boundaries in terms of times when students can directly contact them. By default, Slack is set to snooze from 10 p.m. until 8 a.m., but as noted in our examples, conversations did take place during snooze hours. This may indicate that Slack could become yet another digital distraction, running the risk of transitioning from being a novel and informal way of communicating to becoming the next email inbox.

Unsolicited instructor feedback was quite common and happened at all hours of the day. Unsolicited peer feedback, however, was very uncommon via Slack. As supported by Resta and Lee (2010), the online community, viewable to all peers and instructors, may influence their activity when providing feedback. In addition, text-based affirmations were a common form of feedback from both peers and instructors. These affirmations were always positive and functioned as the equivalent of hitting the "like" button on other social platforms such as Facebook or Twitter.

Limitations

This study was limited to peer and instructor feedback in Slack and did not investigate how feedback was provided in person or via the LMS. The data analyzed for this study examined only two out of seven team channels, so other types of feedback may have been present in the low- and high-message channels. This use of Slack was limited to a unique case study at a research university, so findings may not be generalizable to other settings. Research about Slack as a collaborative learning tool in higher education is still emerging, thus further research needs to be done to learn about how the platform can be used to elicit peer and instructor feedback.

Conclusion

This study found that Slack was a viable tool for eliciting peer and instructor feedback as part of an interdisciplinary project-based course that had weekly face-to-face meetings. Students elicited feedback by directly requesting it from either their peers or instructors. Unsolicited feedback came in the form of advice or recommendations made by instructors, but rarely by peers. Instead, positive affirmations from both peers and instructors were the most common form of feedback. The platform provided a space outside of the LMS where students could post photo and video updates about their project while engaging in (a)synchronous communication. Members of the Slack learning community were

able to participate at their own pace and could choose whether they wanted to reply outside of traditional working hours.

References

Adams Becker, S., Cummins, M., Davis, A., Freeman, A., Hall Giesinger, C., & Ananthanarayanan, V. (2017). *NMC Horizon Report: 2017 Higher Education Edition*. Austin, TX: The New Media Consortium. Retrieved from http://cdn.nmc.org/media/2017-nmc-horizon-report-he-EN.pdf

Altebarmakian, M., & Alterman, R. (2017). *Engagement and social cohesion in an online collaborative learning environment* (Report No. CS-17-290). https://doi.org/10.13140/RG.2.2.17630.13122

Anderson, K. E. (2016). Getting acquainted with social networks and apps: Picking up the Slack in communication and collaboration. *Library Hi Tech News*, 3(9), 6–9. https://doi.org/10.1108/LHTN-10-2016-0049

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., … Watkins, S. C. (2013). *Connected learning: An agenda for research and design*. Irvine, CA: Digital Media and Learning Research Hub.

Lipponen, L. (2002). *Exploring foundations for computer-supported collaborative learning*. In *CSCL '02 Proceedings of the Computer Supported Collaborative Learning* (pp. 72–81). New York, NY: ACM. https://doi.org/10.3115/1658616.1658627

McCracken, H. (2015, February 19). How Slack uses Slack. *Fastcompany.com*. Retrieved from https://www.fastcompany.com/3040638/how-slack-uses-slack

Miles, M. B., Huberman, A. M., & Saldaña, J. (2013). *Qualitative data analysis: A methods sourcebook*. Thousand Oaks, CA: Sage.

Resta, P., & Lee, H. (2010). Peer and self-assessment. In R. Ubell (Ed.), *Virtual teamwork: Mastering the art and practice of online learning and corporate collaboration* (pp. 45–64). Hoboken, NJ: John WIley & Sons.

Sabin, J., & Olive, A. (2018). Slack: Adopting social-networking platforms for active learning. *PS: Political Science & Politics*, 51(1), 183–189. https://doi.org/10.1017/S1049096517001913

Stahl, G. (2000). A model of collaborative knowledge-building. In B. Fishman & S. O'Connor-Divelbiss (Eds.), *Fourth International Conference of the Learning Sciences* (pp. 70–77). Mahwah, NJ: Erlbaum.

Tuhkala, A., & Karkkainen, T. (2018). Using Slack for computer-mediated communication to support higher education students' peer interactions during master's thesis seminar. *Education and Information Technologies*, 23(6), 2379–2397. https://doi.org/10.1007/s10639-018-9722-6

Zhang, X., Meng, Y., Ordóñez de Pablos, P., & Sun, Y. (2019). Learning analytics in collaborative learning supported by Slack: From the perspective of engagement. *Computers in Human Behavior*, 92, 625–633. https://doi.org/10.1016/j.chb.2017.08.012

9. Creative Production With Tablet Applications for Learning Digital, Social, and Interpersonal Skills in the Primary-Level Classroom

VELISLAVA HILLMAN

Abstract: This paper looks at a primary school curriculum for information and communication technologies (ICT) and the digital skills taught and practiced by students during these lessons in comparison to their practices and experiences outside school. Discrepancies between what children make with digital tools outside school and during ICT lessons are identified and used to design and test a model that enables digital, social, and interpersonal skills learning and practice. The paper presents the tested model as a proposal to transform the primary school ICT curriculum and pave the way for contextual digital, social, and interpersonal skills learning and practice.The skills children need to acquire today to ensure future job security are evolving from "perennial" skills to "contextual" (Dede, 2009). The ability to collaborate with people from various backgrounds is of growing importance in information-based economies where work is no longer a solitary experience as in the past (Karoly & Panis, 2004). Classrooms should provide opportunities for group collaboration and contextual digital skills learning and practice. This research demonstrates the objective to use primary-level ICT lessons as a platform where children can learn such skills.

From Technical to Contextual Digital, Social, and Interpersonal Skills

This paper addresses the question of creative production as a means to acquiring contextual digital skills and fostering social and interpersonal learning as part of the information and communication technologies (ICT) curriculum in the primary education in one European country, Malta. It explores how, through digital applications (apps), children can self-organize to create projects, stories, or games as a means to acquiring such skills.

Making things can be seen as a way for one to express personal ideas and views (Gauntlett, 2007) or as a process of learning (Papert, 1980; Resnick, 2017). When children engage in making projects, stories, or games using digital media they can learn in an interdisciplinary and self-driven way (Guay, Ratelle, & Chanal, 2008; Kafai, 2006). Cebeci and Tekdal (2006) emphasize the learning opportunities that stem from producing podcasts. Ejsing-Duun and Skovbjerg (2016) analyze how Danish children tap into existing knowledge to develop further when they engage creatively with digital reproduction during mathematics and Danish. These are some examples of the benefits when engaging in creative production with digital media. Yet there is little research to demonstrate that such methods work in the primary-level classroom.

With the growing use of data-driven automation and decision making it no longer suffices for ICT lessons in primary schools to equip children with solely technical skills (i.e., knowing how to use Excel, a software program), but lessons should also provide contextual skills that enable group collaboration and self-organization and enable connected learning across disciplines and systems. Thus, a model is proposed (see Figure 1) to replace the ICT curriculum whereby children engage in creative production with the available digital tools as a means to foster self-organized and interdisciplinary learning and practice of digital, social, and interpersonal skills.

Context

In 2014 the government of Malta launched a national one-tablet-per-child policy (Ministry for Education and Employment, 2014). It aimed to introduce digital tablets—LearnPads—to Year 4 and Year 5 students, aged 7 to 10, to modernize the curriculum, to encourage digital media literacy, and to support learning (Department of eLearning, 2015). While there is a global call to bring up digitally literate and critical young thinkers, the reality is that classroom initiatives to attain such goals vary and so do the outcomes. Although research was conducted in a European setting, the proposed model (see Figure 1) can have a wider application across primary schools with digital literacy initiatives.

The current ICT curriculum in Malta for Grades 3 to 5 (7–10-year-olds) has limited learning objectives in comparison to what children this age group typically do with digital devices outside school, as preliminary research for this paper has identified. The discrepancy between in- and outside-school activities presents a drawback to pursuing children's greater potentials (Vygotstky, 1978), since use in class is bound by the curriculum and not flexible to accommodate children's perspectives, skills, and motivations. As the ICT lessons do not provide opportunities that students find outside school, their perspective on what interests them or what they might want to explore further is left out. This can lead to children's disengagement in class while they can also miss out on other learning opportunities.

Research Questions and Methodology

This paper focuses primarily on the skills that children aged 7–10 practice and acquire when they engage in organized creative production using digital applications. The identified skills become the learning objectives that can serve to improve the ICT curriculum at the primary-school level. The guiding research questions were:

1. What do children make in and outside of school with digital tools from children's, parents', and teachers' perspectives?
2. What are the ICT lessons' learning objectives and practices and how do those compare to what children do outside school?
3. What happens when children create things using digital technologies? What are the skills they practice, the topics they explore, the challenges they tackle, and the social relationships they engage in as they delve into the creative process?
4. How can we build better ICT lessons in the primary school knowing what children are capable of creatively making with digital technologies outside it?

Personal interviews were carried out with 342 children aged 7–10 across the Maltese islands; 309 parents were surveyed to gauge their knowledge of their children's digital use, and 48 of them were further interviewed to understand their view on children's creative production with digital tools. Interviews were conducted with eight ICT teachers and eight school principals to grasp their views on children's digital use. The ICT teachers were further interviewed to assess their perspective on the curriculum and the opportunities—or lack thereof—for their pupils to engage in creative production. Last, seven experimental workshops were conducted with 21 children, grouped into three and four, that aimed to engage them in creative production with digital tablet apps. The subjects were randomly selected from a pool of private, state, and church schools with equal representation from both genders and various socioeconomic backgrounds.

The workshop structure (see Figure 1) was drawn from an extensive literature review on creativity and learning. Yet each workshop followed a typical school lesson length of 45 minutes with three sessions spread over three nonconsecutive days. Four parameters guided the choice of apps the participants could use: (a) apps that allowed unstructured idea

creation (Gauntlett, 2011); (b) apps that could cover one of three fields: writing, audiovisual, and artistic, but also a combination of those three, all of which enable visualization as an aid to learning and creativity (Kervin, 2016); (c) apps that can address the participants' interests, values, or emotions (Anderson & Krathwohl, 2001); and (d) apps that are age-appropriate (Common Sense Media, 2012).

Direct observation and chronicling children's behavior and attitudes were recorded to assess the effectiveness of the workshops and to identify the type of learning that took place. Behavioral and attitudinal indicators were marked (Ott & Pozzi, 2010) when present using the following indicators: (a) personally able and motivated to propose a solution; (b) able to respond with solutions at researcher's prompts; and (c) unable to respond with solutions. The direct observations were not limited to this methodology. Children's personal verbal and nonverbal communication was also observed, recorded, and considered in the analysis of the workshops' outcomes. The observations were recorded on monitoring sheets. Personal interviews before and after the workshops were conducted and audio-recorded. Freestyle notes during the workshops were also taken. The final data include interviews, class observations, survey data, and artifacts created from the workshops.

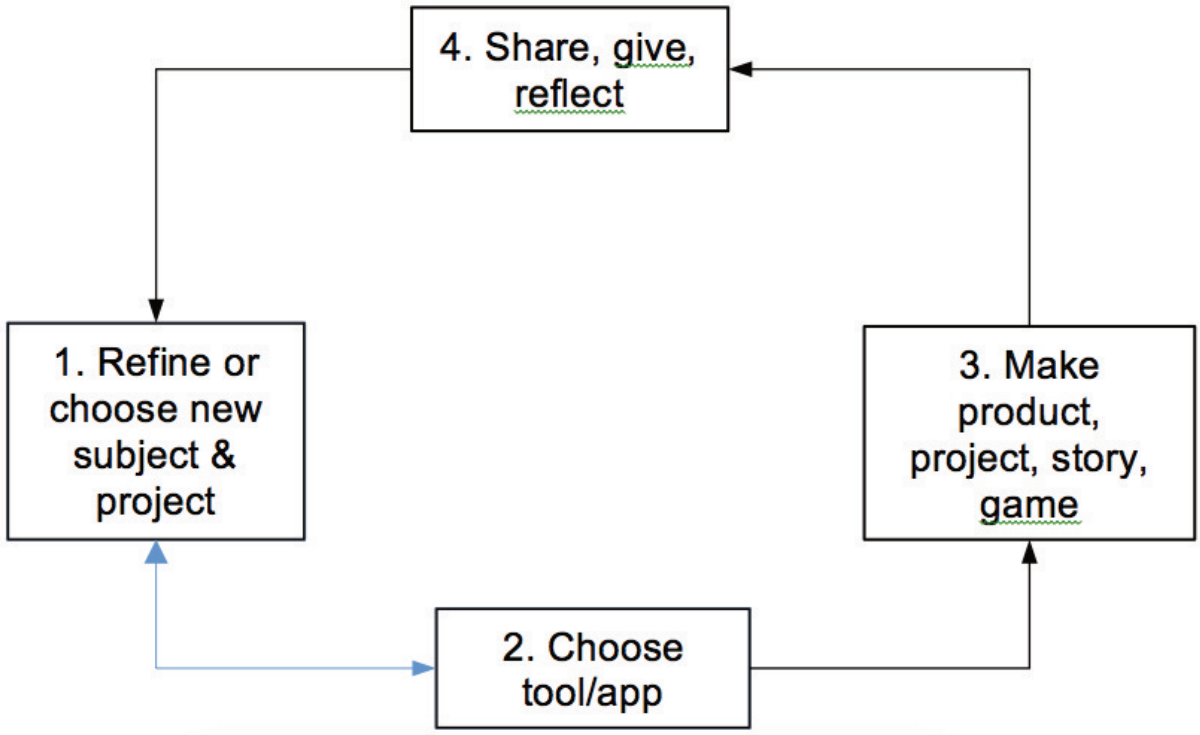

Figure 1. Model for creative production to teach ICT lessons: Learner (1) delves into a subject (e.g., environment); (2) selects the digital tool—an app that allows for the creation of an audio-, video-, or text-based narrative; or, in reverse, (2) selects tool and then (1) thinks of project; (3) creates it; (4) shares and reflects.

Findings

Technical Curriculum Versus Connected Learning

An analysis of the ICT curriculum (see Table 1) for Grade 3 to 5 students shows that the ICT lessons provide rather limited digital education in light of the pressing necessity for children to grow up digitally literate, especially as they become regular users of digital tools outside school and at a much younger age (Rideout, 2017).

	Learning objectives of primary level ICT curriculum (Ministry for Education and Employment)				
Year	Communicate information	Handle information	ICT management	ICT evaluation	Control
3	Write, enhanced by pictures; format text	Using pictures to present information	Using software and more items from pull-down menus; managing computer files	Describe interactions with the software; explain how to use PC; talk about activities on PC	-
4	Create audio-visual text; access web content; use email	Log data; use CD-ROMs	Manipulate text; export/import and manipulate graphics; access stored files; learn printing options	Talk about ICTs social impact; learn to search information; online behavior related to emails	-
5	Audio-visual and text manipulation; share content; bookmarking; attaching files	Search CD-ROMs; excel basic operations; tables & graphics creation; printing	Manipulate text; print preview;	Distinguish values between ICT and non-ICT tools as "means of communication"; appreciate ICT effects on society (e.g. how scanners or cameras change society); evaluate web content; web safety.	Recognize control mechanisms (remote controls); operate with them e.g. rewind a tape

Table 1. Learning objectives for ICT syllabus for primary education (children aged 7–10).

The learning objectives focus on technical practices and as preliminary research confirmed, such practices in the classroom were predominantly teacher-led with prescribed decontextualized activities that all children had to follow. The interviewed ICT teachers and principals acknowledged the importance of creativity and the need to foster creative production in general and specifically when children used the technologies available to them. Yet some teachers insisted on giving pupils ready examples to practice digital skills without making room for self-expression. To teachers, assigning such ready tasks was a way of controlling students, while allowing them to self-organize in creative production could compromise this control.

Table 2 summarizes the learning objectives drawn from two of the seven workshops carried out for this research. These learning objectives provide evidence of the skills children engaged in practicing while self-directing in creative production. These learning objectives help to further develop strategies for learning assessment. They can also guide teachers in their pedagogical efforts and lesson structuring.

WORKSHOP	PRACTICED SKILLS
Workshop 1 Three children, aged nine, designed a food menu using *Foldify*, an app for creating 3D printable objects.	Technical skills • Formatting text and images: e.g. copying/pasting images and text • Researching content using Google Chrome/ Explorer • Conceptualizing, designing and creating 3D figures; learning to print • Saving/deleting/retrieving files • Navigating through the app's menu Social skills • Working with others; assigning and practicing different roles • Solving personal conflicts • Moving on from unsolved issues or conflicts • Managing work with others (within the designated 3 days for the workshop) • Practicing communication skills • Bonding and camaraderie; using humor to steer work • Exchanging knowledge and seeking support from one another Academic exploration • Researching on the subject of culinary
Workshop 2 The children teamed to develop a fictional story, "The Story of Aidawrabel" – the name comprises parts of the participants' names. They designed 3D characters using *Foldify*, printed them, photographed them and inserted them into a digital presentation. They wrote a story line and audio-recorded it as a voice-over	Technical skills • Audio and visual recording; working with sequence and montage • Conceptualizing, designing and creating 3D figures; learning to print • Operating with photography and photo editing • Researching information online • Developing a storyboard and script writing • Copying/pasting and editing text and images • Saving, editing, deleting and retrieving files - text, images, and audio Social skills • Distributing roles, assigning tasks and setting deadlines • Managing frustrations and conflict resolution • Learning to share • Practicing communication skills • Bonding and camaraderie; using humor to steer project Knowledge • Exploring the topics of astronomy and physics • Learning about photography and video production • Learning how to create a storyboard and film montage

Table 2. Summary of the learning objectives being introduced and practiced by the children during the workshops carried out during this study. Only two of the seven workshops are given as examples here.

Fostering Creative Production as a Preamble to Teaching Social, Digital, and Media Skills in Primary-Level ICT Lessons

Table 1 presented the current ICT objectives for primary schoolchildren. ICT teachers adhered to these but as they reported, they often redrafted their lessons in search of more engaging activities. The proposed model aimed to overcome the limiting objectives of the current curriculum by seeking to (a) foster creativity, (b) engage children in meaningful project making for practicing digital, social, and interpersonal skills and (c) enable self-organized and interdisciplinary learning.

An improved ICT curriculum can have two overarching goals (see Table 3). The first encompasses teaching, learning, and practicing digital and technical skills. The second enables social and interpersonal skills and other key subjects that aim to enable critical understanding and interpreting of media and technologies as students delve into creative

production. Students will be steered to make creative things on subjects they care about or are interested in. Moreover, this curriculum allows for subject crossover—connected learning; students can develop projects related to topics from their other lessons, say, history, biology, or ethics. Students can use the tools available at the moment and as these change so will learners' technical skills. Students will not aim to explain how to use the computer to present ideas; they will demonstrate creative expression on subjects they care about, discover, and learn.

	Learning by making: ICT curriculum objectives					
Year	Communicate information	Technical skills	Creative skills	Interpersonal skills	Old vs. new media education	Social media skills: children as recipients, participants, and actors
3	Make projects, products, ideas, games, etc. based on a selected subject: e.g. environment, family, culture, music, physics and so on	Manipulate content; use Internet; use apps to build projects, products, or games; save, retrieve files	Demonstrate creativity by making a product, a project or a game. Reflect on the accomplished work	Work and manage groups and projects; self-organize; practice communication skills; adapt to changing environments (re-group when initiating new projects)	Create projects, products, ideas, games, etc. using 'old' and 'new' media tools; introduction to storyboards; montage; promotional vs. factual content	Contact risks and opportunities; Content risks and opportunities Commercial risks and opportunities
4	Include new subjects: e.g. physics, astronomy, biology, music, sport	As above. Make apps; basic coding, e.g. design on Scratch	As above. Reflection can include making digital journals using Scratch	As above. Share reflections and projects	As above; using a wider spectrum of tools	As above; include understanding civic engagement; digital citizenship
5	Focus projects on subjects in-depth	Include computer science	As above	As above	As above	As above

Table 3. Proposed learning objectives for the ICT curriculum in primary schools, Grades 3 to 5.

Conclusion

This paper draws attention to several points of discussion. First, the workshops presented an opportunity to examine children's perspectives on creative production with digital devices in and outside school. From a constructionist perspective (Papert, 1993), the workshops designed for this research aimed to foster 7–10-year-old children's creative production as a way to allow them to practice a variety of skills and expose them to new subjects. While self-directed learning can be fruitful (Mitra, 2000), this research also highlighted the importance of the facilitator—the teacher. Children can get bored or lose focus when simply left to experiment (Clements & Sarama, 2002). Teachers are important to steer the learning process and to enable children's greater potentials.

The participants' feedback was acknowledged and collected as it evidenced their personal feelings about the given experience. This feedback clearly contrasted with the participants' views on their ICT lessons. When asked to describe how devices were used in the classroom, most participants discussed software programs and apps, not specific themes or subjects. They talked about using PowerPoint and Excel without referring to a topic except for general titles such

as “maths,” “English,” or “science.” Respondents mainly focused on describing the format and the tools with which they were taught and not the subject or the issues that they were being taught. This resonates with the research conducted by Livingstone and Sefton-Green (2016); the researched children’s school had imprinted their structure of leveling learning and comparing levels in such a way that students—and their parents—“were directed to a standardized level of attainment … [where] levels [are] divorced from their original meaning in relation to the subject matter” (Livingstone & Sefton-Green, 2016, p. 133). Because of leveling learning in such a “ritualized and procedural” manner, the “content and meaning has become subordinated to the process of simply moving through” these levels (p. 132).

In contrast, the workshop participants’ reflections on their experience veered around the content. They researched information, which gave them further topics for discussion. For example, Workshop 2 researched Mars and life on other planets. This research became a stepping-stone for the participants to delve into various subtopics (e.g., Earth’s system components in comparison with those of other planets) in a seamless way. This process led the children to a form of learning—and discovery—without the typical school structures (separating knowledge into subjects and time slots). The workshop participants seemed to experience a sort of “flow” (Csikszentmihalyi, 1998) of learning from one topic to another as they searched for the pieces that would make their project. This flow happened in an organic way, without the children realizing what they were learning or *that* they were learning. These observations were evident across different socioeconomic backgrounds, gender, and age. In contrast, at school, children often focused on what is being repeated to them by parents and teachers—that they are there “to learn”; somehow, *what* to learn is left as a less clear concept. Learning and skills acquisition became contextualised.

ICT lessons for learning and practicing digital skills take center stage. The child becomes the guest who arrives to obtain what is offered during the lesson without initiation or inquiry. By developing a personal project, on the other hand, as a newly proposed framework for the ICT curriculum, children can find purpose in learning new things by taking an active role in the curriculum design and become the center of the learning process.

References

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning. Teaching and assessing: A revision of Bloom’s taxonomy of educational objectives.* New York, NY: Longman.

Cebeci, Z., & Tekdal, M. (2006). Using podcasts as audio learning objects. *Interdisciplinary Journal of E-Learning and Learning Objects*, *2*(1), 47–57.

Clements, D. H., & Sarama, J. (2002). The role of technology in early childhood learning. *Teaching children mathematics*, *8*(6), 340.

Common Sense Media (2012). *Kids media app helps parents find the best apps, games, movies, and more.* San Francisco, CA: Common Sense Media.

Csikszentmihalyi, M. (1998). *Creativity: Flow and the psychology of discovery and invention.* New York, NY: Harper Perennial.

Dede, C. (2009). *Comparing frameworks for “21st century skills.”* Cambridge, MA: Harvard Graduate School of Education.

Department of eLearning. (2015). *Digital literacy 21st century competences for our age.* Valletta, Malta: Department of eLearning.

Ejsing-Duun, S., & Skovbjerg, H. M. (2016). Copycat or creative innovator? Reproduction as a pedagogical strategy in schools. *The Electronic Journal of e-Learning*, *14*(2), 83–93.

Gauntlett, D. (2007). *Creative explorations*. Cambridge, UK: Polity Press.

Gauntlett, D. (2011). *Making is connecting: The social meaning of creativity, from DIY and knitting to YouTube and Web 2.0*. London, UK: Polity Press.

Guay, F., Ratelle, C. F., & Chanal, J. (2008). Optimal learning in optimal contexts: The role of self-determination in education. *Canadian Psychology*, 49(3), 233–240.

Kafai, Y. B. (2006). Playing and making games for learning instructionist and constructionist perspectives for game studies. *Games and Culture*, 1(1), 36–40.

Karoly, L. A., & Panis, C. W. A. (2004). *The 21st century at work: Forces shaping the future workforce and workplace in the United States* (Prepared for the US Department of Labor). Santa Monica, CA: Rand. Retrieved from www.jstor.org/stable/10.7249/mg164dol

Kervin, L. (2016). Powerful and playful literacy learning with digital technologies. *Australian Journal of Language and Literacy*, 39(1), 64–73.

Livingstone, S., & Sefton-Green, J. (2016). *The class: Living and learning in the digital age*. New York, NY: NYU Press.

Ministry for Education and Employment. (2014). *A national literacy strategy for all in Malta and Gozo*. Valletta, Malta: Ministry of Education and Employment.

Mitra, S. (2000, June). *Minimally invasive education for mass computer literacy*. Paper presented at the CRIDALA 2000 Conference, Hong Kong.

Ott, M., & Pozzi, F. (2010). Towards a model to evaluate creativity-oriented learning activities. *Social and Behavioural Sciences*, 2, 3532–3536.

Papert, S. (1980). *Mindstorms: Children, computers and powerful ideas*. New York, NY: Basic Books.

Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer*. New York, NY: Basic Books.

Resnick, M. (2017). *Lifelong kindergarten: Cultivating creativity through projects, passion, peers, and play*. Cambridge, MA: The MIT Press.

Rideout, V. (2017). *The Common Sense census: Media use by kids age zero to eight*. San Francisco, CA: Common Sense Media.

Vygotsky, L. (1978). Interaction between learning and development. In M. Gauvain & M. Cole (Eds.), *Readings on the development of children* (pp. 34–40). New York, NY: Scientific American Books.

10. A Toolkit for Analyzing Teaching and Learning Across Contexts

JEFFERY B. HOLMES, EARL AGUILERA, AND KELLY M. TRAN

Abstract: This session explicates a theoretical perspective that addresses the complexities of moving across teaching and learning contexts in everyday life, both in formal settings such as school but also informal settings, and between physical and virtual spaces. While the education research community has made important progress toward understanding learning in a variety of formal and informal contexts, less emphasis has been placed on understanding how teaching and learning experiences can be connected across these contexts and about the variety of teaching and teachers that are essential to them. We outline an analytic perspective called *distributed teaching and learning systems* (DTALS), which augments other models of learning by stressing the importance of movements across contexts and foregrounds teaching as a key feature alongside learning. We then provide a set of tools for analyzing pedagogical situations through a DTALS perspective and a brief worked example of the tools in action.

Learning is ubiquitous in the world—people learn in schools, but also in workplaces, in the home, on playgrounds, through cultural resources, and increasingly across a range of digital and online spaces beyond any formalized institutional contexts. Furthermore, people move across these contexts in their learning; they are not bounded by one particular site but make connections between them and have their learning shaped by the contacts between them through time (Erstad et al., 2016). While a number of models for addressing informal learning contexts have been developed, including concepts such as "affinity spaces" (Gee, 2003; Hayes & Duncan, 2012) and the connected learning research agenda (Ito et al, 2013), these often miss the importance of a learner's movement across contexts and time. These models often focus on a single site of activity or type of participation as a unit of analysis, whereas a more thorough understanding and examination of how people travel from site to site and participate in different learning activities might provide additional insight into their learning (Erstad et al., 2016; Sefton-Green, 2016). Even less attention has been paid to the critical role of teaching in these nonschool settings. Teaching, broadly understood to include acts of designing and curating learning resources and pathways in addition to more direct "instructional" acts, is just as ubiquitous as learning in the world but is often effaced from analyses or invisible because it may not resemble more common conceptions of classroomlike instruction, and so it is treated as something else entirely.

To address these often overlooked features of learning in the 21st century—the connections and movements across learning contexts through time, and the teaching that plays an essential role regardless of where it happens or by whom—we use a theoretical framework called *distributed teaching and learning systems* (DTALS). A DTALS framework provides a means of addressing the full scope of a learner's pathways and how he or she navigates physical, digital, and socially constructed boundaries. A DTALS perspective also highlights the important ways teaching works within and across these boundaries, and how connections between them can be intentionally designed and curated. Finally, a DTALS approach emphasizes the *designed and emergent systems* in which teaching and learning occur, both proximally (the resources, locations, and people that make up a particular learning pathway) and distally (the larger social and ideological systems that drive the creation and enactment of these encounters).

A DTALS perspective is both a conceptual framework and an analytical tool. Elsewhere (Holmes, 2015, 2017; Holmes, Tran, & Gee, 2017) we have outlined several key features that help us conceptualize teaching and learning as distributed across a variety of resources, designed by "teachers" of all sorts as well as by learners as they move across sites, and primarily centered on deep problems. In this working paper, we wish to turn our attention to how to use the DTALS perspective as an analytical tool in order to carefully and systematically examine the kinds of complex and intricate ways people design, enact, and encounter teaching and learning in their everyday lives. We outline a set of tools that enable

researchers to uncover additional important dimensions that other perspectives may not address; we also provide a brief worked example of the analytical toolkit in action in order to provide a glimpse into the kinds of analysis possible through a DTALS perspective.

Situating DTALS

There are numerous ways in which learning beyond school has been addressed by scholars and educators, including attention to informal STEM learning, literacy learning in and out of school, and digital literacies. The focus often has been on (a) understanding particular sites or contexts of out-of-school learning and (b) identifying differences or disconnects between in- and out-of-school learning. Instead of focusing on these isolated contexts, however, numerous scholars have argued for a holistic approach and outlined how in-school and out-of-school learning are connected (Hull & Schultz, 2001; Sefton-Green, 2004), as well as called for a reassessment of the dichotomy between schools and informal contexts (Vadeboncoeur, Kady-Rachid, & Moghtader, 2014). Frequently, the goal of such research is to encourage educators to make connections between out-of-school and in-school learning, varying from acknowledging kids' cultural "funds of knowledge" to bringing popular digital media into the classroom to using more "authentic" learning activities (Erstad & Sefton-Green, 2013; Jenkins, Ito, & boyd, 2015).

More recently, there has been interest in how kids move across spaces out of school as well as the connection between in- and out-of-school learning, so that the classroom and children's out-of-school learning activities do not stand in opposition to each other but rather inform each other, especially as technology changes the social and material nature of children's lives (Leander, Phillips, & Taylor, 2010). Barron's (2006) learning ecologies model investigates how adolescents learn both in and out of school motivated by a personal interest in a topic, and these in- and out-of-school activities are both essential to understanding students' learning. Still, research that focuses primarily on one context predominates, and examinations of the specific nature of these connections are relatively sparse.

Just as there sometimes exists a narrow definition of learning, "teaching" is often narrowly conceived of as a classroom teacher in the professional context of school rather than something that can happen in various contexts. While literature does exist that explicitly examines teaching in informal contexts (Marcus, Stoddard, & Woodward, 2011; Quinn, 2014; Wick, Pollock, & Jefferson, 2010), these focus on more formal and schoollike practices in contexts such as workplace training and museums. In reality, there are myriad spaces for learning such as participation in online spaces and learning in the home, in which teaching takes forms that do not resemble schoollike teaching. We argue that more research is necessary that focuses specifically on teaching in such environments, or that even mentions teaching practices or informal teachers at all.

Finally, in much of the literature around informal learning, a tension exists around idealizing what kids learn out of school versus trying to make up for "deficiencies" in out-of-school learning experiences. This is partly because of narrow conceptions of what "counts" as learning, with value being placed primarily on schoollike learning. Schools do not always value youths' out-of-school learning activities because of the often narrow focus of classroom learning (Erstad & Sefton-Green, 2013). Indeed, school may not value the backgrounds and experiences of nondominant cultural groups and students' own funds of knowledge (Barton & Tan, 2009; Zipin, 2009). As such, out-of-school learning is sometimes conceptualized as a challenge to school learning, and as a way of asserting the value of identities and knowledge that might not be valued in school (Rajala, Kumpulainen, Hilppö, Paananen, & Lipponen, 2016).

A DTALS Toolkit

The DTALS toolkit we present in this working paper is meant to provide a means for looking at a teaching and learning situation, regardless of where it occurs, in order to trace out the important connections, movements, designs, and experiences of teachers and learners. This toolkit is inspired—both philosophically and structurally—by Gee's discourse analysis toolkit (2011), in that the tools are meant to be applied not in isolation from each other but at once to any pedagogical phenomenon under analysis. Some tools may uncover more or less relevant insight depending on the situation at hand, and researchers may emphasize one tool over others, but together the tools provide a more robust understanding. Indeed, as Gee points out, the tools build on each other and, when taken in aggregate, will likely provide more "valid" analysis than any one tool in isolation.

Analytic Framing Tools

These tools provide a high-level way of organizing the contexts, perspectives, and limits of the teaching and learning interactions under consideration in your analysis. They should inform how you proceed in using the subsequent feature-specific tools as well as highlight the necessary limits of any such analysis.

Boundaries Tool. For a pedagogical phenomenon of focus, begin by staking a claim as to what the "bounds" of that situation are. This will likely be modified in the course of your analysis, but an initial claim on this will inform how the analysis begins. Describe where the "cutoffs" for things such as time, resources, or activities are made and why. For example, a study of a middle-school fanfiction writer may not need to trace a learner's pathway back to elementary school to discuss how he or she learned to write per se, so a reasonable starting point of the learner's entry into fanfiction writing spaces may be appropriate and sufficient for analysis.

Perspectives Tool. For a given pedagogical situation, determine whether your analysis will focus primarily on the overall range of sites and resources available to learners and how they are designed (i.e., a "top-down" approach) or about a specific individual (or group) as they design or move across sites (i.e., a "bottom-up" approach). Individual perspectives of analysis can include both those of a "learner" who has a particular objective or outcome and is engaging with one or more "teachers," or from the perspective of a "teacher" or "designer" who has a particular objective or outcome and is engaging with one or more "learners." Analyses may also combine these perspectives by looking at a particular grouping of teachers and learners, such as a classroom, an Internet message board, or a video game affinity space. For example, analysis of a video game DTALS may look at the various types of sites and how designers build and connect them to view them systematically, or it may focus on a specific learner as he or she is introduced to the game and journeys to specific sites in a particular way across the system.

Feature-Specific Tools: Distributed Across Space, Time, and Resources

Participatory Roles Tool. For a given pedagogical situation, ask which participants (human or nonhuman) are involved. Ask what teaching and learning roles they appear to be enacting, and whether these roles seem to change over time, contexts, or interactions. In some situations, the role of teacher and learner are fluid, and participants may exchange roles or act in different roles depending on context. In other cases, one participant may depend on others in the situation, such as with a commercial game that is played in the classroom accompanied by explicit instruction.

Places and Spaces Tool. For a given pedagogical situation, ask what places and spaces, physical or virtual, the situation seems to encompass. A student who may be searching for online resources to support his or her understanding of a concept that was lectured on in chemistry class may involve both physical and virtual spaces. The Boundaries Tool may be used to "bound" the spatial context as fits the focus of the research.

Movement and Connections Tool. For a given pedagogical situation, ask how learners move from site to site and what kinds of connections are made by (and for) them. In conjunction with the Pathways Tool, consider how people move across resources and what are the relationships that form and are fostered by them.

Feature-Specific Tools: Teaching and Learning

Teaching Acts Tool. For a given pedagogical situation, ask how teaching is being enacted by a human or nonhuman agent. Such acts can include the design of resources, the curation and connections between resources, and direct engagement in instruction. Note that just as humans cannot *not* communicate, even if their communicational "objective" has not been achieved, so too can teaching be enacted without evidence that a pedagogical objective has been achieved. Complement this with the What, Why, and How? Tool to better understand intended teaching outcomes and realized learning outcomes.

What, Why, and How? Tool. For a given pedagogical situation, identify intended pedagogical outcomes, reasoned logic behind those objectives, and the process through which those outcomes appear to have been realized (or not). Do this also for unintended outcomes.

Evidence of Learning Tool. For a given pedagogical situation, identify empirical evidence of learning outcomes, intended or unintended. Depending on the focus of the research, these can be observationally determined or analyzed through an "artifice"—for example, a test, survey, or interview.

Feature-Specific Tools: Designed and Emergent Systems

Gateways Tool. For a given pedagogical situation, identify potential "gateways" through which participants can move into and out of the situation. Ask what gateways are "officially sanctioned" by teachers or designers, and which gateways emerge from outside of these official sources and which may run counter to the overt learning goals. For example, a formal science classroom might serve as a gateway into domain-specific learning, but so might a video game or a book.

Designed Elements Tool. For any given pedagogical situation, ask about the role that design plays and identify evidence for the degree of its impact on the situation. Ask about what kinds of choices designers make about what to include or exclude, what kinds of resources they make or curate and how they connect them for learners, and what kinds of assumptions they make about what learners need and where they should go next within the system.

Emergent Elements Tool. For any given pedagogical situation, ask about the role that emergent actions and connections that are due to a learner's specific movements play and identify evidence for the degree of its impact on the situation. For example, what kinds of connections do they make that are not explicitly due to designed pathways, and what kinds of resources do they connect?

Worked Example: Code Club Through a DTALS Perspective

To illustrate an application of this toolkit, we turn to data collected as part of a study conducted on a library-based computer programming club for middle school–aged youth known as the Code Club (Aguilera, 2017a; Holmes, Aguilera, & Tran, 2018). This project collected observational, artifactual, and interview data over the course of a nine-month observational study of the experiences of 33 participants, 8–14 years of age, as they took part in 45-minute weekly sessions to engage in activities related to the Code Club. Data sources for the study included digital artifacts produced by students, archival user interface data of virtual spaces, publicly available participant profile information, observational field jottings, interview and survey data, postsession field notes, and analytic memos. These sessions were co-facilitated by library staff, along with one member of our research team, between the period of September 2016 and August 2017.

Applying the Boundaries Tool to our analysis, this analysis focuses on the meeting spaces in which student participants gathered each week along with library facilitators. The virtual contexts for teaching and learning we chose to analyze were the online sites visited by students during the Code Club's weekly meeting times. These included Code.org, Khan Academy, and MIT's Scratch platform. While some students accessed Code Club resources and engaged in related activities outside of the program's meeting times, our initial analysis did not encompass these connections. However, future work might consider how expanding the boundaries of focus might inform other interpretations of distributed teaching and learning in this context. Using the Perspectives Tool, we focus on the pathways of individual learners as they traveled across the designed artifacts (such as the online platform that acted as a "gateway" to distributed teaching and learning resources) and made connections with peers and tools for teaching and learning. We chose such a perspective because while the librarians in the space helped coordinate student efforts as "facilitators," they did not have particular domain-specific or pedagogical goals themselves. An alternative approach could consider the stated goals in a given online tutorial, for example, in Khan Academy, and examine how a collection of users in that system might take up, navigate, or transform designed learning pathways within the system.

Having established this framing of the analysis, we can turn to a feature-specific analysis of distributed teaching and learning across time, space, and resources. For example, several of the Code Club's participants engaged in activities hosted on the website Khan Academy. Our artifactual analysis of the Khan Academy computer science curriculum "Simple Snowman" Challenge suggests that the tutorial is designed to involve a user, such as a novice Code Club participant, and a set of digital resources, including tutorial text, a responsive programming environment designed to present "novice-friendly" feedback, and a "hint" area representing a possible solution to the puzzle presented. However, we noticed in our observations that while some students mainly used the Khan Academy's designed resources, others navigated across the Internet to "off-site" resources, such as discussion boards, to address a challenge that arose. In the latter case, applying the Places and Spaces Tool suggests that beyond the "sanctioned" virtual space of Khan Academy, some students added alternative virtual spaces to their individual DTALS. In addition, if contributors of "solutions" on a discussion board are previous users, then the roles of "teacher" and "learner" appear more fluid and interchangeable in this situation. Finally, tracing how users move between virtual spaces that present a "problem" or puzzle to be solved (such as Khan Academy), and virtual spaces that offer a "solution," such as a particular posting on a discussion board, may be highlighted using the Movement and Connections Tool to provide a kind of "model" for how new members of the Code Club might overcome challenges they encounter.

Turning our attention to interactions between the library facilitators and the youth participants in Code Club, we can apply the Teaching and Learning Tools to examine how teaching is enacted and learning is experienced. A common site for more experienced members of the Code Club to visit is a website called Bitsbox. While the site offers free programming challenges for children, Code Club participants have expressed challenges in reading the small font size of digitized versions of the "cards" that the challenges are displayed on. In such cases, we have observed the librarian facilitator downloading "zooming into," and printing these resource cards for students to apply to the development of

simple online apps. Examining such an interaction using the Teaching Acts Tool, we can see that while content creators on the Bitsbox site are enacting teaching through the design and curation of interactive digital artifacts for students, the library facilitator is also enacting a kind of teaching by resourcing students and helping them overcome some limitations of a purely digital experience. While in interviews, librarian facilitators have appeared quick to distance themselves from the notion of formal instruction, they have also explained why it is important for students to learn to problem solve "independently." Applying the Why, What, How Tool to the Bitsbox example, librarians appear to realize this pedagogical objective by "stepping back" while students learn by trial and error, all the while informally observing to gather evidence of success or frustration on the part of students. At the end of the most recent iteration of the Code Club, in the summer of 2017, the main library facilitator organized a "showcase" of students to present projects they had created during the sessions. Applying the Evidence of Learning Tool, we might consider a multidimensional evaluation of (a) the on-the-screen "look and feel" of student-designed artifacts, (b) the code students have written "behind the screen," and (c) the ways they have integrated their awareness of social context into the projects (Aguilera, 2017b).

Having examined situated examples of such pedagogical interactions, we might then "zoom out" to consider the broader Designed and Emergent Systems that connect these distributed teaching and learning experiences into a more cohesive whole. Through the Gateways Tool, we can interpret the offering of the Code Club program itself, an effort of the public library accompanied by a dedicated space, adult facilitator, and Internet-connected computers as one kind of physical "gateway" into the world of computer programming, along with the Designed Elements of the various websites and online resources used by students. However, once students have "entered" the creative and collaborative practices promoted by the Code Club, we have observed events such as students sliding their chairs next to one another or pushing together computer monitors to enact a more "communal" experience than working or playing individually. Library facilitators have shown enthusiasm for these Emergent Elements, which had not initially been enacted in the more "individualized" design of the computer stations. Indeed, subsequent observations suggested that these interactions became more regular through time.

Implications

The Code Club worked example highlights several important insights made possible by using a DTALS perspective. First, it shows how learners move from site to site—some in person, such as with the facilitator and their own peers; some online, such as StackOverflow and YouTube—and how those movements demonstrate varying learning pathways that they take around learning to code. Second, it shows how some of these pathways are actively designed and curated for learners, such as the tutorials on the "formal" Khan Academy platform and hyperlinks to additional resources, but that many of these connections emerge from a learner's interest or specific learning need. Last, it shows that many different objects and people act as teachers throughout the learners' journey, and that learning does not just "magically" happen in nonschool contexts; learning is the result of designed and carefully connected learning opportunities that then intersect with the learners' own agency. DTALS addresses the complexities of moving across teaching and learning contexts regardless of where they occur.

More broadly, we take inspiration from the Working Paper session format by noting that the DTALS framework and this particular toolkit are very much a work in progress. While we have multiple publications around the conceptual features of DTALS, we are now actively developing and using this toolkit across a variety of settings, from video games (including *Dota 2*, *Pokémon GO*, and the Twine development community) to museum and library contexts and more. Future research using this toolkit will highlight the importance of thinking about movements across contexts by both intentional design and emergent practices. We expect that this toolkit will demonstrate these crucial, but as yet undertheorized, acts and help situate the DTALS framework as a useful complement to existing models of formal and especially informal learning and teaching wherever they occur.

References

Aguilera, E. (2017a). More than bits and bytes: Digital literacies on, behind, and beyond the screen. *Literacy Today*, 35(3), 12–13.

Aguilera, E. (2017b; October). *What's literacy got to do with it? Youth literacy practices in a computer coding club.* Paper presented at the 2017 Digital Media and Learning Conference, Irvine, CA.

Barron, B. (2006). Interest and self-sustained learning as catalysts of development: A learning ecology perspective. *Human Development*, 49(4), 193–224.

Barton, A., & Tan, E. (2009). Funds of knowledge, discourses and hybridspace. *Journal of Research in Science Teaching*, 46(1), 50–73.

Erstad, O., Kumpulainen, K., Mäkitalo, Å., Schrøder, K. C., Pruulmann-Vengerfeldt, P., & Jóhannsdóttir, T. (2016). *Learning across contexts in the knowledge society*. Rotterdam, The Netherlands: Sense.

Erstad, O., & Sefton-Green, J. (Eds.). (2013). *Identity, community, and learning lives in the digital age*. Cambridge, UK: Cambridge University Press.

Gee, J. (2003). *What video games have to teach us about learning and literacy*. New York, NY: Palgrave Macmillan.

Gee, J. (2011). *How to do discourse analysis: A toolkit.* New York, NY: Routledge.

Hayes, E., & Duncan, S. (Eds.) (2012). *Learning in video game affinity spaces.* New York, NY: Peter Lang.

Holmes, J. (2015). Distributed teaching and learning systems in *Dota 2*. *Well Played*, 4(2): 92–111.

Holmes, J. (2017). Video games, distributed teaching and learning systems, and multipedagogies. In F. Serafini & E. Gee (Eds.), *Remixing multiliteracies: Theory and practice from New London to New Times* (pp. 134–147). New York, NY: Teachers College Press.

Holmes, J. B., Aguilera, E., & Tran, K. M. (2018, April). *Bridging the divide between formal and informal contexts through distributed teaching and learning systems.* Paper presented at the Annual Meeting of the American Educational Research Association, San Antonio, TX.

Holmes, J. B, Tran, K. M., & Gee, E. R. (2017). Distributed teaching and learning systems in the wild. In M. F. Young & S. T. Slota (Eds.), *Exploding the castle: Rethinking how video games and game mechanics can shape the future of education (pp.* 253–270). Charlotte, NC: Information Age.

Hull, G., & Schultz, K. (2001). Literacy and learning out of school: A review of theory and research. *Review of Educational Research*, 71(4), 575–611.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., … Watkins, S. C. (2013). *Connected learning: An agenda for research and design*. Irvine, CA: Digital Media and Learning Research Hub.

Jenkins, H., Ito, M., & boyd, d. (2015). *Participatory culture in a networked era: a conversation on youth, learning, commerce, and politics*. Cambridge, UK: Polity Press.

Leander, K., Phillips, N. C., & Taylor, K. H. (2010). The changing social spaces of learning: Mapping new mobilities. *Review of Research in Education*, 34, 329–394.

Marcus, A., Stoddard, J., & and Woodward, W. (2011). *Teaching history with museums*. New York, NY: Routledge.

Quinn, M. (2014). *Revolutionize learning and development: Performance and innovation strategy for the information age*. New York, NY: Pfieffer.

Rajala, A., Kumpulainen, K., Hilppö, J., Paananen, M., & Lipponen, L. (2016). Connecting learning across school and out-of-school contexts: A review of pedagogical approaches. In O. Erstad, K. Kumpulainen, Å Mäkitalo, K. C. Schrøder, P. Pruulmann-Vengerfeldt, & T. Jóhannsdóttir (Eds.), *Learning across contexts in the knowledge society* (pp. 15–35). Rotterdam, The Netherlands: Sense.

Sefton-Green, J. (2004). Literature review in informal learning with technology outside school. *NESTA Future Lab Series*, 7, 1–43.

Sefton-Green, J. (2016). Can studying learning across contexts change educational research or will it lead to the pedagocization of everyday life? In O. Erstad, K. Kumpulainen, Å Mäkitalo, K. C. Schrøder, P. Pruulmann-Vengerfeldt, & T. Jóhannsdóttir (Eds.), *Learning across contexts in the knowledge society* (pp. 243–251). Rotterdam, The Netherlands: Sense.

Vadeboncoeur, J. A., Kady-Rachid, H., & Moghtader, B. (2014). Learning in and across contexts: Reimagining education. *National Society for the Study of Education*, 133(2), 339–258.

Wick, C., Pollock, R., & Jefferson, A. (2010). *The six disciplines of breakthrough learning: How to turn training and development into business results*. New York, NY: Pfeiffer.

Zipin, L. (2009). Dark funds of knowledge, deep funds of pedagogy: Exploring boundaries between lifeworlds and schools. *Discourse: Studies in the Cultural Politics of Education*, 30(3), 317–331.

11. Outputs and Insights From 12 Years of Game-Based Learning Research at the Danube-University Krems' Center for Applied Game Studies

NIKOLAUS KOENIG AND ALEXANDER PFEIFFER

Abstract: For almost 12 years, the Center for Applied Game Studies at the Danube-University Krems, Austria, has conducted game-based learning (GBL) research. Guided by the aim to enable classroom integration of game-based learning on a broad scale, this research has centered on the development of a GBL toolkit for (and in cooperation with) teachers, enabling them to use GBL strategies within the context of current educational practice, while at the same time expanding their own knowledge and skills as GBL experts. The toolkit contains tools to evaluate the pedagogical potential of digital games, to plan and conduct GBL projects, and to exchange with other teachers and form an active GBL community. The current step consists of the development of an educational game-design tool and the first in a series of educational game editors for teachers. The talk will present these tools and discuss lessons learned from their development.

Overview

Since its foundation in 2006, the Danube-University Krems' Center for Applied Game Studies has examined, argued for, and put to the test the pedagogical potential of digital gaming media and their value for educational practice.

One of the center's earliest master's courses ("Media & Game Pedagogy" or—due to the Austrian weakness for compound nouns—"MedienSpielPädagogik") was one of the first academic training opportunities worldwide centered on the theory and practice of game-based learning (GBL) and (with regular updates to its curriculum) persists until today.

At the same time, some of the center's major research projects have been focused on the conditions under which game-based learning can be successful in educational practice, guided by the idea that the potential of digital games to enable meaningful learning experiences can only unfold in an adequate educational environment, and that it is dependent on skilled teachers and their ability to facilitate connected learning experiences through digital games. This research has laid the foundation for the center's teaching activities, but at the same time, the involvement of its students in these research projects has greatly contributed to the center's research profile. In the following, an overview will be given of the center's major GBL-related research projects and their relation to educational practice in Austria, with an emphasis on the ongoing effort of developing a game-based learning toolkit for teachers.

Background: Didactic Scenarios of Digital Game–Based Learning (2007–2010)

Starting in 2007, the center's first major research project in the field of digital game–based learning was focused on using digital games to close the gap between school life and the daily (media) experiences of children and youth—and by

finding out *how* digital games might be used in the classroom in order to achieve this. At the center of this investigation were questions regarding the feasibility of game-based learning approaches in educational practice, especially within the Austrian school system (and even more specifically, within the Austriawide educational concept of the new middle school/"Neue Mittelschule"/(NMS).

As the aim of this project—the first in a series of investigations funded by the Austrian Ministry of Education—was to harvest the potential of digital games to close the gap between school life and students' daily (media) experiences, the project used a series of commercial off-the-shelf games that enjoyed a certain popularity among students; on the other hand, most of these games had been used in the educational context before, so it would be possible to distinguish whether specific problems were caused by the game products themselves, or by the ways they were applied in the context of the project.

Over the course of the project, Austrian teachers worked closely with experts from the fields of game studies and media pedagogy to (a) develop a basic understanding of the medium-specific properties of digital games and their educational potential, (b) develop didactic concepts for using specific games in their own classrooms and to make their own decisions regarding game choice and didactic goals, and (c) apply the concepts in their classroom, reflect on their success, and involve their students in a discussion of the pros and cons of digital game–based learning, based on the shared experience of using a game in their classroom. The project was accompanied by a qualitative as well as quantitative evaluation as a basis for future strategic decisions regarding the use of digital game–based learning in Austrian schools.

Not only did the project establish the pragmatic perspective that would determine the center's research activities until today; it also led to the formulation of 12 "Theses regarding the use of computer games in the classroom" (Mitgutsch & Wagner, 2008).

The Game-Based Learning Toolkit (2013/2014)

At the beginning of the 2010s, there already was wide academic consensus that digital games have the potential to enable meaningful learning experiences (e.g., Annetta 2010; Gee 2009). But attempts to actually use game-based learning in educational practice were still rare, and if they were made (e.g., Salen 2011), they were designed as more or less radical alternatives to traditional education and, even more important, accessible only to a selected few.

In Austria, there was high demand for game-based learning strategies because of the reorganization of the school curricula and the introduction of the educational concept of the new middle school (NMS) with its core principles of *differentiation*, *individualization*, and *personalization*. However, the needs of the New Middle School could not be met with exceptional pilot projects alone but required strategies to consolidate game-based learning approaches with existing educational practice, and to facilitate the best possible application of game-based learning within the restrictions of the (Austrian) educational system; the goal was enabling the use of digital games as catalysts for connected learning experiences, not as an alternative to, but as a part of, the existing school model. A second project (Gaming Media and Their Application in Educational Practice) was therefore initiated (once again funded by the Austrian Ministry of Education).

Building on the earlier project's theses as well as the demands of the Austrian educational system, the project's aims were to consolidate game-based learning with contemporary models of educational practice, while at the same time facilitating the building of teachers' competencies on a broad scale (Koenig, Pfeiffer, & Wernbacher, 2014). The goal of the project was to cooperate with game experts as well as with educators in the development of a series of tools that teachers could use to:

1. Identify the educational potential of any given digital game, while at the same time developing their own understanding of the medium-specific properties of digital games (the Analysis Tool);
2. Develop suitable didactic scenarios to use these games in their educational practice, accounting for the specific needs of their respective students as well as the possibilities and obstacles at their own school location (the Application Tool);
3. Form and participate in a game-based learning community, while at the same time making game suggestions, discussing game-based learning scenarios, and assisting each other with their projects (the Online Platform);
4. Develop their own game projects using an easy-to-use game editor, systematically translating their pedagogical and didactical needs into game-design choices (the Game Design Tool and Editor).

The guiding idea behind these tools' development was that the integration of game-based learning into educational practice must be addressed in a sufficiently pragmatic manner: Game-based learning cannot be regarded as a fixed procedure that can be imposed on all educational settings alike but is a contingent set of principles that need to be adapted for every particular school, classroom, and even student. While rooted in sound educational and game theoretical concepts, the iterative development process involving experts from both areas was aimed at creating tools that were flexible enough to be adapted by teachers for their own students' needs and classroom situations.

The Analysis Tool

For the development of the Analysis Tool, game experts (graduates in game studies and professionals in various game-related fields) as well as experts in education (teachers holding a master's degree in media and game pedagogy) were put together in teams. These teams were presented with a preliminary questionnaire based on a structured translation of game-theoretical concepts into pedagogic and didactic principles, complete with detailed comments on the concepts and principles used (this outline would later be adapted, refined, streamlined, and reformulated according to the teams' findings in the subsequent project steps). Additionally, each team picked a specific game, which would later serve as a testing ground for the development and refinement of the Analysis Tool. In the following weeks each of the teams assessed the preliminary questionnaire, based on their professional experience and the analyses of the example games in order to assess what adaptations they deemed necessary to help teachers (a) identify a game's pedagogical potential and (b) gain an understanding of the distinct qualities of the medium. Based on the thorough feedback of the teams, the questionnaire and comments were then restructured, adapted, and refined.

The final version of this Analysis Tool consists of six basic categories that are further divided into subcategories to enable a more detailed insight into the respective category. The questions constituting these categories/subcategories are separated into general questions, which highlight the most important aspects of the respective category, and advanced questions, which either help to examine a category more closely or help to get a better grasp on those categories that are more difficult to use.

The first category—*General Information*—assesses the game's basic production data, gaming platform, and operating system. It is asked whether the game has been designed for educational or entertainment purposes, or whether it is a game-related software product rather than an actual game. While this first category is very general, it encourages us to perceive games as embedded in a broader technological, economic, and creative context.

The second category—*Form and Technology (Game Product)*—includes *technological requirements*, the game's purported *theme*, and its *presentation*. All in all, this category presents a soft entry to the analysis by restricting itself to aspects that can easily be assessed, even before the game is actually played.

The third category—*Content (Game World)*—requires a closer look into the game but deals with aspects that computer games share with more traditional media such as film or literature: What is the *setting* of the game, what are the *data and facts* it contains, and what kinds of *narratives* (if any) does it rely on?

The remaining three categories finally take the specific qualities of digital games into account. These game-specific categories of the Analysis Tool are closely related to the mechanics, dynamics, and aesthetics (MDA) framework for computer game analysis (Hunicke, LeBlanc, & Zubek, 2003).

The fourth category—*Mechanics (Game System)*—examines the game's *core mechanics* as well as the *flexibility* of the game system (room for errors/alternative solutions), as well as the relation between *game system and learning experiences*.

The fifth category—*Dynamics (Player Actions)*—deals with game verbs and complexity (player actions and depth of cognitive involvement; see Webb, 2002), with matters of roles and identity, and with player interactions (cooperation vs. competition).

The aim of the sixth category—*Aesthetics (Player Experience)*—is to make the volatile field of gameplay/learning *experience* tangible by highlighting possible fields of experience, asking teachers to reflect on their own gameplay experiences by encouraging the observation and discussion of other players' gameplay experiences.

As is obvious in the description of the various categories, the goal of the Analysis Tool is not to conduct a thorough and authoritative analysis of a game, but to guide teachers in approaching digital games from a sound perspective, getting a grasp on their medium-specific qualities while at the same time developing the skills necessary to assess the pedagogical potential of a specific game on various levels of the medium.

The Application Tool

The goal of the second project phase was to design a tool that assists teachers to apply the pedagogical potential of a specific game to their own classrooms by enabling the design of classroom-specific game-based learning scenarios. In this phase, it was crucial to reconcile the pedagogical potential of the medium with the strict limitations of educational reality. The teams were expanded by teachers who had no prior experience with digital games to ensure that the tools were accessible even without a prior understanding of game-based learning principles.

The Application Tool was designed to be used as a flexible supporting tool for the development and application of game-based learning scenarios in the teachers' own educational settings. As a result of workshop discussion and subsequent testing of the tool during the pilot projects, four key areas have proven relevant for a pragmatic, yet meaningful implementation of game-based learning strategies in educational practice: (a) the *educational objectives* that can be pursued based on the game; (b) the *added value and limitations* of employing a game-based learning strategy to reach these objectives; (c) the *methods* required to tap the pedagogical potential of the game in the classroom; and (d) the *problems* that must be solved before game-based learning strategies can be successfully employed in a specific educational setting.

1. *Educational Objectives*—The definition of educational objectives forms the starting point of meaningful learning design (Westfall-Greiter & Hofbauer, 2010). What are the *core questions* that define how these concepts are approached? What are common *misunderstandings* in regard to these concepts, and how are they addressed by the game? And finally, how can the game help to enable meaningful learning and understanding (Schratz & Weiser, 2002)?
2. *Added Value and Limitations*—Game-based learning is not an end in itself. What can the game add to a meaningful learning process? Can the objectives be reached in alternative ways, and what are the upsides and downsides of

these approaches? Which aspects of the educational goals are not sufficiently addressed by the game, and what complementary strategies are required?

3. *Methods*—The success of game-based learning is dependent on how they are integrated in the learning situation: What preparations are necessary for a specific game-based learning project, and how must the gameplay be hosted to be meaningful and effective? How does the transition from playing a game back to the educational setting take place, and what will students need in order to benefit from the game?
4. *Problems*—The integration of a new medium into educational practice is not without problems. It is important to be aware of these problems in order to counter or minimize them early enough. Will expert help be needed, or is it necessary to adapt the scenario in order to minimize these problems? Is it possible to conduct the game-based learning project within the class schedule? Can the schedule be adjusted, or does the project itself need to be adapted? What support will students need to comprehend the game's topic and achieve the educational goals? Are colleagues, parents or even student skeptical toward the use of computer games in the classroom? How can this skepticism be reduced in order to create a cooperative educational environment?

The Online Platform

In the final phase of the project, the basic demands of the Online Platform (whose actual development would take place in another project) were defined. While it was clear that the Online Platform would also provide access to the previously developed tools, its main function was to provide adaptable entry points depending on the user's expertise and previous experience with computer games and game-based learning strategies. The basic goal was to enable dynamic and discursive competence building within the teaching community by fostering a "choose what to use" approach; according to their respective demands and competencies, teachers were to be able to choose different ways to use the platform.

The First Application: Game-Based Learning to Alleviate Early School Leaving in Malta (EU)

Contrary to the first two tools (the Analysis Tool and the Application Tool), which were developed, tested, and refined in the context of the Austrian education system, the development of the Online Platform was conducted as part of an Erasmus Plus Strategic Partnership between five partners: the Malta Information Technology Agency (MITA), the University of Malta, St. Margaret's College Malta, Nyströmska School Sweden, and Danube University Krems, Austria. While the development of the online tool was only one segment of this partnership, whose main goal was to explore the potential of game-based learning to alleviate early school leaving, this embedded approach enabled us to develop and test the platform on a broader scale than a national project would have allowed us to, while at the same time providing a first application for the previously developed tools.

As it was one of the main aims of the project to enable teachers to become "agents of change" within their schools by expanding, practicing, and sharing their expertise in game-based learning, the platform needed to provide entry points for teachers of all skill levels regarding game-based learning, varying from game-based learning experts to novices and even sceptics. Based on the previous project's output, the following ways to engage with the game-based learning community via the platform become the guiding principles of its development and refinement.

1. *Scuttle*—The platform contains a database with existing game-based learning scenarios and game analyses, as well as commentated documentations from game-based learning projects that have already been used in the classroom. Furthermore, the platform contains background material on digital games and game-based learning.

Looking through the material on the platform, teachers are able to gain first insights into the use of computer games in educational practice and get familiar with the work of colleagues and the theoretical foundations of game-based learning.

2. *Dabble*—It is not necessary to have experience with game-based learning to engage in the game-based learning discourse. In the discussion forums, teachers without prior knowledge about game-based learning can be assisted by more experienced colleagues, but they can also contribute insights from their own teaching experience. The discussion forums help teachers get familiar with the topic and—most important—become part of the game-based learning community.
3. *Sample*—While the design of the Analysis Tool and Application Tool aims to enable classroom-specific game-based learning scenarios, it is possible and valid to draw on existing scenarios and use them in one's own classroom. While these scenarios have not been adapted to the specific educational setting, they will still provide an opportunity to gain firsthand experiences with game-based learning and highlight the demands and opportunities of the specific classroom, thereby inspiring the development of more specific scenarios.
4. *Grapple*—Teachers feeling sufficiently familiar with the basic principles of game-based learning can decide to use the Analysis Tool to identify the pedagogical potential of a particular game. The tool may lay the foundation for designing a game-based learning scenario, or it may simply be used to gain insight into a game that the teacher's students keep bringing up in the classroom. In any case, using the Analysis Tool is the first step of developing an autonomous approach toward game-based learning.
5. *Embrace*—As soon as teachers feel ready, they can develop their own game-based learning scenarios using the Application Tool. In addition to using the tool, teachers can discuss problems and ideas with colleagues in the discussion forums, or in the comments section of a project they have shared on the platform.
6. *Lead*—Using the platform, teachers increasingly gain experience and confidence as game-based learning experts. As their own competencies continue to grow, they might choose to actively engage in supporting their colleagues in getting hold of game-based learning and its application to the classroom. As "teachers' leaders," they become an integral part of the game-based learning community, helping others in becoming familiar with the pedagogical potential of digital games and their application in educational practice.

Outlook

The next tools in the game-based learning toolkit are now being developed in the form of an Educational Game Design Tool and an Educational Game Editor (EGE-1) that enable teachers to design and create their own games for/with their students. The development of these tools is again embedded in an Erasmus Plus Strategic Partnership, in cooperation with the Malta Information Technology Agency (MITA), the University of Luxembourg, the Science Centre Malta, the game-development company waza! UG, Germany, and the Research and Innovation Management GmbH, Austria.

The Game Design Tool is based on the research conducted for the development of the Analysis Tool. However, the creation of the new tool requires a basic redesign of the questionnaire and its structure, as well as the comments on the underlying concepts and principles. The goal behind this tool's development is to provide easily accessible guidelines for teachers without a background in game design and development that will enable them to:

1. Assess whether specific educational goals can benefit from a game-based learning approach using a self-made game;
2. Define a realistic scope for the project and translate the educational topic into a game concept;
3. Decide which game form best supports the educational goals and choose an appropriate game editor;
4. Implement their game concept step-by-step using a game editor.

Mirroring the insights from the creation of the Analysis Tool, the finished Game-Design Tool will translate game-design principles into educational concepts to enable teachers to base game-design decisions on their own skill set as educators. (However, insights from the development process will be used to assess how adaptations for a similar tool might look, allowing game designers to base the pedagogic/didactic decisions in the development of educational games on their existing expertise in game design).

The Game Editor (EGE-1) is the first in a series of low-threshold educational game editors. Each of these editors will highlight another primary mechanic, so that teachers have appropriate editors available depending on the choices made using the Educational Game Design Tool. EGE-1 uses a dual decision–tree mechanic that makes action-consequence relations tangible by means of simple interactive narration. This and later editors will be developed in cooperation with teachers and education experts, the goal being to employ interface conventions, design strategies, and vocabulary stemming from the educational context in order to enable easy translation of educational aims into game-design decisions.

The first Game Editor (EGE-1) is in its testing phase and will be ready for presentation for the Connected Learning Summit 2019.

References

Annetta, L. A. (2010). The "I's" have it: A framework for serious educational game design. *Review of General Psychology*, 14, 105–112.

Gee, J. P. (2009). Video games, learning, and "content". In C. T. Miller (Ed.), *Games: Purpose and potential in education* (pp. 43–53). New York, NY: Springer US.

Hunicke, R., LeBlanc, M., & Zubek, R. (2004, July). MDA: A formal approach to game design and game research. In *Proceedings of the AAAI Workshop on Challenges in Game AI* (pp. 04–04). Retrieved from https://users.cs.northwestern.edu/~hunicke/MDA.pdf

Koenig, N., Pfeiffer, A., & Wernbacher, T. (2014, October). Gaming media and their application in educational practice: An interactive toolkit for teachers. In *Proceedings of the European Conference on Games Based Learning* (Vol. 1, pp. 286–295). Berlin, Germany.

Mitgutsch, K., & Wagner, M. (2008). *Didaktische Szenarien des Digital Game Based Learning* (Research report). Austria: Danube-University Krems.

Salen, K. (2011). *Quest to learn: Developing the school for digital kids.* Cambridge, MA: The MIT Press.

Schratz, M., & Weiser, B. (2002). Dimensionen für die Entwicklung der Qualität von Unterricht. *Journal für Schulentwicklung*, 6(4), 36–47.

Webb, N. L. (2002). Depth-of-knowledge levels for four content areas. Retrieved from http://facstaff.wcer.wisc.edu/normw/All%20content%20areas%20%20DOK%20levels%2032802.pdf

Westfall-Greiter, T., & Hofbauer, C. (2010). Shared Leadership setzt Teacher Leaders voraus: Lerndesigner/innen im Feld der Neuen Mittelschule. *Journal für Schulentwicklung*, 4, 8–14.

12. Fostering Information Literacy Through Autonomy and Guidance in the Inquiry and Maker Learning Environments

KYUNGWON KOH, XUN GE, KATHRYN ROOTS LEWIS, SHIRLEY SIMMONS, AND LEE NELSON

Abstract: The study investigates high school students' information practices and educators' guidance during inquiry and maker learning. Self-determination theory and imposed query offer theoretical lenses in exploring students' information practices in the learning environments that support learners' choices and interests within the standards-based curriculums. Students engaged in a variety of information behaviors, such as information seeking, use, evaluating, creating, and sharing. Information searching and credibility judgment were some of the most challenging but helpful activities for students to complete their projects. Students enjoyed production-centered activities. When given a wide range of options for information creation in the maker unit, students seemed to be both excited and overwhelmed. Educators offered different strategies to scaffold students' information practices and learning, striving to achieve a balance between providing guidance and allowing student autonomy and choice. Overall, students were appreciative and found the guidance beneficial, yet they felt some guidelines were restrictive. The study suggests educators be intentional in providing guidance that is flexible and not too restricted or controlled. The ongoing research investigates the optimal environments for learners to exercise autonomy over their information practices and learning while feeling supported and guided.

Introduction

Connected learning is learning in an age of abundant access to information and social connection, combining personal interests, supportive relationships, and real-world opportunity (Connected Learning Alliance, 2019). In this learner-centered approach, students frequently seek information in the area of their interest and construct meaning, rather than passively receiving information from teachers or textbooks. Therefore, the authors suggest, to succeed in the connected learning environment learners must be information literate—that is, be able to recognize when information is needed, and to find, evaluate, and use the needed information effectively (Association of College and Research Libraries [ACRL], 1989). Further, one of the core properties of connected learning is production-centered activities (Digital Media and Learning Research Hub, 2013); accordingly, learners—the creators of knowledge—must be able to produce information in critical, creative, effective, and ethical manners (Koh, 2013).

There is a dearth of research that investigates learners' information literacy and information practices in the context of connected learning, except for a couple of studies that explored information sharing in an online community (Martin, 2014) and information behavior in afterschool programs (Davis & Fullerton, 2016). We know little about information skills and practices that might affect students' connected learning experiences. To fill this gap, the study explored high school students' information practices in inquiry- and maker-based units. The overarching research questions are:

- What are high school students' information-related experiences during inquiry and maker learning?
- How do educators—school librarians and teachers—provide guidance to facilitate student information practices?

Ultimately, the study aims to inform educators (e.g., librarians, teachers, and administrators) how to best support student information practices and promote information literacy in the connected learning environment.

Theoretical Frameworks

Self-determination theory (SDT; Ryan & Deci, 2000) suggests the following three needs must be met in order for students to be intrinsically motivated: autonomy, competence, and relatedness. The concept of imposed query (Gross, 1995) indicates an information task in service to or on behalf of someone else, as opposed to information activities conducted voluntarily based on his/her own needs. In this study, SDT and imposed query offer theoretical lenses in exploring students' information practices in the learning environments that support learners' choices and interests, yet within the standards-based curriculums.

Review of Selected Literature: Information Literacy in Inquiry and Maker Learning

Research on information literacy in the K–12 inquiry-learning context revealed students' criteria for assessing information credibility, such as being current, topical, and easily verifiable elsewhere, as well as writing styles (Pickard, Shenton, & Johnson, 2014), reputations of the information source provider, comprehensibility, and completeness (Watson, 2014). A handful of studies focused on information literacy and information practices in the maker learning environment. Koh, Snead, and Lu (2019) found information played an integral role when high school students engaged in creative production and learning in a maker class; students identified information as help, challenge, how they learn, and learning outcomes. Meyer and Fourie (2018) studied third-year college students' information behavior and suggested information resources stimulated creativity for architecture projects. The same researchers conducted a thematic analysis of literature and suggested information behavior studies can inform the design of creative workspaces, such as makerspaces (Meyer & Fourie, 2017). Li and Todd (2016) investigated young people's information practices in a public library makerspace and found that youth sought information and help from interpersonal resources as well as through trial and error. Lofton (2017) proposed that maker programs can play a vital role in promoting student information literacy.

Research Design

The study presented in this paper is part of a three-year design-based research project that investigates inquiry and maker learning in formal school curricula (Koh et al., 2018). The study was conducted in two 10th-grade classes in Pre-AP English Language Arts II in a public high school in a suburban community in the South-Central region of the United States. In Spring 2018, each class implemented two inquiry units on social justice (Unit 1) and culture and world literature (Unit 2). The curriculum standards for the units included research skills—for example, data collection, finding credible sources, citing sources, using and synthesizing information, and constructing their own arguments. Both classes implemented two different inquiry approaches: guided inquiry design (GID) and GID integrated with maker learning (GIDM). GID is a specific type of inquiry-learning framework for pre-K–12 curricula. In GID, students select, formulate, and pursue their own inquiry questions within the subject curriculum, and educators use scaffolding strategies and tools, such as inquiry journals, logs, and one-on-one conferencing, to guide student inquiry learning (Kuhlthau, Maniotes, & Caspari, 2015). The GID framework presents eight sequential, yet flexible and iterative phases: *open*, *immerse*, *explore*, *identify*, *gather*, *create*, *share*, and *evaluate*. While all units were centered around the phases of the GID process, in the GIDM units (inquiry-based maker units) educators experimented with the integration of maker

mindsets and processes into the inquiry instructions. Two English teachers and two school librarians collaborated to implement the units. The project team members—consisting of school administrators, university researchers and their graduate assistants, and a grant manager—provided professional development on inquiry and maker learning, as well as technical, instructional, and organizational assistance.

In the social justice units, each student researched a social justice issue that he or she deeply cared about and aimed to provide possible solutions to address the problem. In the culture and world literature unit, students read a literature piece of their choice set in a different part of the world and conducted research on the culture depicted in the literature. Students constructed a research question, conducted research, and created final products. Students in the two groups (GID or GIDM) created different types of final products to address their inquiry question and demonstrate learning. GID-group students were assigned an essay and annotated bibliography, while GIDM students created a variety of projects of their choice, including 3D objects, fiction and nonfiction pieces, pictures, videos, music, and more. Each class had between 30 and 35 students. Fifteen students from Teacher A's class and 16 students from Teacher B's class agreed to participate in this study by submitting both parent consent and student assent forms.

	Teacher A	Teacher B
Unit 1: Social Justice	GIDM	GID
Unit 2: Culture & World Literature	GID	GIDM

Table 1. Units.

The data collection methods included: eight student group interviews, one group interview for two teachers, one group interview for two school librarians, participation observation and field notes, and artifact analysis of teaching materials. Qualitative analysis of data from the multiple sources was conducted (Miles & Huberman, 1994) using Dedoose, a web-based qualitative data analysis software.

Findings

Information Literacy Guidance in the Inquiry and Maker Units

Active information seeking, use, and creation occurred throughout the inquiry process in both GID and GIDM units, as students formulated an inquiry question, conducted research to answer the question, and produced a product to demonstrate their learning. The team of educators—school librarians and English teachers—provided a range of guidance, including library database instructions, one-on-one conferencing, maker technology instructions, and various classroom prompts. In the beginning of the unit, the classes met in the school library, and two high school librarians provided overviews and tutorials on information resources over multiple days. The instructions covered library materials and databases (e.g., library online catalog, reference books, encyclopedias, CQ Researcher, EBSCO, Gale, and more), along with information credibility judgment, such as the CRAP test (current, reliable, accurate, and purpose). All students had one-on-one conferencing with a teacher or a librarian at least twice during the unit, including when they formulated an inquiry question and when they collected information sources and drafted a prototype product.

The teachers used several prompts to guide students' information practices throughout the unit. The opening prompt included: "During the research process, you will construct a research question, complete academic research using reliable internet sources and academic texts, and create an annotated bibliography." Students were asked to collect a

certain number of pieces of information from credible sources and cite them correctly in order to substantiate their arguments: "For each of your 6 pieces of evidence (quote, statistic, graph, picture), you must have a parenthetical (in-text) citation." The teachers provided guidance and reminders regarding information seeking and information-credibility evaluation, such as: "Verify the source and context"; "Be aware of politically framed content"; "Make sure you address the counterargument and a solution at some point in your essay"; "Choose a source you found yesterday and check to make sure it passes the CRAP test"; "Don't get most of your news from social media websites"; "Is the source credible? Why or why not?"; and "Do you feel confident that the information you've collected will properly answer your research question? Why or why not?" One of the major assignments in all units was the inquiry log (Figure 1)—a resource students were asked to use "to keep track of your sources, compile your facts/quotes, and reflect on how you could potentially use the source."

Inquiry Log

Research Question: Type your research questions here.

Directions: Use this document to keep track of important research that you may want to use in your research paper. You can include paraphrases, direct quotes, pictures, URLs, etc. Make sure to place any direct quote in "quotation marks."

You must gather…

- A total of at least 20 pieces of evidence
- From at least 5 credible sources (use the databases!)

Source (MLA works cited entry)	**Evidence** (Individual facts, tidbits, pieces of information, etc. Start a new row for each piece of information).	**Analysis** (What will I use this information for? How does it relate to my research question?)

Figure 1. Inquiry log template.

Beyond information seeking, the educators offered guidance on information organization, creation, and sharing and presenting. After students collected information sources that might potentially answer their inquiry question, the teachers encouraged students to think about "how to answer our research questions and how best to organize our ideas and evidence." Students were asked to write in their inquiry journal about: "(1) How could I share the information I have found in a more direct/concrete way? What is a product I could create that would demonstrate my knowledge this way? (2) How could I share my information in a metaphorical way? What is a product I could create that would represent what I have learned?"

Students in GID and GIDM units synthesized their research in different ways. In GID units, each student wrote a "research paper that defines the problem and poses a possible solution to address the problem," while GIDM-unit students created "a product using the Makerspace tools that illustrates the problem and poses a possible solution to address the problem." In the beginning of the GIDM unit, librarians presented the concept of making and different types of tools for maker projects in order to help students start brainstorming and determine how to present information and knowledge they obtain beyond a text-based product such as an essay. Educators provided feedback on student choice of type of maker project through one-on-one conferencing.

Imposed Information Tasks: Information Search and Credibility Judgment

The major information search task in both GID and GIDM units was finding at least 15–20 pieces of evidence (20 pieces in Unit 1: Social Justice; 15 pieces in Unit 2: Culture and World Literature) from at least five credible sources using the library databases. Students recorded information they gathered in the inquiry log. Several students in both GID and GIDM units mentioned that the inquiry logs were helpful and they would use the log again in future research projects.

Students from GID units said: "That [the inquiry log] was helpful a lot with keeping track [of] what you found so far and how it related to it"; "The inquiry log [was helpful], because I won't be really organized on my own, so it was good to have it in small steps that gradually grew to the final paper. … I feel like it made me write better." Students from GIDM units concurred: "I realized once I went back in there [inquiry log], all the information I need for my project was already there. And all I had to do was putting it in my video and then I would be done." Some students recognized that the practice of gathering information and documenting in the inquiry log was demanding, but helpful: "It [inquiry log] was not fun to complete, but it was necessary for most projects"; "the inquiry guide [log] was really hard and it was really tedious but it was … it kind of helped." Students also said they improved their information literacy skills over the semester: "I feel like I learned a lot during this process … it [the research process] helped me expand the vocabulary that I was using throughout the whole process, because you couldn't just search for the same keywords in every single article. … I feel like I am much more confident with my ability to go and find credible information that is applicable to the topics that I am researching."

Data from multiple sources—student interviews, educator interviews, and field observations, however, revealed that one of the most difficult tasks for students in the inquiry and maker processes was finding credible information relevant to their inquiry questions. Students said it was challenging to find "right information," "solid evidence," or "reliable sources on my topic." In general, two types of parameters were imposed to guide student information tasks: the number and the type of information sources to be included in their inquiry log. Students mentioned that meeting the parameter on the specific number of the required information resources (15 or 20 pieces) was somewhat daunting, although the teachers allowed a little bit of leeway. A student from the GID unit said: "Whenever I write a paper, whenever I research stuff, my issue is I don't need to find 15 different pieces from articles." A student from a GIDM unit said: "The only thing that was an issue about the project was the inquiry log; it was really large information quota to reach … that was a little bit difficult, because … it was forcing me out of the targeted space that I was really looking for, like the specific examples, and making me kind of get broader with the topic."

The educators encouraged students to use credible, academic sources instead of general Internet or social media sources. Librarians found it frustrating when students turned to nonlibrary resources just because looking online is less work than using academic resources: "That's really frustrating to me as a librarian, because (a) we spend a lot of money on [purchasing] resources, especially for social justice, we have so much money over the last five or six years, and (b), we spent a lot of time showing them how to use these databases and working with them." Teachers also promoted the use of academic databases during class discussions: "Why do you think academic databases (a collection of information that includes access to academic journals) tend to be more credible for research than a standard Google search?" … "These databases contain scholarly and peer-reviewed articles written by credible authors, such as journalists, researchers, and experts in their fields."

A student from GIDM who found library databases useful recounted: "A lot of the school databases gave us a lot of opportunities just because when I was looking through… even if I only found one quote from it, it gave me a bit of a way to start to crawl off to a different subject and pick up a lot more information." A few students, however, mentioned difficulty finding information from library databases on their topics: "It was actually rather hard gathering for sure because our teacher even had us use specific sites at first and some of those sites just did not have anything at all for me. … We were supposed to find some from like books and I just couldn't find anything because for some reason whatever I searched just nothing showed up that was like with the topic." Other students mentioned times they did not use information pieces that looked relevant to their inquiry question because of the low credibility of the sources, especially sources from social media: "It [information source for the project] was supposed to be credible. … I did find this really great … paragraph talking about this stuff but whenever I looked over it again, I was like, oh my gosh this is Twitter. I was like well, what you going to do …"; "I was trying to understand emotional [aspects of abortion] … it was kind of hard. I couldn't use these different blogs and some people went anonymously so I couldn't cite them in using them because it could be a 60-year-old man sitting at a computer [pretending to be a female who experienced abortion]"; "I found the blogs like little snippets … but it can literally be anyone on the other side of the screen."

Some students actually used library resources to avoid information-credibility evaluation. Students mentioned in the interviews: "I feel like that [using library resources] was helpful just because sometimes I am not very good judging if it's a reliable source or not so I just chose the library sources"; "I was just with the school databases because I didn't want to branch out and find stuff that you know … just in case it wasn't credible. I'd be paranoid with whether it was [credible] or not so I just focused on school databases." The researcher field notes captured a class conversation in which a student raised a question on why they still have to prove the credibility of sources if sources are coming from the high school library: "One of the kids asks why they need to question the credibility of sources found through the library, if the library sources have been vetted by public school employees who are technically government employees."

Information-Creating Behavior: Imposed Type (Essay) Versus Open Choice (Making)

As explained earlier, the teachers allowed students in the GIDM units to create a maker product of the student's choice, while GID students were assigned to write an essay. This production stage—called the *create* phase—was the students' favorite phase by far in both units. Students reported they felt a sense of accomplishment when they were able to take everything they had researched and put it all together in their product: "Whenever it's created it's not only are you done but you just have this piece that you made yourself and it's just really good, feels good. Especially if you know you feel confident in the materials you gather and everything matches up. I love that feeling."; "[My favorite phase was] create—just making the final argument, really. And making everything come together nicely."

During the interviews, a slightly higher number of students from the GID units reported they enjoyed the create phase than those from the GIDM units. A few students said writing is their preferred activity over making other projects. Writing an essay seemed a more familiar and well-defined task for the students, compared to a maker project that offered a range of options and might have caused anxiety and uncertainty for some students. Students who preferred the create phase in GID over GIDM said: "[Compared to GIDM] it [the GID unit] had a lot more structure and it was more straightforward, and it was in a way easier to do because you didn't have to think of a project [referring to a maker project]; you didn't have to be creative"; "I enjoy writing papers more than I like making videos [in the GIDM unit] … it [the GID unit] was really well-defined. There was a lot less freedom to it—a lot of freedom with choosing our topics but a lot less freedom in writing. And I don't think that's a bad thing when you're restrained … it kept us from getting off on other things."

Students who reported they enjoyed create in GIDM mentioned: "I feel like with doing this [maker] project I was more excited to come to class. You know, when we're writing an essay I'm like, 'We're just gathering information or we're doing a rough draft,' but when I was doing this project I was more excited to use my hands and be able to actually create something in class"; "[My favorite phase was] the create—the part where we actually started to put our hands on and start making something out of the information that we had"; "I looked at how to create a unique product that was outside of standard like essay style. … Being able to create a video just allowed me to look at something and think and feel a little bit differently." Educators' feedback on the maker project was crucial to inspire students to stretch their potential. A student said: "I was pushed out of my comfort zone just a little bit by our teacher, because I was just going to do something really easy at first … and she [the teacher] pushed me towards this software called Adobe Spark which is used for video editing, and it just really, really came to me because I got to implement music and information and I got to talk and do all of that and that was really kind of something I am comfortable with." Students appreciated teachers and librarians who encouraged them to try to create information in a new way and expand their talent.

On the other hand, teachers suggested it seemed harder for students to demonstrate their information-synthesizing skills in the making units: "It felt like there was, at least with my kiddos, less synthesizing of information with the making project because they tended to lean towards one article, one source. That is all they needed for their project, and I don't know how else I could have facilitated or changed the assignment up to what I had. I forced them to include multiple

sources." Teachers also discussed the standards and assessment issues for the GIDM units: "We spent so much time on the making unit … in terms of critical thinking, problem solving, those skills, I think they [students] really benefit from [the maker approach]. But in terms of some of those standards [on research skills]—synthesizing information and communicating your knowledge—I didn't see that, and I don't even know how to assess for that, besides having a one-on-one conversation or making them write something, and I'm very curious how much they learned in this [maker] unit in terms of their research, versus the paper where it kinds of forced them to make maybe a bit more to research."

Discussion and Conclusion

Students exhibited a range of information behavior during inquiry and maker learning. Information searching and information-credibility judgment were the major challenges that students experienced, and were, at the same time, some of the most helpful activities for students to complete their research and making. Beyond information search and use, students further engaged in information-creating activities in different formats. Educators strived to find a fine balance between providing guidance (e.g., clear instructions, templates, and boundaries) and allowing student autonomy and choice. Students were appreciative and found the guidance helpful, though they felt some guidelines were restrictive (e.g., the parameters on the number and types of information sources). When they were given a range of options for information creation in the maker unit, students seemed to be both excited and somewhat overwhelmed and needed guidance. Students tended to be more familiar with synthesizing and producing information in a text format rather than other formats, such as audio, video, demonstration, or other artistic or technical forms. The study suggests it is important for educators in the connected learning environment to provide appropriate scaffolding and facilitation, which are different from direct instruction or giving students direct answers. To promote students' autonomous learning and information practices in schools, guidance must be flexible and not too restrictive or controlled. When a parameter is given, educators can help students see the rationales behind the boundary and allow adaptations to each individual's own learning and situation.

The study established the critical role of educators' scaffolding in guiding students' information practices in a holistic cycle—while identifying information needs, searching, using, evaluating, creating, and sharing information. Students in this study were honing their information literacy skills and greatly benefited from effective scaffolding strategies, such as detailed prompts, inquiry logs, and one-on-one conferencing. One of the most unexpected consequences when teaching students to use credible resources in this study was that some students used the library databases to avoid information-credibility judgment. Along with providing vetted resources curated by information professionals, educators must prepare students for the real-world information environment, in which students need to use critical-thinking skills to judge information encountered in their everyday lives, whether it is from blogs, social media, or other people. Findings also suggest a need for students to increase their ability to identify and create an appropriate form of information that best conveys its meaning, including nontext-based forms of information. The ongoing research investigates the optimal approaches and environments for learners to exercise autonomy over their information practices and learning while feeling supported and guided.

References

Association of College and Research Libraries (ACRL). (1989). *Presidential committee on information literacy: Final report*. Retrieved from http://www.ala.org/acrl/publications/whitepapers/presidential

Connected Learning Alliance. (2019). Connected learning. Retrieved February 26, 2019, from https://clalliance.org/about-connected-learning/

Davis, K., & Fullerton, S. (2016). Connected learning in and after school: Exploring technology's role in the learning experiences of diverse high school students. *Information Society*, 32(2), 98–116. https://doi.org/10.1080/01972243.2016.1130498

Digital Media and Learning Research Hub. (2013). *Connected learning: An agenda for research and design*. Retrieved from http://dmlhub.net/publications/connected-learning-agenda-research-and-design

Gross, M. (1995). The imposed query. RQ, 35(2), 236–243.

Koh, K. (2013). Adolescents' information-creating behavior embedded in digital media practice using Scratch. *Journal of the American Society for Information Science and Technology*, 64(9), 1826–1841. https://doi.org/10.1002/asi.22878

Koh, K., Ge, X., Lewis, K. R., Simmons, S., Nelson, L., & Doucette-Frederickson, J. (2018). When inquiry meets making: Demystifying inquiry-based making using guided inquiry design. In *Proceedings of the 2018 Connected Learning Summit* (p. 351). Retrieved from https://connectedlearningsummit.org/cls2018/proceedings/

Koh, K., Snead, J. T., & Lu, K. (2019). The processes of maker learning and information behavior in a technology-rich high school class. *The Journal of the Association for Information Science and Technology*, 70(12), 1395–1412. DOI:10.1002/asi.24197

Kuhlthau, C. C., Maniotes, L. K., & Caspari, A. K. (2015). *Guided inquiry design: Learning in the 21st century* (2nd ed.). Westport, CN: Libraries Unlimited.

Li, X., & Todd, R. J. (2016). Information practices of young people at a public library makerspace – A sense-making approach. *Proceedings of the Annual Conference of CAIS / Actes Du Congrès Annuel de l'ACSI*. Retrieved from https://journals.library.ualberta.ca/ojs.cais-acsi.ca/index.php/cais-asci/article/view/946

Lofton, J. (2017). Students are makers! Building information literacy skills through makerspace programs. *CSLA Journal*, 40(2), 18–16.

Martin, C. (2014). Information sharing, connected learning, and a professional wrestling fan community. *Proceedings of the ASIST Annual Meeting*, 51(1). https://doi.org/10.1002/meet.2014.14505101148

Meyer, A., & Fourie, I. (2017). Thematic analysis of the value of Kuhlthau's work for the investigation of information behaviour in creative workspaces in academic libraries. *Information Research*, 22(1). Retrieved from http://www.informationr.net/ir/22-1/isic/isic1626.html

Meyer, A., & Fourie, I. (2018). Information behaviour of architecture students in creative design projects. *Aslib Journal of Information Management*, 70(4), 414–433. https://doi.org/10.1108/AJIM-02-2018-0030

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage.

Pickard, A. J., Shenton, A. K., & Johnson, A. (2014). Young people and the evaluation of information on the World Wide Web: Principles, practice and beliefs. *Journal of Librarianship and Information Science*, 46(1), 3–20. https://doi.org/10.1177/0961000612467813

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78.

Watson, C. (2014). An exploratory study of secondary students' judgments of the relevance and reliability of information. *Journal of the Association for Information Science & Technology*, 65(7), 1385–1408. https://doi.org/10.1002/asi.23067

13. An Asset-Based Approach to CS Equity

Ethnographic Research on Google igniteCS

SETAREH MAHMOUDI, MIZUKO ITO, AND KURT SQUIRE

Abstract: The field of computer science (CS) struggles to expand the representation of women and minorities. To help strengthen a sense of belonging and confidence in the field for these underrepresented groups (URGs), Google launched igniteCS (iCS), an educational mentorship program run by undergraduate CS students in the United States and Canada. This paper presents a qualitative study of iCS that found the program exemplifies an "asset-based" approach that grows out of the unique strengths and interests of URGs. The program's peer support and leadership opportunities led to significant positive outcomes for undergraduates most at risk of dropping out of CS programs. These positive outcomes included: (a) psychological safety, (b) peer relationships in CS, and (c) identity transformation. The key design features that supported these outcomes included: (a) validating and sponsoring the strengths of youth from URGs, (b) supporting student autonomy and initiative, and (c) peer-to-peer and near-peer mentorship.

Introduction

Broadening participation in computer science (CS) requires expanding formal educational programs and career opportunities, as well as informal supports such as mentorship, peer friendships, and role models that reflect diverse identities and interests. Studies of CS programs in higher education show that a lack of mentors and peers whom they identify with can be barriers for students from underrepresented groups (URGs). URGs in CS refers to students who identify as female, Latinx, African American/Black, Native American, or Pacific Islander. Research on informal supports for learning emphasizes benefits of programs taking an "asset-based" approach that builds on the strengths that URGs bring to CS, rather than only orient toward remedying deficits. Integrating these findings, the connected learning approach to program design has documented how supportive relationships, meaningful projects, and a sense of belonging are essential for most young people to persist in challenging fields such as CS (Ito et al., 2013). This study examines key features of a Google-sponsored experiential learning program, igniteCS (iCS), through a connected learning lens to highlight features that broaden participation for students from URGs.

iCS was a Google-sponsored program designed to improve retention rates in undergraduate CS majors for women and other URGs. The program supported undergraduate volunteer clubs at colleges and universities in the United States and Canada from 2015 to 2018. Participation in iCS clubs centered on teaching CS and computational thinking to K–12 learners in local communities. Student volunteers had a high degree of autonomy in forming teams, designing curricula, and establishing relationships with community partners. Across all four years, the program included 155 clubs, 3,176 undergraduate volunteers, and more than 10,700 young students. The outcomes of this initiative were captured through surveys conducted by Google and in a qualitative study of the final program year conducted by the Connected Learning Lab (CLL) at UC Irvine. The CLL study complements Google's quantitative research by providing a textured, student-centered view of club experiences, focusing on students at risk of dropping out of CS programs.

Background

iCS is situated within a growing range of initiatives aimed at broadening access to CS careers, particularly for women and underrepresented minorities. Studies show a persistent and long-standing underrepresentation of women, Blacks, Hispanics, and Native Americans in CS courses and the workforce. The National Science Foundation (NSF; 2017) found a downward trend of women pursuing CS in the past decade, and by 2014, less than 20% of undergraduate degrees in computer science and engineering were earned by women. By contrast, the representation of women in other STEM fields is growing (e.g., women earn 59% of U.S. undergraduate degrees in biology), and nearly half of all law and medical graduates are women. The combined representation of Black and Hispanic students in CS was 19.5% by 2014 (NSF, 2017). Efforts supported by industry, government, and philanthropy address a range of settings and factors, including the K–12 system (Vogel, Santo, & Ching, 2017).

Even when they have access to CS programs in higher education, sociocultural influences such as stereotypes and lack of diverse mentorship can be barriers for youth from URGs in CS (Cheryan, Master, & Meltzoff, 2015; Cheryan, Plaut, Davies, & Steele, 2009; Choney, 2018; Cozza, 2011). Young women and students of color struggle to find role models and frameworks in which they imagine their future selves as computer scientists or engineers (Barton et al., 2013). Addressing these barriers can have a significant impact (Moghadam & Bates, 2017). For example, Project Rise Up 4 CS is a targeted CS program that helps high school students from URGs pass their AP CS exams through a combination of near-peer support, weekly seminars, and twice-weekly webinars (Ericson, Parker, & Engelman, 2016). Results show significant improvement in student attitudes toward CS and increased perception of their ability to pass the AP exam. A study of Black Girls Code found that CS programs tailored for Black and Latino girls supported confidence in computing and a desire to persist in the field (Rockman et al., 2017).

iCS builds on this prior research, targeting the undergraduate phase of CS learning and identity development to strengthen social and cultural supports for students who are interested in a CS undergraduate major. Among varied efforts to address equity in access to CS education, iCS stands out in its focus on providing a context for otherwise marginalized youth to connect their college experience to their authentic interests and identity. It goes beyond a specific curricular or mentorship intervention to support a holistic civic engagement opportunity that enhances a sense of purpose and expands social capital in CS for the most vulnerable of CS majors. It is particularly notable in taking an asset-based rather than a deficit-oriented approach. Rather than focus on direct aid such as mentorship, financial support, and instruction, the program provides a context for these youth to exercise power and leadership through civic engagement that grows out of their unique identities and assets. It recognizes and amplifies the strengths of youth from URGs in CS rather than seeking to "fix" a perceived deficit.

The program exemplifies an approach to learning and program design developed and refined by the Connected Learning Research Network and a broader network of partners (Ito et al., 2013). In a nutshell, connected learning is when a learner is engaged in a pursuit that grows from his or her interest and identity, is supported by peers and mentors who share that identity, and is tied to opportunities for success. In the case of iCS, the program was designed to legitimize the identities of students from URGs and connect their interests in social justice to a supportive set of relationships, which were in turn connected to opportunities for success in the field of CS. This research study investigates learner experiences and outcomes in iCS in order to extend our understanding of how connected learning approaches can best support broadened access to CS degrees and careers.

Research Methodology

Between February and April 2018, researchers from the CLL conducted interviews with 25 undergraduate volunteers, six Google employee mentors, and focus groups at two campuses. Interviews were designed to capture the backgrounds of undergraduate participants, their experiences in the program, and how these experiences contributed to their commitment and feelings of belonging in CS. Researchers also sought to understand which iCS features contributed to positive outcomes. The study was not designed to provide a comprehensive view of iCS participation, but rather focused on iCS features that contributed to positive outcomes for students most marginalized in CS. The program was sunsetted in 2018, but the underlying factors and design implications can inform other programs with similar goals and theories of action.

Research Questions

Research questions addressed in this study and report include:

1. Program Design: What are the intended design and key features of iCS?
2. Participant Characteristics: What are the characteristics of iCS student volunteers?
3. Experiences and Outcomes: How do student volunteers experience specific iCS features? Does participation in iCS affect student commitment to and belonging in CS and career aspirations?
4. Supports: What experiences and program features contributed to student commitment and sense of belonging to the field of CS and CS career aspirations?

iCS Program Background and Student Characteristics

iCS seeks to increase retention in undergraduate CS by increasing participants' sense of professional belonging. Many qualified, competent undergraduates leave CS because they perceive that the field "is not for them" (Cheryan et al., 2015; Choney, 2018). In iCS, undergraduates teach CS to K–12 learners within supportive peer networks with mentorship that might heighten their sense of purpose, affiliation, and ultimately, belonging in CS. iCS posits that through a shared mission to introduce K–12 students to CS concepts, undergraduate CS students will foster a deeper sense of belonging that also increases their chance of completing their degree. Likewise, iCS would inoculate students against feeling disconnected from their local communities through the practice of measurable, meaningful volunteer engagement.

Students already active in academic organizations working toward equity within CS are eligible to participate in iCS. The program is composed of undergraduates who assemble into teams of five or more volunteer students who identify and collaborate with K–12 community partners to address a particular community need for CS education. The curriculum has multiple entry points for differently aged students and is flexible so that undergraduates can tailor learning experiences to local needs. Google is a key component of the program, as it offers professional legitimacy, affiliation, and potential professional mentors. Additionally, Google provides iCS programs a curriculum, supporting materials, and in the first three years of the program, up to $10,000 to reimburse expenses.

Good programs include overlapping and reinforcing components. iCS program designers theorized that undergraduate CS students teaching K–12-age learners would deepen their understandings of CS and strengthen their identification with and commitment to the field. Although iCS was not designed to specifically address the high school-to-college pipeline, seeding successful undergraduate CS students with local partners could imbue these communities with

knowledge and experiences of what it is like to go to college and study in CS. K–12-age learners develop CS skills in addition to recognizing how people with backgrounds similar to theirs belong in a university CS program. This cycle could lead to a self-renewing pipeline of women and minorities in CS. As such the desired *outcomes* of iCS were:

1. Increased retention of women and underrepresented minorities in undergraduate CS;
2. Stronger connections to local communities and building a pipeline to university CS programs;
3. Improvement of faculty-student relationships in undergraduate CS;
4. Building community across campuses;
5. Increased interest and participation of students from URGs in university CS courses programs.

Participating students completed a survey about their background, their current academic status, and future career interests. The total survey sample is 41 out of 44 total participants (see Table 1). The majority of participants attended public universities that served between 11,000 and 30,000 students. This sample has an above-average representation of women, Black, Hispanic, and first-generation students compared to 2016 national statistics. Both universities where we conducted focus groups were commuter schools that predominantly served local students and were recognized as Hispanic-serving institutions.

Student demographics	Frequency (n=37)	Percentage
Average age	22.4	--
Female	17	46%
First-generation college student	7	19%
Computer science major	28	76%
STEM major	35	95%
Race	**Frequency (n=41)**	**Percentage**
African American/black	3	7%
Asian	19	46%
Caucasian/white	12	29%
Hispanic	7	17%

Table 1. Student demographics.

Data Collection

Data collection took place between February and April 2018. Interviews and focus groups were conducted by the lead author with the exception of one iCS staff interview conducted by another author. iCS staff were interviewed as part of the research design and helped describe the motivation, intended design, and objectives of Google iCS. Six Google employees volunteered as MentorNet mentors, and all of them were invited to participate in the study by iCS staff. Four out of six Google mentors participated in the interviews. Student volunteers were invited to participate in the study by program administrators at Google. These students were given information about the evaluation and self-selected to be contacted as a part of the study. Interview participants were recruited from the sample of students (n = 38) who responded to this call. We contacted each of the 38 student volunteers individually by email to schedule online video interviews over Google Hangouts. A total of 25 students from the initial sample were interviewed. Interviews lasted approximately 50 minutes. Focus group participants were selected by geographic proximity to the research team at UC Irvine, thus only iCS groups in California were considered. The proximity of the institutions allowed us to visit the student groups and observe their group interaction in person. The two groups who participated in the evaluation were indicative of the variety of ways iCS groups structured their programs in different institutions. The first group was affiliated with a Southern California institution, and a total of 16 active members participated in the two-hour

group interview. The second iCS group was affiliated with a Northern California institution and consisted of six active members, four of whom were participants in the group interview.

Analysis

This cultural and practice–based analysis is naturalistic, interpretive, and qualitative, seeking to understand and theorize participants' experiences of the program. A coding tree was developed to surface themes that responded to the original research questions, as well as to allow for emergent findings (a priori and emergent coding). Although codes were developed, code counts or saturation rates are not reported, as we are not attempting to characterize iCS or CS participation more generally. Rather, we identify specific cultural patterns and forms of social participation among target youth that suggest promising directions for program design that could be amplified. From this analysis, the following findings emerged.

Findings

Student volunteers who were interviewed for this study reflected varied backgrounds in relation to CS. They included students who were allies but not themselves from URGs, and many youth who already had substantial exposure to and supportive relationships in CS before entering college. The outcomes for youth who already had strong informal and relational supports in CS were less profound than for those youth who were newer to CS, had identities that did not conform to the dominant culture of CS, and had fewer CS friends and mentors before volunteering for iCS. Here we focus on this latter group of student volunteers, showcasing their voices and subjective experiences, and identifying the ways in which iCS contributed to outcomes that supported their persistence in CS.

Outcomes

Although young people engaged with iCS in varied ways, the positive outcomes of iCS hinge on this power shift from a deficit-oriented to an asset-based approach. Three student gains were identified as: (a) psychological safety, (b) peer relationships in CS, and (c) developing CS identities.

Psychological safety. Participation in an iCS team resulted in feelings of psychological safety, which spilled over to confidence in CS college courses. This sense of safety emerged from experiences of teaching and mentoring younger students in a lower-stakes setting, combined with a supportive team environment. Miriam, a junior CS major, described her developing feelings of confidence and safety:

> One thing I learned [by working with young students] was that I always expect it to be hard so I, like I tighten up my skin and tell myself that it is going to be hard, judging it before actually seeing the program. [My students] actually challenged that problem. They were like, okay, let's do this. And I learned that oh, you don't have to panic about it. They kind of told me like, hey, take it easy; it's okay.

Peer relationships in CS. Participation also led to peer relationships in CS that provided socioemotional and concrete support for academic success in CS. The team context created strong bonds and friendships, and students supported

each other in classes and in navigating other opportunities in the university and beyond. Leon, a senior CS major, explains, "If somebody needs notes, then we get the notes. If we need to study together, we know we can study together."

Developing CS identities. The most vulnerable student volunteers experienced profound identity transformation into someone who has unique value to contribute to CS. Volunteers who once thought they were marginal or did not fit in described how iCS helped them realize that they could provide value to the field of CS *without* having to conform to the dominant culture of CS. Diego, a junior CS major, describes how being part of iCS stretched what he thought he was capable of. "I never thought I would go on and teach students, but they got me to go out and teach students. I never thought I would learn to create different lesson plans but now I do."

Key Features

These outcomes are driven by three key features of iCS: (a) validating and incentivizing activities for students from URGs, (b) supporting student autonomy and initiative, and (c) peer-to-peer and near-peer mentorship.

Validating and incentivizing activities for students from URGs. By focusing on community service through mentorship and equity in STEM, iCS validated their interests in using their knowledge and experience to make a difference. iCS volunteers described a shared purpose in providing equitable access to CS education. Prisha, a senior CS major, joined iCS to help bring more young women into CS. She underscored the importance of active participation of volunteers from URGs, explaining how "if you see a lot of people who look like you doing something, then you feel more inclined to consider that as an option for yourself." In their interviews, 13 volunteers emphasized that making CS accessible to students with limited opportunities to develop computer literacy and programming skills was most important to them.

Previn, a sophomore CS major, notes how this sense of purpose infused his approach to CS more broadly: "What I'd say is I think teaching students how to do something and seeing a positive outcome of it motivates you to want to better yourself. And so indirectly I think it would motivate you to want to take computer science more seriously, which would make your attitude toward it a bit more positive." Participants describe how iCS helped improve their attitude toward CS, as well as how their connection to CS improved their sense of civic efficacy. As a commuting CS freshman who recently joined the club, Nina says, "Sure, politics and governments may be out of my scope, but being in ignite is saying that you can still contribute to closing that socioeconomic gap." In other words, iCS gave students who were not otherwise civically engaged an outlet for justice-oriented action connected to their STEM identities.

Enabling student autonomy and initiative. Student volunteers identified with the mission and purpose of iCS, affiliated with it as a program, repurposed materials with relative ease and confidence, and took ownership over their local clubs. Even when direct financial support was withdrawn in Year 4, students took pride in their clubs and did not report feeling exploited, undercompensated, or as if iCS wasted their time. Rather, iCS volunteers designed their club mission and objectives to address needs in their local communities and to reflect goals that were most meaningful to them. Participants iterated on their program design and expanded their social network to provide a more seamless and sustaining learning environment for CS fluency.

For example, three student volunteers said they helped local K–12 CS teachers as classroom aides, and two incorporated remote online support for students in CS classes. One student volunteer, who attended a small liberal arts college, opened her iCS classes to fellow undergraduate students, because the majority of her (liberal arts) peers had never had the opportunity to develop computer literacy or programming skills before. This fluidity is common to interest-driven connected learning communities, but less common in planned, organized groups with institutional sponsorship. Volunteers brought their interests and skills to their clubs and expressed pride in the cultures they cultivated.

Peer-to-peer and near-peer mentorship. The act of creating and running a club provides opportunities for formal and informal socializing, varying from the focused development of activities to the less formal "down times" between sessions. The ability to work with peers in this relatively unstructured setting enabled forms of formal and informal knowledge sharing. The professionally intimate nature of teaching and the open-ended nature of clubs helped students grow strong, trusting bonds around professional matters. Raquel, a senior CS student, told us how her relationships with iCS peers helped her persist in CS. "Once I joined iCS I started getting involved with my peers more," she told us as she described how her university experience changed after joining iCS. "We started taking classes together, we all see each other [as] equal on the team. We all help each other out. It has made me feel better about myself. I walk into class and there's a whole bunch of guys, but who cares, you know?"

By contrast, student volunteers described how they felt unmoored in the vast selection of courses in their program and that faculty often seemed inaccessible. Even when offered the option of industry mentorship via MentorNet, a portal to professional mentors provided by the iCS program, few took advantage of this opportunity. The fear of "not knowing enough" or being intimidated by a Google employee prevented most of the student volunteers from reaching out to available mentors. Yet all volunteers felt comfortable approaching peers for advice. Without diminishing the importance of supportive professional and faculty mentors, our findings point to great advantages in building strong ties between students in different levels.

Implications

iCS approached the problem of undergraduate retention in CS through a unique set of levers. The program reflected the strengths of experiential and project-based learning in nurturing efficacy and motivation, but it tailored these approaches to the identities and backgrounds of those most vulnerable to dropping out of CS degree programs. Rather than take the more typical approach of providing "disadvantaged" young people with more resources and support, iCS calls on these same young people to give *more with less*, in service of CS and communities that they identify with. While more researchers investigating educational equity have been pointing to the importance of an asset-based orientation, few programs have fully embraced this approach at the scale that iCS has. The case of iCS is an important addition to this growing body of research.

Programs that seek to increase a sense of efficacy and belonging in CS for students from URGs should consider validating and amplifying existing strengths, such as their commitment to activism and justice. Whether it is prior experiences of marginalization or other skills such as community organizing, youth who are not part of the dominant culture of CS bring unique assets to the field. Programs could encourage student agency by providing model projects, resources, and materials but allowing students to co-design the mission and focus of local sites, so that the interests, passions, and concerns of both volunteers and students are reflected in projects. Designers should be mindful about providing materials and funding in ways that could limit student initiative. Peer mentorship can form naturally from students who (a) self-selected into groups by interest, (b) engaged in teaching as a sustained purposeful activity, and (c) were in courses with one another.

While it is tempting to shower marginalized students with resources and powerful connections, charity has the unintended side effect of not only calling out deficits, but reducing initiative. In iCS, professional mentoring relationships occurred less regularly, naturally, or spontaneously than peer mentorship. Particularly with a population that has already made it so far as to declare a CS major, empowerment is a critical component to achieving a strong sense of belonging. In this context, the experience of leadership, self-determination, and being co-equal with other peers with shared identities conferred greater benefits than professional mentorship and material resources. Further, benefits of this approach accrue disproportionately to the most marginalized students, making it attractive to those

seeking to change the balance of representation, rather than simply distributing resources more equitably. Add to this the advantage of being a leaner way to support and scale programs, and the iCS approach stands out as an effort worth emulating.

References

Barton, A. C., Kang, H., Tan, E., O'Neill, T. B., Bautista-Guerra, J., & Brecklin, C. (2013). Crafting a future in science: Tracing middle school girls' identity work over time and space. *American Educational Research Journal*, 50(1), 37–75. https://doi.org/10.3102/0002831212458142

Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology*, 6(49), 1–8. http://doi.org/10.3389/fpsyg.2015.00049

Cheryan, S., Plaut, V. C., Davies, P. G., & Steele, C. M. (2009). Ambient belonging: How stereotypical cues impact gender participation in computer science. *Journal of Personality and Social Psychology*, 97(6), 1045–1060. https://doi.org/10.1037/a0016239

Choney, S. (2018). Why do girls lose interest in STEM? New research has some answers—and what we can do about it. Microsoft | Stories. Retrieved from https://news.microsoft.com/features/why-do-girls-lose-interest-in-stem-new-research-has-some-answers-and-what-we-can-do-about-it/

Cozza, M. (2011). Bridging gender gaps, networking in computer science. *Gender, Technology and Development*, 15(2), 319–337. https://doi.org/10.1177/097185241101500207

Ericson, B. J., Parker, M. C., & Engelman, S. (2016). Sisters Rise Up 4 CS. In *Proceedings of the 47th ACM Technical Symposium on Computing Science Education – SIGCSE '16* (pp. 309–314). https://doi.org/10.1145/2839509.2844623

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., … Watkins, C. S. (2013). *Connected learning: An agenda for research and design.* Irvine, CA: Digital Media and Learning Research Hub. Retrieved from http://dmlhub.net/publications/connected-learning-agenda-research-and-design

Moghadam, S. H., & Bates, T. C. (2017). *Research brief: Retention of Black and Hispanic students in CS* (Internal Google report). Unpublished.

National Science Foundation, National Center for Science and Engineering Statistics. (2017). *Women, minorities, and persons with disabilities in science and engineering* (Special Report NSF 17-310). Retrieved from https://www.nsf.gov/statistics/2017/nsf17310/static/downloads/nsf17310-digest.pdf

Rockman et al. (2017). *An intimate look at Black Girls CODE: A case study of culturally-relevant coding programming and its long-term benefits.* San Francisco: Rockman et al Research, Evaluation, and Consulting.

Vogel, S., Santo, R., & Ching, D. (2017). Visions of computer science education: Unpacking arguments for and projected impacts of CS4All initiatives. In *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education* (pp. 609–614). https://doi.org/10.1145/3017680.3017755

14. Supporting Educator Reflection and Agency Through the Co-Design of Observation Tools and Practices for Informal Learning Environments

CAITLIN K. MARTIN, ERIC REYES, EPHRAN RAMIREZ JR., LISA BRAHMS, AND PETER WARDRIP

Abstract: Spaces for youth to create what they imagine, such as makerspaces and learning labs, are proliferating in community centers, libraries, schools, and museums. There is still much to learn about how to document what happens in these spaces, especially in ways that can support educators in design and practice. In this paper, we share exploratory design-based research investigating how making and learning practices are identified and interpreted by educators working in library spaces connecting teens to tools, mentorship, and support for creative production. First, we share how researchers and educators co-designed observation tools, building on existing frameworks of learning practices involved in making activities. Second, emergent themes from co-design activities are presented, including the importance of organizational history and shifting perceptions about evaluation and data collection as opportunities for professional learning and advocacy. Finally, implications and future work are discussed.

Introduction

A teen boy leans forward on his chair toward a computer screen, engrossed in frame-by-frame editing of a digital video, painstakingly playing, editing, testing, and re-editing. The boy is deleting frames in which the lead actor freezes and an offscreen teen quickly rushes in to place an object in his hand. In the completed clips, the object magically appears. Two other teen boys sit on either side of the editor looking at their phones. One is an actor in the video. The other has a small speaker playing music in his backpack tucked under the chair. They remain in their positions for more than 30 minutes while the editor does his thing. Other music fills the space from speakers behind the front desk. A group of teens eat snacks and play video games nearby and across the room six teens on couches are having a discussion during a mentor-led science program. This scenario is just a typical afternoon at this YOUmedia location. While mentors constantly navigate from moment to moment, providing help and support as needed, identifying what is happening for whom is often difficult to unpack and certainly difficult to capture and share in a way that is systematic and summative. Additionally, for those new to the space, interpretations of who is learning through making and who is not can be oversimplified. Concerns about providing quality opportunities for youth, about equity of access and goodness of fit, and about understanding learning in ways that are authentic to the environment and its community, are key reasons that research-practice efforts to document learning practices in informal spaces are urgently needed.

In this paper, we share one part of a larger collaborative research-design partnership to develop observation tools documenting youth learning processes through making that are authentic to the learning environment and useful for stakeholders, including youth, educators, and administrators. Overarching questions that guide this work include: (a) How are learning practices in making interpreted by educators? (b) How can observations support professional learning and inform changes in practice and design of spaces and programming? Initial themes emerging from the work are presented and discussed, as are implications for design, practice, and future work.

Understanding Making and Learning in Informal Spaces

Spaces for youth to create what they imagine using analog and networked tools, such as makerspaces and learning labs, are increasingly popping up in community centers, libraries, schools, and museums (Hatch, 2014). There is evidence that skills, dispositions, and experiences of making and creating are increasingly important. Research focused on middle school found that greater involvement in production-oriented experiences was significantly related to important competencies, including more confidence in their own capacity to generate new ideas, stronger self-efficacy with professional tools, a propensity to share technical expertise with a broader network of people, and intent to continue to develop technical expertise in the future (Barron & Martin, 2016; Martin, Barron, Stringer, & Matthews, 2014). Incorporating spaces for making and creative production into libraries is of interest as a way to respond to current thinking about critical literacies and future workforce needs in ways that resonate with libraries (Moorefield-Lang, 2014), and it is suggested that through these spaces patrons have new ways to collaborate, play, solve problems, explore, and produce (Britton, 2012).

Research-practice design partnerships have contributed to operationalizing what learning in making and production spaces looks like in ways that resonate with educators. Bevan, Gutwill, Petrich, and Wilkinson (2015) worked with museum practitioners to catalog video cases of making in the museum and empirically identified dimensions of learning in tinkering. Wardrip and Brahms (2015) similarly worked with teaching artists at another museum space and developed a framework of learning practices of making. These frameworks use a practice-based perspective on learning that asserts an understanding of learning as fundamentally tied to the social and cultural contexts in which it occurs and focuses on the "practices" that define learning communities (J. S. Brown, Collins, & Duguid, 1989), including interactions with others, as well as with tools and materials and practices (Wardrip & Brahms, 2015). These models are helpful in providing a common language to guide discussions about making as a learning process by identifying ways to conceptualize, support, and assess such forms of learning through design. But there remains a need for tools and measures that can illuminate these practices in the learning spaces in ways that can be documented by practitioners.

Documenting and assessing learning in informal and media-rich environments in general is recognized as difficult (Lemke, Lecusay, Cole, & Michalchik, 2015). Much of the existing research in these spaces has focused on the design of the spaces and projects and the experiences of participation (e.g., Blikstein, 2013; Buchholtz, Shively, Peppler, & Wohlwend, 2014; Sheridan et al., 2014) and sought to measure the outcomes of programs and participation as opposed to documenting processes. In addition, methods used in these studies often use rich qualitative data collection such as ethnographies that necessitate a research team (e.g., Buchholtz et al., 2014; Sheridan et al., 2014) or require youth to systematically document their contributions through portfolios and reflections (e.g., Keune & Peppler, 2017). These options are often not feasible for practitioners to use regularly to access data in ways that can summarize patterns and inform practice.

Methods

This paper summarizes part of a larger research-practice initiative exploring how four different informal environments interpret and observe learning that happens in their makerspaces and developing a suite of observation tools to inform research and practice. The initiative is based on previous work that identified seven salient learning practices of making (Brahms & Wardrip, 2014; Wardrip & Brahms, 2015). The work takes a design-based research approach, engaging in iterative development of solutions to practical and complex educational problems in an actual learning environment (A. L. Brown, 1992). Key to this approach is collaborative design work, ensuring that practitioners

have a voice as part of the research team, thus promoting uptake and use of emergent designs and knowledge and ideas (Datnow, Hubbard, & Mehan, 1998; Gravemeijer & van Eerde, 2009).

Context and Participants

This paper centers on one of the four partner locations, a YOUmedia library space in Chicago, Illinois. YOUmedia spaces are designed for teens to spend time, build relationships with peers and adults, and access opportunities to explore and deepen their learning in ways that connect with interests and emphasize creative production (Barron, Gomez, Pinkard, & Martin, 2014; Ito et al., 2013). The YOUmedia space shared in this paper is equipped with areas to hang out and play video games as well as areas encouraging creative arts and technology pursuits with materials such as video cameras, drawing tablets, sewing machines, paints, and an in-house recording studio. In the space, teens have access to adult mentors, many of whom have a content-area specialty, who hang out alongside the teens, work on their own projects while being available for questions and support, and design and run weekly programming that changes quarterly.

Two staff from YOUmedia, a frontline branch mentor and the digital media coordinator, and a learning sciences researcher from outside of the library collaborated over the course of a year (the first three authors). Throughout the process, they regularly engaged other YOUmedia staff, including librarians, mentors, and administrators, as well as research and design partners at the other project locations.

Process

Regular time for research-practice discussions. The three-person YOUmedia team met every two weeks in person over one year to identify and negotiate the problems of practice and potential design solutions. Meetings were captured through field notes (18 pages). Once a month the team met virtually with researchers and practitioners from the other co-located project sites to share work and get feedback.

Local context setting and relationship building. To build trust and understanding between the three local research-practice project collaborators and other YOUmedia staff, time was reserved for bidirectional communication and learning. This phase included learning about and sharing the seven learning practices of making (Brahms & Wardrip, 2014; Wardrip & Brahms, 2015) and existing observation tools and learning frameworks used at YOUmedia. Data included field notes (10 pages) and artifacts from four meetings with YOUmedia mentors and administrators throughout the year.

Identifying learning values. To identify and negotiate learning values and how they connected to making and production and to explore practices of observation and assessment at YOUmedia, the research and practice team invited YOUmedia staff to participate in short informal feedback sessions. Seven mentors and three administrators participated in conversations that queried reactions to existing frameworks of learning, their personal and organizational learning goals for youth, and indicators of youth learning and development at YOUmedia. Questions were shared with participants beforehand. Conversation notes were typed into the document by the researcher during or directly after the meetings, and some staff added additional responses in a Google doc (13 pages).

Prototyping, testing, feedback, and revision. Based on information collected, representations of learning goals within the site and digital and analog forms for documenting observations and reflection questions were prototyped and regularly discussed, negotiated, and renegotiated during team meetings and informal check-in reviews with staff. Potential value, usability, and potential-use cases were focal feedback and discussion themes. During the course of the project, three distinct documents were developed: rationale for valued learning practices at YOUmedia, guide for observations, and a tool to document observations. Each had multiple rounds of prototyping and revision. All versions

were archived as data (15 documents). Notes and other data were regularly synthesized and translated into shareable Google slide decks that served as editable anchors for discussion and negotiation. This collaborative analysis served as the basis of identifying emergent themes.

Findings

1. How Were Learning Practices of Making Interpreted by Educators?

Attention to language was important and mentors translated practices. Mentors valued existing frameworks of learning and making and recognized many of the practices as important within the YOUmedia space, but they frequently translated the practices into their own institutional language. They made sense of the seven learning practices of making defined by Wardrip and Brahms (2015) by grouping and ordering them, often linking them to fundamental frameworks of YOUmedia, including HOMAGO (hanging out, messing around, geeking out; Ito et al., 2010) and connected learning (Ito et al., 2013). For instance, the practice of *tinkering* was considered valuable and was identified as one of the ways youth "mess around" in YOUmedia, as per the HOMAGO language. Other practices were modified to better represent the practices in their space, as when one mentor commented,

> Like for *hack and repurpose* there is the more familiar practice of breaking apart a computer and putting it back together. But then also cutting apart beats. Hacking and repurposing different segments of a song to create something new. (May 2019)

In addition to the language used to identify and define practices, other word choices related to the development of an observation tool emerged as culturally problematic. These included *evidence* and *evaluation*, which had negative connotations for youth and mentors in the library space and in the community. One asked, "How can we establish a tool where the observation/evidence are not assumptions made by other people?" (May 2019)

Opportunities for connections and relationships through making were of interest. The organizational history of YOUmedia heavily influenced the interpretations of the learning practices of making (Wardrip & Brahms, 2015), and YOUmedia staff recognized a critical absence of two constructs: (a) relationships, including communication, sharing, collaboration, and bidirectional teaching and learning with peers and mentors, and (b) connections to opportunities beyond the immediate learning opportunity observed, including establishing connections to the learning space itself, meeting experts from the field, and being referred to other tools, programs, and support beyond the library space. Recent studies in connected learning environments have identified a variety of ways mentors (Barron et al., 2014) and peers (Maul et al., 2017) can support an interest-related creative pursuit, such as encouragement, teaching, motivating sustained engagement in a pursuit, and making friends. Mentors saw connections to these other practices within the existing frameworks (for example, one mentor noted, "Within *sharing resources* there is a collaboration piece") but wanted more explicit attention.

> I enjoy when I can see a teen is comfortable yet respectful when experimenting and using the tools available on their own. Especially when they shift their approach to incorporate more tools and resources both in and outside of the space. (May 2019)

> [This framework needs to include] critique and criticism and reflection about work and the world in general. To situate [teens] and their work in it. (May 2019)

Learning practices were interpreted holistically. Initial project observation tools represented one learning practice. YOUmedia mentors determined that single-practice observations would not capture the nature of their programming, which acknowledges that youth engage in multiple learning dimensions at once, including social and creative learning pursuits. To observe authentically in the space, mentors advocated for a tool that holistically documented indicators but assigned them to areas of overarching importance. As such, four primary learning values were identified, collapsing and organizing important practices. For instance, agreement in the YOUmedia context that the practices of "*inquire* and *seek resources* are pretty similar; they are both really getting at the idea of having curiosity and figuring out what you are doing" was mediated by folding them into a larger dimension of "messing around." Under this theme, observers could document what they saw related to common indicators of engagement, such as asking questions (inquiring) or checking out tools (seeking resources) at YOUmedia. Similarly, staff stressed the importance of a simple observation tool that allowed for flexibility to document the space in different ways (e.g., both a formal program in action and open-ended time during which teens are in a certain production area) and for different units of time (reflecting that mentor time for observation was limited and that trajectories of learning in the space were often and necessarily a "slow and nonlinear process" as teens made decisions about what to do and how to do it). Reflection questions included in the observation tool were appreciated but only if they were "to the point" and "not redundant."

Implications for design. The observation tool was expanded to support a holistic view of YOUmedia learning practices and at the same time simplified to encourage observer participation and ease of observation practice. Details of observation were pushed to the second page and the primary space for documenting what was noticed was foregrounded, including open-ended entry within primary quadrants using YOUmedia practitioner language (messing around, geeking out, building community, and making connections) with subindicators available for identification but not requiring itemized response (Figure 1). Open-ended questions for reflection and to spark discussion for learning and decision making were added on the second page. The adapted observation tool was designed to observe multiple contexts—a program, activity in a particular space, or the design of the environment. In this way, the observation focused not on making claims about a particular youth but rather on the interactions (or potential for interaction) between youth and mentors and space. A user observation guide was also created that framed observation as a way to *document* learning and *support* learning in practice as opposed to *collecting evidence* for *evaluation*. The guide includes a crosswalk document identifying commonalities between YOUmedia learning goals and the multiple frameworks the project and practitioners referenced, and descriptions of indicators of learning from the language of mentors and administrators.

Figure 1. Three major design phases of the observation tool, (c) being the most recent iteration.

2. How Can Observations Support Professional Learning and Inform Changes in Practice and Design of Spaces and Programming?

Informal evaluation and assessment is happening but is difficult to share. Before the development of the observation tool, staff had ways of determining challenges and successes and making adjustments in the moment and from program cycle to program cycle, but this was happening at an individual level or small-group level, rather than at a programmatic or organizational level. There was not a formalized practice nor were there systematic ways to share decision making and observations with others, and this was especially concerning when thinking about how existing knowledge was being shared with newer mentors. Through conversations with staff, it was clear that traditional evaluation of learning, such as pre-postsurveys, was not of interest, but ways to document what they cared about in ways that could be shared with others (within and outside of the organization) was. They were especially interested in how to document practices that were difficult to capture through traditional write-ups or attendance numbers. One example was asynchronous collaborative work, such as a model train landscape built by multiple teens often working at different times over months. Others include showing how going deeper with a smaller number of youth is critical for youth learning and development and how youth *hanging out* in the YOUmedia space achieves goals that might be overlooked or less obvious than other practices. Multiple staff noted that stakeholders and outside audiences are often "too judgmental about one [type of activity] being better than the other" (July 2018). One mentor reflected how staff saw things differently:

> Each of these practices lives on a continuum of value that is fairly evenly spread. It is important to value *Inquiry* similarly to *Fluency*. (May 2018)

Mapping observation onto existing practices of evaluation and professional development suggested potential shifts in practice to support staff. Observation and evaluation were initially interpreted by many staff as problematic and not necessarily helpful in supporting their practice:

> Evaluations are a necessary evil. I hate them. As a staff member, I want to spend all my time with students. The thing that is most rewarding is actually doing the work. I will do this because it takes this to keep the funding going and we want to make sure we are doing as well as we can. I don't resist it. (April 2018)

> We have done reflective practices that has not been tied back into our other work. Not necessarily transparency around it. So, there are feelings that nothing will come of it. (July 2018)

More systematic observations using shared tools was identified by mentors as a way to illuminate reasons and decision making, including advocating for changes in programming and planning for thematic reflection discussions during staff meetings. Also, using one tool for observation and program planning was of interest to support joint understanding of YOUmedia goals and to ensure that the data being collected and the reflection questions being asked are of interest to educators for use in practice as opposed to collecting information for other people.

Implications for practice. Specific opportunities to use the observation tool to convey information and as an anchor to guide discussion were identified. *Mentor program planning:* Quarterly meetings to support mentors in planning for the next program cycle are using the observation tool to guide goals and activities (Figure 2), using shared language and emphasizing depth and breadth of learning practice. *New hire mentor shadowing*: YOUmedia mentors shadow at other branches as part of the onboarding process and the observation tool is being experimented with as a way to focus what new hires observe within YOUmedia core learning values and key indicators. *Summative data review*: Qualitative summaries and photographs of spaces and activities were of interest for both documentation of practice and guiding staff conversations. Based on the preference for digital data collection, an online version was developed, allowing open-ended documentation and reflection along major themes and questions and summative analysis. As we return to the opening scenario, the observation tool allows documentation of the ways in which the two youth hanging out around the video editor are engaged in the creation process through relationships, supporting and sustaining his focused video production work (Figure 2). Using qualitative counts of observations documented can reveal the proportion of observations in each primary learning values quadrant (Figure 2), with the option to explore the presence of specific indicators within those broad areas. This articulation of distinct activities can promote conversation, reveal patterns of coverage, and suggest potential areas for more support and/or offerings.

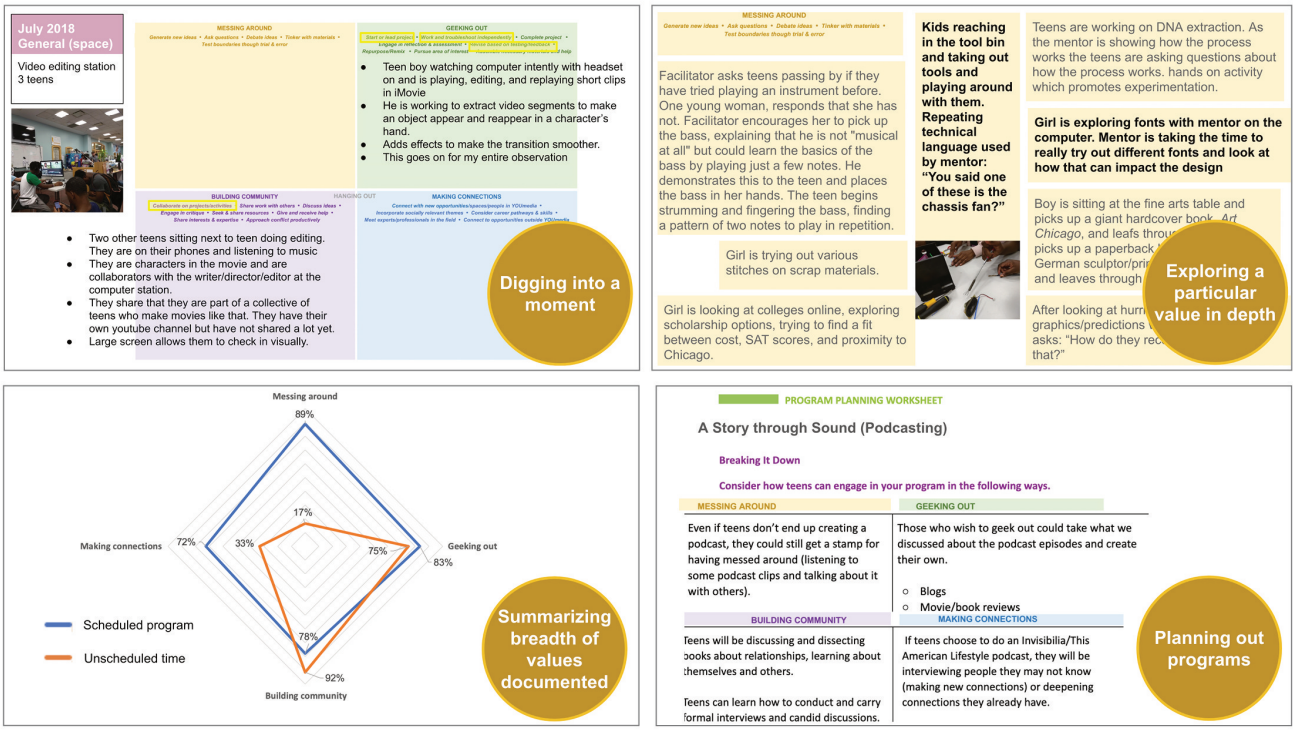

Figure 2. Examples of observation tool data visualizations (single observation and across multiple observations) and planning documents.

Discussion

Our thematic findings stress the importance of organizational history and support, both in the interpretations of learning practices in making that emphasized core YOUmedia learning frameworks of connected learning and HOMAGO (Ito et al., 2010), and in the necessity of changes in day-to-day practice that would allow observation to thrive. They also suggest that co-design and use of observation tools and practices have the potential to shift educator perceptions of observation as top-down evaluation to observation as professional learning and in support of practitioner-led advocacy for what they care about, including a broader view of making and learning. Promising uses of observation tools are to share common language, goals, and facilitation strategies across a distributed system and to celebrate work and ideas in ways that can inform practice. Recent work has provided empirical evidence that the shared process of the adaptation of materials for use in learning environments through collaborative design offers ample opportunities for professional development and educator agency for educational change (Voogt et al., 2015). This work has implications for both design and practice in that it provides an example of a flexible observation tool for informal teen making and production spaces that values the ideas of connected learning, including thematic insights about design and practice directly from practitioners, but perhaps more important, it suggests multiple benefits related to the process of co-designing an observation tool.

References

Barron, B., Gomez, K., Pinkard, N., & Martin, C. K. (2014). *The digital youth network: Cultivating digital media citizenship in urban communities.* Cambridge, MA: The MIT Press.

Barron, B., & Martin, C. K. (2016). Making matters: A framework for assessing digital media citizenship. In K. Peppler, Y. Kafai, & E. Halverson (Eds.), *Makeology: Vol. 2. Makers as learners* (pp. 45–72). New York, NY: Routledge.

Bevan, B., Gutwill, J. P., Petrich, M., & Wilkinson, K. (2015). Learning through STEM-rich tinkering: Findings from a jointly negotiated research project taken up in practice. *Science Education*, 99(1), 98–120.

Blikstein, P. (2013). Digital fabrication and "making" in education: The democratization of invention. In J. Walter-Herrmann & C. Büching (Eds.), *FabLab: Of machines, makers and inventors* (pp. 1–21). Bielefeld, Germany: Transcript.

Brahms, L., & Wardrip, P. (2014). *The learning practices of making: An evolving framework for design*. Pittsburgh, PA: Children's Museum of Pittsburgh.

Britton, L. (2012). The makings of maker spaces, part 1: Space for creation, not just consumption. *Library Journal*, 15(2), 85–108.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2(2), 141–178.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32–42.

Buchholz, B., Shively, K., Peppler, K., & Wohlwend, K. (2014). Hands on, hands off: Gendered access in crafting and electronics practices. *Mind, Culture, and Activity*, 21(4), 278–297.

Datnow, A., Hubbard, L., & Mehan, H. (1998). *Educational reform implementation: A co-constructed process* (Research report). Berkeley: University of California Center for Research on Education, Diversity & Excellence.

Gravemeijer, K., & van Eerde, D. (2009). Design research as a means for building a knowledge base for teachers and teaching in mathematics education. *The Elementary School Journal*, 109(5), 510–524.

Hatch, M. (2014). *The maker movement manifesto*. New York, NY: McGraw-Hill.

Ito, M., Baumer, S., Bittanti, M., boyd, d., Cody, R., Herr-Stephenson, B., … Tripp, L. (2010). *Hanging out, messing around, and geeking out*. Cambridge, MA: The MIT Press.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., … Watkins, C. S. (2013). *Connected learning: An agenda for research and design*. Irvine, CA: Digital Media and Learning Research Hub.

Keune, A., & Peppler, K. (2017). Maker portfolios as learning and community-building tools inside and outside makerspaces. Philadelphia, PA: International Society of the Learning Sciences.

Lemke, J., Lecusay, R., Cole, M., & Michalchik, V. (2015). *Documenting and assessing learning in informal and media-rich environments*. Cambridge, MA: The MIT Press.

Martin, C. K., Barron, B., Stringer, D., & Matthews, J. (2014). Patterns of engagement: How depth of experience matters. In B. Barron, K. Gomez, N. Pinkard, & C. K. Martin (Eds.), *The digital youth network: Cultivating digital media citizenship in urban communities.* Cambridge, MA: The MIT Press.

Maul, A., Penuel, W. R., Dadey, N., Gallagher, L. P., Podkul, T., & Price, E. (2017). Measuring experiences of interest-related pursuits in connected learning. *Educational Technology Research and Development*, 65(1), 1–28.

Moorefield-Lang, H. (2014). Makers in the library: Case studies of 3D printers and maker spaces in library settings. *Library Hi Tech*, 32(4), 583–593.

Sheridan, K., Halverson, E., Litts, B., Brahms, L., Jacobs Priebe, L., & Owens, T. (2014). Learning in the making: A comparative case study of three makerspaces. *Harvard Educational Review*, 84(4), 505–531.

Voogt, J., Laferriere, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. (2015). Collaborative design as a form of professional development. *Instructional Science*, 43(2), 259–282.

Wardrip, P., & Brahms, L. (2015). Learning practices of making: Developing a framework for design. In *Proceedings of Interaction Design and Children* (pp. 375-378). https://doi.org/10.1145/2771839.2771920

Acknowledgments

We thank the Chicago Public Library YOUmedia mentors, librarians, and administrators for their contributions to this work and their collaboration on research and practice, and to the teens for putting up with observations in the space. The Making Observations work is made possible through the support of the Institute of Museum & Library Services (Grant number MG-10-16-0073-16). Making Observations is in partnership with the Children's Museum of Pittsburgh, the Science Museum of Minnesota, Chicago Public Library, and Montshire Museum of Science.

15. Designing in 360 Degrees

Cueing the Player for Immersive Learning

LARYSA NADOLNY, KRISTIE TANK, AND QUINNE FOKES

Abstract: Previous research on cueing has focused on multimedia environments where the information is within the player's field of vision. Virtual reality environments have the unique challenge in that information is located in all directions around the player. The purpose of this study was to examine the impact of cueing on patterns of engagement within a 360° image. Exploratory data analysis was used to examine 3,337 user interactions. Although there was an overall decrease in clicks from front to back in all groups, the text- and audio-cueing groups more frequently selected items behind the field of view. These findings support the use of cueing as a way to direct the player's attention to the back of the virtual environment.

Introduction

In complex digital environments, the location and combination of media impact the cognitive ability of the player to understand and process information. The work by Mayer and other researchers on multimedia learning have demonstrated principles for reducing extraneous processes in these visually rich learning environments, including the importance of cueing the player on important information (Mayer & Moreno, 2003). This foundational research is focused on computer-based learning experiences in which the field of vision is in front of you. Rapid advances in technology have complicated the application of these principles, particularly in learning environments that are not only in front of your field of vision, but also all around you (Dodd & Antonenko, 2012). Examples are the increasing popularity of educational uses for virtual reality (e.g., Google Cardboard) and augmented reality in which information is presented in front, above, below, beside, and behind the player. Therefore, research is needed to examine how players navigate these 360° learning environments. This research study specifically examines user engagement with content overlaid on a 360° image. In this study, cueing is used to signal the player to engage with information located in all directions.

Theoretical Framework

Cueing has been shown to increase academic achievement and retention of information in multimedia environments (Jamet, 2014; Mautone & Mayer, 2001; Tabbers, Martens, & Van Merriënboer, 2004). For example, a simulation may include audio cues, text cues, color changes, or highlighting as a way to focus attention. This method of decreasing cognitive load is categorized as the signaling effect of multimedia learning (Mayer & Moreno, 2003). Signaling can be defined as "the placement of non-content visual and or verbal elements that serve to guide the learner's attention and aid in the cognitive processes of selecting and organizing instructional materials" (Dodd & Antonenko, 2012, p. 1103). The mechanism for this process is that the cued information assists the player in more quickly and efficiently finding and processing important information (Ozcelik, Arslan-Ari, & Cagiltay, 2010).

In 360° environments, a majority of the presented information is outside of the player's visual field at any given time. Few studies have examined the signaling effect in virtual reality, particularly when used to guide the player's attention and progress (Dodd & Antonenko, 2012). Preliminary research includes how the use of arrows in a virtual learning

environment resulted in a significant increase in learning as compared with the noncued environment (Chen & Ismail, 2008). In this study, we examined user interactions with both audio and visual cueing in a 360° environment to answer the following research question: How do players engage with 360° content in cued and noncued learning environments?

Method

Exploratory data analysis (EDA) is a data-driven approach to exploring quantitative information through visualization with the goal of generating areas of study for hypothesis testing (Tukey, 1977; Weiner, Schinka, & Velicer, 2012). This methodology was selected in response to the lack of prior research studies on cueing in educational simulations within virtual environments. The study was designed with three versions of the simulation for data collection and analysis: (a) no cueing, (b) text cueing with four additional text cue buttons, and (c) audio cueing with an audio cue every four minutes.

Simulation Design

The study used the ThingLink educational technology platform that can immerse viewers in a 360° image or video. The simulation can be navigated and viewed using a computer mouse on a computer, swiping finger movements on a cell phone, or physically moving around on a cell phone or VR viewer. The activity the research team created in this environment, *Ocean Exploration*, allowed viewers to experience a 360° interactive virtual tour of an underwater coral reef that presented a variety of links in front, above, below, to both the sides, and behind the player (Figure 1).

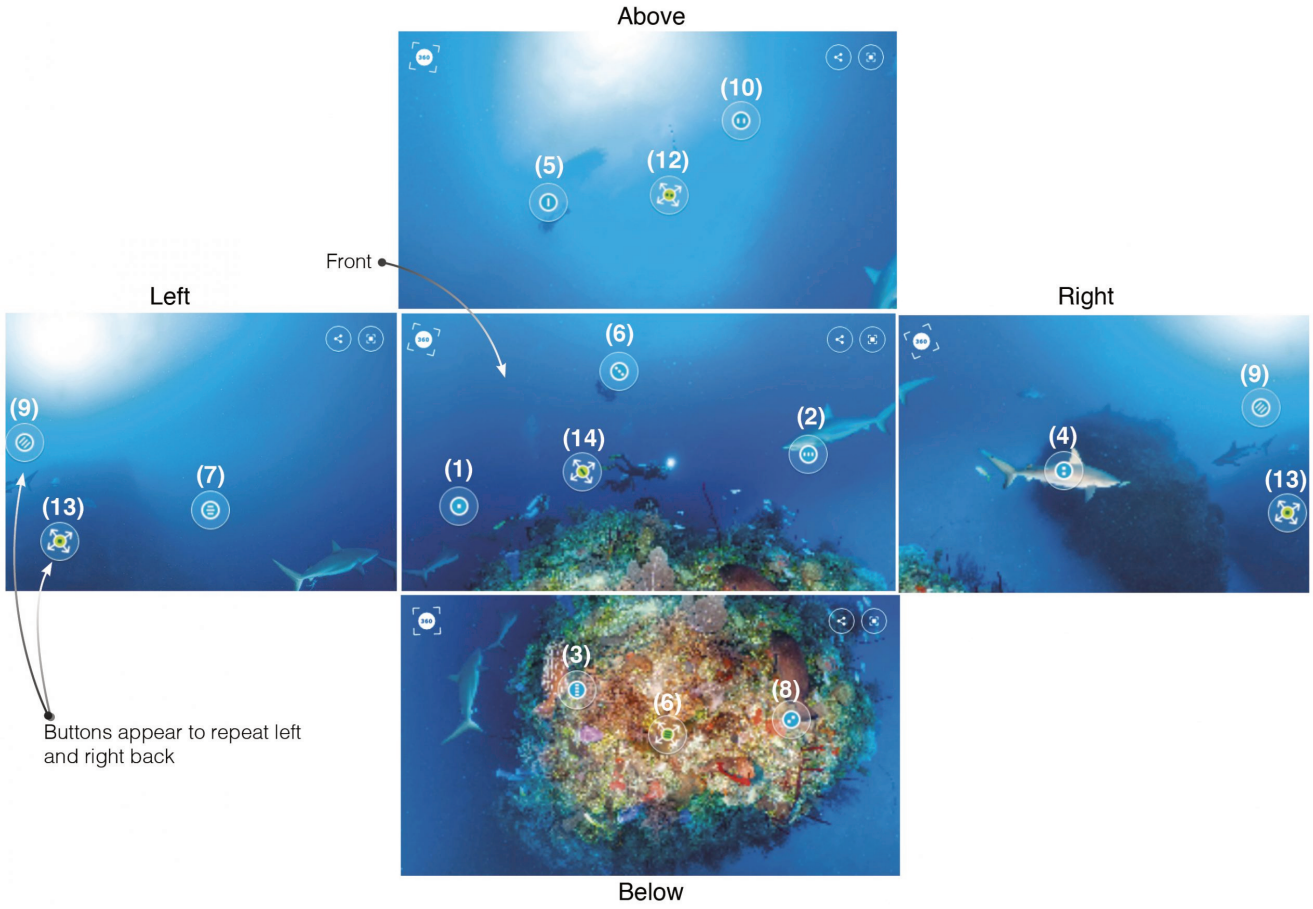

Figure 1. Flat 2D representation of the 360° simulation.

The buttons or tags in the environment can be selected to reveal additional content such as videos, interactives, and maps. The 360° underwater image, the placement of buttons, and content buttons were identical in all three groups with the exception of the additional text cue buttons in Group 2 (Table 1).

Button #	Button location	Button Educational Content
1	Front	Prezi on coral reef bleaching
2	Front	Prezi on coral reef food chain
3	Below	360 image of bleached coral reef
4	Right	360 image of sharks
5	Above	Video on 3D printed reefs
6	Front	Video on history of scuba diving
7	Left	360 image of coral reef nursery
8	Below	360 image of dead coral reef
9	Back	Video on coral reef basics
10	Above	Video on restoring coral reefs

Table 1. Button location and educational content.

The environments for both audio cueing and no cueing contained a total of 10 buttons, while the version with text cueing included an additional four buttons. The buttons were spread out through the environments roughly equally (see Figure 1), and the types of educational content were also distributed equally. Button #6 is directly in front of a player's field of vision while #9 is directly behind the player.

The buttons were marked with small glyphs in order to differentiate the buttons for the player and provide a visual marker for the location in the environment. To minimize the level of visual distraction, while still affording searchability, the buttons were designed using a primarily white color for a higher level of luminance contrast against a predominantly blue (lower luminance) background (Xu, Higgins, Xiao, & Pomplun, 2007), and they were also designed with a moderate level of complexity and distinctiveness (Huang, 2008; Näsänen & Ojanpää, 2003). Numbers were not used on the buttons in order to avoid semantic bias (Telling, Kumar, Meyer, & Humphreys, 2010).

Design of the text cue. In order to visually separate the cue buttons from the content buttons within the text cue treatment group, the cue buttons were marked with a glyph surrounded by four small arrows. When selected, a text box appeared with the statement "Be sure to look all around! This is a 360° image, so there's more to see all around you!"

Design of the audio cue. The researchers recorded and inserted an audio file into the simulation for the audio cue treatment group. The audio group presented the same cueing instruction as the text group, lasting seven seconds and repeating every four minutes.

Participants

To encourage a wide distribution of the simulation in authentic contexts, the *Ocean Exploration* link was promoted and shared through media outlets of the target audience for formal and informal educators. This included direct communication to science teachers, professional society mass communication, social media, and as a feature on the ThingLink education blog.

Data Collection

Before accessing the virtual reality experience, participants were directed to a survey link that randomly assigned the participant to one of three conditions. Although most viewers accessed the simulation through the survey and randomization, it could also be viewed by participants sharing a direct link. The data set that was used for this study was a collection of click data retrieved from the ThingLink site for the period from March 31, 2017 to July 6, 2017.

Data Analysis

Quantitative data were analyzed using descriptive statistics to compare the total number of clicks per button for each group. To assist in direct comparison of the three groups, the clicks per button were scaled to represent equal maximum click counts for each group. Those results were then graphed in three dimensions in order to more easily uncover and analyze.

Results

The 360˚ environment with no cueing received 239 total clicks, text cueing 833 total clicks, and audio cueing 2,265 total clicks, for a total of 3,337 clicks (Table 2). At one point during the study, the ThingLink platform featured the audio cue version on its education blog, which accounts for the high number of clicks in that group.

Button #	No Cueing	Text Cueing	Audio Cueing
1	32	96	303
2	32	78	311
3	21	58	163
4	28	71	244
5	25	54	159
6	26	68	289
7	25	66	186
8	23	61	177
9	14	61	272
10	13	43	161

Table 2. Button click counts for each comparison group.

When scaled for a direct comparison of the three groups, there was a general decrease in the number of clicks between the front to back (Figure 2). Players most frequently selected the front left (#1) and front right (#2) buttons. The buttons below (#3) and above (#10) were the most infrequently selected across all three groups. Overall, the buttons above the player were infrequently selected, with the exception of button #5 for the no cueing group.

In comparing the three groups, the button directly behind the participant (#9) was selected least often in the no cueing group. There was an increase in the selection of the back button for the text cueing group and an even greater selection by the audio cueing group.

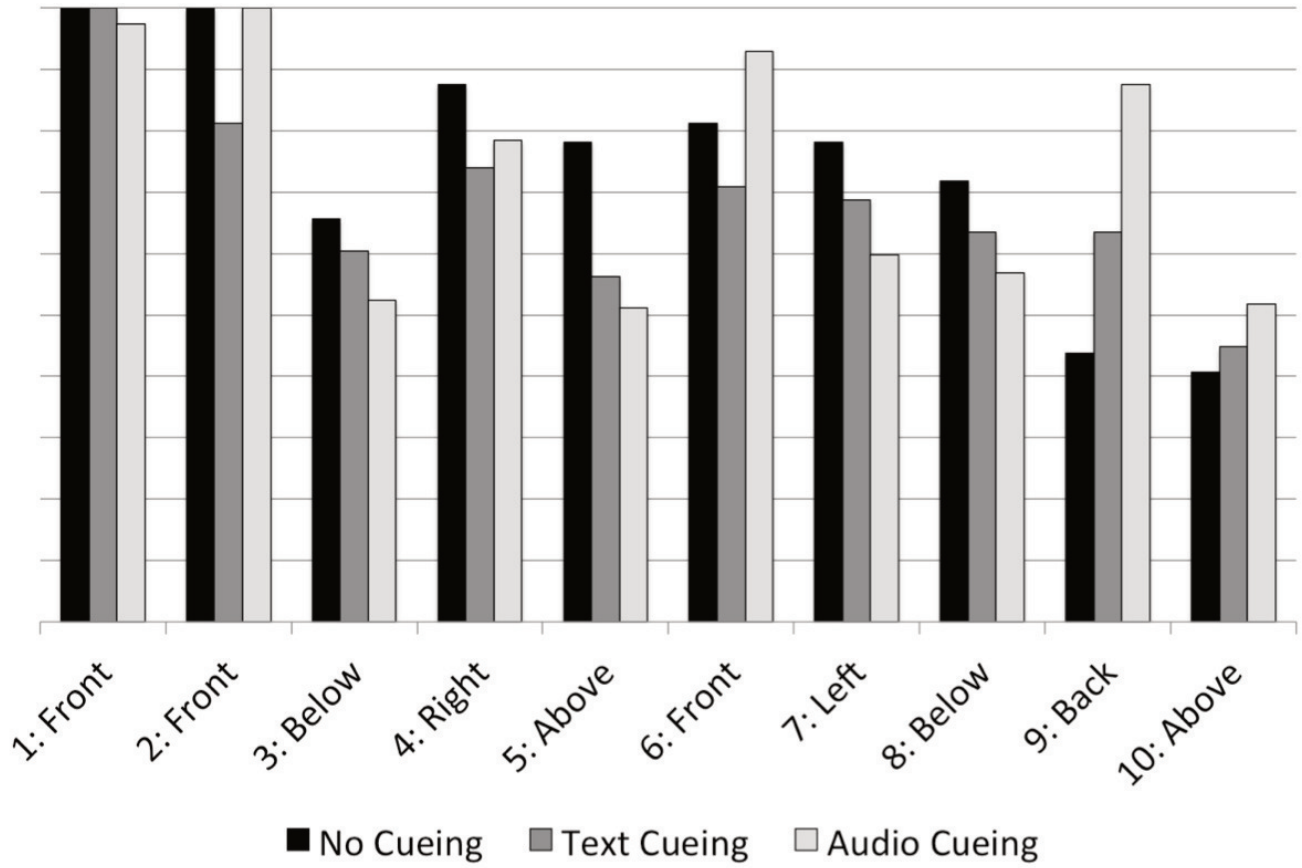

Figure 2. Scaled click counts per button for each comparison group.

The difference in the clicks on the back button is evident when viewing a three-dimensional representation of the simulation (Figure 3). The number of clicks is greater in the cueing groups and largest in the audio cueing group.

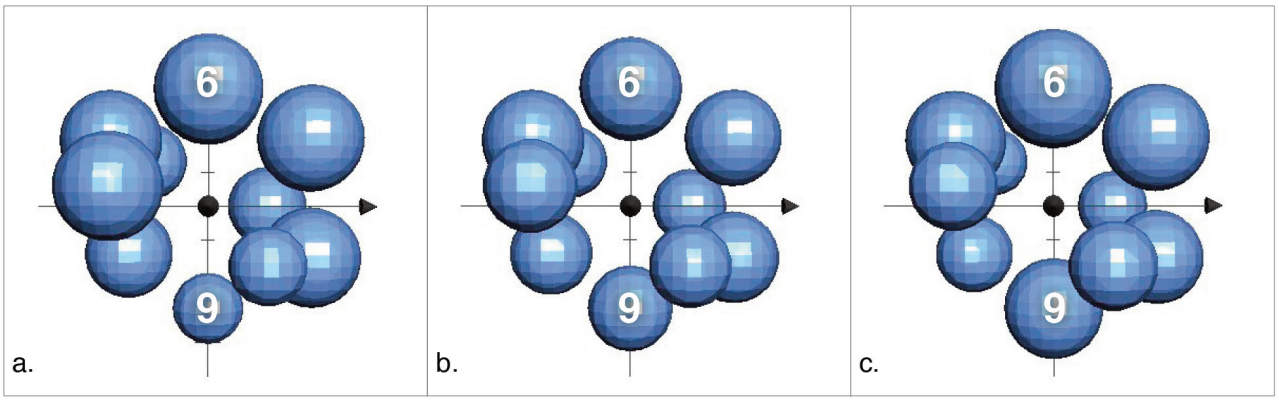

Figure 3. Graphic representation of data as viewed from above: no cueing (left, a.), text cueing (center, b.), and audio cueing (right, c.).

Discussion and Limitations

The more frequent selection of the button behind participants in the two cueing environments confirms studies indicating that text and audio cueing in 360° environments can lead to increased engagement for viewers, provided the cues are not so distracting as to cause cognitive overload (Dodd & Antonenko, 2012; Huang, 2008).

All three groups had lower click rates for the buttons above their field of vision, particularly the above back button (#10). This result may be explained through research in the fields of human computer interaction, psychology, and human factors engineering. A human's line of sight is usually measured to be 10 to 15 degrees below the horizontal plane (Wickens, Lee, Liu, & Gordon-Becker, 2013), and participants' apparent pattern of turning their heads from side to side and looking down may reflect an ergonomic preference. The increased selection of the top button closest to field of vision in the no cueing group (#5) may indicate a normal pattern that was interrupted by the visual or verbal cueing (Hancock, Mercado, Merlo, & Van Erp, 2013) and can be further explored through eye-tracking studies.

Few studies have examined the signaling effect in virtual reality environments, and this study is significant in that it confirms the positive impact of cueing on attention getting but also presents questions for future study. For example, although the audio cue in this study occurred every four minutes, researchers may want to compare different time intervals and the impact on engagement. In addition, one of the affordances of virtual reality is perceptual immersion in the environment, which may be affected by the static view of desktop or the movable view of cell phones. Technology used to access the simulation may affect immersion and presence, and therefore cognitive gains.

The study is limited by the exploratory research design, with data collection occurring in uncontrolled real-world settings. Future studies should include a replication of this study using randomization, controlling for access through similar devices, and setting time limits in the simulation.

Conclusion

This study is a first step toward the bigger question of looking at how and why players navigate these 360° learning environments, by providing insight into how users engaged with content in a 360° image. The results suggest that both text and audio cueing were effective in signaling the player to engage with information in all directions within this virtual reality experience. Therefore, when thinking about the design of 360° environments, it is important to recognize that players do not navigate equally in all directions. If the intent is to have players look around and interact with buttons left, right, above, and below them and take full advantage of what a 360° virtual reality experience can provide, then a cueing component can help facilitate these interactions. However, it may not be enough to just add a general cueing component to "look all around," as this work found that users did not tend to look upward regardless of cueing. Future work is needed to extend the learning from this study to look more closely at where and how users engaged in these 360° environments.

References

Chen, C. J., & Ismail, W. M. F. W. (2008). Guiding exploration through three-dimensional virtual environments: A cognitive load reduction approach. *Journal of Interactive Learning Research*, 19(4), 579–596.

Dodd, B. J., & Antonenko, P. D. (2012). Use of signaling to integrate desktop virtual reality and online learning management systems. *Computers & Education*, 59(4), 1099–1108.

Hancock, P. A., Mercado, J. E., Merlo, J., & Van Erp, J. B. (2013). Improving target detection in visual search through the augmenting multi-sensory cues. *Ergonomics*, 56(5), 729–738.

Huang, K. C. (2008). Effects of computer icons and figure/background area ratios and color combinations on visual search performance on an LCD monitor. *Displays*, 29(3), 237–242.

Jamet, E. (2014). An eye-tracking study of cueing effects in multimedia learning. *Computers in Human Behavior*, 32, 47–53.

Mautone, P. D., & Mayer, R. E. (2001). Signaling as a cognitive guide in multimedia learning. *Journal of Educational Psychology*, 93(2), 377.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, 38(1), 43–52.

Näsänen, R., & Ojanpää, H. (2003). Effect of image contrast and sharpness on visual search for computer icons. *Displays*, 24(3), 137–144.

Ozcelik, E., Arslan-Ari, I., & Cagiltay, K. (2010). Why does signaling enhance multimedia learning? Evidence from eye movements. *Computers in Human Behavior*, 26(1), 110–117.

Tabbers, H. K., Martens, R. L., & Van Merriënboer, J. J. (2004). Multimedia instructions and cognitive load theory: Effects of modality and cueing. *British Journal of Educational Psychology*, 74(1), 71–81.

Telling, A. L., Kumar, S., Meyer, A. S., & Humphreys, G. W. (2010). Electrophysiological evidence of semantic interference in visual search. *Journal of Cognitive Neuroscience*, 22(10), 2212–2225.

Tukey, J. W. (1977). *Exploratory data analysis.* Reading, MA: Addison-Wesley.

Weiner, I. B., Schinka, J. A., & Velicer, W. F. (2012). *Handbook of psychology: Vol. 2. Research methods in psychology* (2nd ed.). Hoboken, NJ: John Wiley & Sons.

Wickens, C. D., Lee, J., Liu, Y. D., & Gordon-Becker, S. (2013). *Introduction to human factors engineering: Pearson new international edition*. Harlow, UK: Pearson Education.

Xu, Y., Higgins, E. C., Xiao, M., & Pomplun, M. (2007). Mapping the color space of saccadic selectivity in visual search. *Cognitive Science*, 31(5), 877–887.

16. The Computer Science Challenge

Equitable Broadening Participation, Policy, and the Responsibility of Prestige

FAY COBB PAYTON, MATTHEW HOAGLAND, AND ALEXA BUSCH

Abstract: Motivated by prior research of 2 public schools centrally located near venerable universities and in an area with a high need for computer science (CS) workforce skills, we conjectured what role higher education needed to play in broadening participation, not just within the university system, but at all levels of education. To address this issue, we sought to use a number of data sources related to high school participation along with college public rankings and research funding levels. Inconsistencies in data sources resulted in our inquiry into equity in CS participation. We offer that equitable broadening participation is multidimensional and is informed by educational prestige, resources, and social capital. Equitable broadening participation can shift the current CS education discourse from one of equality and a single measure of success to a framework focused on *inclusion* of underrepresented groups and *policy* shaping primary education through higher education pathways.

Introduction

We examined the computer science (CS) enrollment among high school students in two Wake County, North Carolina, public schools. In earlier works, Abu-El-Haija, Payton, and Hoagland (n. d.) and Abu-El-Haija and Payton (2019) found that underrepresented minority students who met the academic requirements to participate were not participating in CS courses. We sought to find data with the goal of modeling the relationship between the perceptions of prestige of higher education CS departments and broadening participation at the high school level. Inconsistencies in the data-collection process left our team with limited ability to model that relationship using statistical techniques. Table 1 shows the data we initially attempted to use and the associated data integrity issues.

Data Desired	Source
Advanced placement CS exam participation	The 10th Annual AP Report to the Nation, 2014
Rankings of university/college CS programs	U.S. News & World Report (2014), Business Insider, Niche
CS and University federal research funding	National Science Foundation
CS participation at the collegiate level	Integrated Postsecondary Education Data System (IPEDS)

Table 1. Data desired for initial analysis modeling and data source.

As a gauge for participation at the high school level, we used AP CS exam participation (College Board, 2014) and attempted to find relationships within the National Center for Education Statistics' IPEDS data regarding participation. The IPEDS data set, however, showed a lack of reporting and/or missing data in many instances. We used federal funding as a gauge of educational prestige, as well as the *U.S. News and World Report*'s ranking publications. These rankings face criticisms concerning the difficulties in making meaningful comparisons because the methodology is not

constant from year to year(Tierney, 2013). Likewise, there is also difficulty comparing academic programs when there is variability with how CS programs are ranked. Reputation and academic quality, often associated with prestige, as "measured" in the rankings also remain questionable.

Given these data inconsistencies, a policy approach to the question becomes even more critical as primary and higher education continues to be challenged by broadening participation (BP) in CS efforts. In this paper, we will do the following: provide a context for broadening participation, examine three important elements to BP, discuss considerations from a case study, and ultimately provide a holistic framework for equitable BP.

Broadening Participation

There is a significant labor shortage in STEM fields, specifically those that call for computing and computational skills (Bayer Corporation, 2014; Xue & Larson, 2015). This shortage indicates the importance of broadening participation in CS, but equitable models are critical if the field will move beyond its capacity-focused approaches to broadening participation while addressing accessibility to a diverse talent pool.

Equitable BP should start in K–12 education as research has shown the number of students taking AP computer science exams is predictive of the number of students intending to major in the subject while in college. In fact, students who take an AP CS course are 4.5 times more likely to major in computer science than those who do not (Kaczmarczyk & Dopplick, 2014). This could partially be attributed to the fact that acquiring CS skills necessary to enter the field are hierarchical in nature and require students to begin preparing in middle school (Frye, Maher, Seehorn, & Morris, 2017; National Academies of Sciences, Engineering, and Medicine, 2019). Therefore, expanding and coordinating access to CS among all levels of education is viewed as imperative to expanding the field while broadening participation (National Academies of Sciences, Engineering, and Medicine, 2019).

Coordination across levels of education needs to be accompanied by the collection of data on equity indicators. This would better enable the field to quantify equity levels in schools and develop policies aimed at BP (National Academies of Sciences, Engineering, and Medicine, 2019). The combination of social capital and resources, two elements of BP discussed later in this article, can create preparatory privilege in the classroom and can limit access to those at the margins (Margolis, Estrella, Goode, Holme, & Nao, 2008). While teacher training can help dampen preparatory privilege (Robinson, Jahanian, & Reich, 2018), measuring equity indicators will allow the field to be more deliberate when implementing policies. The rest of this article will define areas that promote equitable BP and offer deliberations on CS-specific policies.

Defining Important Elements to Broadening Participation

There are three important elements to broadening participation: *educational prestige*, *resources*, and *social capital*. We adopt a multilayered definition of educational prestige, in which there is a "prestige hierarchy" with prestigious universities, prestige-seeking universities, and reputation-seeking universities (Brewer, Gates, & Goldman, 2004; Wong, 2018). Universities that have educational prestige are those that are highly selective, have significant monetary resources (endowment, research grants, etc.), and seek to leverage those resources to maintain that status (Zemsky, 2003. However, we reference resources relative to family support, teacher availability and quality, and access to postsecondary schools. We specifically will discuss equity issues surrounding resources as defined by The National Academies of Sciences, Engineering, and Medicine (2019) and why resources cannot just be provided to a community. Finally,

social capital can be defined as "features of a social organization such as networks, norms, and trust, that facilitate coordination and cooperation for mutual benefit. Social capital enhances the benefits of investment in physical and human capital" (Putnam, 1993, para. 4).

Educational Prestige

Since U.S. *News & World Report* (USNWR) published its first ranking of U.S. colleges in 1987, many students have relied on national rankings to help them decide where to apply and attend college (Griffith & Rask, 2007; McDonough, Antonio, Walpole, & Perez, 1998). These rankings cultivate perceptions of higher education institutions but have some side effects that negatively influence BP and help consolidate existing prestige perceptions.

When thinking of BP in an equitable way, there is a goal to widen the net to underrepresented minority groups (URMs), and when it comes to educational prestige, these ranking systems are a limiting factor to URMs. Research suggests that in ranking publications, such as USNWR, there is an implicit racial bias. For instance, historically black colleges and universities (HBCUs) are not considered in the main ranking publication, but have a separate report (Richards, Awokoya, Bridges, & Clark, 2018. Moreover, students from higher socioeconomic status backgrounds are most heavily influenced by these rankings, which create a homogenous applicant pool (McDonough et al., 1998).

The ranking institutions, such as USNWR, consider a variety of factors when ranking a university or a specific program: selectivity, university library system, research grants, and research produced (Griffith & Rask, 2007; Morphew & Swanson, 2011. Among the common factors listed, there are few social impact or community variables to advance a university's ranking. In the 2020 USNWR ranking methodology, the *only* social marker is the success of students who are on Pell Grants (Morse, Brooks, & Mason, 2019. With the resources and the accompanying prestige, higher education programs acquire an inherent institutional responsibility to significantly contribute to broadening participation. To this end, computer science is not exempt from this deliberation. Because of the numerous challenges faced by CS, we offer that this institutional responsibility is especially true for highly ranked CS programs.

Resources

Earlier we looked at how university resources can play a role in their rankings and perceptions by students. Here, we consider resources of students, secondary schools, families, and how they influence BP. Measuring disparities in resources is an important element to equity in education (National Academies of Sciences, Engineering, and Medicine, 2019), but the design of resources is imperative to how they influence the student educational experience.

Resources need to be designed for the communities that they intend to help (Reich & Ito, 2017). Open-source technologies are an example of resources that reduce some economic barriers to access. There are disparities in how they benefit certain student groups as open-source technologies disproportionately benefit those privileged (Reich & Ito, 2017). The health-equity model from the Robert Wood Johnson Foundation mirrors the result from Reich and Ito, in which resources can be provided uniformly across groups, addressing equality or everyone with the same resources, but not equity or the ability to have the same outcome, as seen in Figure 1 ("Visualizing Health Equity: One Size Does Not Fit All" infographic, 2017).

Thus, we pose the following question: How should the resources and ingenuity of higher education institutions serve in broadening participation, and what factors are salient to equitable BP? We note that resources are not limited to monetary resources, but include the institutional expertise.

Figure 1. Visualizing health equity: One size does not fit all. Infographic © 2017 Robert Wood Johnson Foundation. May be reproduced with attribution.

Social Capital

Economic development, financial capital, and social activities are positively linked to social capital (Engbers & Rubin, 2018; Putnam, 1993. Networks, norms, and trust are built from the development of social capital in a community. Social capital can be directly linked to building trust and confidence in the classroom, and it translates directly to student success (Allan & Persson, 2018). Education and its attainment can be positively influenced by the development of social capital, thus requiring a change in education to go beyond curricula, and to the promotion of social capital and networks, which we provide an example of later in this paper (Paarlberg, Hoyman, & McCall, 2017).

An Example From North Carolina

In a prior study, we analyzed data from two Wake County, North Carolina, public magnet high schools with the goal of following students through the CS pipeline. The data set contained student course enrollment for academic years 2009–2010 to 2015–2016. The data were structured to allow for post hoc evaluation of students in the CS pipeline. With the new structure the data were used to find participation rates for each demographic group (Asian, Black, White, and Hispanic male and female students). Asian male students in School A participated in CS at the highest rate across all levels. Figure 2 shows projected CS enrollment based on our statistical model, the actual number of students who participated in CS courses, and the difference between these two. There are several groups that did not participate up to potential baselines—namely, White female, Asian female, and Hispanic female students in the college preparatory magnet school (School A). This leads to the question of equitable broadening participation, in which we have groups of

students who are capable of CS and who, based on the enrollment data, academically qualify but choose not to or were faced with some barrier(s). This projection was not done for School B, as the offering of CS courses was inconsistent and the participation was minimal in some years.

Demographic	Introductory CS			Higher CS			AP CS		
	Projected	Actual	Difference	Projected	Actual	Difference	Projected	Actual	Difference
White Female	21.15	3	-18.15	15.29	2	-13.29	19.67	2	-17.67
White Male	23.4	36.71	13.31	16.85	22.99	6.14	21.76	24.13	2.38
Black Female	2.7	2.8	0.1	1.94	0	-1.94	2.51	0	-2.52
Black Male	2.25	5.88	3.63	1.62	0.74	-0.88	2.09	0	-2.09
Asian Female	30.6	19.5	-11.1	21.6	7.8	-13.8	27.9	9.76	-18.14
Asian Male	39.6	41.13	1.53	28.8	29.79	0.99	37.2	39	1.8
Hispanic Female	5.85	4.35	-1.5	4.21	0	-4.21	5.44	0	-5.44
Hispanic Male	5.4	14.85	9.45	3.89	2.97	-0.92	5.02	0	-5.02

Figure 2. Projected students in CS versus actual from School A.

Equity Discussion

Equitable solutions to BP in CS should be about more than capacity in the field. Along these lines CS is not exempt from larger ecosystems impacting education attainment and equity, that is, implicit bias and stereotypes may affect the likelihood of academic success (Carnevale, Fasules, Quinn, & Campbell, 2019). Math has been shown to be a predictor of student readiness, serves as a gateway into computer science, and needs to be included when discussing equity in CS (Abu-El-Haija et al., n.d.). Policies that promote math to all students are an obvious area to focus on when considering equitable BP, but we can extend beyond math. Students who have shown interest in the arts/STEAM (STEM + ARTS) have also shown interest in CS, but those students often confront the dichotomy of pathway selection rather than content integration (Abu-El-Haija & Payton, 2019; Sax et al., 2017). To speak to the magnitude of mathematics in the educational equity discourse and per the Georgetown University Center on Education and Workforce, Carnevale et al. (2019) recently concluded: "Across racial and ethnic groups, top-half math scores increase the odds that a low-SES tenth grader will become a high-SES young adult" (p. 35).

There are also considerations surrounding educational prestige, resources, and social capital. As we have shown, the *education prestige* consists of the college/university ranking, its social impact, and current resources, such as grant funding and endowments. The *resources* are salient to the individual student and capture socioeconomic status and how an intervention (or program) serves and impacts the community. Last, *social capital* depicts trust and conference, role of community, and economic development as enabling to the student and educational outcomes. Equitable BP solutions require multidimensional approaches (Figure 3) that must consider these elements. The intersection of these three factors can better foster equity in the broadening participation discourse and implementation. This is not a single-lens approach. Rather, holistic thinking and approaches are warranted in an effort of inclusive participation to assess impact.

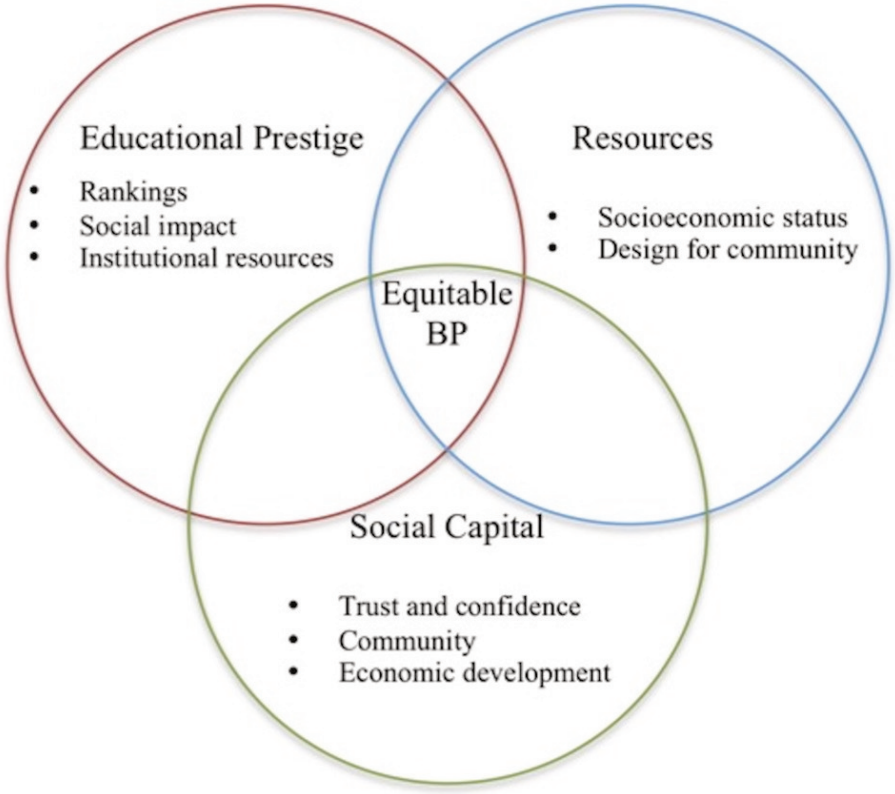

Figure 3. Multidimensionality of broadening participation.

The elements that promote BP can also have adverse side effects that also need to be considered when approaching policies, such as preparatory privilege, which is when a student enters the classroom having previous experience with the concepts (Robinson et al., 2018). Preparatory privilege can be found at the intersection of resources and social capital and limit access to the CS field (Margolis et al., 2008). Resources are also protective in education to White students compared to Black students (Carnevale et al., 2019). Similar findings are likely for others underrepresented in CS participation in K–12, namely Latinx, Native Americans, persons with disabilities, rural students, females, and others.

It is critical to understand the three elements of equitable broadening participation beyond the intersectional identities noted above. We contend that any equity solution or approach will have a clear focus on the systems of oppression that cause the inequities to begin with. This ultimately provides direction to data analyses interpretation and can illuminate reasons for disparate student outcomes.

Conclusion

There is a need for expansion in STEM fields where there is a labor shortage (Bayer Corporation, 2014; Xue & Larson, 2015). Expansion can take several directions, one of which is recruiting more students into these fields and/or a systematic approach to reaching groups that are not currently represented in the field. It has been shown in an analysis of North Carolina public high schools that in secondary education CS misses out on a significant amount of talent. CS skills are largely hierarchical, and by missing students in primary education pathways, the diversity of the field is further limited in higher education matriculation. Thus, equitable broadening participation is needed to grow the discipline with parity. While social capital promotion and trust building in the classrooms and community are also needed, highly resourced higher education institutions can better use what some consider as prestige to leverage their influence and take more collective action in their BP strategies.

References

Abu-El-Haija, L., & Payton, F. C. (2019, February). *Computer science enrollment in magnet high schools: Issues of curricula, equity, and pathways.* Paper presented at RESPECT conference, Minneapolis, MN.

Abu-El-Haija, L., Payton, F. C., & Hoagland, M. (n.d.). *Pathways, participation and policy: Considerations for high school computer science enrollment.* Manuscript submitted for publication.

Allan, J., & Persson, E. (2018). Social capital and trust for inclusion in school and society. *Education Citizenship and Social Justice*, 1–11. https://doi.org/10.1177/1746197918801001

Bayer Corporation. (2014). The Bayer facts of science education XVI: US STEM workforce shortage—myth or reality? Fortune 1000 talent recruiters on the debate. *Journal of Science Education and Technology*, 23(5), 617–623.

Brewer, D. J., Gates, S. M., & Goldman, C. A. (2004). In pursuit of prestige: Strategy and competition in U.S. higher education. Santa Monica, CA: RAND.

Carnevale, A. P., Fasules, M. L., Quinn, M. C., & Campbell, K. P. (2019). *Born to win, schooled to lose: Why equally talented students don't get equal chances to be all they can be.* Washington, DC: Georgetown University Center on Education and the Workforce, McCourt School of Public Policy.

College Board. (2014). *The 10th annual AP report to the nation.* Retrieved from https://research.collegeboard.org/programs/ap/data/nation/2014

Engbers, T. A., & Rubin, B. M. (2018). Theory to practice: Policy recommendations for fostering economic development through social capital. *Public Administration Review*, 78(4), 567–578.

Frye, D., Maher, M., Seehorn, D., & Morris, S. (2017). CS4NC Summit 2017: Lessons learned in developing a coordinated statewide CS for All initiative. In *SIGCSE '18 Proceedings of the 49th ACM Technical Symposium on Computer Science Education* (pp. 1041–1042). Baltimore, MD: ACM.

Griffith, A., & Rask, K. (2007). The Influence of the US News and World Report collegiate rankings on the matriculation decision of high-ability students: 1995–2004. *Economics of Education Review*, 26(2), 244–255.

Kaczmarczyk, L., & Dopplick, R. (2014). ACM report: Preparing students for computing workforce needs in the U.S. *SIGCSE Bulletin*, 46, 8.

Margolis, J., Estrella, R., Goode, J., Holme, J. J., & Nao, K. (2008). *Stuck in the shallow end: Education, race, and computing.* Cambridge, MA: The MIT Press.

McDonough, P. M., Antonio, L. A., Walpole, M., & Perez, L. X. (1998, October). College rankings: Democratized college knowledge for whom? *Research in Higher Education*, 39(5), 513–537.

Morphew, C. C., & Swanson, C. (2011). On the efficacy of raising your university's rankings. In J. C. Shin, R. K. Toutkoushian, & U. Teichler (Eds.), *University rankings. The changing academy–The changing academic profession in international comparative perspective* (Vol. 3, pp. 185–199). Seoul, South Korea: Springer, Dordrecht.

Morse, R., Brooks, E., & Mason, M. (2019, September 8). How U.S. News calculated the 2020 best colleges rankings. Retrieved from https://www.usnews.com/education/best-colleges/articles/how-us-news-calculated-the-rankings

National Academies of Sciences, Engineering, and Medicine. (2019). *Monitoring educational equity.* Washington, DC: The National Academies Press.

National Center for Education Statistics. *Integrated postsecondary education data system.* https://nces.ed.gov/ipeds/

National Science Foundation. https://www.nsf.gov/

Paarlberg, L. E., Hoyman, M., & McCall, J. (2017, August 28). Heterogeneity, income inequality, and social capital: A new perspective. *Social Science Quarterly*, 99(2), 699–710.

Putnam, R. (1993). The prosperous community: Social capital and public life. *The American Prospect*, 13. Retrieved from https://prospect.org/article/prosperous-community-social-capital-and-public-life

Reich, J., & Ito, M. (2017). *From good intentions to real outcomes: Equity by design in learning technologies.* Irvine, CA: Digital Media and Learning Research Hub.

Richards, D. A., Awokoya, J. T., Bridges, B. K., & Clark, C. (2018). One size does not fit all: A critical race theory perspective on college rankings. *The Review of Higher Education*, 42(1), 269–312.

Robert Wood Johnson Foundation. (2017). Visualizing health equity: One size does not fit all [Infographic]. Princeton, NJ.

Robinson, K., Jahanian, K., & Reich, J. (2018). Using online practice spaces to investigate challenges in enacting principles of equitable computer science teaching. In *SIGCSE '18 Proceedings of the 49th ACM Technical Symposium on Computer Science Education* (pp. 882–887). Baltimore, MD: ACM.

Sax, L., Kathleen, L., Jacobs, J., Kanny, M., Lim, G., Monje-Paulson, L., & Zimmerman, H. (2017). Anatomy of an enduring gender gap: The evolution of women's participation in computer science. *The Journal of Higher Education*, 88(2) 258–293.

Tierney, J. (2013, September 10). Your annual reminder to ignore the U.S. *News & World Report* college rankings: The list's real purpose is to "exacerbate the status anxiety" of prospective students and parents. *The Atlantic.* Retrieved from https://www.theatlantic.com/education/archive/2013/09/your-annual-reminder-to-ignore-the-em-us-news-world-report-em-college-rankings/279103/

U.S. News & World Report. (2014). Best colleges 2014: Top 10 national universities. Retrieved from https://www.usnews.com/education/best-colleges/slideshows/best-colleges-2014-top-10-national-universities/6

Wong, A. (2018, September 11). At private colleges, student pay for prestige. *The Atlantic.* Retrieved from https://www.theatlantic.com/education/archive/2018/09/america-private-college-tuition/569812/

Xue, Y., & Larson, R. (2015, May). *Monthly labor review.* Bureau of Labor Statistics. Retrieved from https://www.bls.gov/opub/mlr/2015/article/stem-crisis-or-stem-surplus-yes-and-yes.htm

Zemsky, R. (2003). In pursuit of prestige: Strategy and competition in U.S. higher education. *The Journal of Higher Education*, 74(4), 474–476.

Acknowledgments

This research is funded by NSF Grant number CNS 1740141.

17. Who Played the Game Correctly?

Data Signatures of Interaction in Playful Assessment

ANTHONY PELLICONE, NATHAN HOLBERT, BETSY DISALVO, VISHESH KUMAR, AND MATTHEW BERLAND

Abstract: In this paper we examine a formative playful assessment called *Beats Empire*, in which learners use data analysis skills to take on the role of a music studio manager. We look at log data of players from classroom implementation of the game, finding 3 signatures: low activity, high activity with low data usage, and data-informed gameplay. Drawing from field notes and play-aloud interviews, we contextualize these data signatures in player conceptions of the game. We find that our data-informed player employed a number of contexts in interacting with the game, such as domain knowledge, game strategies, and perceptions of popular music. Furthermore, we find that money earned within the game, and achieving a win state (while both intuitively good metrics for assessment), are not as informative as gameplay signatures. We conclude by emphasizing that all 3 approaches to play are valid, and that each represents its own design challenge in terms of tuning the gameplay as well as creating supporting material to help players provide formative assessment to various types of players.

Introduction

Beats Empire (*Beats*) is a game designed to be a formative assessment tool to assist teachers in evaluating students' data-science knowledge by simulating a music studio (see Figure 1). Data and analysis skills are measured by how well players sign and develop artistic talent and guide their team of musicians toward creating songs that match the preferred moods, topics, and genres of their audience. The goal is to create a personally meaningful and culturally responsive method of formative assessment in which a player's studio represents an externalization of his or her understanding of the data that are uniquely generated for each play session. Drawing from theoretical foundations of formative assessment (Sadler, 1989), culturally relevant pedagogy (Au & Jordan, 1982), and constructionist games (Weintrop, Holbert, Horn, & Wilensky, 2016), *Beats* is situated in a nascent field known as Playful Assessment (PA) (Kim, 2018). PA refers to the use of games and play to provide formative assessments that are more meaningful for learners as well as providing richer data for instructors to practice formative assessment.

This paper examines *Beats* within the PA framework, using patterns derived from player log data as well as a deeper analysis using qualitative data from player surveys and interviews. We describe three data signatures from our early implementation data: low activity, high activity with low data usage, and data-informed gameplay. Through qualitative analysis of a data-informed player, we observe the various strategies that she employed in playing the game, including using data to make strategic choices, as well as creating in-game artifacts that reflected her personal tastes in music. We find that two metrics that would typically be associated with traditional assessment (money earned through play and achieving a win state) are not necessarily as informative as looking at patterns of interaction within the game. We conclude by discussing how all three approaches are valid, and how each suggests its own approach to configuring gameplay, as well as creating teacher resources to assist in formative assessment.

Theoretical Framework

Beats is designed as a constructionist assessment environment. Constructionism is an approach to pedagogy that engages learners in constructing a personally meaningful artifact that requires knowledge of a domain in order to function. Constructionist approaches provide rapid feedback, allowing for tinkering and gradual refinement of strategies; social feedback from within a community; and authentic problem spaces for construction (Harel & Papert, 1991). Constructionist games are useful for assessing student understanding because they are designed to be culturally relevant to students, necessarily involve a deep understanding of the domain that is being assessed, and present content in an active and engaging fashion (Berland, Baker, & Blikstein, 2014). Furthermore, when designed to provide rich information about how players interact and create in the constructionist game space, such games also serve as a powerful means of formative assessment. Thus, we can think of playful and game assessments as providing "objects-to-think-with," where students are able to put concepts from the target domain into practice through playful tinkering and experimentation (Berland, 2016; Holbert & Wilensky, 2019; Papert, 1980).

We draw the following analysis from an early implementation of the game in a classroom environment. Through discussion among field researchers we noticed a common pattern, in which some players were able to exercise what we termed a "meta-game" approach to *Beats*. Here, *meta-gaming* refers to applying knowledge of common game mechanics, and how those mechanics can be maximized or subverted against the intents of the design (Consalvo, 2009). This led us to a guiding question to approach preliminary data from our classroom implementations, as well as a design question that follows from that.

- *Research Question (RQ)*: How do players' strategies differ in a formative, playful assessment? Specifically, what gameplay patterns can we observe that indicate how players understand the role of data in *Beats*?
- *Design Question (DQ)*: How might these patterns inform the design of future playful assessments?

Design of *Beats Empire*

As described in our theoretical framework, we saw cultural relevance (Ladson-Billings, 1995) as being a primary design consideration for our game, and thus we employed design methodologies to understand not only student interests, but also values and conceptions of the domain (DiSalvo & Bruckman, 2011). Other research has identified music as an important social and emotional tool for youth (North, Hargreaves, & O'Neill, 2000; Tarrant, North, & Hargreaves, 2000). Through our previous experience as educational game designers, and a series of focus groups with our target population, we came to understand music as being a generally resonant theme that allowed for individual expression, but that also carried shared understandings in terms of our salient domain concepts (e.g., the recognition of the music industry using data to inform the creation and marketing of popular songs), and thus made it ideal as an aesthetic for a formative assessment centered on data analysis.

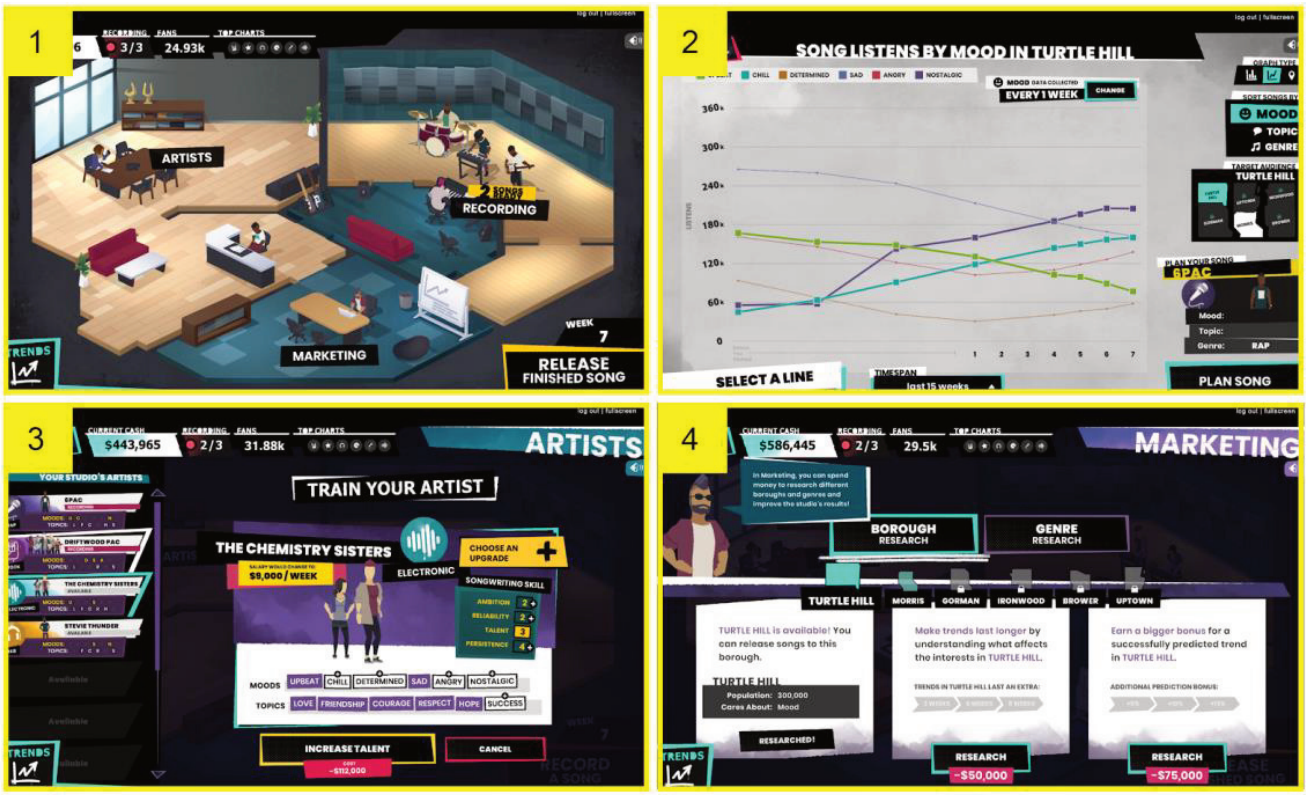

Figure 1. Beats Empire is modeled after management-type games. From the studio (screen 1) players follow trends in moods, topics, and genres (screen 2) and use that information to sign and develop artists who are assigned creating songs (screen 3); players can upgrade various aspects of their studio to increase the reach and impact of their music (screen 4).

Data Analysis

For this paper we are reporting on data collected from the second implementation of *Beats Empire*, which took place in winter of 2019 at a New York City public school with a group of 10 seventh-grade participants. All names used in this paper are pseudonyms. We collected data through automatic log files of gameplay, pre- and postsurveys with students, and one-on-one "play-aloud" sessions with field researchers, in which students narrated their reasoning behind choices in the game, as well as a final focus group with the entire class. Important for this analysis, we used the automatic log data to investigate our guiding question and to understand general patterns in how our participants approached the game. Those signatures then allowed us to explore the qualitative data with individual participants in order to understand their perceptions of gameplay. As shown in Figure 2, we focused specifically on three constructs from the log data: advancing the releasing songs, referencing the data tools, and advancing to the next turn (which in-game uses the metaphor of advancing to the next week).

Findings

Gameplay Signatures

We observed three general play styles that we have here termed as *low-activity play*, *high-activity/low-data play*, and *data-informed play*. In this subsection, we present participant interaction visualizations (see Figure 2) illustrative of each of these styles. Each graph represents the same duration of time (approximately 30 minutes of gameplay on the second day of data collection). On each tick mark, a dot indicates if a player: accessed data visualizations (insightScreens in Figure 2), released a song (songRelease), or advanced the game state to the next week (turns). These actions indicate interactions with core game mechanics and/or target content. Furthermore, an overabundance or an absence of one of the actions suggests quite different play styles, such as a player moving quickly through in-game time in order to build large banks of money (high count of *songRelease* and *turns*), or a player engaging deeply with data visualizations to make informed decisions (high count of *insightScreens*). Additionally, we examine total amount of cash on hand as we have observed players using this metric as a personal measure of success.

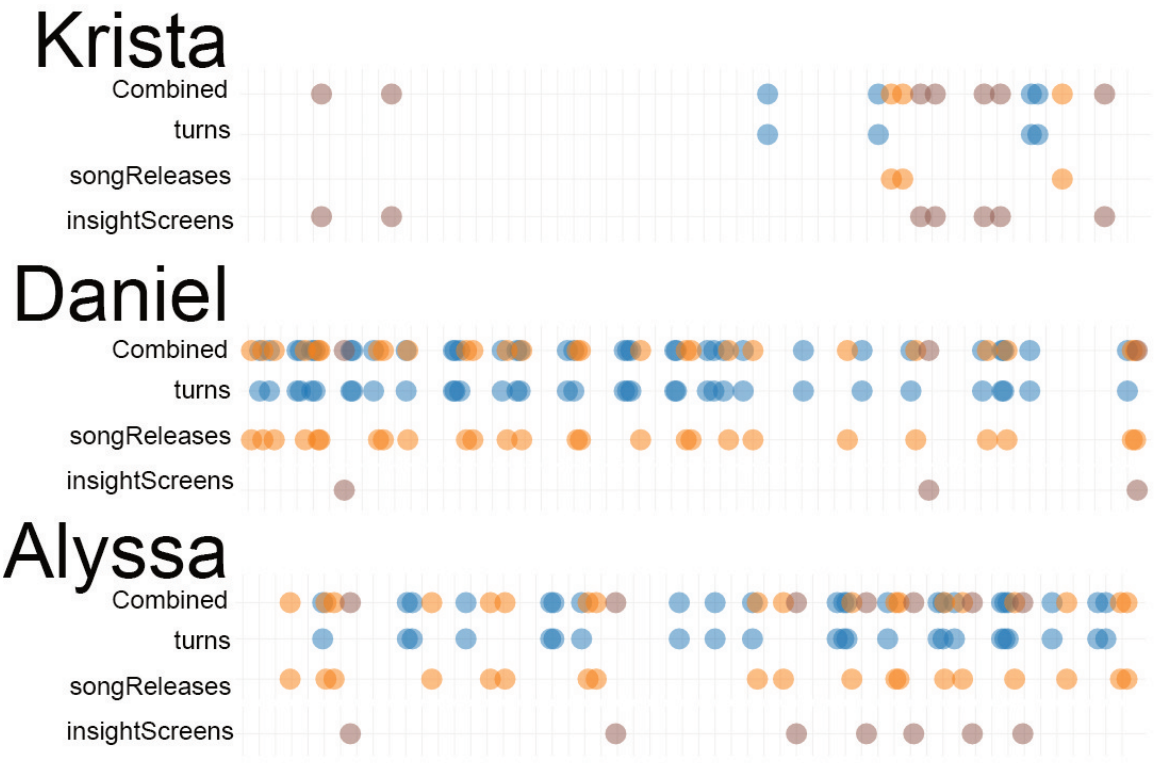

Figure 2. Visualizations derived from player log files. Blue dots on the top line of each player's visualization represent advancing the in-game calendar (turns), orange dots on the middle line represent releasing a song that generates revenue (songReleases), and brown dots on the bottom line represent use of data tools within the game (insightScreens). Below each line is a combined signature, showing a player's total interaction over the course of the 30-minute gameplay session.

Krista, low-activity play. Krista does make use of the data visualization tools, and during her play-aloud interview she justifies several activities with information garnered from the data visualizations of the game. However, after the play-aloud session, Krista also says that she was not very engaged with the game and did not find it appealing. This is reflected in her chart in Figure 2, which shows large gaps in real-world time between actions. From the play-aloud

interview, we know that Krista spent much of the time in that first gap methodically exploring the interface of the game, and then she devoted a few minutes per song picking one of the randomly generated titles. While Krista did draw on some knowledge of data analysis as a domain, she was also not engaged with the mechanics of the game and made very little progress toward either of the game's win conditions.

Daniel, high-activity and low-data play. Daniel amassed a great deal of in-game money during play and is one of the few players to beat the game within the three-day time span. On a survey asking him how often he plays games, Daniel did not report many hours per week of gaming, claiming to play approximately six hours per week. However, Daniel's gameplay was similar to that of gamers who play substantially more frequently. We have found these players often employ a strategy that relies on releasing a large number of songs, and moving quickly through in-game time, in order to earn a large amount of money. In the chart in Figure 2, Daniel looks at the data screens only three times, but he moves through 35 weeks—compared to Krista's looking at data seven times and advancing through four weeks.

Alyssa, data-informed gameplay. Finally, Alyssa represents a type of gameplay that relies heavily on using data visualizations provided in-game to make informed choices about which artists to sign, what type of song to record, and to gradually improve song quality through time.

Alyssa's Empire

In the presurvey Alyssa reported that she played about 20 hours of games per week, later claiming that this was mostly *Fortnite* (Epic Games, 2017) with her friends. When she was asked about her goals in *Beats*, Alyssa described them as "to build my empire." When the interviewer asks her to clarify if she means having higher popularity, the most money, or the best music, Alyssa replies, "All of the above." Alyssa uses data frequently while choosing what kind of song to record. When asked by the researcher why she has chosen the current set of parameters for one such song, Alyssa gives an answer derived from the data, "[I checked] the trends, and um, then I'll see that 'Sad' [a mood] is very popular and also 'Determined' [another mood]." Alyssa also recognizes a mechanical aspect of the game, which is that certain boroughs care only about one element of a song (in this case mood), saying, "Well, the genre doesn't matter, and the topic doesn't matter, the only thing that matters is the mood."

However, Alyssa doesn't use only data in crafting songs. In addition to data, Alyssa also prefers to record music from her favorite genre and often chooses the topic "Love" because that is what she says that she personally enjoys in the music that she listens to. Despite these non-data–driven choices, Alyssa is still able to create a successful music studio and make substantial progress toward winning the game. Her being able to succeed in the game, even when not using data for every decision, indicates that *Beats* allows players to call on their personal understandings of music while still advancing along a path toward victory that the curriculum-inspired mechanics have laid out for them.

It's Not All About the Money

An alternative source of insight for gameplay patterns is a player's total cash on hand. While our game design considers cash to be a resource for players—to invest in opening up new boroughs for song releases, artist and studio upgrades, or signing new talent, and so forth, data from observations and focus groups suggest players also viewed cash as an indicator of success. Examining how players accumulated and used money provides an alternate indicator of how students engaged with game mechanics. Figure 3 visualizes the cash-on-hand totals of our three example players over the same day of play.

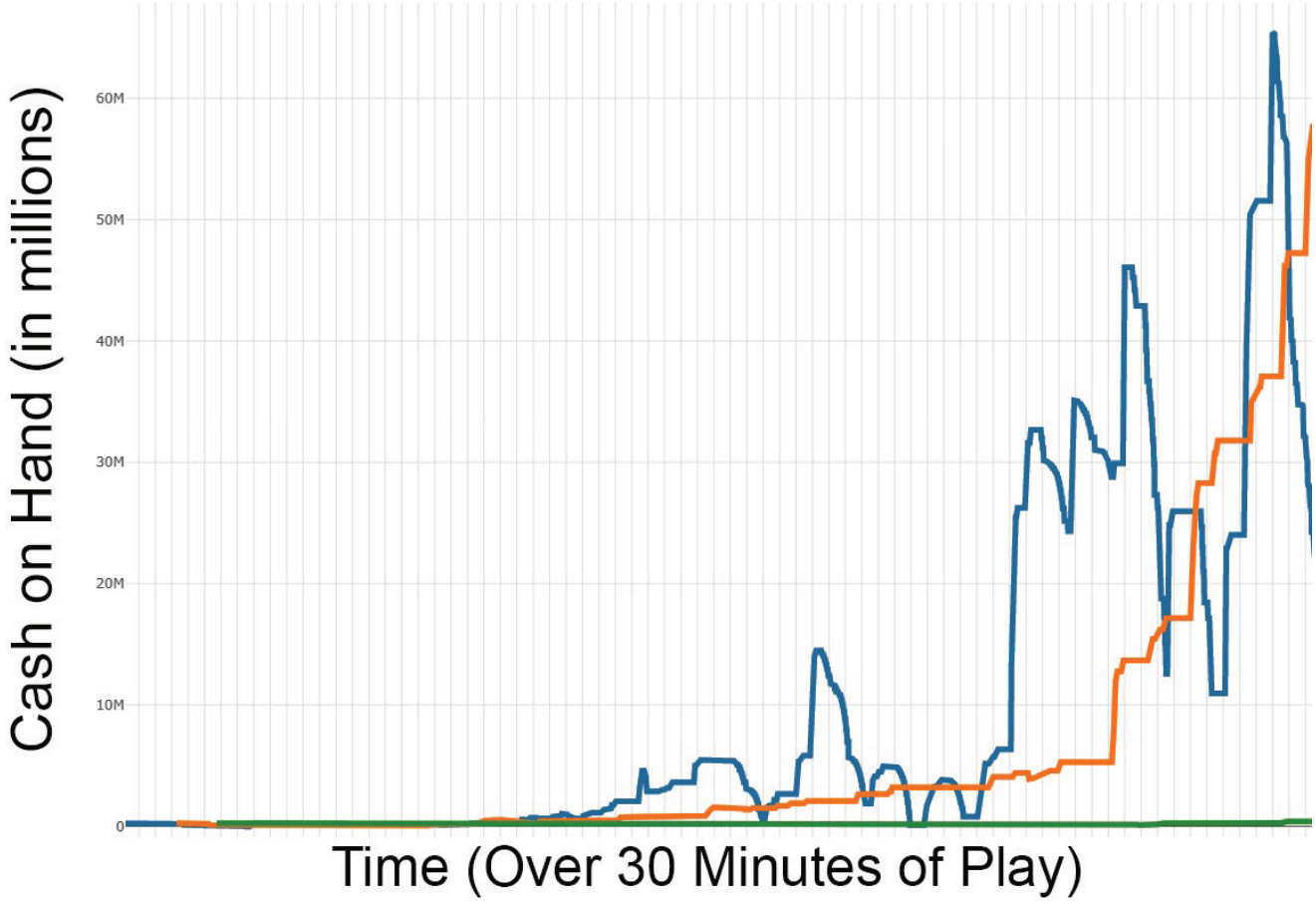

Figure 3. The spikier blue line represents Daniel, the more gradual orange line represents Alyssa, and the green line (which at this scale is close to the X axis) represents Krista.

Daniel often has a great deal of money invested in terms of artist salaries while also recording songs and advancing time at a high velocity, leading his overall bank to both grow and shrink rapidly (the dip at the end of Day 2 is an example of Daniel's having purchased new artists immediately before the end of the session). In the third day, after we have explicitly called out the concept of upgrading to players, Daniel is able to use his large bank, and exponentially expand his earning capabilities, resulting in a victory condition. By comparison, over this same period, Alyssa's studio's growth is steady and always increasing. Alyssa signs fewer artists, releases fewer songs, and does not spend money on upgrades. Despite this more constrained gameplay, because Alyssa uses data to make strategic recording/releasing decisions, she is able to produce roughly equivalent amounts of in-game cash while advancing through fewer in-game weeks.

Discussion and Conclusions

RQ: How Do Players' Strategies Differ in a Formative, Playful Assessment?

Each of the three players described above brings his or her own set of existing identities and literacies as data scientists, gamers, and music fans to *Beats Empire*. Alyssa's case gives a good example of what this integration looks like in

practice—in her play-aloud data we can see her bridging across her experience with digital games, her own cultural understandings of popular music, and her knowledge of data analysis. We have designed *Beats* to accommodate a wide variety of conceptions within these domains. For example, Alyssa has experience with games, and takes quickly to the mechanics, but she still has some gaps in understanding about how to use varying types of data visualization. She interacts with game mechanics strategically, with a stated goal of improving her "empire," but she also allows her personal preferences about music to drive aspects of her play. Our desire to create a culturally relevant constructionist formative assessment game led us to design *Beats* with this particular dynamic in mind. Offering multiple win conditions and including boroughs that have varying interests in moods, topics, or genres, ensures that a player such as Alyssa (who enjoys the genres of rap and R&B) can succeed while creating a studio that specializes in genres just as well as a student who takes a more generalist approach. However, both forms of gameplay enable players to create something that is personally meaningful and situated in a practical application of domain knowledge (Berland, 2016; DesPortes, Spells, & DiSalvo, 2016; Holbert & Wilensky, 2019).

Daniel's case presents us with a signature of a player who is taking an approach to *Beats* that we might think of as "meta-gaming," or using optimized strategies that are broadly applicable across individual games—in this case, quickly amassing a lot of resources while ignoring other elements of the game (Boluk & LeMieux, 2017; Consalvo, 2009). While Daniel spends less time with data tools central to our goals for the game, he is still exhibiting complex, strategic thinking in how he has created his music studio. If we think of *Beats* gameplay as a traditional assessment (in which there are right and wrong ways to play the game) we might conclude Daniel has either failed or in some ways "gamed the system." However, in recognizing digital gameplay as a social practice, we can instead ask, first, how can game mechanics be modified so that students who play this way are *also* encouraged to use data, and second, how can we prepare instructors to recognize the gameplay signature so that they can provide feedback and support to help students to leverage their gaming literacy for also better understanding the target domain (Holbert & Wilensky, 2019; Sadler, 1989).

Krista's case offers a real challenge for the design of playful assessments. Krista does employ data in making decisions, but she also is less engaged with *Beats* as a game experience. Not every player will enjoy every game, and it is helpful to recognize that other forms of assessment may be necessary to complement a playful assessment. It is useful to note that the field researcher administering Krista's play-aloud interview was using less prompting than the researcher administering Alyssa's. However, we can think of Alyssa's nurturing coaching in similar terms to theories of formative assessment, in which feedback helps students to perceive gaps between a desired goal and their current understandings and assists them in closing that gap (Black & William, 1998). The sort of subtle coaching that is present in Alyssa's gameplay session, but absent in Krista's, points toward the importance of data informing supportive, tailored feedback from an instructor (Sadler, 1989).

DQ: How Might These Patterns Inform the Design of Future Playful Assessments?

As our title suggests, a question that one might have in reviewing just the scatterplots in our findings is: What represents the *correct* way to play *Beats*? However, we reject this binary choice and argue that instead there are multiple valid approaches to gameplay. Although Daniel is not using data to the same degree that Alyssa is, he is still engaging with the mechanics of the game in a way that make sense given the mix of conceptions that he is bringing to the game involving music, data, and games themselves. Krista, who is not fully engaged with the game, might be guided toward an alternative form of assessment or work with an instructor in order to clear up questions she might have about game mechanics. In a formative assessment, it is the job of designers and educators to not only provide culturally relevant content that students can relate to but to also develop culturally responsive instructional tools (Richards, Brown, & Forde, 2007) that are adaptable in how students can approach play to meet their diverse cultural backgrounds, play practices, and motivations. In this way we anticipate students will be more engaged than through typical assessment, and thus provide better feedback to teachers on which to build a stronger knowledge of data analysis. Through our

data visualizations, however, we can see fuller pictures of player interaction and imagine various productive avenues of teacher guidance. Thus, we offer two primary design considerations for playful assessments:

1. Understand that your players will be drawing across multiple literacies and identities. The sort of feedback and guidance that Alyssa would require is not the same as for Krista or Daniel. Structuring teacher materials and resources for playful assessment should account for those differences.
2. Provide rich visualizations for instructors to help them recognize and adequately support all types of learners. A playful assessment is unique in the level of fine-grained data that it can deliver to an instructor, as seen in our Findings section above. Playful assessments need to present this information to teachers in a way that is both quickly obtained and grasped.

References

Au, K. H., & Jordan, C. (1982). Teaching reading to Hawaiian children: Finding a culturally appropriate solution. In E. T. Trueba, G. P. Guthrie, & K. H. Au (Eds.), *Culture and the bilingual classroom: Studies in classroom ethnography* (pp. 139–152). Rowley, MA: Newbury House.

Berland, M. (2016). Making, tinkering, and computational literacy. In K. A. Peppler, E. Halverson, & Y. B. Kafai (Eds.), *Makeology* (pp. 196–205). New York, NY: Routledge.

Berland, M., Baker, R. S., & Blikstein, P. (2014). Educational data mining and learning analytics: Applications to constructionist research. *Technology, Knowledge and Learning*, 19(1), 205–220. https://doi.org/10.1007/s10758-014-9223-7

Black, P., & William, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles Policy and Practice*, 5(1), 7–73.

Boluk, S., & LeMieux, P. (2017). *Metagaming: Playing, competing, spectating, cheating, trading, making, and breaking videogames*. Minneapolis: University of Minnesota Press.

Consalvo, M. (2009). *Cheating: Gaining advantage in videogames*. Cambridge, MA: The MIT Press.

DesPortes, K., Spells, M., & DiSalvo, B. (2016). The MoveLab: Developing congruence between students' self-concepts and computing. In *Proceedings of the 47th ACM Technical Symposium on Computing Science Education – SIGCSE '16* (pp. 267–272). Memphis, TN: ACM. https://doi.org/10.1145/2839509.2844586

DiSalvo, B., & Bruckman, A. (2011). From interests to values. *Communications of the ACM*, 54(8), 27. https://doi.org/10.1145/1978542.1978552

Epic Games. (2017). *Fortnite* [Video game]. Epic Games.

Harel, I., & Papert, S. (1991). *Constructionism: Research reports and essays, 1985-1990*. Norwood, NJ: Ablex.

Holbert, N., & Wilensky, U. (2019). Designing educational video games to be objects-to-think-with. *Journal of the Learning Sciences*, 28(1), 32–72. https://doi.org/10.1080/10508406.2018.1487302

Kim, Y. J. (2018). Game-based assessment. In B. B. Frey (Ed.), *The SAGE encyclopedia of educational research, measurement, and evaluation*. Thousand Oaks, CA: Sage.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, 32(3), 465–491.

North, A. C., Hargreaves, D. J., & O'Neill, S. A. (2000). The importance of music to adolescents. *British Journal of Educational Psychology*, 70(2), 255–272. https://doi.org/10.1348/000709900158083

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. New York, NY: Basic Books.

Richards, H. V., Brown, A. F., & Forde, T. B. (2007). Addressing diversity in schools: Culturally responsive pedagogy. *Teaching Exceptional Children*, 39(3), 64–68.

Sadler, D. R. (1989). Formative assessment and the design of instructional systems. *Instructional Science*, 18(2), 119–144. https://doi.org/10.1007/BF00117714

Tarrant, M., North, A. C., & Hargreaves, D. J. (2000). English and American adolescents' reasons for listening to music. *Psychology of Music*, 28(2), 166–173.

Weintrop, D., Holbert, N., Horn, M. S., & Wilensky, U. (2016). Computational thinking in constructionist video games. *International Journal of Game-Based Learning*, 6(1), 1–17. https://doi.org/10.4018/IJGBL.2016010101

Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant numbers 1742011 and 1741956.

18. Holding Values in Tension in a Technology-Enhanced Afterschool Club

ROBBIN RIEDY, KELSEY TAYNE, AND A. SUSAN JUROW

Abstract: In this paper we reflect on our experiences designing for and supporting learning in a technology-enhanced making and play-based afterschool club. We examine various tensions related to the values we wanted to support in this making space, such as tensions between providing access to rich experiences and environmental sustainability and between valued technology practices. We draw on critical approaches to care to understand our design and facilitation decisions as we grappled with these tensions.

Introduction

There are often competing aims within a given learning setting (Coburn, 2004). When designing learning spaces, educators must balance multiple learning goals and values. While it is clear that multiple, potentially conflicting, goals are the norm, it is not always clear how educators go about deciding which learning aims to pursue and which values to emphasize in design work and facilitation. Critical theories, such as critical care (e.g., Rolón-Dow, 2005; Thompson, 1998), as well as a critical reflection on computer science education (e.g., Booker, Vossoughi, & Hooper, 2014), provide resources for thinking through the many tensions that educators will inevitably face. We draw on critical approaches to computer science (CS) education and a critical understanding of caring taken together to reflect on values and practices in a technology-supported, play-based after-school club that emphasized making. We examine tensions in values regarding our design and facilitation of learning in this space and consider our own reflections and learning as designers and facilitators working toward more humanizing approaches to technology-supported education.

In collaboration with our research team, we noticed certain tensions between access to rich technology and making materials in the learning environment and supporting practices of socioenvironmental sustainability. We grappled with how to provide for expansive making opportunities while knowingly contributing to a culture of consumption, production, and waste. We also found that the kinds of technology and materials, and the ways of engaging with them that we were valuing as designers and facilitators, were sometimes in tension with the practices related to technology use, play, and creativity that children wanted to bring into the club. While we examine these values in tension in one making space, these are enduring tensions that emerge across makerspaces. As a community supporting rich learning with making and CS, it is important that we examine our practices and support each other in creating learning environments that are rooted in critical care.

Critical Computer Science and Critical Care

Recent calls have asked educators and designers of learning environments to take a critical perspective on the learning goals and values embedded in technology and computer education (e.g., Booker et al., 2014). To take a critical approach is not necessarily to adopt a skeptical or negative position, but rather to critically examine the historical influences of unequal power relations and the influences of racism, sexism, classism, cultural hegemony, and other oppressive forces on the development of a particular field (e.g., Carspecken, 2013). Critical CS does this by posing questions regarding whom technology education is for, what purposes it serves, and who benefits. Caring from a critical perspective similarly

reiterates the need to account for how race, privilege, and power influence the way that classroom participants give and receive care. Scholars who advocate for this model of care argue that caring must go beyond simply being nice to students in the classroom, but also must include a concern for the community that children come from (e.g., De Royston, Vakil, Ross, Givens, & Holman, 2017; Rolón-Dow, 2005; Thompson, 1998). Lines of work in the field of critical CS and critical care have included critiquing the framing of the maker movement as White and male, a framing that can ignore or erase the deep history of making practices that happens in nondominant communities (Vossoughi, Hooper, & Escudé, 2016), pushing back on the traditional workforce justifications for teaching technology in the CS for All movement (Philip, Gupta, Elby, & Turpen, 2018), and advocating for caring that goes beyond academics and takes the whole person into account (Rolón-Dow, 2005; Thompson, 1998; Valenzuela,1999).

Using critical CS and critical care, we examine design tensions in this makerspace. Tatar (2007) described design tensions as the mismatch created between vision and approach, the difference between what is and what ought to be: "Tension could be constituted by a dichotomy between two goals, or by a continuum, or by the relevance of two or more incommensurate forces" (p. 445). Exploring these tensions within the club allowed us, as Tatar suggested, to reflect on trade-offs, insights, and the ways in which the club could be reformulated to accommodate differing values.

When placed in conversation with each other, critical caring and critical CS suggest that as educators and designers of technology-enhanced making spaces, we must be concerned with more than whether or not the children we work with are learning to use the tools we bring into a learning environment, but rather, (a) to what ends these tools are used, (b) what values are being supported, and (c) how are we demonstrating genuine and holistic care for young people who enter these spaces. We see these as important questions for any designer or facilitator of a makerspace to grapple with.

When we asked these questions of ourselves and our own makerspace, we found multiple answers. For instance, opportunities for access to future STEM careers was one important goal for technology use at this club, but at the same time, we resisted the idea of supporting learning around technology simply to develop a future workforce. While designing for new ways of engaging with making and technology to support the repertoire of practices available to children, we also wanted to specifically design for and facilitate learning that served the desires and dreams expressed by the children themselves. Additionally, we struggled with tensions between supporting wide forms of engagement with (and consumption of) technology and other making materials, while seeking to engage more socioenvironmentally sustainable forms of making and learning. What follows are two bricolage vignettes or composite stories (Solórzano & Yosso, 2002) of common events that took place at the club over the course of a semester that highlight the multiple values enacted by the various participants, and the ways in which we attempted to hold these values in tension.

Context

The EPIC afterschool club is the heart of a long-standing university-school partnership that serves as a site for teacher education (Freeman & Jurow, 2018). The partnership is an intentional approach to organizing and studying equity (Gutiérrez & Vossoughi, 2010). The aims of the partnership between the School of Education at the University of Colorado Boulder and Sanchez Elementary School are multiple: supporting robust learning opportunities for children from nondominant communities and organizing equity-oriented teacher education. The club is a local iteration of the Fifth Dimension model, a type of school and university partnership that was originally developed at the University of California, San Diego (Cole & the Distributed Literacy Consortium, 2006; Nicolopoulou & Cole, 1993). Common to Fifth Dimension programs is activity across two main settings: a university course in which students study sociocultural theories of learning and an afterschool club for elementary students, which serves as the required practicum for the course, founded upon those same theories of learning. Core values of EPIC include play, equity, and side-by-side learning between children and facilitators.

EPIC operated in the school's large, open cafeteria with folding tables and chairs, and play at the club included both the use of "low-tech" resources (i.e., paper, pencils, cardboard) and "higher-tech" ones (i.e., iPads, Chromebooks, laser cutters, radio transmitters). The kids who participated in the program ranged from second to fifth grade and came from a number of different racial and ethnic backgrounds. Many of the children who participated in the club were Latinx (many students were of Mexican descent). Club participants valued hybrid language practices and we tried to promote multilingual communication. An aim of the club was to disrupt traditional power imbalances between kids and instructors (Freeman & Jurow, 2018). In different semesters, club participants would explore themes (i.e., superheroes, futurism) as a means of creating space for children to play and reimagine alternative futures. Children, undergraduates and graduate students, and university faculty worked together to imagine, design, and build for potential futures.

Two of the authors of this piece were graduate student facilitators, and one was the principal investigator. We also worked with a larger research team that included other club facilitators, instructors of the university course, and our primary partner at the elementary school, the director of the afterschool program. Together we met once or twice per week to design and reflect on what was happening in the club and the university course. It is with our research team that we grappled with these ongoing tensions, and we expand on these conversations here.

Design Tension 1: Balancing Access and Sustainability

> Kids are using LED lights to make greeting cards that light up in designs of their choice. The students talk about showing their cards to younger siblings and to their parents; however, the graduate facilitators cannot let the students take the cards home without first sending a note letting parents know that coin cell batteries are used in the cards, and that they should be kept away from younger children and pets. Most children leave their cards at site, so they sit in the supply closet until the end of the year, when they are recycled. As soon as the kids are finished with their cards, a few children begin to ask to make slime. The undergraduates prepare a space for making the slime by getting paper bowls, plastic spoons, and a plastic tablecloth. As some kids make slime, others make ice cream in Ziploc bags using ice and rock salt, at a table covered in a plastic cloth. Kids with hands sticky from slime or ice cream take turns washing up in the restroom around the corner as everyone tries hard to make sure to avoid staining the tables or the floors of the cafeteria, a community space shared by the entire school. Kids and undergraduate partners begin to clean up at some of the tables, throwing away construction paper, plastic bags, salt, copper tape, and several large unfinished crafting projects made of popsicle sticks, glue, cardboard, and pompoms.

Although we valued providing access to rich and varied materials, we found tension in a philosophy of making that values high levels of consumption and equates access to a wide variety of materials with supporting rich learning opportunities. We contest this consumerist approach as the basis for deep learning, yet we also value youth engagement with materials that support them in creative and meaningful making. Taking a critical approach to technology use forced us to reflect on the human and environmental costs of our tools (Bonds & Downey, 2012). In making and using technology with racially and linguistically historically marginalized communities, with many youth who were living in poverty, we also thought it was unjust to emphasize the need for material waste reduction at the potential expense of young people's access to materials that support their goals for making—especially considering the fact that our project had funds to buy the materials that that kids wanted to use and that the *vast* amount of material waste around the world is produced by more dominant communities. We wanted to provide as many opportunities for exploration as possible, while using resources wisely, as well as recognizing the often unacknowledged (often female) labor that goes into creating many of our electronics in sometimes harsh conditions (Arriola, 2000) and the disproportionate impact of technological waste on women and people living in the least developed countries (McAllister, Magee, & Hale, 2014).

We recognized that we were providing a model to the children for how to think about and use technology, and yet we realized that many clubs ended with at least one bag of waste from our making materials. Additionally, each semester, we would throw away materials to make room for new ones because we had limited storage space at the school. We sometimes worked with electronic materials (micro:bits, batteries, LED lights) that had a one-time use and were then thrown away.

This design tension between consumption, sustainability, access, and equity caused us to reflect on our practices. Inspired by other groups who were doing work around making and resource repurposing (e.g., the Watsonville Environmental Science Workshop), and making that challenges "problematic constructions of materiality seeped in human entitled nature-culture relations leading to unsustainability" (Barajas-Lopez & Bang, 2018, p. 8), we began design work toward increased sustainability in our material practices. We held our values in tension by encouraging multiweek, ongoing design work, and we attempted to more deeply incorporate planning into the process of design so that students began projects they were more likely to find greater meaning in and see to completion. We did not limit children who did want to use new materials each week, but rather we encouraged ongoing iterative design work. With electronics, we attempted to design for multiple projects that could incorporate the same micro:bit in different forms so that children could iterate with the same electronics for new projects. We also tried to move away from purchasing bulk materials at the beginning of the year and instead tried to purchase materials that were specifically requested by children, rendering that material more meaningful for the child. This allowed students to work with the particular materials they wanted while also reducing the waste we produced. However, this is an ongoing tension in our space and other makerspaces that must be confronted if "makerspaces are serious about transformative and equitable learning" (Barajas-Lopez & Bang, 2018, p. 8).

Design Tension 2: Valued Technology Practices

> The children are working in groups of two or three, alongside their undergraduate partners. Some groups of children are using small sewing machines to make pillows, onto which they will eventually glue or sew LED lights. Another group of children and undergraduates are playing a board game, made of paper, glue, clay, and markers, which the kids had made in a previous day at the club. An undergraduate uses her phone to take a picture of the game to help jog her memory when it is time for her to write field notes for the university course later that week. A small group of girls is making friendship bracelets, while an undergraduate student sits nearby to help. On the other side of the room, an undergraduate student sits patiently beside a child who is using an iPad to watch videos of games and music. The undergraduate gently cajoles the student to join one of the other groups in working on a project. Some students sit on the floor in the corner, listening to music on a cell phone, while a graduate student attempts to entice them to join a project group. Two or three of the children ask an undergraduate to take them outside so that they can meet some of their other friends and play on the swings.

Although there was varied technology present at the club, used in innovative ways by the children, there were tensions surrounding which technological tools, and which uses of those tools, would be most valued in the club. In the computer science world, "making" can be more valued than "consuming" technology, "high-tech" tools, play, and skills can be viewed as more worthwhile than "low-tech" ones. At the club, these tensions arose when children wanted to use tools such as iPads and cell phones to listen to music, play games, or communicate with others and when the kids wanted to engage in low-tech (or "no" tech) play.

We typically designed for different forms of technology use, particularly coding with micro:bits, designing LED greeting cards, and making radio transmitters; however, some students were drawn to using forms of technology that were either not part of the main activity or were at times against the rules of the school space, such as using cell phones

or tablets to play music, watch videos, or communicate with others. We wanted to support students' engagement with different forms of technology and value how children wanted to participate with technology. We wanted to both leverage the practices children were bringing in and also engage kids in new making and CS practices with which they were unfamiliar. We sometimes "pushed" children to participate in different forms of making, and in particular forms of making that involved computer science, as we wanted to pursue equity, in part, through access to societally valued CS practices. However, at times the children did not want to use technology at all. Some kids wanted to play outside and in those cases, it was also important for us to pay attention to what the children actually needed in each moment, even if that meant ignoring planned activities with specific technologies for the day. For example, after a schoolday filled with standardized testing, some of the children wanted to spend their time on the playground. It was important for us as facilitators and designers to consider what the children needed and to value play even when it was unstructured and technology free.

While we experienced tension as facilitators, our ultimate goal was to design the space with kids' own problem posing and solving in mind, not just because we wanted them to be engaged and to have fun, but because we hoped to create spaces for heterogeneous, culturally sustaining learning opportunities. We wanted to design against a learning environment that was rooted in monocultural practices, that dismissed various ways of knowing, or that focused on production above all else (Rendon, 2011). To avoid practices that further colonized spaces, bodies, minds, and ideas (Tuck & Gaztambide-Fernández, 2013; Tuck & Yang, 2012), we worked to value the different ways that children wanted to use technology and play, and we aimed to help kids make meaningful connections to their interests and their environment while engaging in play. We reflected on historical power imbalances in the production and use of technology and pushed back against notions of CS learning simply for future employment purposes.

Teaching technology for the sake of creating future workers, at the expense of learning for self-actualization and democratic engagement, creates a narrow definition of learning. An emphasis on job creation fosters a narrative that promotes outreach to diverse communities, rather than "the critical examination and potential reorganization of the activities and pedagogies themselves" (Vossoughi et al., 2016, p. 214). We wanted to provide access to valued technology practices, while not encouraging a workforce-focused orientation to CS skills. We hoped to push kids to try something new, while also respecting their need to run outside and play. We tried to balance these tensions within the twice-weekly, two-hour sessions in which we worked with the children. Ultimately, we landed on a series of trade-offs. Kids could use the facilitators' phones and iPads for certain purposes. For example, we asked some children who wanted to film with a cell phone to help document their friends' projects and interview other kids about what they were making. Cell phones were also used to support the kids in creating stop-motion and scary movies. We made efforts to integrate varied forms of technology in different ways, including cell phones, tablets, and computers to access information, look up instructional how-to videos, listen to music, shoot and edit clay animation movies, and film skits. Sometimes we packed our soldering irons and LEDs away and went outside to spend time together in the sun. We acknowledged the value placed on STEM careers, but instead of focusing on "employability," in terms of training children to take directions or complete tasks, we emphasized kids' roles as agentic creators and problem posers. We still experienced conflict, but we minimized these instances by trying to incorporate these technologies into the club in a way that maximized children's agency whenever possible. Our desire to facilitate in this way was not conflict or tension free, and for us facilitators it was a continual learning process, but we thought it was worthwhile to struggle with the complexity in hopes of better serving our EPIC kids.

Discussion

Bang and colleagues (Bang, Faber, Gurneau, Marin, & Soto, 2016) wrote elegantly about the potential for axiological innovations in education, changes in what counts as "good, right, true, and beautiful" (p. 2), to shape how learning takes

place. By centering the multiple values held in tension at the club, we were able to reimagine what counts as "good" in technology education. Critical reflection helped us better support the values of students from minoritized communities in our designs. Designing and planning for EPIC meant refusing to see the multiple, sometimes competing, values as *binaries*, but instead to find ways to address the complex mix of needs for everyone in the space. We tried to avoid accepting some assumptions that we have encountered, such as technology is always good and should always be used, or that coding is the most important technology skill for students to learn. Through considering our vision for technology use that was situated in children's practices, that helped kids explore, and that built off their interests and experiences, we reflected on ways to reimagine what counted as technology education and why it was important. We did not want to convey to students that they needed to learn these skills *only* so that they could one day contribute their talents to the global economy. Rather, we aimed to provide some additional tools and experiences that supported them in interpreting, expressing, and creating their everyday experiences and shaping their worlds. Caring for the children in the club involved taking learning, above and beyond academics, into consideration. It mattered to us that the kids in the club saw their technology use as meaningful in their lives outside of the school doors. A critical caring perspective also meant sometimes abandoning the use of technology altogether in order to meet kids where they were.

In this paper we considered our own learning as designers and facilitators of learning in an afterschool club. We gave accounts of several design tensions that arose as we reflected on learning goals and values, as we worked to incorporate critical perspectives on technology education and caring into our pedagogy. Taking a critical perspective on technology in the makerspace, as well as a critical approach to caring, placed historical inequalities and power in balances at the center of our pedagogical concerns. This approach required us to consider who technology is for, what ends justify its use, and what multiple values may be in play. It meant considering *why* we wanted kids to learn particular things in the club. We held several aims in mind, providing access to STEM learning for youth underrepresented in the field, supporting technology use as a method of self-expression and agency, and modeling good stewardship of material resources, all while having fun.

References

Arriola, E. R. (2000). Voices from the barbed wires of despair: Women in the maquiladoras, Latina critical legal theory, and gender at the U.S.-Mexico border. *DePaul Law Review*, 49(3), 729–816.

Bang, M., Faber, L., Gurneau, J., Marin, A., & Soto, C. (2016). Community-based design research: Learning across generations and strategic transformations of institutional relations toward axiological innovations. *Mind, Culture, and Activity*, 23(1), 28–41. https://doi.org/10.1080/10749039.2015.1087572

Barajas-López, F., & Bang, M. (2018). Indigenous making and sharing: Claywork in an indigenous STEAM program. *Equity & Excellence in Education*, 51(1), 7–20.

Bonds, E., & Downey, L. (2012). Green technology and ecologically unequal exchange: The environmental and social consequences of ecological modernization in the world-system. *Journal of World-Systems Research*, 18(2), 167–186.

Booker, A. N., Vossoughi, S., & Hooper, P. K. (2014). *Tensions and possibilities for political work in the learning sciences.* Boulder, CO: International Society of the Learning Sciences.

Carspecken, F. P. (2013). *Critical ethnography in educational research: A theoretical and practical guide*. New York, NY: Routledge.

Coburn, C. E. (2004). Beyond decoupling: Rethinking the relationship between the institutional environment and the classroom. *Sociology of Education*, 77(3), 211–244.

Cole, M., & the Distributed Literacy Consortium. (2006). *The fifth dimension: An after-school program built on diversity*. New York, NY: Russell Sage Foundation.

De Royston, M. M., Vakil, S., Ross, K. M., Givens, J., & Holman, A. (2017). "He's more like a 'brother' than a teacher": Politicized caring in a program for African American males. *Teachers College Record*, 119(4), 1–40.

Freeman, Q., & Jurow, A. S. (2018). Becoming a more disruptive teacher. In E. Mendoza, B. Kirshner, & K. Gutiérrez (Eds.), *Power, equity, and (re)design: Bridging learning and critical theories in learning ecologies for youth* (pp. 35–52). Charlotte, NC: Information Age.

Gutiérrez, K. D., & Vossoughi, S. (2010). Lifting off the ground to return anew: Mediated praxis, transformative learning, and social design experiments. *Journal of Teacher Education*, 61(1–2), 100–117. https://doi.org/10.1177/0022487109347877

McAllister, L., Magee, A., & Hale, B. (2014). Women, e-waste, and technological solutions to climate change. *Health and Human Rights Journal*, 16(1), 166–178.

Nicolopoulou, A., & Cole, M. (1993). Generation and transmission of shared knowledge in the culture of collaborative learning: The Fifth Dimension, its play-world, and its institutional context. In E. A. Forman, N. Minick, & C. A. Stone (Eds.), *Contexts for learning: Sociocultural dynamics in children's development* (pp. 283–314). New York, NY: Oxford University Press.

Philip, T. M., Gupta, A., Elby, A., & Turpen, C. (2018). Why ideology matters for learning: A case of ideological convergence in an engineering ethics classroom discussion on drone warfare. *Journal of the Learning Sciences*, 27(2), 183–223.

Rendon, L. I. (2011). Cultivating una persona educada: A sentipensante (sensing/thinking) vision of education. *Journal of College and Character*, 12(2). https://doi.org/10.2202/1940-1639.1788

Rolón-Dow, R. (2005). Critical care: a color(full) analysis of care narratives in the schooling experiences of Puerto Rican Girls. *American Educational Research Journal*, 42(1), 77–111.

Solórzano, D. G., & Yosso, T. J. (2002). Critical race methodology: Counter-storytelling as an analytical framework for education research. *Qualitative Inquiry*, 8(1), 23–44.

Tatar, D. (2007). The design tensions framework. *Human–Computer Interaction*, 22(4), 413–451.

Thompson, A. (1998). Not the color purple: Black feminist lessons for educational caring. *Harvard Educational Review*, 68(4), 522–555. https://doi.org/10.17763/haer.68.4.nm436v83214n5016

Tuck, E., & Gaztambide-Fernández, R. A. (2013). Curriculum, replacement, and settler futurity. *Journal of Curriculum Theorizing*, 29(1), 72–89.

Tuck, E., & Yang, K. W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society*, 1(1), 1–40.

Valenzuela, A. (1999). *Subtractive schooling: U.S.-Mexican youth and the politics of caring*. Albany: State University of New York Press.

Vossoughi, S., Hooper, P. K., & Escudé, M. (2016). Making through the lens of culture and power: Toward transformative visions for educational equity. *Harvard Educational Review*, 86(2), 206–232.

Acknowledgments

We could not have done this work without the support of many people and institutional partners. Thank you to our collaborators on the CU-Sanchez EPIC team, specifically Aaron Guggenheim, Max Hollingsworth, Jovita Schiffer, and Ben Shapiro. The University of Colorado Boulder provided funding and time for us to do this work. Thanks to CU Boulder's School of Education and the Office of Outreach and Engagement for their continued support of EPIC. This work was also supported by the NSF Grant 1722504 (Developing High-Tech, Low-Cost Making Projects to Enhance Computational Teaching and Learning). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

19. It's About Relationships

Examining Facilitation as a Relational Practice

RICAROSE ROQUE AND KRISTINA STAMATIS

Abstract: In this paper, we focus on the experiences of facilitators in informal settings designed to engage families in creative computing, or making, designing, and tinkering with computing. Facilitators can play important roles in developing welcoming spaces that enable youth to create and to learn computational literacy skills; however, research is still needed to examine the practices that facilitators use to engage with families in these activities. In this study, we highlight the ways that new facilitators came to take on the role of facilitators and focus specifically on the role of relationship building in their development and practices as facilitators. We worked with 9 facilitators during 5 intergenerational computing workshops to examine the practices they used to develop relationships with participants and the ways they interpreted and reflected upon these relationships to deepen their development as facilitators. Our findings indicate that facilitators and families in these workshops built relationships by leveraging common language and learning practices, sharing family stories, and using space to influence interactions. Additionally, as facilitators recognized and reflected on these relationships, they also reported growing in their understanding of facilitation.

Introduction and Background

In this study, we focus on the experiences of adult facilitators in out-of-school settings designed to engage youth and families in creative computing, or making, designing, and tinkering with computing. Facilitators can play important roles in developing welcoming spaces that enable youth to create and to learn with computing (Barron, Gomez, Martin, & Pinkard, 2014; Vossoughi, Escude, Kong, & Hooper, 2013). Because facilitators may have varying experiences with computing, supporting youth, or facilitating technology-based learning, staff at informal learning spaces who recruit and train facilitators face challenges in supporting them to develop the practices that can meaningfully engage diverse learners.

While many studies have examined the experiences of youth in creative computing programs, relatively few studies have examined what kinds of supports facilitators need to engage learners of diverse backgrounds. Past studies have primarily focused on facilitation practices, such as surfacing learner interests, providing encouragement, guiding rather than directing, and deepening engagement (Gutwill, Hido, & Sindorf, 2015). Studies of caretakers highlight the different roles caretakers can play, such as teacher, collaborator, and learner (Barron, Martin, Takeuchi, & Fithian, 2009; Nacu, Martin, Pinkard, & Gray, 2016). The identification of these roles and practices are important to help define what facilitators can do, but how do students, professionals, and volunteers learn to take on these roles?

In our study, we examine the ways that facilitators came to take on the role of facilitators. We focus specifically on the role of relationship building in their development. We draw on education research, which is often grounded in the ways that relationships impact learning. Literature across settings tends to emphasize the need to create space for learners to build community, while supporting learners in bringing funds of knowledge to bear on learning goals (Gonzalez, Moll, & Amanti, 2005). Much of this literature also emphasizes relationships as central to learning (e.g., Ladson-Billings, 1995; Reyes, Da Silva Iddings, & Feller, 2016). The relationships described in this literature are often developed through mutual care (Noddings, 1984, 1996, 2005), acknowledgment of cultural practices (Ladson-Billings, 1995; Paris & Alim, 2017), mutual vulnerability (San Pedro & Kinloch, 2017), and pedagogies of critical love (Freire, 1970/2000). While much

of this literature has focused on formal learning, this study adds new perspectives on the ways that relationships are built within informal, intergenerational settings.

We studied the experiences of new facilitators in a family technology program called Family Creative Learning (FCL), which engages children and families from nondominant groups in computing (Roque, 2016). Our analysis of facilitators' experiences builds on sociocultural frameworks of learning, in which learning is embedded in shared activities and involves taking on practices and roles that change over time (Lave & Wenger, 1991; Rogoff, 1984). We highlight the ways that facilitators and families interacted, particularly the ways they developed facilitation practices to build relationships. We examine how facilitators entered these relationships and explore themes to discuss facilitators' conceptualizations of relationships and how relationship building might be used to better support facilitator development.

Facilitation in Family Creative Learning

In this paper, we examine the experiences of new facilitators in Family Creative Learning (FCL), which invites families to design and learn together using creative technologies (Roque, 2016). FCL includes four to six workshops held in a community center once a week for two hours. Each workshop is divided into four parts: Eat, Meet, Make, and Share. In Eat, families and facilitators share a meal together. In Meet, facilitators check in separately with parents and children to talk about their experiences in the workshops. In Make, parents and children create stories using creative technologies, such as the ScratchJr programming environment. In Share, families talk about their projects and receive feedback.

The design of FCL draws on constructionist traditions of learning, which argue that people learn best when they are building things that are personally and socially meaningful (Papert, 1980; Kafai, 2006). Constructionism builds upon theories of knowledge as something actively constructed through experience (Piaget, 1976). As people build projects, they build ideas. The design of FCL also draws on learning theories that emphasize the social aspects of learning (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991). Families are encouraged to work together and build on their diverse "repertoires of practices" and "funds of knowledge" (Gutiérrez & Rogoff, 2003; Moll, Amanti, Neff, & Gonzalez, 1992).

Before the workshops, facilitators met as a team to become familiar with the tools, activities, and practices. Both authors met with facilitators and highlighted the role they play in supporting families to engage in personally and socially meaningful experiences with computing. They shared the *Family Creative Learning Facilitator Guide* (Roque & Leggett, 2014), particularly the Facilitating Fundamentals, which included practices such as "build relationships and trust," "ask questions rather than giving answers," and "surface their interests." For example, to build trust, facilitators are encouraged to eat with families and focus on a few families rather than the whole room to build deeper connections. Additionally, the authors prepared some activities for new facilitators, such as what to do if someone asks a challenging question or what to do if someone becomes frustrated with the making process.

During the workshops, facilitators supported the workshop implementation and helped families with their projects. Immediately after a workshop session, facilitators debriefed for 30 minutes to discuss what went well, what questions they have, or things that could be improved or challenging interactions they witnessed. Between the workshops, the facilitators met again to consider their reflections from the previous workshops and to discuss changes or strategies to implement in the next workshop.

Methods

Participants

In this paper, we focus on the experiences of facilitators who participated across five FCL implementations held in community-based organizations that consisted of libraries and schools in urban and suburban contexts in the Western Mountain region of the United States. The facilitators were primarily recruited from the university of which the two authors are also members, through an online student jobs board with multiple job descriptions that were titled: "Community Outreach Assistant," "Spanish Interpreters," and "Video and Photo Production Interns." Nine facilitators engaged across the five workshop implementations held from Fall 2017 to Fall 2018, with varying participation. Two members participated in all five, four members participated in four, and others participated from one to three workshop implementations. One facilitator had prior experience with computer programming, but the remaining facilitators were new to programming. Experiences working with youth ranged from very little to helping with a daycare center and babysitting jobs.

About 40 families participated in workshops. Families were recruited through community organizations, with staff actively seeking families that had limited access to resources around computing. Youth ranged in age from 3.5 to 15 years and parents or adult caretakers ranged in age from 25 to 75 years.

Data Collection and Analysis

While the data collected and analyzed for this paper focused on facilitators, this paper is part of a larger qualitative study examining how families create and learn together in creative computing activities (Roque, 2016). To understand the experiences of facilitators from their perspective, we conducted 60–90 minute interviews with facilitators in May 2018 and again in December 2018. We also audio-recorded and transcribed facilitator debrief sessions that immediately happened after workshop sessions. Facilitators took field notes in three of the five FCL workshop implementations, one in Spring 2018 and two in Fall 2018. Before the interviews, we asked facilitators to reflect on three to five moments that mattered to their experience. In addition to asking questions about these moments, such as why they chose them and what they took away from those moments, we asked them questions to surface their motivations, their facilitation challenges, and the strategies they developed. These multiple methods of data collection before, during, and after the program allowed us to triangulate their experiences as well as capture their development as facilitators over time.

We examined data through an iterative process, analyzing data through first-cycle coding, employing deductive coding to identify the practices facilitators employed to build relationships, and then inductive coding to remain open to emerging thematic analysis. We looked for patterns using second-cycle coding, and then wrote analytic memos (Miles, Huberman, & Saldaña, 2014). Much of our analysis focused on facilitators' reflections on their interactions between families and facilitators and among facilitators.

Findings

In our analysis, we recognized that themes around facilitator and participant relationship building emerged chronologically. Across five iterations of Family Creative Learning workshops from 2017 to 2018, we noted that

facilitators' entry points into the workshops impacted both the practices they used to establish relationships with participants and their interpretations of those relationships over time.

Entry Points

Entering relationships through shared backgrounds. While each of the facilitators we worked with during this study expressed an eagerness to connect with families, the ways that they approached these relationships differed. For example, Emilia, a facilitator who self-identified as Latina, explained that she joined FCL because she "wanted to interact with more diverse people." Emilia had grown up in a very diverse city and expressed that since moving to a majority-White college town, she began to feel out of place. In an interview, she elaborated, "I need to talk to people in Spanish'" (May 2018 interview). Emilia's desire to speak Spanish drove the ways that she approached relationships in the workshops. Even when she expressed feeling uncomfortable during the initial workshop sessions because she did not have previous experience supporting family learning, she continued to reference how much she valued speaking Spanish with participants. Emilia's experience was echoed by many of the other bilingual facilitators we worked with across these workshops. Armando, who was a recent immigrant from Mexico, would often find an instant connection with parents who had also immigrated. "It doesn't matter what kind of immigrant you are, it's just this connection, this emotional connection that you have with people."

While we expected facilitators to enter relationships with participants based on their shared languages, we found that shared backgrounds were extremely important, even for monolingual facilitators and those who did not speak Spanish. Daniel, a facilitator who self-identified as Latino and was not fluent in Spanish, repeatedly expressed how comforted he felt in being surrounded by people who reminded him of his family. While Daniel was not confident that he could connect with participants through Spanish, he reflected that their interactions were familiar and said that they reminded him of his family, which made him want to get to know them. Similarly, Quon, a facilitator whose primary language was Chinese, was initially nervous about facilitation because he feared that participants would not be able to understand his accent. Within the first workshop, however, he expressed a new appreciation for his ability to relate to participants because of his choice to come to the United States. He explained, "I told [the family I was working with] that I'm a nonnative speaker, and so if you don't get what I say, just let me repeat it again. Then they were curious about [me] because I think they were also not born in this country … they were not good at English [either]" (May 2018 interview). These experiences were echoed across other facilitator interviews. Facilitators who shared fluency in language with participants were able to find entry points through similar and shared experiences.

Entering relationships through learning experiences. Another way we observed facilitators building relationships with participants was through their own experiences as learners. As they prepared for these workshops, facilitators often framed their understanding of the relationships they were going to build with families by recounting their own learning experiences. Lacy, for example, explained that she was interested in participating in FCL because of her own participatory learning experiences in high school.

> In high school, I was always a really traditional student. … When I took Geometry in Construction [which engaged students in learning geometry through building and infrastructure] … I kind of fell in love with just the different aspects I saw in it and through that … it just grew [to be] something that I became really passionate about (May 2018 interview).

Lacy's desire to join FCL grew out of a personal learning experience and subsequent appreciation for learning through creating and making as opposed to what she termed "traditional" ways of learning. Lacy continued to explain that she relied on these past experiences to build her practices of facilitation, attempting to let families figure things out before "stepping in" to help (May 2018 interview).

Facilitation Practices

Throughout workshops, four themes emerged around the ways that facilitators and families built relationships; these themes included leveraging shared language practices, trading family stories, placing themselves within proximity of multiple family members, and using tools to broker conversations.

Leveraging language. Across the nine facilitators, field notes and interviews suggested that nearly all of them leveraged conversational practices from other parts of their lives in building relationships with families. Amy, a facilitator who self-identified as White, explained in a reflection that she intentionally spoke Spanish to participants as they entered the workshop for the first time. She wrote,

> I noticed that with multiple families, the kids began speaking English to us and then [the kids] were telling their parents what to do in Spanish until we started speaking Spanish to their parents. The kids would then move on and speak to each other when they did not have to translate for their parents. … [One father] saw me and exclaimed, '*no sabia que incluso las gueras hablan espanol aqui!*' (Translation: I didn't know that even the white ones speak Spanish here.) He then continued to joke about how he could not say anything behind my back and mentioned that the food was good and spicy (October 2018 field note).

Amy described how she felt that this moment "was important because he kept asking me questions and I felt as though it started to build a relationship with him and his family." While this is a poignant example of using shared languages to build relationships with families, we also noted that even facilitators who did not speak participants' primary languages used dialogue to build relationships. On more than one occasion, facilitators reported approaching participants with smiles and using hand gestures to begin establishing communication. Often, facilitators and participants reported realizing that they shared enough common vocabulary between English and Spanish to communicate effectively. Both Lacy and Jess reflected that the experience of struggling toward dialogue and discovering common communication practices resulted in feelings of closeness with and appreciation for participants.

Trading family stories. Another relationship-building practice that emerged in our data was the sharing of stories. This was reflected by Lacy, who explained sharing stories marked a meaningful connection.

> To me, when you can reach that moment of sharing the story, or sharing a personal experience, I think that signifies that something meaningful is taking place. I don't necessarily know what that meaningful interaction is, but it means the person is comfortable enough to share. Comfortable in the experience to share a part of themselves (May 2018 interview).

Jazmine, a facilitator who self-identified as LatinX, exemplified this practice. Throughout three workshops, Jazmine would recount stories of her 11-year-old twin brothers for participants, explaining that it was easy to relate to kids because of her relationship with them. On multiple occasions, we observed Jazmine telling stories about her brothers in order to build relationships with the young people she was facilitating. She would also rely on these stories when the children with whom she was working were performing in ways that she deemed "misbehaving." In a reflection after the one workshop, Jazmine explained that she used these stories to help her relate to what the families were experiencing and "be patient" when youth were acting in ways that she did not know how to support.

The trading of stories became a reciprocal practice between families and facilitators, as well as an indication for facilitators of successful relationship building. As the workshops progressed, facilitators described a moment when one mother, Alejandra, pulled out her phone and began showing them images of her family outside of the workshop. In field notes Amy described having the impression that "Alejandra seemed very proud showing me her family and seemed very happy when I told her how nice they looked" (November 2018 field notes). Alejandra had taken out her phone to share memories of her children with Amy, the facilitator, in order to deepen Amy's understanding of the family. For

Amy, this was a moment that indicated the family's desire to be known; she felt that the family had developed a trusting relationship with her if they were willing to share other memories from moments outside of the workshop.

Proximity. Across data sources, we observed facilitators using proximity to families to broker relationships. Lacy described this process as "stepping in" and "stepping back." During sections of the workshop, facilitators would use proximity to different family members as a means of encouraging collaboration, directing interactions, and allowing family members to navigate the technologies on their own. While each facilitator navigated proximity to participants differently, this process often involved kneeling next to families to explain an idea or to offer direction, standing behind families as they worked together and leaning in if instruction or clarification was needed, sitting between families and waiting to be engaged directly, and stepping away when families appeared to need to navigate ideas or disagreements on their own. In separate interviews, both Lacy and Daniel explained that they tried to make sure that families had the space they needed for discovery, but that they also wanted to be privy to the moments when families were learning something new. Jazmine explained that using space helped her navigate building relationships by giving her a nonverbal way for "getting their attention or making them want to listen to you" (May 2018 interview). She also explained that when she felt nervous about facilitation, she relied on stepping back and taking a moment to herself to make sure that she was being responsive to the family's needs. She explained that moving away from families occasionally made sense to her as moving toward them because as they learned "they didn't need us as much. Which I kind of like when they don't need us, because it means they're growing." For Jazmine, using space was a way to check in and make sure that the relationships she was trying to build with families felt mutual; she used physical closeness as a means to ensure that families felt cared for while also ensuring that they had the space they needed to work out struggles or frustrations without feeling as though she were interfering.

Conceptualizing Relationships

Across data sources, facilitators shared that relationships played a substantial role in helping them develop into their role. Facilitators highlighted connections with families—as Jazmine highlighted, of "being on the inside" rather than the "outside"—as instrumental in pushing them to think about how families learned together. Amy further described her realization that families are "receptive to talking and they want to connect." In recognizing that this desire for connection existed across workshop participants, facilitators reflected that they were more motivated to employ relationship-building practices and ultimately recognized that these practices supported them in developing into more skilled facilitators.

Facilitators shared how making these meaningful connections with families shifted how they saw their roles as facilitators. Emilia explained that it is "not just *working* [with families], it's actually *building relationships* with families." She continued to say that relationships make families' experiences better because they become familiar with facilitators and are not afraid to ask questions. Amy shared these perspectives and whenever she met new families, she would ask questions about their experiences in order to "get them talking right away so they feel comfortable talking to you and asking questions." Emilia hinted that their relationships with families also encouraged families to come again.

Making these connections with families helped to shift their relationships into a more level and equal relationship. One facilitator, Quon, shared how his prior experiences in learning environments often had an "authority figure" and students were expected to listen and follow their instructions. He found his experiences as a facilitator departed from this interaction and instead, this learning environment fostered a "more equal relationship." Lacy shared how in the past she might have been hesitant to open up to a facilitator because of their "superior" role. However, because of building relationships with families, she found it be more of a "partnership" that was powerful and where "new learning can take place."

Discussion

This study highlights the role of relationship building in the development and practices of facilitators. Within creative computing spaces in out-of-school settings, staff might be inclined to recruit new facilitators who have STEM or computing skills. Additionally, preparation of new facilitators might substantially focus on developing those STEM or computing skills in facilitators and how to cultivate those skills in participants. However, our study highlights the ways that encouraging and providing opportunities for relationship building can support both the development of facilitation practices and the learning experiences of participants. In FCL, opportunities for connection are inherent in the four-part structure of the FCL workshops: Eat, Meet, Make, Share. Three of the four parts (Eat, Meet, and Share) highlight social interaction. Even in Make, families and facilitators are encouraged to work together. Staff and informal learning educators might consider the ways that their activities and spaces create an environment that supports facilitators and participants to connect more meaningfully in their interactions.

While we recognize that not every setting can implement a program such as FCL, these facilitators' experiences hint at how these relationship-building practices and opportunities might be supported. As they entered, developed, and reflected on their relationships, facilitators drew on their funds of knowledge (Moll et al., 1992) and funds of identity (Esteban-Guitart & Moll, 2014). While a significant body of literature has established that people learn by leveraging their cultural backgrounds (e.g., Moll et al., 1992; Gonzalez et al., 2005; Esteban-Guitart & Moll, 2014), these facilitators were also leveraging their backgrounds and beliefs to support participant learning. Further, as facilitators engaged in these practices, our data analysis demonstrated that they were becoming increasingly metacognitive about the ways that relationships and learning intertwined.

Additionally, centering key facilitation practices around relationships can help to disrupt typical power dynamics within instructional and technology-based spaces. Power dynamics are inherent within relationships and every learning experience—especially where technology is involved—has the potential to be influenced by these dynamics because of the ways that learning and technology have historically been tied to privilege (Esmonde & Booker, 2017; Foucault, 1977; Vossoughi et al., 2013). Freire (1970/2000) describes learning as liberation that fosters love and therefore dialogical relationships. As facilitators noted, developing relationships with families created a leveling effect on their dynamic and countered their notions of facilitators as "authorities" or "superior figures." The FCL model has worked to acknowledge traditional power structures between institutions, facilitators, participants from historically marginalized backgrounds, and technological tools—and disrupt those structures by centering relationships. Our analysis demonstrates that as computing spaces and other making and tinkering spaces aim to engage more nondominant groups, there is a continued need to build understandings around facilitation practices centered on relationship building to support the engagement of diverse learners.

We aim to build on this work to continue understanding the network of relationships at play within creative computing environments in informal learning settings. Our analysis primarily focused on the direct social interactions between facilitators and families. However, facilitators' uses of space to build relationships hint at how other features in a learning environment can be used to broker relationships. For example, facilitators shared how valuable it was to witness families' shifting relationships with tools. As facilitators positioned parents to work with and build their confidence with the tools, parents were, in turn, able to work more meaningfully with their children and build their relationships with children in the context of computing. The FCL context allows us to examine a network of relationships—between parents and their kids, between families from the same neighborhood, between families and their local community-based organization, and between families and new technologies—and the role that these relationships play in fostering an inclusive, welcoming, and creative learning experience for nondominant groups to create and express themselves in computing.

References

Barron, B., Gomez, K., Martin, C. K., & Pinkard, N. (2014). *The digital youth network: Cultivating digital media citizenship in urban communities*. The MIT Press.

Barron, B., Martin, C. K., Takeuchi, L., & Fithian, R. (2009). Parents as learning partners in the development of technological fluency. *The International Journal of Learning and Media*, 1(2). doi:10.1162/ijlm.2009.0021

Brown, J. S., Collins, A., & Duguid. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32–42.

Esmonde, I., & Booker, A. (Eds.). (2017). *Power and privilege in the learning sciences: Critical and sociocultural theories of learning*. New York, NY: Taylor & Francis.

Esteban-Guitart, M., & Moll, L. C. (2014). Funds of identity: A new concept based on the funds of knowledge approach. *Culture & Psychology*, 20(1), 31–48.

Foucault, M. (1977). *Discipline and punishment*. (A. Sheridan, Trans.). New York, NY: Random House.

Freire, P. (2000). *Pedagogy of the oppressed* (M. B. Ramos, Trans.; 30th anniversary ed.) New York, NY: Bloomsbury.

Gonzalez, N. E., Moll, L. C., & Amanti, C. (Eds.) (2005). *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. Mahwah, NJ: Lawrence Eribaum.

Gutiérrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher*, 32(5), 19–25.

Gutwill, J., Hido, N., & Sindorf, L. (2015) Research to practice: Observing learning in tinkering activities. *Curator: The Museum Journal*, 58(2), 151–168.

Kafai, Y. B. (2006). Constructionism. In K. Sawyer (Ed.) Handbook of learning sciences (pp. 35–46). Cambridge, UK: Cambridge University Press.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, 32(3), 465–491.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: An expanded sourcebook* (3rd ed.). Thousand Oaks, CA: Sage.

Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory Into Practice*, 31(2), 132–141.

Nacu, D., Martin, C., Pinkard, N., & Gray, T. (2016). Analyzing educators' online interactions: A framework of online learning support roles. *Learning, Media, and Technology*, 41(2), 283–305.

Noddings, N. (1984). *Caring: A feminine approach to ethics and moral education*. Berkeley: University of California Press.

Noddings, N. (1996). Stories and affect in teacher education. *Cambridge Journal of Education*, 26(3), 435–447.

Noddings, N. (2005). What does it mean to educate the WHOLE child? *Educational Leadership*, 63(1), 8–13.

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas.* New York, NY: Basic Books.

Paris, D., & Alim, H. S. (2017). *Culturally sustaining pedagogies: Teaching and learning for justice in a changing world.* New York, NY: Teachers College Press.

Piaget, J. (1976). Piaget's theory. In B. Inhelder, H. H. Chipman, & C. Zwingmann (Eds.), *Piaget and his school.* Berlin, Germany: Springer.

Reyes, I., Da Silva Iddings, A. C., & Feller, N. (2016). Building relationships with diverse students and families: A funds of knowledge perspective. *Journal of Early Childhood Literacy*, 16(1), 8–33.

Rogoff, B. (1984). Introduction: Thinking and learning in social context. In B. Rogoff & J. Lave (Eds.), *Everyday cognition: Development in social context* (pp. 1–8). Cambridge, MA: Harvard University Press.

Roque, R. (2016) Family creative learning. In K. Peppler, E. R. Halverson, & Y. B. Kafai (Eds.), *Makeology in K- 12, higher, and informal education* (pp. 47–63). New York, NY: Routledge.

Roque, R., & Leggett, S. (2014). *Family creative learning facilitator guide*. Retrieved from http://familycreativelearning.org/guide/

San Pedro, T., & Kinloch, V. (2017). Toward projects in humanization: Research on co-creating and sustaining dialogic relationships. *American Educational Research Journal*, 54(1), 373S–394S.

Vossoughi, S., Escude, M., Kong, F., & Hooper, P. (2013). Tinkering, learning, & equity in the after-school setting. In *Fablearn Conference Proceedings*. Palo Alto, CA: Stanford University.

Acknowledgments

This project was made possible in part by the Institute of Museum and Library Services (LG-96-17-0176-17). We also want to thank the families and facilitators who ate, met, made, and shared with us.

20. Designing for Group Flow in Collaborative Cross-Platform Learning Experiences

MEREDITH THOMPSON, LAURA ZHANG, MOHAMED SEYAM, JING FAN, ANNIE WANG, DAN ROY, JUDY PERRY, AND ERIC KLOPFER

Abstract: Technological resources have expanded the goal of education from individual knowledge acquisition to include the development of critical thinking, communication, and collaboration. This shift requires a reevaluation of what students learn (e.g., content vs. skills) and how students learn in formal education settings (Saavedra & Opfer, 2012). Thus, there is a critical need to find ways to create environments that enable embodied, enactive, extended, and embedded learning and develop critical thinking, communication, collaboration, and creativity. MIT's Education Arcade and the MIT Game Lab are exploring ways to meet this need by developing a cross-platform, collaborative educational game with a conceptual focus on cellular biology and a developmental focus on 21st-century skills. To this end, we are creating learning environments that incorporate collaborative problem solving that are connected across different contexts.

Intervention

Our first CLEVR project, *Cellverse*, is designed to help high school students learn about cellular biology and build collaborative skills by diagnosing and selecting a therapy for a diseased cell. *Cellverse* is played in pairs—the Explorer views the cell using a virtual reality (VR) head-mounted display (HMD); the Navigator views the cell through a tablet. The Navigator has a less detailed "bird's-eye" view of the cell environment and access to reference material available about possible diseases. By distributing information across two platforms (VR and tablet), we intend to establish complementary resources to enable a deeper engagement than a single-player game would. We also seek to understand how to build educational experiences in which the choice of modes (tablet or HMD) dovetails with the goals of learning (cultivating positive interdependence through resource distribution). In this study, we have two main research questions: whether and how players collaborate during the game, and how they reflect on that collaboration after the game is over.

Research Questions

1. How, if at all, do players' interactions demonstrate the attributes of group flow: shared vision, equal ownership and contribution, and effective communication?
2. How, if at all, does the game design establish and support an environment conducive to group flow?

Theoretical Background

Collaborative problem-solving skills are essential for the work of the future (Fiore et al., 2017). Research provides theoretical frameworks for understanding and improving collaboration that can be useful in situations in which teams

work in virtual environments (Lee, 2009). Collaborative problem solving requires interdependence, the thoughtful formation of groups, individual accountability, and attention to social-skill development (Cuseo, 1992). Positive interdependence is achieved when all members of the group need to interact to achieve a common goal (Johnson & Johnson, 1994; Laal, 2013).

In order to educate students to be better collaborators, we also need a framework to understand optimal interaction within groups. In his book *Group Genius: The Creative Power of Collaboration*, Sawyer (2017) builds on Csikszentmihalyi's theory of flow (Csikszentmihalyi,1998; Nakamura & Csikszentmihalyi, 2012) to describe "group flow," an optimal state of collaboration when groups have a shared vision, equal ownership and contribution, and effective communication (Duncan & West, 2018; Sawyer, 2017). Research suggests that digital simulations are promising tools for learning and practicing skills and that they create a record of communication to be used for reflection (Kaufman & Ireland, 2016). We aim to give players a chance to develop, rehearse, and self-assess their collaboration skills during the *Cellverse* game. Thus, this pilot study investigates how players interact with *Cellverse* and whether there is evidence of moving toward or achieving group flow.

Methodological Approach

We are using a qualitative approach to explore interactions between the players and with the game environment (Bengtsson, 2016). We approached the data with an *etic* and an *emic* viewpoint. Our etic codes were based on Duncan and West's (2018) interpretation of Sawyer's (2017) group flow theory: shared vision, equal ownership and contribution, and effective communication. *Shared vision* is established by having a shared specific goal in mind with the potential for failure. *Ownership and contribution* hinge on a balance between the perception that each player has *autonomy and control* over his or her actions and demonstrates *flexibility* to listen and adapt to the ideas of the team. All members of the group need to feel that they can *participate and contribute* to the collective action for group flow. *Familiarity with group members* can assist group flow, as does *familiarity with guiding principles* of understanding processes and a common language among group members. *Communication* requires *close listening* when participants are attentive to the problem and open to ideas from the group. The group should be focused on the task, exhibiting *complete concentration* in the activity, and members need to *blend egos* by building on the contributions of their team. Close listening, complete concentration, and blending egos can culminate in *collective emergence*, in which the team is "not just coming up with a solution, but trying it out, following through with it, and continuing to expand on the innovation after it's done" (Duncan & West, 2018, p. 8).

Group flow theory describes *what* we are looking for; our *emic* codes documented *how* players interacted in the game. These codes precipitated from weekly discussions of individual cases, noting recurring themes in the discussions, and establishing new codes to reflect those themes. Themes included events during gameplay such as orientation to the problem that leads to shared vision and the synthesis of memos written for the weekly discussion. We noted recurring themes in the data, discussed them during weekly research meetings, and created new codes to reflect the themes.

The Sample

This pilot study is one of a set of exploratory studies about the *Cellverse* game. The sample for this study includes a convenience sample of eight secondary STEM teachers (five males and three females) from a weeklong on-campus teacher summer workshop who volunteered to try the game. Although teachers are not our targeted audience, their insights were important not only in the game experience, but also in how their students might receive the game and

how the game connected to their curriculum. Teachers played the game in the evening after the workshop and were given pizza. A summary of the teachers' VR experience, domain knowledge, and role during the game appear in Table 1.

	Pseudonym	VR experience	Domain knowledge	Role in game
Case Study 1	Peter	Once or Twice		Navigator/Tablet
	Denise	None	Biology Teacher	Explorer/VR
Case Study 2	Daniel	None		Navigator/Tablet
	Geoff	None	Physics Teacher	Explorer/VR
Case Study 3	Chris	None	Biology Teacher	Navigator/Tablet
	Derek	Some (games)	STEM Teacher	Explorer/VR
Case Study 4	Nadine	None	Biology Teacher	Navigator/Tablet
	Tina	None	Biology Teacher	Explorer/VR

Table 1. Teachers' background, domain knowledge, and role in game.

Procedure

Participants decided on their own roles and played the game side by side and were able to talk with one another throughout the experience. At the beginning of each session, the partners were interviewed separately at different corners of the same room. We shared the game objective of working together to figure out what is wrong with the cell. After they were set up with their respective technology (headset or tablet), each player completed an individual tutorial. After the tutorial, the players started the game. The staff who were present asked a few questions of the participants while the participants played the game (How does the headset feel? What do you think of the cell environment?). The staff also answered questions from the participants during the game. The teams either played until they solved the game or were stopped after 40 minutes of gameplay. They completed a postinterview about their experience. A screen shot of the explorer view, the navigator view, and a sample setup are included as Figures 1, 2, and 3.

Figure 1. Sample setup.

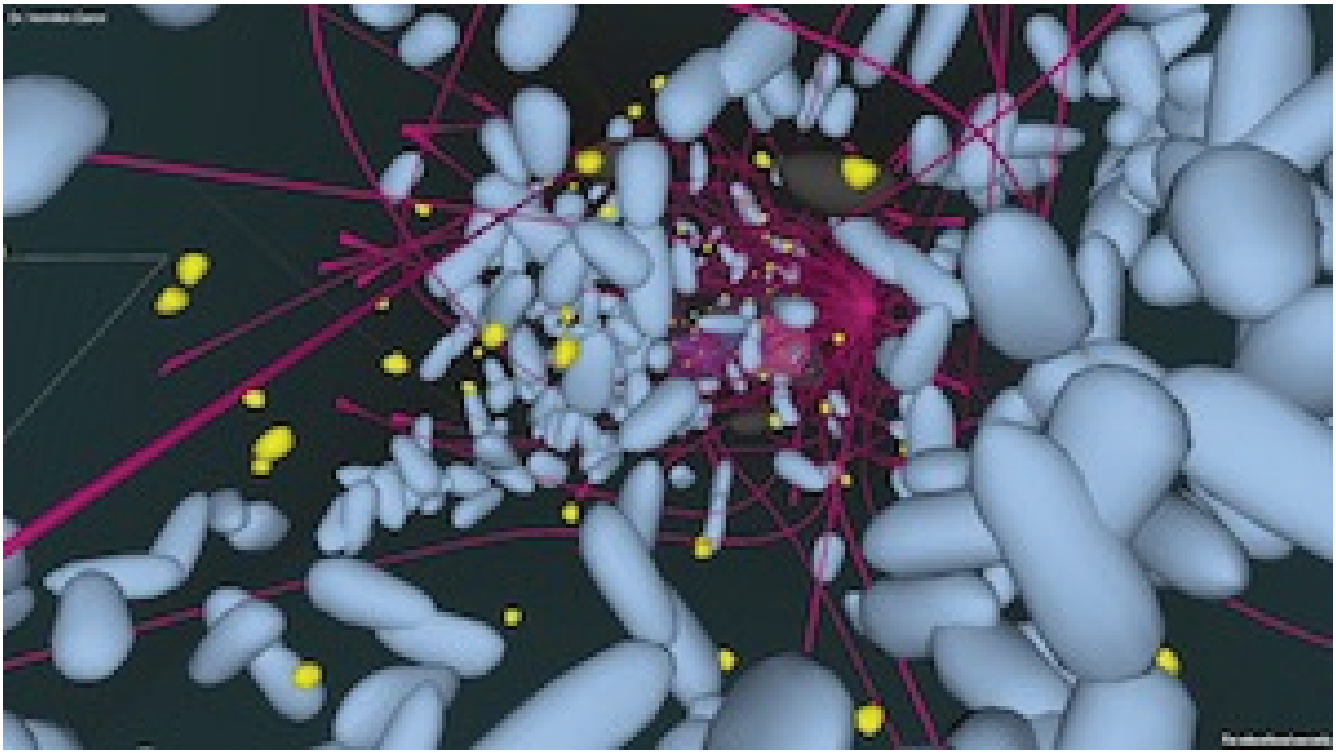

Figure 2. Explorer's view of the cell.

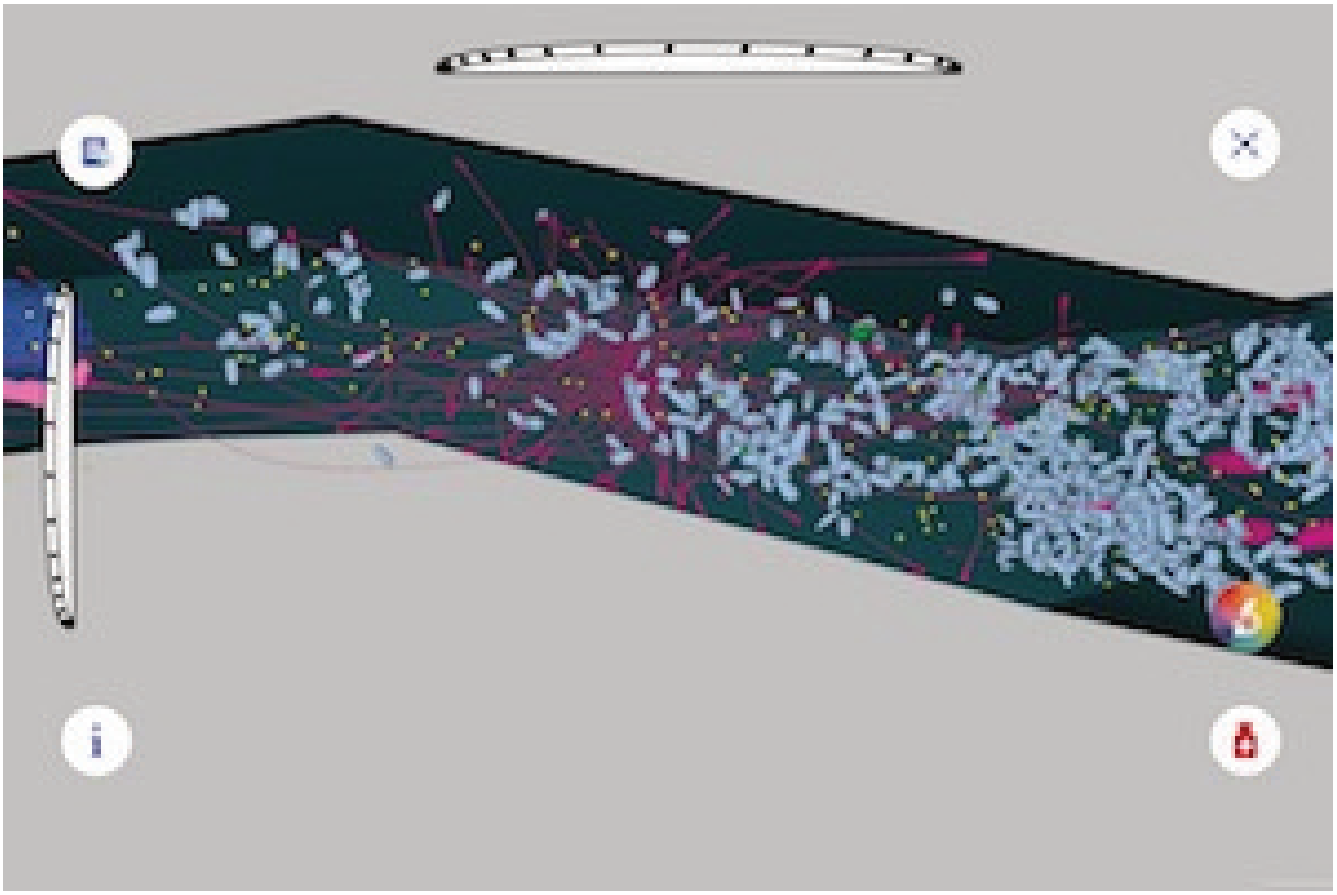

Figure 3. Navigator's view of the cell.

Analysis

We reviewed the transcripts, videos, interviews, and observational notes to identify similar themes that emerge from all four case studies and to search for evidence of developing group flow during the interaction.

Establishing a Shared Vision

Players started the game by selecting a role, either explorer or navigator, and doing a tutorial that introduced the actions and environment specific to their role. The explorer learned how to move around, select organelles, and view a clipboard with information about those organelles. The navigator learned how to rotate the whole cell view, how to place a beamlike "beacon" in the cell, and was also introduced to the reference information about the diseases. "Beacons" are lines that the navigator could place in the cell to guide the explorer to a specific spot. One participant described the beacons as a "light saber." The explorers in this study each finished their tutorial quickly and wandered around the cell waiting for the navigator to finish. The navigator spent a lot more time doing the tutorial, learning how to manipulate the cell, and reading the reference material about the diseases. In particular, the navigators spent a lot of time learning how to place "beacons" in the cell.

Not surprisingly, the partners did not communicate much when they were acclimating to their environment in the beginning of the game. As they became more familiar with their environment, they began communicating with each other. Part of the communication was developing a shared language to discuss the unusual environment using colors, shapes, location, and biology terminology to describe what they saw in the cell. The communication in the beginning part of the game was primarily one-way communication—players just stated what they saw and their partner did not connect the information. This happened in Cases 2, 3, and 4, when the explorers narrated what they observed. Only one pair (Nav1 and Exp1) engaged in joint orientation: Peter went step by step through the organelles and used colors and shapes to compare his tablet view with her virtual view.

Negotiating Contributions

Midway through the game, frustration set in. In all four cases, the explorers asked the navigators whether they had additional information to share. Just as Geoff asked Daniel whether he had additional information, about 10 minutes into the game Derek asked Chris, "OK, are there any other prompts you have? I have no others" (10 min). Denise asked Peter, "What shall I look for? You're reading to yourself—I can't understand anything" (32 min). In Case Study 4, Nadine the navigator asks Tina the explorer (21 min.):

> Nadine to Tina: So do you have any information on the two diseases?
>
> Tina: Not that I can see, no. I don't know if there's a place that I have to go.
>
> Nadine: So I think I have that information. So we're looking for …
>
> *Note*. N reads softly to herself. E is still looking around the cell.

This exchange reinforced the idea that they each had different information and prompted Nadine to explore her information more thoroughly.

Blending Egos and Collective Emergence

The conflict of figuring out who had the information to solve the game prompted the navigator to emerge as the leader in the investigation. In *Cellverse*, the navigator has two tools that the explorer does not have: reference information about the disease symptoms and the ability to put a "beacon" in the environment. The navigators in Case Study 2 (Daniel), 3 (Chris), and 4 (Nadine) used beacons to focus the explorer's attention on the specific areas of the cell. As Chris and Derek zero in on the clues, Chris talks about "beaconizing" the Golgi Apparatus so Derek could find it. Daniel tells Geoff, "I am trying to figure out where to put the beacons so you can go there. And you can investigate." Daniel decides to direct Geoff toward the centrosomes using two beacons. Once Geoff finds the selected spot, Geoff focuses on finding the centrosome. Daniel asks about the color of the centrosome, which is a symptom of the disease. Nadine also uses beacons to guide Tina to view the centrosome.

> Nadine: OK, so should I shoot a beam to have you go check this out?
>
> Tina: Yes.
>
> *Note*: Nadine takes a second to figure out how to shoot a beam on-screen.
>
> Nadine: Do you see where those two beams cross?

Tina: Yes.

Nadine: What color is that thing?

Tina: The circle with the spidery thing? It's blue and the things coming off are green.

Nadine: Oh, great!

Tina: The centrosome is blue, and the microtubules are green.

Nadine to staff: Great. So then, do I just tell you the disease? It's the _____.

In responding to Nadine, Tina describes the shape of the centrosome as a "spidery thing." Providing a shape confirmed that Tina was looking at the correct object in the cell and helped them come to a conclusion about the game.

Postgame Reflection

The game is designed to create a positive interdependence between the players so that they need to collaborate to achieve the goal. In each of the four cases, the respondents recognized that the different types of information given to the explorer and navigator required them to work together. Peter (Case 1) enjoyed learning more about the cell from his partner Denise, who was a biology teacher. Denise compared the experience to "an Easter Egg hunt" but also commented that having a partner made it "more fun than going in by myself." Geoff (Case 2) explained that he was "relying on my partner to give me context" about the game, and Daniel appreciated having a partner to discuss the information.

Chris and Derek (Case 3) and Nadine and Tina (Case 4) thought the balance of information was weighted toward the navigator and suggested giving more information to the explorer. Derek explained that he relied on Chris for what to look for in the cell. Chris acknowledged that the different views of the cell made it important to have both roles, but he thought that "it seemed like I was more helpful to him, like I was a navigator, but I needed his information to to complete the goal. Because If I don't tell him my info and where to go, then he's going around aimlessly, and if he doesn't tell me, I can't tell which disease it is then I will never know." At the conclusion of the gameplay, Tina was slightly disappointed that her role was relatively small. During the debrief, she noted, "All I did is get there and then describe the color to you." Tina and Nadine recognized that the different views and information supported the collaboration, and that collaboration is a good goal for their students. They did not recognize that they had different views while they played the game. They both suggested making it clearer in the game that the views and the information were different and reminding the players that they have to communicate in order to play effectively.

Conclusions

In this study, we viewed patterns of interaction that included establishing a shared vision, negotiating contributions among team members, blending egos to establish a solution, and collective emergence in acting on their ideas to finish the game (Duncan & West, 2018; Sawyer, 2017). Completing the tutorial and acclimating to the environment was initially an individual activity. When partners realized they had different information, they began to work together in earnest, suggesting that the game setup encourages positive interdependence (Johnson & Johnson, 1994; Laal, 2013). They developed a shared language around the unfamiliar environment of the cell, and they recognized that communicating with their partner was necessary—and challenging. The task was especially challenging because splitting the views

between a virtual reality headset and a tablet created a good inequality (Spante, Axelsson, & Schroeder, 2006); as the partners were not able to see each other's views, precise and effective discussion became essential. The shared goal of finding out what is wrong with the cell prompted the partners to offer information so they could understand their different views and roles and develop a shared language about how to communicate effectively about a complex problem in an unfamiliar environment. Through this research, we are gaining insight into how to connect conceptual and skill-building experiences and understand how to optimize new technological tools such as virtual reality.

References

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *NursingPlus Open*, 2, 8–14. http://doi.org/10.1016/j.npls.2016.01.001

Csikszentmihalyi, M. (1998). *Creativity: Flow and the psychology of discovery and invention*. New York, NY: Harper Perennial.

Cuseo, J. (1992). Cooperative learning vs. small-group discussions and group projects: The critical differences. *Cooperative Learning and College Teaching*, 2(3), 5–10.

Duncan, J., & West, R. E. (2018). Conceptualizing group flow: A framework. *Educational Research and Reviews*, 13(1), 1–11.

Fiore, S. M., Graesser, A., Greiff, S., Griffin, P., Gong, B., Kyllonen, P., … von Davier, A. (2017). *Collaborative problem solving: Considerations for the national assessment of educational progress*. Alexandria VA: National Center for Education Statistics.

Johnson, R. T., & Johnson, D. W. (1994). An overview of cooperative learning. In J. Thousand, A. Villa, & A. Nevin (Eds.), *Creativity and collaborative learning*. Baltimore, MD: Brookes Press.

Kaufman, D., & Ireland, A. (2016). Enhancing teacher education with simulations. *TechTrends*, 60(3). http://doi.org/10.1007/s11528-016-0049-0

Laal, M. (2013). Positive interdependence in collaborative learning. *Procedia – Social and Behavioral Sciences*, 93, 1433–1437. http://doi.org/10.1016/j.sbspro.2013.10.058

Lee, M. (2009). How can 3d virtual worlds be used to support collaborative learning? An analysis of cases from the literature. *Journal of e-Learning and Knowledge Society*, 5(1), 149–158. Retrieved from https://www.learntechlib.org/p/43518/

Nakamura, J., & Csikszentmihalyi, M. (2012). Flow theory and research. In S. J. Lopez & C. R. Snyder (Eds.), *The Oxford handbook of positive psychology* (2nd ed.). Oxford, UK: Oxford University Press. http://doi.org/10.1093/oxfordhb/9780195187243.013.0018

Saavedra, A. R., & Opfer, V. D. (2012). Learning 21st-century skills requires 21st-century teaching. *Phi Delta Kappan*, 94(2), 8–13. http://doi.org/10.1177/003172171209400203

Sawyer, K. (2017). *Group genius: The creative power of collaboration*. New York, NY: Basic Books.

Spante, M., Axelsson, A.-S., & Schroeder, R. (2006). The good inequality: Supporting group-work in shared virtual environments. In R. Schroeder & A. Axelsson (Eds.), *Avatars at work and play* (pp. 151–166). Dordrecht, The Netherlands: Springer. http://doi.org/10.1007/1-4020-3898-4

21. Education Through Navigation

Exploring Wayfinding in Mission HydroSci

ALEX URBAN, WENYI LU, HAO HE, AND JOE GRIFFIN

Abstract: Some popular 3D educational video games incorporate vast amounts of content with limited direct instruction. This exploratory study investigates player navigation to determine how wayfinding aids and level design impact interaction with embedded instructional content. To investigate player behavior, participants completed navigational tasks within a larger usability study of an environmental science video game, *Mission HydroSci*. This study adopts a mixed-method approach, including: (a) demographic questionnaires and geographic skills assessment, (b) virtual participant observation, (c) game logs of user actions, and (d) analysis of eye-tracking data related to in-game navigational aids. We found that participant self-reported average weekly gameplay, affect toward science, and navigation experience correlated to player interaction with some wayfinding aids and the speed in which participants completed tasks. In addition to these demographic correlations, in-game player movement and visual fixation duration present differences that may be valuable for future behavioral clustering. We use these results to discuss design implications for 3D virtual learning environments.

Introduction

As immersive virtual learning environments (IVLEs) are increasingly adopted in both K–12 and higher education, it may be incumbent on instructional designers to understand and potentially create virtual worlds that effectively guide students to reach particular locations with embedded instructional content. Game designers often employ navigational systems to support wayfinding in virtual worlds, and researchers have made an effort to understand how these aids influence player behavior. Explicit visual signaling to complete in-game tasks, for example, may be used to reduce cognitive load in an IVLE (Nelson, Kim, Foshee, & Slack, 2014). Although signaling or feedback may aid players in navigational tasks, others have noted that designers may want to hide apparent paths to promote exploration in video games (Moura & Bartnam, 2014). In virtual worlds without explicit signaling, environmental patterns as well as player variables, such as experience with 3D games, may influence the ease with which some players complete navigational tasks (Biggs, Fischer, & Nitsche, 2008). Some researchers (Si, Pisan, Tan, & Shen, 2017) go further to say that demographics may contribute to dominant and subordinate exploration archetypes when conducting in-game tasks.

This exploratory study investigates an additional element in this balancing between demographics, navigational systems, and exploration: topographic knowledge. While conducting a larger, summative evaluation of *Mission HydroSci* (*MHS*), an environmental science and scientific argumentation video game for middle school students, we asked the following question: *What forms of navigational behavior emerge within this IVLE?*

Findings from this pilot study not only provide summative results for *MHS*, but they contribute to the body of knowledge on player exploration in IVLEs. Our results may inform instructional designers on how to include and scaffold embedded content without hindering exploration.

Research Questions

To answer the main RQ of *What forms of navigational behavior emerge within this IVLE?*, there are the following subquestions: (a) *What is the relationship between player demographics and unguided navigation?* And, conversely, (b) *How does the inclusion of an explicit wayfinding cue change player behavior?*

Methods

This mixed-methods exploratory study occurred within a summative evaluation project. Participation was divided into three sessions, each consisting of playing two learning units of *MHS* in 90-minute segments. Participants were compensated with a $50 Amazon gift card after completing each session. We conducted this pilot study during the first evaluation session. The following section of this paper presents the context and design of the IVLE as well as the data collection and analysis methods used during this first session.

Participants

Participants were nine middle school students (Grades 6–8); 56% percent of the sample was female (44% male). We obtained Institutional Review Board approval as well as parental/guardian consent and the assent of the students before beginning the study. Recruitment was conducted via email through established points of contact with local middle schools. To maintain confidentiality, all transcripts and data were anonymized.

Mission HydroSci

To investigate player behavior within an IVLE, we used *MHS*, a 3D game focusing on water in socioecological systems and scientific argumentation. *MHS* aligns with Next Generation Science Standards (NGSS; National Research Council, 2013) and is an i3- and IES-funded research and design project by Adroit Studies at the University of Missouri (MIZZOU). *MHS* positions players as junior scientists on an interstellar mission to establish a settlement on a newly discovered alien planet. Because *MHS* places players in a 3D world with varied terrain, this game is well positioned as a medium to research player navigation in an unfamiliar virtual environment.

Exploration tasks within *MHS*. This study presents initial findings on player behavior during Unit 2 of *MHS*. We focused on two particular tasks:

1. *Task A—Navigation Without an Explicit Wayfinding Cue:* The player is separated from his or her team of nonplayer characters (NPCs) on an alien planet. To reconvene with the team, the player must use embedded content such as a topographic map as well as an in-game menu that stores "Backing Information," such as previous dialogue and task prompts. The surroundings themselves are also educational content; they provide identifying landmarks that correspond with the topographic map. In addition to this content, the game provides players with an in-game visualization of how to use a topographic map before beginning the challenge.
2. *Task B—Navigation With an Explicit Wayfinding Cue:* Having reconvened with his or her team, the player must gather evidence from the two nearby rivers to determine which will better support hydroelectric power. The game

aids players with a single wayfinding cue that sequentially pinpoints where to gather this evidence. As players move through the environment, they have the opportunity to interact with supplemental instructional content, such as objects and an NPC who provides information regarding watershed size.

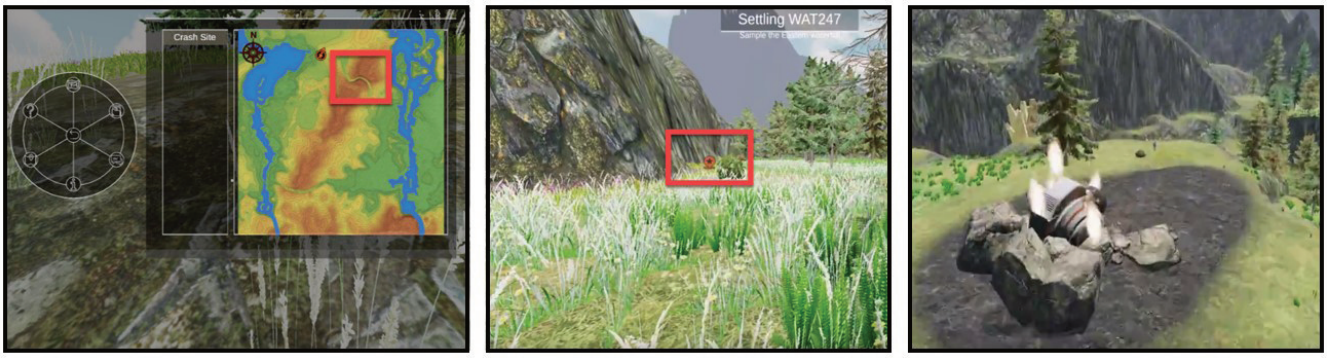

Figure 1. (Left) In Task A, participants may use only a topographic map and embedded content to navigate the environment. (Center) In Task B, participants may also rely on a prominent navigational waypoint. (Right) The environment that houses Task B also includes supplemental educational content in the form of in-game objects and an NPC.

Instruments

We employed three instruments to determine player navigational patterns and interaction with in-game content.

Demographic interview. Because curiosity and value influence learner performance (Keller, 2008), we employed the Measure of Affect in Science and Technology questionnaire (MAST; Romine, Sadler, & Wulff, 2017). As this research is ongoing and postintervention MAST questionnaires have not yet been conducted, we instead relied on brief demographic interviews, asking participants to report enjoyment of science and video games (measured with separate 10-point scales) as well as average weekly gameplay hours as this may influence in-game navigation (Biggs et al., 2008; Si et al., 2017).

Topographic knowledge assessment. Because spatial cognitive processes and visual fixations may differ between students with varying degrees of geographic skills (Dong, Zheng, Liu, & Meng, 2018) and might influence in-game behavior, we asked participants to complete a topographic knowledge assessment before playing *MHS*. This assessment, created by a subject matter expert, consisted of four multiple-choice questions related to elevation, predicting water flow, and placement of watersheds based within 2D topographic maps.

Navigation experience questionnaire. We adopted three Likert-scale questions to evaluate participant self-reported navigation experience in everyday life (Si et al., 2017). They are: (a) Every time I leave home, I have a clear understanding of the distance I have traveled and directions to get home, (b) I am easily disoriented in an unfamiliar environment, and (c) I have a good spatial memory of places I have visited. For example, I can recall the placement of objects throughout a room I recently visited. According to Si et al. (2017), these questions embody key aspects of navigational abilities of distance estimation, spatial orientation, and spatial memory.

Play Measures

For this initial study, we used three play measures to investigate relationships with the instrument data.

Eye tracking. Because eye tracking may provide an understanding of attentional processes (Duchowski, 2017), participants wore Tobii Pro Glasses 2, a wearable eye-tracking system, to capture viewing behavior while conducting the gameplay tasks. We used the associated Tobii API to help conduct live-stream observation and to scrutinize postrecording analytics. For this pilot study, we examined players' total fixation durations while viewing the topographic map in Task A as well as heat maps showing fixations.

Game logs. In addition to observation, we relied on data derived from game logs. These data included: (a) navigational paths, which depict the movement across the in-game environment, (b) number of instances when accessing navigation aids such as topographic maps and in-game resources, (c) timestamps of completion of both the guided and unguided tasks, and (d) interaction with supplemental in-game objects and NPCs.

Observations. We observed each task, making note of emerging patterns of in-game movement (Boellstorff, Nardi, Pearce, & Taylor, 2012). These observational notes guided additional questions for post-gameplay, semistructured interviews.

Results

Data Analysis

We conducted a multivariate relationship exploration between demographics, in-game logs, and pretest topographic assessment scores. All correlations were calculated based on Spearman correlation formula, which is a nonparametric method based on original data's ranks. Our correlational map highlighted that participant self-reported average weekly gameplay, affect toward science, and spatial orientation as well as distance estimation experience correlated to player interaction with some wayfinding aids and the speed in which participants completed tasks with and without explicit navigational cues.

For the guided Task A, we found a correlation with (a) the amount of time to complete the task and self-reported average gameplay hours (correlation coefficient = -0.6963, p-value = 0.0372) and (b) distance navigated to complete the task and distance estimation experience (correlation coefficient = -0.8141, p-value = 0.007757). These correlations existed for Task B, but they were less pronounced. Additionally, we found that students with higher affect toward science used the topographic map more than their peers (correlation coefficient = 0.7463, p-value = 0.0209). For Task B specific correlations, we found an additional relationship between completion time and spatial orientation (correlation coefficient = -0.780, p-value = 0.0132).

In our investigation of students' prior knowledge level of topology and its relationship with other variables, we did not find a significant relationship with completion time in either the guided tasks or, to our surprise, the unguided task. Instead, the only significant correlation with the topographic assessment was, oddly, with checking the in-game map during Task B (the guided part). We will need more data to verify this unexpected relationship, such as posttest gains, as well as an evaluation of the topographic assessment instrument.

Unguided Navigation Observations

Throughout the virtual observations, players exhibited three different styles of behavior during the unguided navigational task, which we are categorizing under the labels *Tracker*, *Roamer*, and *Mountaineer*.

Trackers. *Trackers* accessed their topographic map an average of 8.8 times during Task A, totaling an average of 5.886 seconds with it open. Observation of in-game movement revealed that these players relied more heavily on the contours of a prominent geographic feature (a climbable mountain). Participants who exhibited this behavior finished Task A in 97.008 seconds. Five participants exhibited this navigation style. These players reported average scores of enjoyment of science as 7.4 and video games as 7.4 on a 10-point scale as well as 13.6 average hours of video gameplay per week. *Trackers*, on average, answered 55% of questions correctly on the topographic knowledge assessment. Concerning real-life navigational experience, players who exhibited *Tracker* behavior reported an average distance estimation score as 4.4, spatial orientation as 2.6, and spatial memory as 3.6 on 5-point scales.

Roamers. *Roamers* accessed their topographic map an average of 11 times during Task A, totaling an average of 5.99 seconds with it open. Observation of in-game behavior revealed that these players used the topographic map to first position themselves and then jettison forward in shorter increments. Participants who exhibited this behavior finished Task A in 117.66 seconds. Three participants exhibited this navigation style. These players reported an average of enjoyment of science as 7.33 and video games as 9 on a 10-point scale. They reported 10.5 average hours of video gameplay per week. *Roamers*, on average, answered 44.6% of questions correctly on the topographic knowledge assessment. Players who exhibited *Roamer* behavior reported average scores of distance estimation as 4.33, spatial orientation as 3.33, and spatial memory as 3.67 on 5-point scales.

Mountaineers. One player exhibited behavior that did not fit into the *Tracker/Roamer* dichotomy. This player accessed the map seven times during Task A, totaling an average of 3.33 seconds with it open. Rather than following the base of the mountain like a *Tracker*, the player decided to climb the mountain range and survey the land to reach the destination. By using this navigational strategy, this player finished Task A in 249 seconds. This player reported enjoyment of science as a 5 and video games as a 7 on 10-point scales as well as an average of six hours of video gameplay per week. This *Mountaineer* scored 0% on the topographic knowledge assessment. This player reported a distance estimation score of 3, spatial orientation as 3, and spatial memory as 4 on 5-point scales.

Figure 2. Examples (left to right) of Tracker, Roamer, and Mountaineer paths.

Analysis of eye-tracking data. Using the eye-tracking analysis software, the researchers assigned an Area of Interest (AOI) to the mountain pass in the topographic map (see Figure 1). Because of technical issues, recordings for two participants (both *Trackers*) were lost, leaving only seven participants to analyze. *Trackers* fixated on the AOI the least with an average of 5.37 seconds; *Roamers* fixated on the AOI an average of 8.49 seconds; the lone *Mountaineer* had the longest total fixation duration with 17.12 seconds. Heat mapping of fixations on the topographic map did not present any notable patterns within nor between the different categories of navigational style.

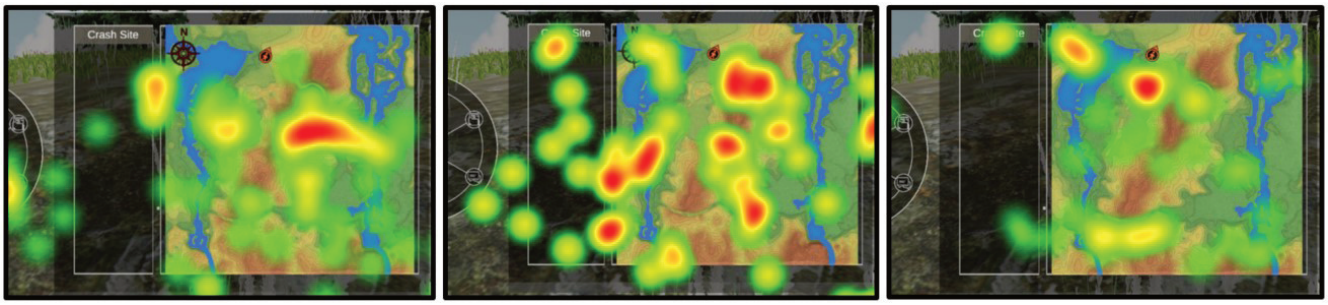

Figure 3. Despite similarities between navigational patterns of some participants, eye-tracking heat maps show a larger amount of variety. Heat maps of Roamers pictured above.

Guided Navigation Observations

Despite the variety of behavior noted in the unguided navigation task, there was little differentiation in player navigational paths in the two guided tasks, which included an explicit wayfinding cue. Although players displayed different patterns of adherence to landscape reliefs near a water feature, navigation patterns noted in Task A did not noticeably transfer to completing the first objective in Task B. Unsurprisingly, there was even less variation in completing the second objective of Task B, which included terrain with another mountain pass; while players could choose to climb these mountains, the landscape was designed to essentially funnel them to their next learning task.

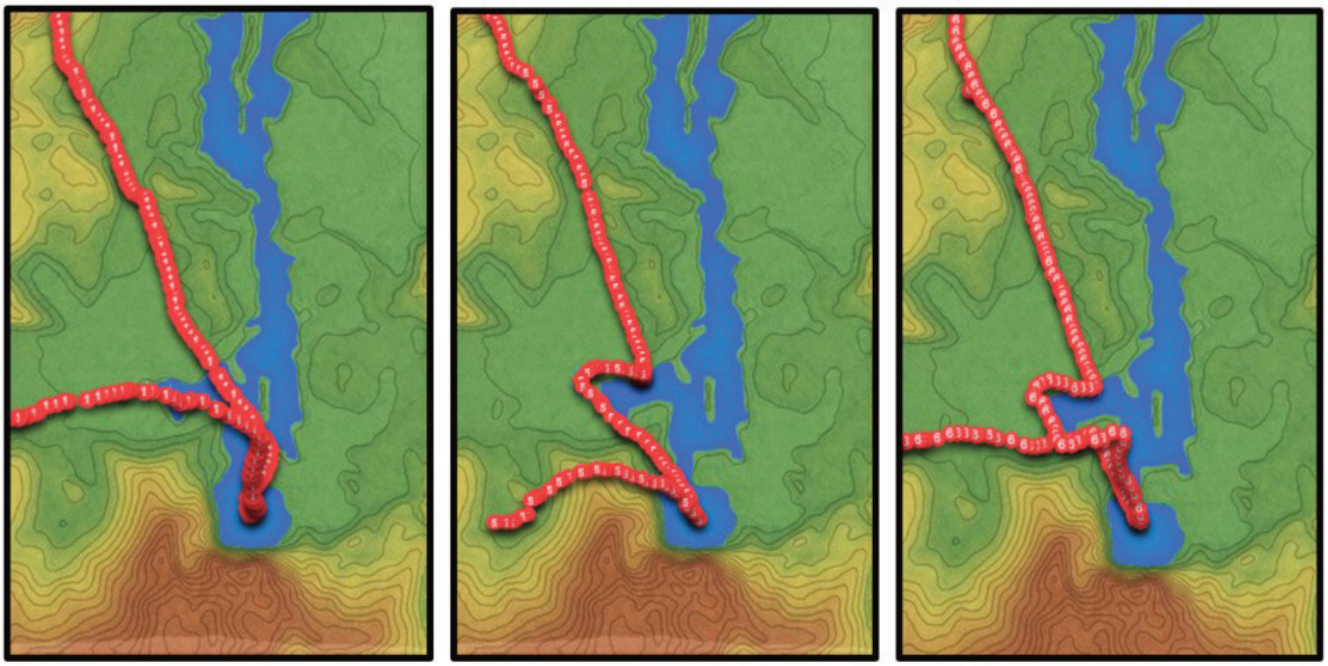

Figure 4. Although there was some variation in approaching the water feature in the map, player navigational paths were relatively similar.

The eye-tracking API we used provides analytics only on static images (such as the topographic map). Because players only nominally used the in-game map after the appearance of an explicit waypoint, we did not conduct eye-tracking analysis for Task B. Instead, we relied on our observations, which showed that players often fixated on the waypoint rather than investigating environmental stimuli.

Supplemental content in the wayfinding task. Rather than exploring the terrain of the IVLE and encountering the supplemental objects and NPC, players appeared to focus almost solely on completing the explicit objective (see Figure 1). This may be due to the design of the environment. For example, although participants had similar navigational paths during Task B, only three participants triggered the cut scene, which hints at the location of the supplemental NPC and content. As such, the sensitivity or placement of the collision event that triggers the cut scene may need adjustment. Nevertheless, despite three participants' viewing this cut scene, only one player actually changed direction to investigate the supplemental content. This may also be due to the researchers ending the play session after completion of the main objective of the unit, rather than allowing participants to revisit the location independently.

Discussion

Overall, we found that participant self-reported average weekly gameplay, affect toward science, and spatial orientation as well distance estimation experience correlated to player interaction with some wayfinding aids and the speed in which participants completed tasks with and without explicit navigational cues. *Trackers*, having the highest scores in these demographics, completed the unguided task the fastest. Their route typically followed prominent contours in the terrain to their destination. *Trackers* also infrequently made use of the in-game menu containing previous dialogue pertaining to the task. Conversely, players who scored lower on the aforementioned demographics (*Roamers* and the *Mountaineer*) used their map more frequently and followed less prominent contours in the environment.

Although there was not a statistically significant correlation between topographic assessment score and task completion time, this preliminary analysis of navigational patterns and topographic skill may be useful for future behavioral clustering or become more significant as we increase our sample size. Additionally, *Trackers* did have the lowest fixation duration on the AOI compared to the other two navigational patterns, which may indicate a better understanding of topographic maps. This would be consistent with findings by Dong et al. (2018) that students more skilled in geography had shorter fixation duration when viewing 2D maps. Further analysis is needed to substantiate this possibility for the current study.

In the tasks that included waypoints, navigational styles exhibited in Task A did not persist. Although the relationship between demographics, average weekly gameplay, and spatial memory remained with regard to completion time, this correlation was less pronounced. Despite embedding supplemental content within this part of the IVLE, only a single participant veered off the direct path to the waypoint to find this supplemental content. Although the inclusion of this wayfinding point may reduce cognitive load (Nelson et al., 2014) and lead to faster completion times, players did not explore their surroundings and access potentially valuable supplemental content.

Conclusion and Implications for Future Research

This pilot study highlighted some of the challenges as well as opportunities for embedding supplemental content into navigational tasks in an IVLE. We found that self-reported average weekly gameplay, affect toward science, and spatial orientation as well as distance estimation experience correlated to player interaction with some wayfinding aids and the speed in which participants completed tasks with and without explicit navigational cues. We were unable to establish, however, whether there were statistically significant relationships between topographic skill and in-game behavior. Nonetheless, based on observation and analysis of visual fixation duration on the topographic aid, player actions certainly did vary in the navigational task without an explicit wayfinding cue. As such, we plan to extend this analysis through our summative evaluation to determine if navigation patterns persist; upcoming units in the game

require even greater navigational aptitude as participants survey watersheds for pollution levels without the aid of waypoints. Additionally, as we increase our sample size, future research will benefit from retrospective think-alouds after task completion. This may yield insightful qualitative data regarding navigational behavior. Future publications regarding these research developments will be beneficial to stakeholders in game-based learning, environmental science education, and navigation systems design.

References

Biggs, M., Fischer, U., & Nitsche, M. (2008). Supporting wayfinding through patterns within procedurally generated virtual environments. In *Proceedings of the 2008 ACM SIGGRAPH Symposium on Video Games*, 1(212), 123–128. https://doi.org/10.1145/1401843.1401866

Boellstorff, T., Nardi, B., Pearce, C., & Taylor, T. L. (2012). E*thnography and virtual worlds: A handbook of method*. Princeton, NJ: Princeton University Press.

Dong, W., Zheng, L., Liu, B., & Meng, L. (2018). Using eye tracking to explore differences in map-based spatial ability between geographers and non-geographers. *ISPRS International Journal of Geo-information*, 7(9). https://doi.org/10.3390/ijgi7090337

Duchowski, A. (2017). *Eye tracking methodology: Theory and practice* (3rd ed.). London, UK: Springer-Verlag. Retrieved from https://bookshelf.vitalsource.com/#/books/9783319578835/

Keller, J. M. (2008). An integrative theory of motivation, volition, and performance. *Technology, Instruction, Cognition, and Learning*, 6, 79–104. Retrieved from http://terrikrause.com/Content/documents/Keller2008IntegrativeTheory.pdf

Moura, D., & Bartram, L. (2014). Investigating players' responses to wayfinding cues in 3D video games. In *CHI EA '14: CHI '14 Extended Abstracts on Human Factors in Computing Systems*, 1513–1518. https://doi.org/10.1145/2559206.2581328

Nelson, B. C., Kim, Y., Foshee, C., & Slack, K. (2014). Visual signaling in virtual world-based assessments: The SAVE Science project. *Information Sciences*, 264, 32–40. https://doi.org/10.1016/j.ins.2013.09.011

National Research Council. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: The National Academies Press.

Romine, W. L., Sadler, T. D., & Wulff, E. P. (2017). Conceptualizing student affect for science and technology at the middle school level: Development and implementation of a Measure of Affect in Science and Technology (MAST). *Journal of Science Education and Technology*, 26(5), 534–545. https://doi.org/10.1007/s10956-017-9697-x

Si, C., Pisan, Y., Tan, C. T., & Shen, S. (2017). An initial understanding of how game users explore virtual environments. *Entertainment Computing*, 19, 13–27. https://doi.org/10.1016/j.entcom.2016.11.003

22. Parent Perspectives on Interfacing With Computing Opportunities in Library Settings

SARI WIDMAN AND RICAROSE ROQUE

Abstract: Libraries have the potential to be important sites for youth and families from nondominant communities to engage in the development of computational literacies needed to fully participate in our digital society. In this study, we focus on the perspectives, interests, and needs of parents and the ways they might take up technology-based opportunities within library settings. Parents can play important roles in their children's technological development as they make decisions and broker resources from their community for their children. We conducted focus groups at 2 library sites to ask parents about their family's relationship with technology, their local library, and other community resources. Their perspectives highlight the ways libraries must pay attention to how their physical interface (e.g., entrance, parking, and spaces), as well as their social and emotional interfaces, can impact families' participation in new and emerging technology-based opportunities.

Introduction and Background

Libraries have long been spaces for families to engage in traditional literacy activities together. As libraries take on a more comprehensive perspective of literacy, researchers, library practitioners, and administrators have had increasing interest in leveraging libraries to engage families in experiences that build computational literacy (Weiss, Caspe, Lopez, & McWilliams, 2016). Computational literacy, which has links to other literacy frameworks, describes the ability to engage in both computational thinking and computational creating (Brennan & Resnick, 2012). Through initiatives such as Ready to Code, community libraries have begun to play a significant role in providing youth, particularly those in nondominant communities, with opportunities to engage in this type of learning (Braun & Visser, 2017; Martin, 2017).

Libraries are also ideal environments to support connected learning, brokering opportunities across school, home, and community, particularly for historically marginalized and nondominant communities (Hoffman, Subramaniam, Kawas, Scaff, & Davis, 2016; Ito & Martin, 2013).With shifts toward multiliteracies, libraries have increasingly becoming spaces for patrons to not only obtain materials but to participate in activities together (Garmer, 2014; Hill, Profitt, & Streams, 2015). They are also free, public institutions that allow for flexible learning arrangements. This includes intergenerational and cross-generational learning, which is important for building connected learning (Larson et al., 2013).

Intergenerational or family learning can also be essential to children's development of technological literacies. Parents were found to be significant supports for technology learning and engagement, particularly when they took on the role of collaborator and colearner, or knowledge broker (Barron, Martin, Takeuchi, & Fithian, 2009). However, parents who hold identities that are underrepresented in STEM fields, or who have little experience with tech, need access to opportunities that help them gain comfort in the roles and practices they can take on to support their children's learning (Livingstone, Mascheroni, Dreier, Chaudron, & Lagae, 2015; Takeuchi & Stevens, 2011).

While libraries are promising sites for engaging nondominant families in computational literacy activities, they may still experience challenges reaching these patron demographics, attracting more parents who engage in what Lareau (2003) calls "concerted cultivation" parenting styles. As low-income families experience challenges to finding and accessing quality education opportunities around technology (DiSalvo, Reid, & Roshan, 2014; Rideout & Katz, 2016), it is essential

for libraries to do all they can to make their resources accessible. Failing to do so contributes to the continued reproduction of existing hierarchies and inequities through digital spaces (Bang, Marin, Faber, & Suzukovich III, 2013).

While connected learning literature has done important work attending to brokering practices and relationship building in library spaces (Hoffman et al., 2016), there has been less attention paid to some of the more concrete barriers to entry that may exist. These barriers to entry have the potential to impact how effectively a particular library can act as a site of connected learning. In order to understand how library users find materials and resources, Danish information studies scholar Bjorneborn names three types of "interfaces" patrons can interact with in the library space: digital, physical, and social (2008). In this study we employ the idea of interactions with the library's physical and social interfaces as something that shapes access.

In this study, we explore challenges to engaging nondominant families, and how libraries can best consider parents' needs for computational learning. As part of an effort to partner with local libraries to engage nondominant families in computational literacy education, we conducted six focus groups with 22 parents across two libraries in very different neighborhood contexts. We highlight parents' perspectives and stated experiences on their interactions with the library and relationship to technology to understand ways that libraries may position themselves to better serve families' technology-related education needs and make the space more welcoming and accessible. We asked: *What challenges and barriers do parents and their children face in participating in technology-based learning opportunities in their libraries? What supports and resources do they want and need regarding their family's engagement with technology and building computational literacies?*

Methods

Context

Focus groups were conducted as part of a collaboration between the Family Creative Learning (FCL) project, which engages families to create and learn together with creative technologies, and two library systems in the Western Mountain region that adapted the program. The project was focused on nondominant families with limited social support and resources around computing.

Morgan, our first partner site, served a diverse patron demographic. While Morgan was a historically African American neighborhood, in recent years there had been significant growth in the immigrant population. The emerging immigrant community was predominantly Spanish speaking, and most of the library staff also spoke Spanish. Morgan offered a number of resources to its patrons, including access to a computer lab, a robust immigrant-services program, and a makerspace. The partnership was originally formed in an attempt to initiate greater engagement with parents and adults in the makerspace through the implementation of FCL workshops.

Our second library partner, Main, was situated in an affluent college town, where immigrant and low-income communities were largely invisible. The library had been renovated in recent years, and the large space included a theater, café, makerspace, art gallery, and a number of private meeting and event rooms that the public could reserve, as well as an edible garden and playground. The library had recently created a new role for community outreach and had named increasing diversity and inclusion as a major goal in a recently released mission statement. Library collaborators expressed a desire to specifically increase library engagement for a small but growing Latinx population in the city.

Data Collection and Procedures

Focus groups, which were called *Parent Tech Chats*, were held before the implementation of FCL workshops at each library to gain a better understanding of parents' library engagement, how they identified resources within their community, and their family's relationship to technology. The focus groups allowed us to get parents' perspectives in conversation with each other as they discussed shared experiences. The aim of these focus groups was to increase our understanding of the local context and gain insight into the needs of parents in the community. Three focus groups were held for each library. A Spanish-speaking research team member assisted with translation for parents who primarily spoke Spanish. All participants were compensated with a gift card. Findings were used to inform recruitment efforts and the adaptation of FCL to the local context.

Our focus group protocol included an icebreaker and group-norming activity, and in some cases a walking tour of the library or trip to the makerspace. The conversations were guided by questions regarding families' library use, accessing resources in the broader community, and technology use, attitudes, and challenges. Two out of the three focus groups held at Morgan included a visit to the makerspace to introduce participants to resources there and to hear their perspectives on the space. Because of the many resources distributed throughout Main's large building, focus groups held there included a walking tour of the library to identify which parts of the space participants used and were aware of. Main focus groups also included a resource-mapping exercise to get a sense of the community assets participants valued in their lives. While we asked questions about community resources in the first set of focus groups at Morgan, we changed our strategy to include mapping at our iteration at Main, as we thought discussions about community resources could be better supported through concrete activity. The two sets of focus groups were facilitated by different members of the research team. It is important to note that these differences, as well as the variety in the protocol noted above, may have had some impact on parents' responses.

Morgan focus groups were all held in the library and had a total of 11 participants. Recruitment for the focus groups was done by library staff. We did not seek to recruit any particular demographic of library users beyond parents and guardians who lived in the Morgan community. All were Latina mothers, some immigrants and some born in the United States. Most had lived in Morgan for at least four years. No fathers or other types of guardians, such as adoptive parents, or grandparents participated.

The Main focus groups had 11 participants in total, with two focus groups hosted at Main and one hosted at a community center for low-income housing. Recruitment was done by library staff and the focus group information was posted on their its calendar and shared with various community partners who worked with nondominant families. The community center had a high concentration of Latinx families and provided a more convenient location to engage parents from that community. Participants were all mothers, with the exception of one father, and were Chinese, Turkish, and Latinx.

Analysis

Codes were developed inductively by the authors through an iterative process. An initial round of open coding was completed to identify themes. Through a second round, codes were developed for place-based phenomena in the library, attitudes toward technology, technology use, library engagement, values, and community assets. These codes were applied to all six focus group transcripts. The authors double coded two of the six transcripts and discussed discrepancies in coding until they reached agreement. The remaining four transcripts were then single coded.

Findings

Family Engagement With Technology

Anxieties and concerns. Across focus groups parents expressed a range of questions and concerns regarding their children's technology use. Overall the parents' primary concerns were around knowing how much screen time was appropriate, navigating strategies for setting limitations, and their ability to monitor their kids' technology use and protect them from seeing inappropriate content online.

Parents with young children wondered when it was appropriate to allow them access to technology such as smartphones and tablets. Across all age groups parents discussed how difficult it was to get their kids to disengage with screens. They described how attempts to take things such as tablets away would end in tears and arguments. While some parents said they were able to put limits on screen time, they found it challenging. The computer or tablet's being what their kids used to study or do homework in many cases made it especially difficult.

Some parents wanted to know about putting child locks on devices and Internet browsers or setting up password protection. In the beginning of one of the focus groups, a mother, Amanda, asked, "How could you secure the children from the computer?" Another mother, Addy, shared how she snuck into her daughter's room while she was using the computer sometimes, so that she could monitor her computer use. Several parents, particularly in the Morgan focus groups, expressed concerns about inappropriate pop-up ads or content their kids might be exposed to, as well as strange adults messaging them on social media. One mother, Aria, shared, "It's something that worries me because I have children of all ages. So, knowing what it is they're watching, what they're into, and I can't keep track … because phones are too advanced for me. I'm very behind." In response, another mother, Arlene, shared, "It doesn't happen to just you. Believe me. All parents are worried."

In one focus group at Morgan, mothers had concerns about their children being socially disconnected or lacking socialization because of increased technology use. On the other hand, across all the focus groups, parents found phones and tablets to be valuable for communication, especially with distant family and with their children's schools and teachers. One mother, whose son was autistic, said that technology was another way for him to communicate, as he had trouble doing so in traditional ways.

Attitudes about learning with technology and desired resources. Many parents expressed pride in how tech savvy their kids were and saw value in technologies as learning tools. Those who had little exposure to technology when they were in school were happy that their children had the opportunity to gain those literacies and access tech in their schools. One mother, Amanda, said, "I like that they're learning something that didn't exist before, because everything has progressed so much. I'm happy my kids know more than me, because, well, what one wants is that your children are better than you, that they can do whatever they do best."

Many of the mothers at Morgan also expressed interest in learning more digital literacy skills and wanted classes that would help them keep up with new technologies. While some were fairly tech savvy, others expressed that their limited knowledge was an obstacle to things such as applying for jobs or filling out government paperwork. They expressed an interest in library classes on basic technology skills, as well as classes that would help them navigate their kids' technology use.

Some parents relied on their children for tech help but found that their kids did not always have the patience to teach them. One of the mothers, whose husband was in IT, described a fairly reciprocal relationship, in which she would teach her kids sometimes, and sometimes they would teach her. Others were concerned that not keeping up with technology would limit their ability to monitor how their kids were using it. Parents also wanted to be able to participate in their

children's learning. Amanda said, "I just wanted to know … how can I play or be more active with them in the computer so that they can learn?" Another mother, Ula, wanted to learn more technology because she wanted to be able to better help them with their schoolwork.

Family Engagement With Libraries

Parents' frequency of visits to the library ranged from weekly to almost never. Across focus groups, most parents described books and literacy activities as being their primary reason for going to the library, both for their kids and for themselves. Many parents brought their children for storytime, but some with older children had stopped coming to the library once their kids had aged out of this activity. Several of the parents who were immigrants attended language classes at the libraries, or had in the past.

Many parents discussed the importance of the library as a physical space to be visited and interacted with. Mothers in one of the Morgan focus groups talked about the library's importance as a place for face-to-face interactions. One Morgan mother, Erica, said she told her daughter, "'OK, we can read a book in the tablet or the phone, but we're not going to stop going to the library.' … If I see something in Facebook or something interesting in the Internet, a movie, a book, I come here and order it. … Technology helps us in a certain way, but they also drift us away from coming here and being with and meeting other people." On the other hand, two mothers in the Main focus groups discussed how technology was helpful because their kids were able to research things online without having to make a trip to the library.

Obstacles to Participation

Knowledge of resources. Unsurprisingly, the association of the library with books was strong, but participating parents were much less aware of the other resources the libraries offered. Parents who stopped going to the library after their children grew out of storytime were largely unaware of programs offered for a range of ages. While discussing ways to increase community awareness of library technology resources at Morgan, Amanda said that many people in her community did not go to the library because "they probably think it's just books." At Morgan, almost none of the mothers knew about the makerspace. One commented that she came to the library all the time but had not known it was there. All the mothers responded positively to touring the makerspace and said they would use the tools there, especially the sewing machine and crafting tools. As Amanda said, "I did not know. Now I have to bring my kids every day. I'll be living here."

At Main, one of the parents had previously used the makerspace, but most were unaware of it. This was unsurprising, since it was completely out of sight in another wing of the building. During the Main focus group library tours, parents had many questions about how the spaces within the library could be used. Questions included whether WiFi was available, if you could read a book in the café, and use various open areas to work or study. Similarly, when a program booklet was passed around at the focus group held at the community center, the parents said they had no idea about all the activities happening at the library. One commented that she thought the program should be mailed out to everyone in the city. In several focus groups across both libraries, parents said that paper materials were better for informing their community about library events and resources than making the information available online.

Child care. Across focus groups parents most frequently brought up a need for child care when discussing obstacles to library engagement. Parents described being unable to use resources such as the computer lab, or participate in programs for adults, because of their children. Even when children were allowed in these settings, parents felt distracted

or embarrassed by the need to keep an eye on their kids. For parents with children of varied ages, especially those with young children, a lack of child care also impacted their ability to attend family programming geared toward a single age group. Parents requested activities designed for all-age participation so that they could attend as a whole family.

Transportation and parking. Parents at both libraries also noted challenges related to parking. At Morgan some parents complained of how limited parking in front of the library often forced them to park across the street. The already small parking lot was shared with the community center next door, and people commonly hung out in their cars to use the library's WiFi. This was an issue for those with young children because they would need to cross a potentially dangerous high-traffic street. As one mother said, "My biggest problem with this library is parking. And that deters me. … I have my little ones. So, having to cross the street is going to be a problem." She also said that although she preferred to come to her local library, she sometimes went to the branch in the next town over because of the parking situation.

At Main, parents were concerned about paying for parking and understanding the parking system. One mother, Danica, said, "We honestly used this space more before they started charging. They used to have three hours of free parking outside and now it's only an hour and a half. And that's changed how we've used the library." Some parents were unsure about where to park, or were concerned about getting tickets. These questions were especially prevalent for parents who spoke to us at the community center and who overall had the weakest ties to the library.

Comfort and belonging. At the Morgan focus groups, some of the mothers discussed deterrents to their coming to the library more often. They discussed the area outside the library, the parking lot, and the entrance, as problem areas, as well as the computer lab. Issues in the computer lab included adult men looking at inappropriate content or smelling like pot, and kids playing violent video games. They suggested that this activity should be better monitored, and that maybe there should be separate computer labs for kids and adults. They also questioned whether there was security at the library, as well as security to monitor activity happening outside.

At Main, on the other hand, a number of parents, particularly those with young children, were concerned about not meeting the library's behavioral norms. They did not bring their children as often as they would like because of worries they would be yelled at if the kids were running or making too much noise. One mother, Martina, said that the librarians would get angry because her kids were running around, and said it was "horrible." Another parent, Ula, talked about how the space for kids at Main was very small, and that "it's not for children because you have to be very quiet. That's one reason I never take my children. … Because my children are super restless, doesn't matter what age they are and the library tenses them up instead of helping."

Some parents said they brought their kids to other library branches with more active play space, even if they were farther away. One of these parents, Daniela, said she often brought her kids to a library in another neighborhood because there were lots of activities: "They have like, little tables for younger kids and have puzzles, and they have sheets and colors and crayons, and have a lot of stuff to do. … They have sofas, and a place where they just relax in the room." Parents in another Main focus group also commented on how they wished there were larger activity tables for kids to spread out and engage in creative activities. Another mother, Mariana, talked about how she thought it was important that play space and reading space be integrated for kids, "because that's how I've seen my kid has learned to love reading, because he knows he can get to the library, he knows we're going for books, but first he plays with Legos or jigsaw puzzles and then goes off and does something."

Some parents also commented on how they used to be more comfortable in the library before the renovation. For example, Daniela said, "I don't know why, but I feel intimidated in this Main library when they renewed it. … It was kind of old, but it was cozy before that, and now you feel like it's so pretty and you just don't want to touch anything." Another mother, Beatriz, felt intimidated by the size of the library: "This library is huge. It's a little bit intimidating." But not everyone felt this way. When discussing the renovation, Hilda, one of the mothers, said, "But now, what I love actually about this library, very colorful. When I see that … my spirit is shining. A lot of colors, bright, hot, warm. I can sleep here."

Practical Implications and Conclusion

While this study represents the local experiences of a small sample of parents, we believe that it may point toward relevant areas of further study and investigation, both for researchers and library staff and administrators. First, we argue that libraries should consider taking a holistic approach to technology resources and address the range of technology-related learning opportunities families could benefit from. Findings from our focus groups suggest that parents would benefit from workshops and resources that address their interest in developing effective parenting strategies around technology engagement, allow them to engage in creative collaborative learning with their kids, and address their own computational literacy needs and interests. There is also opportunity to leverage the traditional literacy activities families already engage in at the library, such as storytime, to bridge interest in computational literacy.

Parents who participated in our focus groups were often surprised and excited to learn about the technology resources their library had to offer. These reactions show that lack of participation may often stem from lack of awareness that a resource exists, rather than lack of interest. While developing recruitment strategies that make nondominant families aware of what the library has to offer may be a complex endeavor, one step libraries can take to ensure patrons know about technology resources is to make them physically more visible within the library space. The many questions posed by parents about how to use different parts of the library also make it clear that the norms of the space are not self-evident. Patrons may need to be guided through them in some ways to feel comfortable making full use of the library and its resources.

Based on our findings, we argue for the importance of acknowledging and investigating concrete barriers to participation that nondominant families may encounter when interacting with a library's interfaces. Libraries that want to increase their diversity and inclusion may take symbolic action by doing things such as incorporating language on diversity and inclusion into mission statements while neglecting to take concrete actions that may help increase accessibility. A lack of recognition that inequitable access may take the form of social and physical barriers may cause parents' stated needs, such as child care, to be brushed aside as outside of the library's core mission and duties.

In addition to more concrete obstacles such as lack of child care, or transportation challenges, it is also important that libraries consider the messaging about behavioral norms that the space is signaling. According to statements by parents in the focus groups, libraries may feel unsafe if behavioral norms are too loosely enforced or the space is lacking boundaries, or unwelcoming if norms and boundaries feel too rigid. There may be no perfect balance, but keeping some of these factors in mind may help libraries reflect on where they fall on the spectrum and how they might adjust to help families feel comfortable and welcome. It is also important to consider how this balance may affect the participation of different patron demographics, as effectively serving the needs of various groups will always be a challenge.

While we consider this study to be preliminary, we believe it may provide some insight into where public libraries should focus their attention if they want to attend to nondominant families' technology-learning needs. We also hope that this can serve as one model for how libraries can learn about their patrons—by engaging them in focus groups and other types of structured conversation.

References

Bang, M., Marin, A., Faber, L., & Suzukovich III, E. S. (2013). Repatriating indigenous technologies in an urban Indian community. *Urban Education*, 48(5), 705–733.

Barron, B., Martin, C. K., Takeuchi, L., & Fithian, R. (2009). Parents as learning partners in the development of technological fluency. *International Journal of Learning and Media*, 1(2), 55–77.

Braun, L., & Visser, M. (2017). Ready to code: Connecting youth to CS opportunity through libraries. *Libraries Ready to Code*. Retrieved from www.ala.org/advocacy/sites/ala.org.advocacy/files/content/pp/Ready_To_Code_Report_FINAL.pdf

Brennan, K., & Resnick, M. (2012, April). New frameworks for studying and assessing the development of computational thinking. In *Proceedings of the 2012 Annual Meeting of the American Educational Research Association, Vancouver, Canada* (Vol. 1, p. 25).

Bjorneborn, L. (2008). Serendipity dimensions and users' information behavior in the physical library interface. *Information Research*, 13(4). Retrieved from http://informationr.net/ir/13-4/paper370.html

DiSalvo, B., Reid, C., & Roshan, P. K. (2014). They can't find us: The search for informal CS education. In *Proceedings of the 45th ACM Technical Symposium on Computer Science Education* (pp. 487–492). New York, NY: ACM.

Garmer, A. K. (2014). *Rising to the challenge: Re-envisioning public libraries.* Washington, DC: The Aspen Institute. Retrieved from https://assets.aspeninstitute.org/content/uploads/files/content/docs/pubs/AspenLibrariesReport.pdf

Hill, C., Proffitt, M., & Streams, S. (Eds.). (2015) IMLS focus: Learning in libraries. Kansas City, MO: Institute of Museum and Library Services. Retrieved from http://www.imls.gov/assets/1/AssetManager/IMLS_Focus_Learning_in_Libraries_Final_Report.pdf

Hoffman, K. M., Subramaniam, M., Kawas, S., Scaff, L., & Davis, K. (2016). Connected libraries: Surveying the current landscape and charting a path to the future. College Park, MD, and Seattle, WA: The ConnectedLib Project. Retrieved from http://connectedlib.test.ischool.uw.edu/connected-learningin-libraries

Ito, M., & Martin, C. (2013). Connected learning and the future of libraries. *Young Adult Library Services*, 12(1), 29–32.

Lareau, A. (2003). *Unequal childhoods: Class, race, and family life*. Berkeley: University of California Press.

Larson, K., Ito, M., Brown, E., Hawkins, M., Pinkard, N., & Sebring, P. (2013). *Safe space and shared interests: YOUmedia Chicago as a laboratory for connected learning.* Irvine, CA: Digital Media and Learning Research Hub. Retrieved from https://dmlhub.net/publications/safe-space-and-shared-interests-youmedia-chicago-laboratory-connected-learning/index.html

Livingstone, S., Mascheroni, G., Dreier, M., Chaudron, S., & Lagae, K. (2015). *How parents of young children manage digital devices at home: The role of income, education and parental style*. London: EU Kids Online, LSE.

Martin, C. (2017). Libraries as facilitators of coding for all. *Knowledge Quest*, 45(3), 46–53.

Rideout, V., & Katz, V. (2016). *Opportunity for all? Technology and learning in lower-income families*. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop. Retrieved from http://digitalequityforlearning.org/wp-content/uploads/2015/12/jgcc_opportunityforall.pdf

Takeuchi, L., & Stevens, R. (2011). *The new coviewing: Designing for learning through joint media engagement.* New York, NY: The Joan Ganz Cooney Center at Sesame Workshop. Retrieved from http://joanganzcooneycenter.org/Reports-32.html

Weiss, H., Caspe, M., Lopez, E., & McWilliams, L. (2016). *Ideabook: Libraries for families*. Cambridge, MA: Harvard Family Research Project Retrieved from https://globalfrp.org/content/download/73/436/file/IdeaBook.pdf

Acknowledgments

This project was made possible in part by the Institute of Museum and Library Services (LG-96-17-0176-17).

23. (Re)making Whiteness

A Critical Discourse Analysis of Equity-Based Maker Literature

PETER J. WOODS

Abstract: Recently, critical scholars have challenged the White, masculine foundations of the maker movement. That challenge has inspired others to create avenues for marginalized individuals to join these spaces. However, immediately jumping from critique to action often produces unintended consequences (Yancy, 2016). With this in mind, I pose the following research questions: How does diversity and equity–focused maker education literature position marginalized students in relation to making and makerspaces? And how does this positioning challenge or reinscribe Whiteness? To approach these questions, I conducted a critical discourse analysis on 14 different articles about equity in making. Findings show that these studies position marginalized subjects outside of the boundaries formed by maker culture and then invite subjects to either join in or redefine the boundaries of making. While beneficial, this process enacts what Ladson-Billings (2017) defines as the social funding of race and, in part, reinscribes Whiteness within making culture.

Introduction

Within the recent and growing body of maker literature, critical scholars have started to question the theoretical foundations at the heart of the maker movement. Britton (2015) exemplifies this push by claiming that the movement "reinforces an engrained culture of white masculinity in the design and deployment of technology while rhetorically claiming universality. Only certain types of Making are truly considered as part of the culture" (para. 1)This process of gatekeeping, in which only certain forms of making count within the movement, often excludes marginalized cultures and includes them only if those forms of making embrace predetermined White masculine practices (Britton, 2015; Vossoughi, Hooper, & Escudé, 2016). Delving even further into these issues, Ames (2018) challenges the constructionist base of maker education initiatives by questioning the atomized and individualistic approach to learning that sits at odds with other social movements. Without answering this challenge, maker initiatives (even those rooted in equity or diversity) remain doomed to replicate the White masculine culture they hope to challenge.

To that end, it becomes imperative for researchers and scholars to, as Yancy (2016) describes, "sit with the problem of whiteness" (p. xii). Rather than jumping to fix the problem, Yancy (2016) suggests that understanding the problem of Whiteness (and, in turn, masculinity) at the heart of any cultural context needs to occur first. To begin this process, this paper will address the following research questions: How does diversity and equity–focused maker education literature position marginalized students in relation to making and makerspaces? And how does this positioning challenge or reinscribe Whiteness? I pose these questions to specifically consider "white everyday practices and the ways in which those white practices re-center white power or challenge white power" (Yancy, 2016, p. xii) in spite of the best intentions of maker researchers. I argue that current attempts to diversify maker populations have proven successful in encouraging marginalized groups to engage in maker activities and spaces. However, these programs have accomplished this by recentering Whiteness and primarily considering maker practices that emerge from White masculine notions of making. This contributes to what Ladson-Billings (2017) describes as the social funding of race, further rooting Whiteness as the dominant (and most valuable) viewpoint within maker culture.

Theoretical Context

Before exploring how Whiteness operates within the maker movement, an overview of critical Whiteness literature proves helpful. As Owen (2007) notes, most literature defines Whiteness as one of three interrelated forms: a social identity, one foisted onto individuals with real-world consequences; an asset or property that acts as a limitless resource through which people gain privilege; or a cultural representation in the form of a visual and embodied understanding of the world, one crafted through imagery and media. Since scholars often frame making as a way of engaging with the world, this last form holds significance when exploring how Whiteness operates within this movement. Jacobson (1999) also notes that "the awesome power of race as an ideology resides precisely in its ability to pass as a feature of the natural landscape" (p. 10) with Whiteness in particular often remaining invisible to White people (yet highly visible to people of color). Yet despite these common factors, Twine and Gallagher (2008) also contend that Whiteness does not act as a universal force. Instead, Whiteness emerges contextually and maintains its power by discursively maintaining privilege for those with access to this dominant social identity. To this end, it becomes vital to individually and thoroughly investigate all cultural spaces (including the maker movement) to understand how Whiteness reinscribes itself (and the power it holds) as a social identity, cultural representation, and form of property in often invisible ways.

Critical scholars in the maker movement have engaged this work by questioning who has access to the benefits of making. This question remains vital to the evolution of the maker movement because, as Halverson and Sheridan (2014) note, "If we believe that making activities and maker identities are crucial for empowerment, then it is, in part, our job to set up situations whereby all learners have the opportunity to engage" (p. 500) in making. In describing the obstacles that hinder this democratization of making, Blikstein and Worsley (2016) contend that the maker movement within educational circles has managed to collapse into a singular and uncontested narrative that takes "the efficacy of 'making' for granted" without challenging how these historical origins influence those engaging in makerspaces and activities" (p. 68). This influence subsequently strips making of its ability to promote reflective intellectual practices while simultaneously delegitimizing ingenuity within marginalized communities. As Vossoughi et al. (2016) note, the discourse surrounding making recognizes only those practices that fit within the dominant economic structure and the cultural understanding of technology that follows. This approach therefore denigrates creative acts more commonly associated with poor communities of color and feminine work. A neutral approach to the movement that fails to reimagine what counts as making reinforces this status quo. Britton (2015) builds on this by asserting that the highly feminized craft movement often overlaps with maker communities but rarely enters the discourse. "This positions Making firmly in the realm of white masculinity, sustaining assumptions that masculine use of technology is normative and women need an invitation and an incentive or special 'female' reason to engage in this masculine space" (Britton, 2015, para. 3). Vossoughi et al. (2016) make a similar argument about race, claiming that the discourse surrounding the maker movement has largely considered White forms of making to the detriment of making practices that emerge from communities of color.

However, this line of critique raises the question of how to address these issues without recentering Whiteness in the conversation. The corrective measures to include marginalized groups described by the authors above often have the unintended consequence of reaffirming a White male status quo. Ladson-Billings (2017) defines this process of reinscribing race as a dominant category in society through both official and unofficial channels as the social funding of race. Rather than taking hasty steps to correct the issue (and subsequently socially funding both race and gender), Yancy (2016) calls for those addressing racism to instead sit with the problem of Whiteness, develop an understanding of how Whiteness operates, and uncover one's own relation to this problem. With this in mind, I will now turn to the discourse surrounding the maker movement to better understand how Whiteness operates within this social space.

Methods

As a first step toward sitting with the problem of Whiteness, I will use the rest of this paper to answer the following research questions: How does diversity and equity–focused maker education literature position marginalized students in relation to making and makerspaces? And how does this positioning challenge or reinscribe Whiteness? I have chosen this problem for reasons similar to those presented by Goldstein Hode and Meisenbach (2017), specifically that scholars often focus critical race analysis on overtly negative examples rather than investigating those prodiversity or equity texts that may unintentionally reinscribe problematic racial power dynamics. To address this question, I performed a text analysis on 14 different pieces of equity and diversity–focused maker education literature from the past five years (see Table 1). The goal of this research is to "see how broader formations of discourse and power are manifest in the everyday, quotidian aspects of texts in use" (Luke, 1995, p. 11) and to identify the dominant forces within these educational practices. While extant publications have nominated a number of other dominant forces within maker practices (masculinity and technocentric forms of upper middle-class culture in particular), I specifically will consider the ways in which Whiteness influences this body of literature.

Title	Authors and Date	Community Addressed
3D Printing with Marginalized Children – An Exploration in a Palestinian Refugee Camp	Stickel, Hornung, Aal, Rohde, & Wulf, 2015	Low income students Refugees
A Longitudinal Study of Equity-Oriented STEM-Rich Making Among Youth From Historically Marginalized Communities	Calabrese Barton & Tan, 2018	Students of color Low income students
Community Ethnography as Pedagogy in Equity-Oriented STEM-Rich Making	Calabrese Barton & Tan, 2017	Students of Color Low income students
Deconstructing Sociotechnical Identity in Maker Cultures	Marshall & Rode, 2018	Women
Educators, Gender Equity and Making: Opportunities and Obstacles	Justice & Markus, 2015	Women
Electronic Textiles as Disruptive Designs: Supporting and Challenging Maker Activities in Schools	Kafai, Fields, & Searle, 2014	Women
Equity-Oriented Pedagogical Strategies and Student Learning in After School Making	Ryoo, Kali, & Bevan, 2016	Students of color Low income students
Hands On, Hands Off: Gendered Access in Crafting and Electronics Practices	Buchholz, Shively, Peppler, & Wohlwend, 2014	Women
Iterative Design Toward Equity: Youth Repertoires of Practice in a High School Maker Space	Martin, Dixon, & Betser, 2018	Students of color Women
Leveraging Cultural Values and "Ways of Knowing" to Increase Diversity in Maker Activities	Holbert, 2016	Women
Putting Making into High School Computer Science Classrooms: Promoting Equity in Teaching and Learning with Electronic Textiles in Exploring Computer Science	Fields, Kafai, Nakajima, Goode, & Margolis, 2018	Students of color Low income students
The Makerspace Movement: Sites of Possibilities for Equitable Opportunities to Engage Underrepresented Youth in STEM	Calabrese Barton, Tan, & Greenberg, 2016	Students of color Low income students
Tinkering with “Failure”: Equity, Learning, and the Iterative Design Process	Ryoo, Bulalacao, Kekelis, McLeod, & Henriquez, 2015	Women
Towards Critical Justice: Exploring Intersectionality in Community-based STEM-rich Making with Youth from Non-dominant Communities	Tan & Calabrese Barton, 2018	Students of color Low income students

Table 1. Texts analyzed in this study and the populations they engaged.

To conduct this analysis, I used the critical discourse methodology described by Jager (2001). First, I developed a structural analysis of proequity maker literature. This mainly entails describing and broadly characterizing the material selected along with locating the ways in which a given theme (in this case, Whiteness) either enters into or is absent from this material base. Second, a fine-grained analysis happens within a more narrow and prototypical selection of materials. Since the selection of articles remains somewhat limited, I conducted this analysis on all articles with a particular focus paid to the Methods and Findings sections. This process involves not only considering the larger themes of the article but using rhetorical devices to consider larger questions of discourse. In doing so, I used both descriptive and thematic coding methods (Saldaña, 2015) to analyze the ways that authors described students and their interactions with making practices. In doing so, I developed a number of themes that allowed me to propose what Glaser and Strauss (1967) define as a substantive theory of Whiteness within equity-focused maker literature. Finally, I concluded this work by connecting the fine-grained analysis to larger notions of discursive power.

Findings

At a structural level, the articles surveyed in this study were, unsurprisingly, very similar. Since all of them came from journals or conference presentations that emphasized empirical research, they largely followed a standard format: theoretical context or literature review, presentation of methods, findings, discussion, and conclusion. Sometimes the authors combined these sections or gave them different names, but the prototypical content from these sections still existed in some form. The content discussed within each of these sections also proved markedly similar. All of the Theoretical Context or Literature Review sections focused on two key areas: the efficacy of making as an educational model and the need to diversify STEM careers, computing fields, or makerspaces. The Methods sections provided a wide range of analytical methods, but the sites of research all focused on makerspaces or classrooms adopting maker practices that included marginalized students. For most of the articles, the research focused on students of color or female students. Stickle, Hornung, Aal, Rohde, and Wulf (2015) provide one exception by researching a makerspace within a Syrian refugee camp. Additionally, Justice and Marcus (2015) focused on gender disparities but considered teachers learning about making practices within professional-development sessions. The Findings sections mostly provided vignettes that displayed the ways in which individual students developed intellectually and socially through making and the Discussion sections connected those findings back to the extant literature. The authors of these studies often discussed how these findings challenged the status quo of making as a White masculine practice by considering new identities or forms of making. However, they rarely (if at all) discussed how Whiteness or masculinity continued to shape the culture or making practices of the study despite their inherent challenges. Buchholz, Shively, Peppler, and Wohlwend (2014) provide a clear exception by considering how gendered making practices and materials continually shaped student engagement with e-textiles projects.

Through a subsequent fine-grained analysis, I produced two pairs of interrelated themes through the coding process. The first relates to the ways that the surveyed literature positioned subjects in relation to maker culture and the act of making. One approach to this process involved positioning students from marginalized communities as outsiders who needed an invitation to participate in making practices. The need for this invitation stems from the assumption that making and makerspaces largely reinforce and reproduce the practices of Whiteness and masculinity that have traditionally dominated this movement. Holbert (2016) exemplified this approach when discussing his efforts to address gender, race, and class disparity in making: "To connect engineering activities and practices to makers underrepresented in STEM fields, we must reframe how and why we make to acknowledge and elevate the values and goals of [their] communities" (p. 16). It is important that Holbert tasks makers and STEM professionals with bringing in new identities, not the students who do the underrepresented forms of making. Justice and Marcus (2015) make this approach even more clear when they say, "We believe that makerspaces and FabLabs need to invite more diverse participation from people of different gender, racial and socio-economic backgrounds" (p. 3). Again, makerspaces and FabLabs do the inviting and the members of underrepresented groups react to that invitation.

In another approach to positioning students, some of the authors of these texts framed students as co-constructors in the act of defining making. Calabrese Barton and Tan (2018), whose study of two makerspaces in Michigan and North Carolina appeared in multiple texts in this study, encapsulated this theme when they stated that students "broadened the boundaries of a 'local maker community' to include salient others who might not be tapped as germane resources in a typical STEM-focused maker program" (p. 794). Rather than makers and STEM educators inviting students into a predetermined maker context, Calabrese Barton and Tan (2018) center the actions of students and credit them with defining making as a practice that incorporated members and actions already existing within this community. Martin, Dixon, and Betser (2018) also consider this theme within a moment of critiquing their research design: "The ways in which Deonne wanted to be a maker, and the rich repertoire of maker practices she brought into the class, were tolerated but not sufficiently embraced or supported" (p. 41). Again, the authors root their work in the actions and identities of the student, despite their inability to adequately respond in that moment.

Finally, the second pair of themes, which position students in relation to knowledge, represent a similar split to the one above. In some instances, the authors position students as needing access to knowledge provided by maker educators or maker experiences. This often referred to the kinds of knowledge related to STEM fields. When discussing their research into e-textiles, Kafai, Fields, and Searle (2014) noted that the foregrounding of aesthetics was "particularly critical as schools have struggled to connect STEM learning activities to students' personal interests and everyday lives" (p. 547). This phrasing positions students as unconnected from STEM practices and the process of making those connections rests in the hands of schools. On the other hand, authors also positioned students as having access to valuable knowledge a priori. Calabrese Barton and Tan (2017) exemplify this theme when discussing the work of students: "The problems the youth hoped to solve through engineering design in their makerspaces reflected both personal and community concerns or needs that were deeply linked to their community's unique history and context" (p. 2). Here, students exist as the source of knowledge about their community, which makerspaces subsequently serve, and about the issues they faced (as opposed to students only acting as recipients of knowledge found within maker practices). However, the distinction between these two themes was not always clearly defined. When Fields, Kafai, Nakajima, Goode, and Margolis (2018) state that "foregrounding student knowledge in front of the classroom framed students as sources of knowledge and validated the new expertise they were developing in the areas of circuitry and coding" (p. 28), they reference both themes simultaneously: They position the students as sources of some knowledge but consider STEM knowledge as coming from maker experiences developed by the researchers. This blurred distinction points to the dynamic nature of this writing in which authors often shifted the position of the subject throughout the article depending on their current focus.

Discussion

While these studies may address issues of diversity and equity within makerspaces at the local level, the findings from this analysis also imply that these practices contribute to the social funding of race. Especially when considering those moments when the authors position the subject as separated from the knowledge associated with making and, subsequently, in need of an invitation to participate within these spaces, this body of literature reinscribes race as a dominant category in contemporary society. As Ladson-Billings (2017) notes, "Even when structural barriers are removed, the social funding of race maintains the belief systems and actions of members of the society" (p. 101). The fact that students of color need a particular invitation into making contexts reaffirms the power and importance of this social construct. This affirms Britton's (2015) assertion that the status quo within makerspaces rests on the assumption of White masculinity and the need to invite othered populations into the space reaffirms that assumption. Moreover, the act of closing gaps by bringing others into Whiteness (a practice at the root of this invitation) furthers the social funding of race (Ladson-Billings, 2017). It also mirrors the unintentionally anti-Black activism described by Bassichis and Spade (2014), as the act of aligning certain practices from nondominant communities with the dominant culture benefits certain bodies while denigrating others.

Even in those moments when the authors position the subjects of their study as co-constructors, both in terms of knowledge and the act of making, similar issues emerge. If the assumption that making, as it stands, exists as a White masculine space, then redefining the boundaries of making still brings the actions and knowledge of these students into Whiteness. This boundary work then acts as a double gesture: By defining certain actions as *making*, the authors simultaneously define other actions or cultural practices as *not making*. Calabrese Barton and Tan (2017) reaffirm this notion when they state that they "see co-making [as] shifting the culture of making toward legitimizing multiple forms of expertise and spaces of making" (pp. 792–793). In other words, this assumes that making exists as a needed, legitimizing body and defining certain actions as making gives them legitimacy within contemporary (White supremacist, patriarchal) society. This assumption leaves certain actions, forms of expertise, and spaces behind. Stickel et al. (2015) reaffirm this critique in the following example of a girl learning how to 3D print:

> She really liked butterflies but was only able to draw them previously, what she frequently did. Through digital fabrication, she is now also able to make her own physical butterfly models that she wants to incorporate in her playing. Furthermore, her butterfly now has depth and a shape, e.g. a curved body.

While the authors go on to discuss how much the student enjoyed this new skill, it still devalues her previous creative efforts. Although subtle, it reaffirms the privileged status held by making as a cultural practice: "She was *only* able to draw them previously," the existence of a 3D model trumping her ability to represent a physical shape in two dimensions, and so forth. Drawing butterflies (a cultural practice that existed before the emergence of a makerspace within this marginalized community) gets left out when defining the boundaries of what constitutes making and further legitimizes the technocentric act of creating with a 3D printer. This mirrors the exclusion of the craft movement from maker discourse described by Britton (2015): Despite the fact that this student had frequently created new tangible artifacts by hand through the act of drawing, the newly defined technocentric boundary of making leaves drawing out and advocates only for her 3D printing efforts.

Conclusion

As Ladson-Billings (2017) notes, "The funding of race can actually occur when the ostensible action is to work against racial categorization or identification" (p. 93). To this end, I question whether reframing making to include othered bodies and practices challenges or reinscribes Whiteness. While all of these studies clearly demonstrate a benefit for the students involved, the assumptions behind these texts continue to reaffirm the White masculine practices of making in often subtle ways. But rather than jump to a solution, I reassert the challenge issued by Yancy (2016) and invite researchers to sit with the problem of Whiteness in the maker movement. As scholars continue to investigate making as a sociohistorical force within education, they need to question who benefits from these practices, boundaries, and definitions and critically investigate the historical practices that construct making and the bodies within this cultural space. Until maker educators and educational researchers truly understand the ways that makerspaces and making practices contextualize, rely on, and reinscribe Whiteness (and, simultaneously, masculinity) as a dominant social force, the problem of Whiteness will continue to influence maker contexts.

References

Ames, M. G. (2018). Hackers, computers, and cooperation: A critical history of logo and constructionist learning. In *Proceedings of the ACM on Human-Computer Interaction*, 2(CSCW), 18. https://doi.org/10.1145/3274287

Bassichis, M., & Spade, D. (2014). Queer politics and anti-blackness. In J. Haritaworn, A. Kuntsman, & S. Posocco (Eds.), *Queer necropolitics* (pp. 191–210). Abingdon, Oxon, UK: Routledge.

Blikstein, P., & Worsley, M. (2016). Children are not hackers: Building a culture of powerful ideas, deep learning, and equity in the maker movement. In K. Peppler, E. R. Halverson, & Y. B. Kafai (Eds.), *Makeology: Makers as Learners* (pp. 64–77). New York, NY: Routledge.

Britton, L. (2015, March 18). Power, access, status: The discourse of race, gender, and class in the maker movement (Web log post]. Retrieved from https://tascha.uw.edu/2015/03/power-access-status-the-discourse-of-race-gender-and-class-in-the-maker-movement/

Buchholz, B., Shively, K., Peppler, K., & Wohlwend, K. (2014). Hands on, hands off: Gendered access in crafting and electronics practices. *Mind, Culture, and Activity*, 21(4), 278–297.

Calabrese Barton, A., & Tan, E. (2017). Community ethnography as pedagogy in equity-oriented STEM-rich making. In *Electronic Proceedings of the ESERA 2017 Conference. Research, Practice and Collaboration in Science Education*, 3. Dublin, Ireland: Dublin City University.

Calabrese Barton, A., & Tan, E. (2018). A longitudinal study of equity-oriented STEM-rich making among youth from historically marginalized communities. *American Educational Research Journal*, 55(4), 761–800. https://doi.org/10.3102/0002831218758668

Calabrese Barton, A., Tan, E., & Greenberg, D. (2016). The makerspace movement: Sites of possibilities for equitable opportunities to engage underrepresented youth in STEM. *Teachers College Record*, 119(6), 11–44.

Fields, D. A., Kafai, Y., Nakajima, T., Goode, J., & Margolis, J. (2018). Putting making into high school computer science classrooms: Promoting equity in teaching and learning with electronic textiles in exploring computer science. *Equity & Excellence in Education*, 51(1), 21–35.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago, IL: Aldine PubCo.

Goldstein Hode, M., & Meisenbach, R. J. (2017). Reproducing whiteness through diversity: A critical discourse analysis of the pro-affirmative action amicus briefs in the Fisher case. *Journal of Diversity in Higher Education*, 10(2), 162–180. https://doi.org/10.1037/dhe0000014

Halverson, E. R., & Sheridan, K. (2014). The maker movement in education. *Harvard Educational Review*, 84(4), 495–504. https://doi.org/10.17763/haer.84.4.34j1g68140382063

Holbert, N. (2016). Leveraging cultural values and "ways of knowing" to increase diversity in maker activities. *International Journal of Child-Computer Interaction*, 9(C), 33–39. https://doi.org/10.1016/j.ijcci.2016.10.002

Jacobson, M. F. (1999). *Whiteness of a different color: European immigrants and the alchemy of race*. Cambridge, MA: Harvard University Press.

Jager, S. (2001). Discourse and knowledge: Theoretical and methodological aspects of a critical discourse and dispositive analysis. In R. Wodak & M. Meyer (Eds.), *Methods of critical discourse analysis* (pp. 32–62). London, UK: Sage. Retrieved from http://ebookcentral.proquest.com/lib/wisc/detail.action?docID=254697

Justice, S., & Markus, S. (2015, September). *Educators, gender equity and making: Opportunities and obstacles*. Presented at the FabLearn 15: Digital Fabrication in Education, Stanford University, Palo Alto, CA.

Kafai, Y., Fields, D., & Searle, K. (2014). Electronic textiles as disruptive designs: Supporting and challenging maker activities in schools. *Harvard Educational Review*, 84(4), 532–556.

Ladson-Billings, G. (2017). The social funding of race: The role of schooling. *Peabody Journal of Education*, 93(1), 90–105. https://doi.org/10.1080/0161956X.2017.1403182

Luke, A. (1995). Text and discourse in education: An introduction to critical discourse analysis. *Review of Research in Education*, 21(1), 3–48. https://doi.org/10.3102/0091732X021001003

Marshall, A., & Rode, J. (2018). Deconstructing sociotechnical identity in maker cultures. In *Proceedings of the 4th Conference on Gender & IT* (pp. 91–100). New York, NY: ACM.

Martin, L., Dixon, C., & Betser, S. (2018). Iterative design toward equity: Youth repertoires of practice in a high school maker space. *Equity & Excellence in Education*, 51(1), 36–47.

Owen, D. S. (2007). Towards a critical theory of whiteness. *Philosophy & Social Criticism*, 33(2), 203–222. https://doi.org/10.1177/0191453707074139

Ryoo, J. J., Bulalacao, N., Kekelis, L., McLeod, E., & Henriquez, B. (2015, September). *Tinkering with "failure": Equity, learning, and the iterative design process.* Presented at the FabLearn 15: Digital Fabrication in Education, Stanford University, Palo Alto, CA.

Ryoo, J. J., Kali, L., & Bevan, B. (2016). Equity-oriented pedagogical strategies and student learning in after school making. In *Proceedings of the 6th Annual Conference on Creativity and Fabrication in Education* (pp. 49–57). New York, NY: ACM.

Saldaña, J. (2015). *The coding manual for qualitative researchers* (3rd ed.). Los Angeles, CA, and London, UK: Sage.

Stickel, O., Hornung, D., Aal, K., Rohde, M., & Wulf, V. (2015). 3D printing with marginalized children—An exploration in a Palestinian refugee camp. In N. Boulus-Rødje, G. Ellingsen, T. Bratteteig, M. Aanestad, & P. Bjørn (Eds.), *Proceedings of the 14th European Conference on Computer Supported Cooperative Work* (pp. 83–102). Basel, Switzerland: Springer International Publishing.

Tan, E., & Calabrese Barton, A. (2018). Towards critical justice: Exploring intersectionality in community-based STEM-rich making with youth from non-dominant communities. *Equity & Excellence in Education*, 51(1), 48–61.

Twine, F. W., & Gallagher, C. (2008). The future of whiteness: A map of the 'third wave.' *Ethnic and Racial Studies*, 31(1), 4–24. https://doi.org/10.1080/01419870701538836

Vossoughi, S., Hooper, P. K., & Escudé, M. (2016). Making through the lens of culture and power: Toward transformative visions for educational equity. *Harvard Educational Review*, 86(2), 206–232. https://doi.org/10.17763/0017-8055.86.2.206

Yancy, G. (2016). Introduction: Un-sutured. In G. Yancy (Ed.), *White self-criticality beyond anti-racism: How does it feel to be a white problem?* (Reprint ed., pp. xi–xxvi). Lanham, MD: Lexington Books.

24. Connected Learning During Disconnected Moments?

HONG-AN WU

Abstract: This paper investigates 2 prevalent assumptions about technologies that underpin common approaches to answering the question of how to harness emerging technologies for learning: the assumption that technologies are obedient tools to serve higher-order cognitive functions and the assumption that technologies are coherent and bounded objects traversing pedagogical exchanges. By analyzing how these 2 assumptions operate in educational discourses that advocate for the adoption of technologies, as well as in my own teaching practices when technologies fail, I argue that these assumptions prevent us from researching and practicing learning with technologies from an ecological and networked approach that centers the situated, relational, caring, and social interactions among teachers, learners, and technologies as the pedagogical encounter unfolds.

Introduction

In *Connected Learning: An Agenda for Research and Design* (Ito et al., 2013), the authors grappled with a common and recurring question in educational discourses today: "How can we capitalize on today's new media to expand these forms of learning opportunity?" (p. 15). Attempts to answer this question by educational policy makers, researchers, teachers, and administrators across the fields of education, such as educational technology, games and learning, art education, curriculum studies, and more, had often focused on exploring the abstracted functionalities of specific emerging technologies and mapping those functionalities onto learning objectives. At the same time, based on the technologies' purported functionalities, attention priority is given to developing probable plans for further implementation of these technologies on a large scale across schools and other educational institutions.

However, as the authors of *Connected Learning: An Agenda for Research and Design* (2013) argued, learning is situated and context specific. Without an explicit deliberation of the specific contextual needs of each formal, informal, or nonformal learning setting, the adoption of emerging technologies by following a standardized formula that prioritizes cost reduction and scaling up merely serves dominant educational hierarchies and further exacerbates existing learning inequity among learners. Furthermore, without considering how pieces of technologies unfold and traverse differently through varying hands, locales, and temperatures, the purported learning potentials are also questionable.

Following this line of inquiry, this paper investigates two prevalent assumptions about technologies that underpin common approaches to answering the question of how to harness emerging technologies for learning: the assumption that technologies are obedient tools to serve higher-order cognitive functions and the assumption that technologies are coherent and bounded objects traversing pedagogical exchanges. By analyzing how these two assumptions operate in educational discourses that advocate for the adoption of technologies, as well as in my own teaching practices when technologies fail, I argue that these assumptions prevent us from researching and practicing learning with technologies from an ecological and networked approach that centers the situated, relational, caring, and social interactions among teachers, learners, and technologies as the pedagogical encounter unfolds. Instead of focusing on moments when technologies are connected and functioning smoothly, a reorientation to think through how we, as educators and researchers, might move forward in addressing learning with technologies during moments when technologies do not work and are disconnected is required.

Educational Discourses Advocating for Technologies

From Moodle to Vimeo to *Minecraft* to 3D printers, all of these entities are named technologies that were advocated for implementation or had been implemented in formal or nonformal educational learning contexts (Overby & Jones, 2015; Roland, 2010; Vanscoder, 2014). Teachers are constantly encouraged, and at times expected, to implement new hardware in classrooms and incorporate new software into their pedagogy for the purpose of harnessing learning potentials for students. In my reading, educational discourses advocating for the continual and further adoption of emerging technologies in the name of benefiting student learning often follow two general trajectories.

The first trajectory involves speculative theorizations about the usefulness and/or uselessness of emerging technologies, based on their generalized capabilities and designed functionalities, for learning in concert with existing pedagogical frameworks and approaches. In other words, these discourses speculate on the affordances of emerging technologies for learning by analyzing and reconciling conceptual tensions and foreseeable practical difficulties of introducing a new piece of mediation into normalized pedagogical practice.

For example, Gee's seminal text *What Video Games Have to Teach Us About Learning and Literacy* (2007) analyzed popular digital gameplay in informal learning contexts using prominent learning theories to develop what he termed *learning principles* for describing players as learners. He advocated for formal learning contexts to be reconfigured according to these principles by revising existing pedagogies, in which digital games were positioned as a possible new tool for teaching and learning. In a similar vein, K–12 art educators Overby and Jones (2015) observed children ranging 5–18 years old playing *Minecraft* and described the affordances of game playing for players as learners. Based on this observation, they devised curricular activities for K–12 art teachers to use to incorporate *Minecraft* into their classrooms by outlining the potential learning outcomes, such as the acquisition of skills for collaboration as well as basic programming skills. Another example lies in the context of the United States' national campaign endorsing the "maker movement" that advocated for learning with a series of digital fabrication technologies, such as "3D printers, laser cutters, easy-to-use design software, and desktop machine tools" (White House, 2016). Alongside this maker movement, Eisenberg (2013) provided a discussion of both the potential affordances of 3D printers as tools for children's learning and the challenges around adopting 3D printers in educational contexts in "3D printing for children: What to build next?" In summary, these authors advocated for the adoption of emerging technologies in both formal and nonformal educational settings by observing these technologies being used in informal settings, or "in the wild," and articulating learning potentials in relation to their use.

The second trajectory involves empirical studies, with a wide range of methodologies, of emerging technology incorporation in formal educational contexts. These studies examined the ways in which emerging technologies had been incorporated into pedagogy to draw conclusions about how it supported, revised, and/or challenged students' learning outcomes. In other words, these discourses build their case for the learning potentials offered by emerging technologies by describing, measuring, analyzing, assessing, and reflecting on student responses before, during, and after the pedagogical encounter with these technologies.

For example, in "Creativity in Digital Art Education Teaching Practices," Black and Browning (2011) articulated a strong stance advocating for fellow art teachers to incorporate digital technologies in classrooms in order to equip students with "emerging modes of literacy" (p. 20). They shared their three years of longitudinal action research study with in-service teachers that focused on their efforts to adopt digital image–editing software in concert with analog art–making media. They concluded by recommending that technologies be considered secondary to conceptual ideas driving the lesson plan for effectively helping students develop their creativity. In other words, emerging technologies are seen as secondary tools to be adopted after considering the primary learning objectives. In "The Education Arcade: Crafting, Remixing, and Playing With Controllers for Scratch Games," Davis, Kafai, Vasudevan, and Lee (2013) described their implementation and evaluation of an elective workshop on Scratch game design and custom controller building

using MaKey MaKey with middle school students. They argued that the incorporation of Scratch and MayKey Maykey under the theme of an arcade "helped the youths see their game in an interactive context, where they could make connections between their games, their peers' games, and the larger experience they were helping to develop" (p. 441). In this instance, they argued that the adoption of these emerging technologies provided students with useful learning experiences that were applicable beyond the pedagogical exchange.

Assumptions About Technologies in Educational Discourses

In both of the discourse trajectories mentioned above, the incorporation of technologies was not seen as the end in and of itself. Rather, technologies were positioned as tools to help equip students with various 21st-century transferable knowledge and skills, with cross-disciplinary deep learning as the actual learning objective (Pellegrino & Hilton, 2012). In other words, these emerging technologies were conceptualized as secondary tools to serve primary and preexisting learning agendas. These authors argued that through the mediation of these tools, students are better able to attain the learning objectives in a specific academic subject. As Roland (2010) stated, art educators need to "focus on the outcome" of our established arts learning goals instead of the tools by which we achieve those goals (p. 19).

However, these narratives rely upon two specific unverified and questionable assumptions. The first assumption is that learning objectives are independent from the technologies by which they are achieved, which might seem paradoxical at first glance. However, if we take a closer look, we can recognize that their arguments for or against specific technologies were built on using the end to the justify the means, or put differently, using the language of learning outcomes/objectives/potentials in existing educational paradigms to justify the adoption of technologies. In doing so, they assumed that there are higher-order and generalizable learning objectives, which are independent of the mediation of the tools themselves, that should drive curricular decisions determining whichever tools to adopt. Learning objectives are the primary nonnegotiable goals, whereas specific technologies are interchangeable to serve those goals.

This assumption risks the romanticization of higher cognitive functionalities that are positioned as independent of technological mediations, which constructivist theories of learning have long rejected (Dewey, 1938/1997; Lave & Wenger, 1991; Piaget, 1962; Vygostsky, 1978). At the same time, this assumption reveals its celebratory position of embracing new technologies: If these learning objectives are independent of the tools and they could be achieved with any tools, why are we centering the adoption of emerging technologies instead of prioritizing questions around how to reconfigure existing educational technologies, such as books or whiteboards, in pedagogy to better serve learning objectives? Underlying this choice to invest attention, capital, and resources in developing procedures to incorporate emerging technologies over other educational questions is an inherent ethos that technological change equals progress and a belief that progress is good. In other words, these narratives assumed the good of adopting emerging technologies from the onset and use existing paradigms in education that traffic in the language of learning objectives to legitimize this belief. This belief deserves reckoning if the aim of educational reform is to disrupt dominant educational hierarchies and to counter existing learning inequity among learners, in which progress to what end, for whom, and in what contexts are called into question.

Following the previous assumption, the second assumption is that the adoption of technologies for the harnessing of their functionalities to serve specified learning objectives is context free and universal. In other words, each piece of named technology is imagined as a completely coherent and bounded object that encompasses the same exact functionalities and unfolding of events even as it travels through different times, locations, and people. However, this assumption has been repeatedly challenged and punctured in the field of science and technology studies. In their book *Culture+Technology: A Primer* (2005), Slack and Wise argued against imagining, understanding, and conceptualizing "technology as a 'thing'" (p. 95), as it deflects our attention away from the interdependent relations among the living and nonliving within which these things are given form. In other words, the observed and documented functionalities

of technologies are reflecting the larger context with which technologies come to perform, rather than a property of the "thing" we call technology. Similarly, in *Human-Machine Reconfigurations: Plans and Situated Actions* (2007), Suchman complicated the boundaries we draw around a piece of named technology and the simplified notion that the functionalities of technologies are inherent in the configuration of its material by its designer. As a case in point, the One-Laptop-Per-Child initiative that aimed to, and yet failed to, replicate learning experiences across geographical, cultural, and political contexts revealed the ways in which the unfolding of technologies' functionalities are not universal (Chan, 2013; James, 2010).

These two assumptions not only underlie educational discourses but also emanate through teaching practices, which prevents us from taking an ecological and networked approach to researching and practicing learning with technologies as advocated by the Connected Learning Research Network. In the following section, I reflect on my teaching practice with technologies to illustrate how these two assumptions played out in my initial interpretation of technological failures in the classroom and how that interpretation prevented me from recognizing the situatedness of unexpected learning potentials being offered by technologies I found myself interacting with during teaching.

Tales From a Teaching Practitioner

Technology never works, or at least that is how the saying goes. I have heard this expression on multiple occasions, particularly during informal exchanges with fellow pedagogues at conferences about the practicalities of teaching with digital technologies for various media-based learning objectives. As a known condition among teaching practitioners, the certainty of technologies' failing to function smoothly often prevents the possibilities for achieving the previously established learning objective given the space and time constraints of pedagogical encounters.

> It was February 3rd, 2016, around 2:30pm, right before the first session of our Minecraft Modification Workshop Series. Lugging giant post-it pads and the laptop cart holding ten Mac laptops, ten laptop chargers, ten computer mice, ten mouse pads, and three extension cords, I arrived at the local public library thirty minutes earlier than the start of the session to set up the mobile computer lab. I maneuvered the tables around the middle of the room, so that the extension cords, which were just slightly too short to rest comfortably under the table, connected to the outlets on the opposite end of the room, could at least reach the edges of the tables. After laying the laptops around the table in a way that successfully connected them each to a charger, I opened their lids, pressed the on/off button and began logging in. However, laptop #6 refused to let me log in. As I pressed "return" on the keyboard after entering the password, a window popped up on the screen to inform me that I could not log in as the time was set incorrectly. The computer provided me with the option to reset the time, which I assumed would enable me to log in afterwards, but it required the admin password. I did not have clearance for the admin password and was only given a general limited access user account, as these laptops were the property of the university where I was a graduate student and I was borrowing them for my workshop/research. I turned the laptop off and on again and repeated the same motions of trying to log in with my general user account a couple of time with no success. The clock was ticking. I decided to abandon laptop #6 and moved on with the workshop without it.

The above vignette was drawn from my action research project, where I studied how to facilitate critical play of digital games with youth in a public library in the United States Midwest. It captured one, among many other, moments throughout the workshop when I also thought to myself, "Technology never works!" Although often expressed in a cheeky and joking manner, the moment the expression is uttered, it communicates truths about how we perceive our reality. Here, I ask the question, "What if we begin to take the expression 'technology never works' seriously?" By exploring the ephemeral moments when this expression emerges, perhaps we can answer the question of why

technology never works that is paramount for practitioners instead of buying into the argument for the adoption of yet another technology as a silver bullet to solve pedagogical woes. Technological apparatuses are often seamlessly embedded within our existing social practice in ways that make us no longer notice them when they perform their delegated duty. And yet, in that ephemeral moment when the technologies behave in unpredictable ways, we begin to take notice, and it is in those moments that this expression emerges.

At first glance, the moments when the expression "technology never works!" emerged during my action research can be grouped into two categories: figuratively not working and literally not working. The vignette above can be considered to refer to technologies not working, figuratively speaking. The reason it is figuratively is that the laptop was performing the initial encoded intentions of its designer, that of illustrating proper ownership of property through the prevention of unauthorized access. In other words, there was nothing wrong with its purported functionalities, and it was performing what it was told to do by those not present in the pedagogical encounter. By contrast, technologies literally not working describes moments when the purported designed functionalities failed to perform even under all the supposedly correct conditions, such as when software crashed and would not reopen for no apparent reason, or the projector refused to connect even though it was properly plugged in with all the right cables. In other words, it was not performing what it was told to do by its designer. With the prompt to send a crash report to the company that developed that software, it was apparent that this category of failure was considered an anomaly even for the designers and deserved dedicated attention on their part to further systematically investigate the conditions underlying this failure.

However, upon closer inspection, it became abundantly clear that these categories are not mutually exclusive at all and in essence point toward the same reality of previously established pedagogical plans being deterred. For example, the software crash simply could have been a result of the laptop's computational power being overloaded. Though perhaps not an intentional limitation encoded by the designer, the way it unfolded in that instance reflected the bottleneck that was set in place by the materiality of these machines. In that sense, it could also be considered a figurative failure. As with the vignette above, it was unknown even to the IT personnel, as we debriefed about the situation later on, as to why the clock reset overnight, and the functionalities that laptop performed actually excluded those who technically do have authorized property access for that point in time. In that sense, it could also be considered a literal failure.

What can be said about these two categories is that they merely classified moments of failure based on whether or not the reasoning for its failure is known, as in "known by the designer specifying its functionalities," and this act of categorization participated in the continual search of a supposedly correct way for usage. It presupposes that there is a perfect and universal operating condition, and under that condition technologies will always work. Through the interpretation of those moments as failures, regardless of whether or not the reasons were known, I was assuming the passiveness of these objects that required human agents to act upon them to unleash their functionalities, as opposed to recognizing the functionalities that they were, indeed, already performing. In other words, I was acting upon the assumption that technologies are completely coherent and bounded objects that should encompass the same exact functionalities and unfolding of events even as they travel through different times, locations, and people. In contrast, what happens if we assume that technologies are fulfilling their duties when they are not functioning smoothly? Where does that lead us in terms of analyzing technologies for learning in both formal and nonformal educational contexts?

At the same time, these categories revealed how I approached interpreting my engagement with these technologies from my position as a pedagogue, in which deciding where to focus my time and energies during teaching are prime sites of negotiation for constructing learning encounters. The expression of "technology never works!" communicated the frustration (at times giving up) of wrangling with technology in an attempt to get it to do what I imagined it is supposed to do so that students can learn through it, about analytical critiques of gender representation in video game texts, for example. With the workshop starting in a few minutes as described in the vignette above, I was torn choosing between abandoning the laptop to search for alternative activities that could substitute for the learning objective intended for that day or trying to solve the issue of accessing that laptop with students while facing the possible abandonment of a predetermined learning objective. In doing so, this scenario outlined how I had positioned technologies as a means to

an end and how I had also acted upon the assumption that learning objectives are independent from the technologies by which they are achieved. In contrast, what happens if we assume that learning objectives cannot be considered independent from technological mediations even during moments of failure? How might that revise our approach to researching and practicing learning with emerging technologies? What emergent learning objectives might we uncover?

Conclusion

Instead of centering on technologies, the Connected Learning Research Network advocates for an ecological and networked approach to researching and practicing learning with technologies that centers around the situated, relational, caring, and social interactions among teachers, learners, and technologies as the pedagogical encounter unfolds. In doing so, it highlights the supporting social infrastructure that is required for "broadened access to learning that is socially embedded, interest-driven, and oriented toward educational, economic, or political opportunity" (p. 4). In this context, this paper analyzed two prevalent assumptions about technologies that underpin educational discourses that advocate for the continual adoption of technologies as well as my own teaching practices when technologies fail. I demonstrated how, in these instances, technologies are imagined and positioned as obedient tools to serve higher-order cognitive functions and they are thought of as coherent and bounded objects traversing pedagogical exchanges. I considered the ways in which these assumptions become detrimental to recognizing the learning potentials being offered by technologies we find ourselves interacting with during pedagogical exchanges.

Instead of asking what technologies can *do* for us in terms of enhancing teaching and learning that assumes an eternal state of perfect functioning and operating, I call for us to ask what technologies *are not* doing for us for teaching and learning during specific moments in time and place as the pedagogical encounter unfolds? By exploring those moments, we might be able to further articulate how the interpretation of "technology never works" relies upon an ontological framework that assumes a passivity of objects and a specific form of agency among human subjects. In effect, this ontological framework configures the materiality of technologies as secondary to learning to make meaning, which requires further attention should we want technologies to work.

References

Black, J., & Browning, K. (2011). Creativity in digital art education teaching practices. *Art Education*, 64(5), 19–34.

Chan, A. (2013). *Networking peripheries: Technological futures and the myth of digital universalism*. Cambridge, MA: The MIT Press.

Davis, R., Kafai, Y., Vasudevan, V., & Lee, E. (2013, June). The education arcade: Crafting, remixing, and playing with controllers for Scratch games. In *Proceedings of the 12th International Conference on Interaction Design and Children* (pp. 439–442). New York, NY: ACM.

Dewey, J. (1938/1997). *Experience and education*. New York, NY: Touchstone.

Eisenberg, M. (2013). 3D printing for children: What to build next? *International Journal of Child-Computer Interaction*, 1(1), 7–13.

Gee, J. P. (2007). *What video games have to teach us about learning and literacy*. New York, NY: Palgrave Macmillan.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., … Watkins, S. C. (2013). *Connected learning: An agenda for research and design*. Irvine, CA: Digital Media and Learning Research Hub.

James, J. (2010). New technology in developing countries: A critique of the one-laptop-per-child program. *Social Science Computer Review*, 28(3), 381–390.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge, UK: Cambridge University Press.

Overby, A., & Jones, B. L. (2015). Virtual Legos: Incorporating *Minecraft* into the art education curriculum. *Art Education*, 68(1), 21–27.

Pellegrino, J. W., & Hilton, M. L. (2012). *Developing transferable knowledge and skills in the 21st century*. Washington, DC: National Research Council.

Piaget, J. (1962). *Play, dreams and imitation in childhood.* New York, NY: W. W. Norton & Company.

Roland, C. (2010). Preparing art teachers to teach in a new digital landscape. *Art Education*, 63(1), 17–24.

Slack, J. D., & Wise, J. M. (2005). *Culture+ technology: A primer.* New York, NY: Peter Lang.

Suchman, L. (2007). Human-machine reconfigurations: Plans and situated actions. Cambridge, UK: Cambridge University Press.

Vanscoder, J. (2014, March). 3D printing as a tool for teaching and learning in STEAM education. In *Society for Information Technology & Teacher Education International Conference* (pp. 188–191). Waynesville, NC: Association for the Advancement of Computing in Education (AACE).

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

White House. (June 17, 2016). Nation of makers. *The White House: President Barack Obama.* Retrieved from https://obamawhitehouse.archives.gov/nation-of-makers

PART II

ABSTRACTS

25. Featured Panels

Keynote With Eve Ewing

Eve Ewing (University of Chicago)

Eve L. Ewing is a sociologist of education and a writer from Chicago. She is the author, most recently, of the poetry collection 1919 and the nonfiction work *Ghosts in the Schoolyard: Racism and School Closings on Chicago's South Side.* Her first book, the poetry collection *Electric Arches*, received awards from the American Library Association and the Poetry Society of America and was named one of the year's best books by NPR and the *Chicago Tribune.* She is the coauthor (with Nate Marshall) of the play *No Blue Memories: The Life of Gwendolyn Brooks.* She also writes the *Ironheart* series as well as other projects for Marvel Comics. Ewing is an assistant professor at the University of Chicago School of Social Service Administration. Her work has been published in *The New Yorker*, *The Atlantic*, *The New York Times*, and many other venues.

Walking With Thoreau: Uncommon Wisdom for Game Designers

Tracy Fullerton (USC Game Innovation Lab)

Designers of games for learning and social impact often talk about the importance of creating game mechanics that are integrated with learning goals and content. We talk about the criticalness of creating mechanics that engage the player and are "fun" in and of themselves. And we talk about the importance of working in cross-disciplinary teams that bring content experts and evaluators together with experienced game designers to build systems together that represent the best of both learning and playing. All of these are indeed important to the design of compelling and innovative social-impact games. But there are other, equally compelling modes of learning and understanding that may complement the systemic, challenge-based activity commonly found in game mechanics. These are modes of reflection and absorption that are often a part of the true synthesis of ideas and the transfer of ideas into a personal and original connection to material. In this talk, which will draw on her own work, as well as other successful impact games, designer Tracy Fullerton explores the role of uncommon mechanics such as walking, musing, waiting, and reflecting on the design of games that go beyond short-term learning to become opportunities for long-term learning and understanding. Tracy Fullerton is an experimental game designer, professor, author, and founding director (emeritus) of the USC Games program. Her research center, the Game Innovation Lab, has produced a number of influential independent games, including *Cloud*, *flOw*, *Darfur Is Dying*, *The Night Journey*, and *Walden, a game.*

https://www.youtube.com/watch?v=GznU1mJrYIY

Fireside Chat With Henry Jenkins

Henry Jenkins (University of Southern California), Justin Scott (Students Deserve), & Jessica Riestra (March for Our Lives)

The Connected Learning Summit kicks off with a Q&A with youth activists Jessica Riestra from March for Our Lives and Justin Scott from Students Deserve, Black Lives Matter, hosted by Henry Jenkins, provost professor of Communication, Journalism, Cinematic Arts, and Education at the University of Southern California. Join us for an inspiring conversation on the power of youth to work for change in the world around them and the challenges and rewards of youth activism.

Reclaiming Digital Futures—Integrating Digital Media in Informal Youth-Development Programs

Haviland Rummel (Susan Crown Exchange), Joselina Fay (DreamYard Project), Rafi Santo (CSforALL), Jerelyn Rodriguez (The Knowledge House), Jeff McCarter (Free Spirit Media), Daniel Thorson (Chicago Public Library), June Anh (University of California, Irvine), Calvin Stalvig (Beam Center), Trudy Ngo-Brown (WMCAT), Anjel Newman (AS220 Youth), & Mary Reisenwitz (Digital Harbor Foundation)

In this session, leaders of out-of-school programs across the country will describe best practices and ways to deeply integrate digital media and learning in community-based learning experiences. The organizations in this session were funded by the Susan Crown Exchange, Digital Learning Challenge, and collaborated to develop a field-facing resource https://digitallearningpractices.org. Educators and leaders from The Knowledge House, West Michigan Center for Arts & Technology, YOUmedia at Chicago Public Libraries, Free Spirit Media, and the Beam Center will share some of the ways that digital media–based learning is deeply embedded in programs that engage youth in computer science, media arts, media production and journalism, making, and engineering.

26. Hall of Failure

A PSA Nightmare: Good Intentions Gone Wrong

Lisa Castaneda (foundry10) & Tim Han (foundry10)

As researchers, we are always looking for new ways to share ideas about our topic area: education. As part of this effort, we decided to team up with a local school that specializes in dyslexic students to share findings about dyslexia in the narrative structure of a public service announcement (PSA). We attempted to bridge the gap between research, education, and emotion and it went poorly. At the heart of our mistake was understanding how to communicate feedback effectively. We found that when collaborating with many folks about a topic that is not only scientifically interesting, but also emotionally intense, it is difficult to capture all the elements one hopes in a two-minute PSA. What we were used to doing as we cowrote papers or worked on presentations was much more challenging to do with people outside our core network and in the more visual and emotional medium of film. Throughout this project we were tasked with connecting the ideas from the school to the actors and film team, all of whom had their own thoughts and experiences with dyslexia. All of these elements put us out of our comfort zone but at the helm of a project we all felt passionate about! Though we made mistakes, mostly around the fine art of specific feedback, we learned important lessons about communicating clearly, using a facilitator, setting shared goals, and agreeing upon concrete, timely benchmarks for progress. It is possible to leave the research publication world and create a PSA, but it requires thoughtfulness!

https://drive.google.com/file/d/1IDajB3mVCusuu6TinCEEY1KZ6RWeSekb/view?usp=sharing

STEM Reform and the Holy Grail

Bob Coulter (Missouri Botanical Garden)

Many STEM reform efforts are motivated by something of a Grail quest—a well-intended effort to enable rich and complex learning environments to take root in contexts where such outcomes have persistently been difficult to achieve. In this session, an analytic framework developed by best-selling historian Yuval Noah Harari guides a postmortem of a recently completed NSF ITEST project engaging 9–11-year-old students with agent-based modeling. While there were a number of successes in the classroom and the research team gained a number of valuable insights, there were strategic limitations relating to technology use, policy frameworks, and participant identity that need to be accommodated in framing future endeavors.

Great to Good: When Time and Design Conspire Against Maximizing Learning

Leigh Peake (Gulf of Maine Research Institute)

At CL2018 we (Gulf of Maine Research Institute) reported on the relaunch of our informal science learning experience, LabVenture, where we host ~70% of Maine's fifth-/sixth-grade cohort annually in our marine research lab for a 2.5-hour exploration of ecosystem complexity. Funded by NASA, the renovated experience features technology-enabled, data-rich, localized climate learning experiences that combine global data sets (e.g., sea surface temperature), local data sets (e.g., lobster landings), and multitouch technology to enable students to investigate the impacts of climate change in the Gulf of Maine. Postlaunch, it was apparent that the length and pace of the experience, combined with key design decisions, were conspiring against our effort to achieve student learning outcomes. At CL2019 we will report on the significant adjustments to the program that emerged as necessary after launch. We will describe our process of integrating observations and perspectives from informal educators, researchers/evaluators, and learning designers and the necessity of embracing the messiness of launching a complex program. This tale of traveling from great to good (and back to great) includes lessons on the limitations of user testing, the integration of research and practitioner voices, the scramble to fund adjustments when you spent most of your dollars on the launch version, and the comfort of reminding ourselves that no children were being harmed as we made our way through this process.

There Is No Reason This Should Have Failed, and Yet …: A Story of Blogs and Educator Professional Learning

Emily Schindler (University of Wisconsin)

This presentation tells the story of the failure of blogging in the Wisconsin Teacher Studio, a maker-based professional learning group for educators. Despite the ample expertise, experience, and well-intentioned design, a blogging site meant to connect professional-development participants between monthly meetings failed spectacularly. This presentation will detail possible reasons for failure, and what it tells us about the design and implementation of connective platforms for educator learning. Ultimately, this failure is instructive for future designs (digital and social), which must always consider interest-based learner participation as a starting point, even when those learners are also teachers.

Learning From Mistakes

Bill Shribman (WGBH)

Digital educational projects typically need proposals and pitches. Failure is not typically mentioned in proposals and pitches: It is not a great selling point. And yet, as we know, failure in digital development is inevitable. Bill Shribman, senior executive producer and director of Digital Partnerships, produces a rich array of VR, AP, mobile web games, apps, and skills at WGBH Educational Foundation in Boston. In an honest and self-deprecating presentation, Bill will share how smart development and transparent processes can effectively bridge the gap between funder expectations and the realities of digital development. This involves a willingness to embrace risk and to include stakeholders—especially when one might otherwise choose not to. This can turn failures into valuable data that inform and improve most products, most of the time. The rest of the time is best summed up here by two noted experts in failure: *Dudley Moore:* "Do you feel you've learnt by your mistakes here?" *Peter Cook:* "I think I have, yes, and I think I can probably repeat them almost perfectly."

Summertime Blues: Building Teaching Capacity Through Informal Summer Learning Experiences

Claudia Urrea (Massachusetts Institute of Technology) & Joe Diaz (Massachusetts Institute of Technology)

The MIT STEAM Camp brings MIT's "Mens et Manus" approach to learning to children. Students work together, designing and building innovative projects that they can share with their communities and families. During the camp, they engage in hands-on activities and explore the use of digital technologies and tools that promote creativity, invention, and collaboration. This program has also been a vehicle for hands-on teacher professional development for educators who work alongside MIT staff to both develop and facilitate camp activities. Our goal is to allow Hong Kong–based teachers to learn from the MIT community while also supplying their own expertise about local learning conditions and areas of interest. Additionally, this program has provided us with the opportunity to develop a framework for the MIT K–12 community to come together to design curriculum and facilitate the program, all while drawing inspiration from the U.N. Sustainable Development Goals (themes included "Energy" and "Into The Water"). The MIT STEAM Camp has successfully engaged local students and teachers and the MIT community in a learning experience. It has been offered for two years to more than 400 students and 50 teachers from different kinds of schools in Hong Kong. They have provided important feedback and recommendations to improve future instances of the camp. However, this process has not been seamless. We reflect upon our model for building teacher capacity and research efforts. We describe our ultimate goals as well as our successes and failures in trying to move those components forward.

27. Ignite Talks

LRNG Podcast Playlist: How Podcasting Became a Vehicle for Connected Learning

La Toia Brown (Nerdy Media)

The Chicago Learning Exchange awarded a $5K grant to Nerdy Media to design one connected learning–focused playlist for the LRNG platform. Because we are nerds and overachievers, we designed two LRNG playlists: the Podcasting Novice and the Podcast Nerd. The Podcast Novice playlist is a series of videos and activities guiding learners through preproduction and the Podcast Nerd playlist guides learners though the production, publishing, promoting, and monetization of podcasting. Each playlist awards learners a digital badge, illustrating podcasting proficiency, and can be shared on LinkedIn. We invited six young adults (who were neither working nor in school) to participate in five sessions and earn stipends to learn how to produce a podcast and provide feedback, helping design this eLearning content. We started with "what is a podcast?" and in the planning session they decided the podcast would focus on Life after High School. The learning phase resulted in a youth-produced podcast, *On Me*, that offers an inside look at Chicago's youth culture—told and produced by those living it. After designing eLearning content, we produced 11 videos in which our youth became on-camera talent, guiding learners through every phase of podcasting. The Chicago Learning Exchange provided Nerdy Media with an opportunity to design a resource that has enabled us to transform this eLearning tool into meaningful community engagement, youth employment, and address the digital divide throughout Chicago's underserved communities.

https://www.youtube.com/watch?v=t76NAfN5lXI&list=PL0ELr5eRiluz7GNLyYqXw1F3uGI6kEcnw&index=11&t=0s

Queering Up Game-Development Spaces Through Discord Servers

Jeremy Dietmeier (University of Iowa)

Videogames are an art form that transmit cultural ideas of what it means to be human. The problem is we typically hear stories only from the White, heterosexual, cisgendered male perspective. Building off an LGBTQ+ Game Development Jam, I looked into LGBTQ+ game-development Discord servers. Discord was developed as a voice chat client but is now a social media platform, providing a way for people to connect and form communities. These communities provide spaces for LGBTQ+ game developers to build communities, explore their identities, and make things with people. Community rules and moderators play a crucial role in developing the atmosphere of the community, making it a welcoming place, and keeping the community safe from trolls and harassment. Additionally, they provide spaces for budding developers to create games and practice their skills. These Discord servers are communities of practice where novices and experts work together making games, giving advice, and filling their portfolios. This talk quickly discusses the importance of representation and identity support in the game-development community. It also highlights two key affordances of Discord that support connected learning. From educators to researchers to developers, we could all do a better job creating inclusive communities.

https://www.youtube.com/watch?v=I6nbb2vfUDg

Crystal City: Modeling Structural Racism in a Board Game

Gerald Dryer (University of Wisconsin-Madison)

Crystal City is an educational board game designed to simulate racialized societies. The game uses a racialized fantasy world theme as a metaphor for real life. In the game society is divided between humans, elves, dwarves, and orcs. Players are randomly assigned a race at the beginning of the game, and events in the game affect each race differently as players try to reach the "Crystal City" at the end. Various game mechanisms, including character generation, pathways, and fortune cards are used to play out events. The game purposely favors humans and is biased against elves, dwarves, and orcs. For example, humans are born into more wealth and social capital than other races, and therefore they have greater access to education and higher-paying jobs or careers. Elves, dwarves, and orcs are marginalized in various ways, from microaggressions (affecting health and well-being), to housing discrimination (affecting access to resources), to racial profiling by imperial guards (with sometimes catastrophic effects). The racialized effects of the game are modeled on well-understood patterns of personal, institutional, and structural racism in real life. The game allows players, especially Whites, to experience racist structures, while the metaphor is intended to give players enough psychological distance to not be defensive. Text within the rules, and printed on game components such as the fortune cards, labels racialized mechanisms and encourages discussion among players. Although anyone can play the game, it is targeted toward White players ages 14 and up.

http://bit.ly/cls-launch

Kids DIY Media: Best Practices and Policy Recommendations

Deborah Fields (Utah State University) & Sara Grimes (University of Toronto)

Where children's creations used to be relegated to refrigerator doors and classroom bulletin boards, they can now be shared with an audience of millions thanks to connected digital technologies. Between 2013 and 2018, the Kids DIY Media Partnership looked at how and where children create and share media online, and at the designs, regulations, infrastructures, and technologies that underpin the platforms kids use. Our focus was on exploring the opportunities and challenges associated with kids' DIY media, and with finding ways to best foster a rights-based, inclusive, child-centric approach to children's online media making and sharing. Working with Canadian and American academics, designers, media producers, child advocates, educators, and NGOs, we identified many strengths in the kids' DIY media landscape. We also spotted some areas for improvement. We share highlights of five years of work across academic, design, policy, and children's domains in the one main document (Best Practices for Design) issued from our research—released in Summer 2019 at http://tinyurl.com/kidsdiymedia—written for broad public consumption by those who design for and create policies that affect children's DIY activities online. We propose a range of principles to consider when designing for and with children. We begin with ways to improve creation, sharing, collaboration, civic engagement, self-representation, and education; next, we turn to legal concerns such as child-friendly privacy policies and copyright regulations; finally, we consider how platforms can be child friendly and age appropriate.

https://www.youtube.com/watch?v=4Uu0ihn3Jcw&list=PL0ELr5eRiluz7GNLyYqXw1F3uGI6kEcnw&index=15&t=0s

More Than Just a Bunch of Parts: Expanding the Learning Ecosystem Analogy Using Insights From Biological Systems

Marijke Hecht (University of Pittsburgh)

Connected learning has been described using the concept of a learning ecosystem, but the frame is often presented as a complicated set of interconnected elements, not a true complex system. Acknowledging connections between ecosystem elements is not enough to affect the kind of systemic change that the complex problem of educational inequity requires. Biological ecosystem management emphasizes assemblages over individuals and relational processes over simple subject/object interconnectedness—two big insights that can reframe how we think about learning ecosystems. For example, visual depictions of learning ecosystems typically show a learner at the center of the system, but in nature an ecosystem has no center. All elements of a system are influencers of and are influenced by one another. When we position learners at the center of the ecosystem, we are steered into thinking about equity in one way: We envision youth moving through the ecosystem and we pose the problem as whether or not individual youth have access to the same opportunities. What if we decentered our focus on individual youth, just as ecologists have moved biology away from an emphasis on individual organisms? Youth learning could still be used as an effective indicator of ecosystem health, but learning-ecosystem design could focus instead on keystones, such as educators, that drive energy through the system. Use of concepts such as these, which are drawn from the adaptive management of biological systems, could help educational researchers and practitioners construct and use a more nuanced and powerful learning ecosystem framework.

https://www.youtube.com/watch?v=jFoH0QXC9I8

Computer Science for All Is a Right, Not an Option

Amy Hutchison (George Mason University), Jamie Colwell (Old Dominion University), Anna Evmenova (George Mason University), Kristie Gutierrez (Old Dominion University), & Jeff Offutt (George Mason University)

Computational thinking and coding skills are rapidly becoming essential for everyday life, so much so that coding has been termed *the new literacy*, and terms such as *coding literacy* have been developed to indicate the importance of coding as a part of everyday communication. Because digital technology is a dominant mode of communication, a person cannot be fully literate without the skills to produce and consume information produced in digital spaces. In response to the growing movement to introduce computer science, specifically coding and computational thinking, to more students starting as early as kindergarten, solutions such as afterschool coding clubs and summer camps have been implemented. Yet many of these solutions are available to only a small percentage of students and most often not to students with learning disabilities such as autism spectrum disorder and attention-deficit hyperactivity disorder. Without intentionality and the development of specific strategies for supporting students with learning disabilities, there is a great risk that these students will not have opportunities to develop computational thinking and coding skills, and therefore they will be robbed of the opportunity to become fully literate. Consequently, it is essential that educators, researchers, technology developers, and policy makers create pathways, approaches, and tools for ensuring students with disabilities are not left without the same opportunities as their neurotypical peers. Through a project funded by the National Science Foundation, our research team is seeking solutions for preparing teachers to support students with disabilities in learning computational thinking and coding. Read more here:

http://www.inlusivecomputerscience.org

The Crisis of Democracy, the Problem With Algorithms, the Lack of Discord, the Truth About Reality and Fantasy, and the Most Important Thing About Humans in Five Minutes or Less

Nikolaus Koenig (Danube-University Krems)

Democracy is in crisis, and it is in crisis all around the world. This crisis is closely tied to a blurring of the concept of "democracy" itself, a concept that is understood less and less as the rule of the people but as the rule of the majority over the minority. Core democratic principles such as political tolerance, checks and balances, or minority rights are first ridiculed, then discredited, and finally (in danger of being) abolished. In this light, the crisis of democracy is also (and mainly) a crisis of discourse, a symptom of societies increasingly reluctant to consider the foreign idea, to respect the opposing position, to listen to the voice of the other. Connected with this is the problem with algorithms, which is not their ability to use large amounts of data to make decisions "for us." The problem lies in the ease with which this ability is used for comfort and control, as we can hardly imagine algorithms used in any other way: In the age of filter bubbles and confirmation bias, we are getting used to algorithms of efficiency and convenience that let us zoom in ever more closely on the information we already want, the voices we already know, and the communities we are already part of. The lack of discord created by these algorithms of efficiency and convenience is the greatest danger for democracy: When society is no longer a variety of different voices, but a collection of well-separated cohorts of opinion, then self-affirmation and an attitude of incomprehension take the place of democratic discourse as a core practice of social connectedness. However, it is possible to imagine a different way: It is possible to use algorithms *not* to connect us to kindred spirits, like-minded souls, or perfect matches, *but* to confront us with those we disagree with the most, creating not matches made in heaven but connections made across the widest possible gap, opportunities for discord, conflict, and confrontation that, ideally, provide a chance for learning and debate. The truth about reality and fantasy is that we must leave behind the idea that we all share the same reality while our fantasies are our own. Neither part of this idea holds up. The more we feel connected through modern technologies, the more we see that we are living in a multitude of different realities, each made up of the things we decide to accept, agree with, and like. This individualization of realities is at the core of the crisis of democracy. The good news is that we can find the lost connection elsewhere (and that this is where we have always found it): Contrary to our realities, it is our fantasies that we can truly share (and have always shared)—using an ability that seems magic but is deeply human. Indeed, it may be the most important thing about humans: It is what Johan Huizinga describes as the "play element of culture," which can be summarized as the ability to not only create a fantasy world, but to share the fantasy and, through common practice and belief, make this fantasy a reality. This is the way we create and constantly re-create culture. And it is the way we have invented abstract, fantastical ideas such as "democracy" and made them a reality through practice and dedication. This ability to play out a fantasy with sacred earnest, and thereby shape reality together, requires more than belief. It requires the willingness to express and listen to foreign ideas, to accommodate those who are strange to us, to hear the voice of the other. The crisis of democracy is a crisis of human connection. The truest form of human connection is play. It seems to be high time that we start playing.

Data Education in Scottish Schools

Tommy Lawson (University of Edinburgh)

Like many countries across the world, Scotland has recognised the value of data in society. The Data-Driven Innovation (DDI) initiative is part of the Edinburgh and South East Scotland City Region Deal, and it aims to help organizations

and all our citizens benefit from the data revolution. The University of Edinburgh and Heriot Watt University are collaborating with industrial partners on data-based projects in the public, private, and third sectors. Moray House School of Education is leading the DDI Data Education in Schools program. This Ignite Talk will give a snapshot of the above program now launching in Scotland. It will show practical examples of the work that has already begun in schools, looking to develop a broad understanding of data from early years into adulthood. Some of the innovative projects under way include the data-rich school (environmental monitoring, activity and fitness, happiness, achievement and attainment, weather, hydroponics) and Network X (redesigning the school infrastructure for cyber-resilient learners).

Classification of Game-Based Assessments and Their Different Approaches

Alexander Pfeiffer (MIT) & Nikolaus Koenig (Danube-University Krems)

In his Ignite Talk Alexander Pfeiffer suggested the following classification of game-based approaches to assessment in the context of education. *Gamified learning assessment* (GLA): Gamified assessment concepts rely on existing psychometric science, including gamification characteristics, such as points and challenges. *Game-based assessment* (GBA): Game-based assessments consist of testing environments that take the form of an actual game; apart from being also based on psychological methodology, the main challenge here is to create a game that stays true to the curriculum by incorporating the testable skills and knowledge in a meaningful way. *Combined game-based learning and assessment* (GBL&A): Because of the success of game-based learning, it makes sense to design game-based assessment and game-based learning tools as complementary to each other. In combined game-based learning and assessment environments, a learning experience might take place in one level of a game, while another level serves as a testing stage for the evaluation of learning progress. *Integrated game-based learning/assessment* (GBL/A): The most promising, but also the most challenging, form of game-based assessment is the actual integration of learning assessments as interlaced parts of game-based learning experiences. Contrary to game-based learning and assessment, there is no noticeable switch between learning and testing, as the system tracks and maps learning progress as it happens, and learners do not have to step out of their learning experiences for the purpose of testing.

https://alexpfeiffer.mit.edu

The Magic Ingredient: Using Pop Culture Effectively

Janae Phillips (Harry Potter Alliance)

Fan activism draws parallels between real-world social issues and beloved pop culture to mobilize fans for social change. In doing so, activism becomes more accessible and sustainable. As a method, fan activism has shown immense success across a broad range of issues; however, it should not be misconstrued as simply a "theme" for already existing activism campaigns. Fan activism is most successful when it can effectively capture the social energy of public imagination, which means media with the most current social relevance is most likely to work best (in example, in 2019 *Star Wars* has much more current energy than *Lord of the Rings*). Further, practitioners should consider connection points between the media and their issue carefully, looking for connections that feel relevant to the media itself (in example, a campaign on chocolate sourcing works well with *Harry Potter*, where chocolate is a major feature of the world, but would be unlikely to work as effectively with *Game of Thrones*). At its heart, fan activism is grassroots organizing—practitioners should invest substantial resources into understanding the fandom community surrounding the media they want to draw from, connecting directly with fans and bringing fandom consultants into their team as necessary. By approaching fan activism

as a community-mobilization tactic and giving special attention to cultural relevance, practitioners can see substantial success using this methodology for social change.

http://thehpalliance.org

Design Charettes: Serving the Community That Served You

Wendy Roldan (University of Washington)

In this Ignite Talk, I share the story of how I spent my winter break running design workshops with more than 400 Chicago Public School students. I discuss the tensions I face as a scholar pursuing equitable engineering education research while feeling selfish for leaving home to pursue my PhD in a different state. As a PhD student in Human Centered Design and Engineering, I research how families and children engage in informal educational experiences, and running the charettes in Chicago was a chance to bring home my research in a tangible way. I detail the intricacies of working with public school systems to make the workshops happen and discuss the implications and responsibilities of researchers when we enter marginalized communities. This experience provoked scholarly and personal questions as I continue to pursue this equitable design research for communities such as my own. I ask: What does it mean to come back and should we come back? How might we work with public school educators and students to introduce our design research in a responsible, ethical, culturally responsible, and sustainable way?

https://www.youtube.com/watch?v=i23NbRmaWQA&list=PL0ELr5eRiluz7GNLyYqXw1F3uGI6kEcnw&index=3&t=133s

Design a Learning Game in One Hour or Less

Jason Rosenblum (University of Texas at Austin)

Designing playful and gameful learning interventions can be complex, involved, and costly, but they do not have to be. Of course, games can be challenging to design. This session showcases a simulation to game the conflict in Syria. The *Syria Simulation* (https://sites.stedwards.edu/syriasimulation/) was delivered in person, in a tabletop role-playing setting, at scale to more than 700 students during Spring 2016. The design was grounded in high-impact instructional design theory and practice, and it employed game-design mechanics to target 21st-century competencies and to supercharge student engagement. It is possible to use similar principles to design powerful, playful, high-impact learning that fits a broad need of learning outcomes and student participation at a narrower scope. It is also possible to do this design on a shoestring budget. View the Ignite Talk on this topic and learn how you can design a simple, high-impact simulation with minimal start-up time. You can do this by identifying one intervention, within one class, to solve one learning problem and subsequently gaming a critical threshold concept that powers that problem. Listen to an overview of this five-step process to design and test your game. Learn how you can spend a dynamic, productive, and *fun* hour to design a sketch of a game that generates powerfully fun learning that targets competencies while powering student engagement.

https://youtu.be/6Zbp0PlgRAg

On Being Late to the Game

Corey Sparks (California State University, Chico)

Our hypercommodified media landscape pushes us to chase after the latest thing or buy into nostalgized commodities repackaged for consumption. I would encourage us to reconsider what I think is the highly pedagogical space between novelty and nostalgia. I call this pedagogical space *being late to the game*. Being late to the game means resisting a language of the cutting edge and instead embracing belatedness. Being late to the game has four interrelated features. First, being late to the game jettisons the assumption that tech adoption transparently signals particular virtues. What would we call people who levy serious critique even as they might be characterized as early adopters? Second, being late to the game reveals how our aesthetic attachments refuse to follow preset time frames. How would we characterize an 18-year-old college freshman who became enamored with '90s web design because of the *Captain Marvel* official website? Third, being late to the game means embracing objects and cultural phenomena with uninspiring aesthetics that are not novel, timeless, or cool. People may want the latest iPhone or the first iPhone, but what about an iPhone 4? Finally, being late to the game reflects on issues of inclusion. Instead of chasing the bleeding edge, we need to reconsider who we count as being innovative. Being late to the game means welcoming people into play where clarified, inclusive rules are the norm. Key to these features of being late to the game is adopting a different relationship to the consumption and production of pedagogical methodologies, platforms, and gadgets.

https://youtu.be/rDwDFy8-t5Q

Toward a Powerful Role for Public Libraries in the CL Ecosystem

Kelly Wortham (Santa Monica Public Library)

Adapting the service-learning model to the public library context has helped the Santa Monica Public Library clarify our vision to address digital opportunity for youth in a holistic way. Learn why we are excited about our Tech Teen program's potential to connect youth to authentic growth experiences and enhanced well-being. Our hope is to invite further discussion about powerful roles for public libraries in supporting connected learning (CL).

28. Posters

Blocks With Friends: Collaborative Programming With *Minecraft*

David Bar-El (Northwestern University), Elana Stettin (Northwestern University), & Marcelo Worsley (Northwestern University)

We report on a comparative study of collaboration in digital gameplay with and without programming as a main interface. Five middle school students completed *Minecraft Education Edition* build challenges under two conditions. In the nonprogramming condition, students built an obstacle course using the keyboard and mouse interface. In the programming condition, students used a programming interface to navigate their in-game agents through an obstacle course. We transcribed the speech from both conditions and coded each utterance based on a code book for collaborative gameplay (Bluemink, Hämäläinen, Manninen, & Järvelä, 2010). Results revealed differences in group-talk under the two conditions. In the nonprogramming condition, responses, content statements, and questions were the most frequent discourse functions respectively. This finding replicates prior studies of group-talk in video games. In the programming condition, content statements accounted for a smaller share of students' speech with responses, questions, and social statements being the most frequent discourse functions. Moreover, a unique discourse function of self-talk emerged during programming gameplay; as students programmed their agents they either uttered their steps or seemed to address their in-game agents directly. Self-talk accounted for almost a fifth of group-talk in the programming condition.

STEMports: A Community-Based, Augmented Reality Learning Game

Scott Byrd (Maine Mathematics and Science Alliance), David Gagnon (University of Wisconsin-Madison), & Gary Lewis (Maine Mathematics and Science Alliance)

Using participatory design methodologies with two rural regions in Maine, the Maine Mathematics and Science Alliance (MMSA) in collaboration with Field Day Lab (FDL) at the University of Wisconsin-Madison are co-designing a community-based STEM learning game called *STEMports*. The game is based on FDL's ARIS and Siftr learning applications and features activities and challenges that take players on localized AR missions to discover emerging STEM (science, technology, engineering, and math) careers in their community–specifically highlighting innovations in the fields of sustainable agriculture and aquaculture, forest products, and renewable energy. The project will discuss findings and insights from the first project year, highlighting the co-design process with teams of youth and adults who help to design and test the platform including: design principles necessary to facilitate a co-designed AR game for STEM learning; interactive dynamics in the online and offline learning environments related to how participants build social networks in an AR community; and, which interactions are the most impactful for participants' STEM identity, agency, and career trajectories. The project's use of community engagement meant to involve local groups, professionals, and youth in the co-design of *STEMports* provides crucial insight into best practices in the field of participatory design research. Year 1's findings will be used to build a fully functional and scalable application that will be promoted in Years 2 and 3. The project team will also present a functioning prototype of the *STEMports* application to experience on our iPads or the conference participant's own iPhone.

Playing and Learning Science as a Family With a PBS KIDS App

Claire Christensen (SRI International), Cindy Hoisington (EDC), Phil Vahey (SRI International), Naomi Hupert (EDC), & Shelley Pasnik (EDC)

Science literacy is essential in today's science- and technology-oriented world. To support family science exploration, the CPB-PBS Ready to Learn Initiative developed the PBS KIDS Play & Learn Science app, which provides in-app and hands-on science explorations for children ages 3 to 6 and their parents. The app introduces science concepts and practices involving weather, solids and liquids, forces and motion, and light and shadow. This study explored the impact of a four-week structured experience that exposed families to the digital and hands-on activities in the PBS KIDS Play & Learn Science app. This study had a single-group design. Parent surveys (N = 31) and researcher-developed child assessments of science vocabulary, concepts, and practices (N = 33) were administered before and after the intervention. Participating children were ages 3 to 6. Children showed gains in (a) understanding of science content and practices; (b) science vocabulary; and (c) excitement about STEM. Parents reported increased parent-child engagement in science and engineering activities and increased confidence in supporting science learning. Results demonstrate the potential of educational media to support children's learning, particularly with adult support.

https://ca.pbslearningmedia.org/resource/pbs-kids-play-learn-science-rtl-funded-evaluation/pbs-kids-play-learn-science-rtl-funded-evaluation/

Platforms, Pedagogies, and Privacy: How the "Platformization" of Education Is Pedagogicizing Home-School Relations

Daniela DiGiacomo (University of Kentucky), Jessica Pandya (California State University, Long Beach), Gwen Shaffer (California State University, Long Beach), & Julian Sefton-Green (Deakin University)

This poster considers the significance of the growth of new digital platforms that link families, home, children, and schools, of which the best-known example is perhaps "ClassDojo." These platforms are now in daily use in many schools around the world, and although they appear to build on uncontroversial and established forms of communication between teachers and parents, we raise questions here about the ways they not only impose behavioral norms on families and teachers, but how such interaction might redefine family relations with schools. We also raise questions about issues surrounding data privacy, examining how (or if) educators and parents consider whether digital platforms they use are privacy protective. We seek to better understand how families and teachers perceive such risks, and whether they act to mitigate them. Our broad concern is to invite further inquiry and spark discussion around how new digital platforms are mediating home-school communication and pedagogicizing families and home life in ways that subvert a variety of everyday learning to school norms and behaviors, and in ways that may afford little data privacy for students and families.

https://platformpedagogies.com

Motivating Computational Weaving: Intersections of Goals and Environmental Aspects to Deepen Engagement

Lillyanna Faimon (Indiana University), Anna Keune (Indiana University), & Kylie Peppler (University of California, Irvine)

Weaving played a crucial role in the history of computer science and has recently been rediscovered as an interest-driven alternative for computer science education. While personal interests and peer engagement can deepen disciplinary learning, we know little about the motivational processes that support youth to engage with computational concepts through weaving. Following a sociocultural approach to motivation, this qualitative research analyzes video data of a middle school weaving. We iteratively coded students' goals and environmental aspects to understand how they drove student motivation to keep going. We found two dominant processes of motivations for computational weaving: (a) peer engagement supported goal accomplishment, and (b) material choice drove pattern variation. We discuss implications for facilitation of weaving for CS learning.

Tracing Students' Socio-Digital Ecology: Learning Through Socio-Digital Participation Inside and Outside of School

Heidi Forsström (University of Helsinki), Netta Tiippana (University of Helsinki), Tiina Korhonen (University of Helsinki), & Kai Hakkarainen (University of Helsinki)

The purpose of the study was to trace Finnish primary school students' (N = 296; Grades 5–7) socio-digital activities varying from ordinary to more advanced practices across informal and formal contexts. Many of their teachers were involved in digital innovation activities and therefore enacted sophisticated socio-digital practices in their classrooms. We examined young people's socio-digital learning ecology, the intensity and complexity of socio-digital participation (SDP), and the digital skills associated with technologies preferred by both girls (n = 136) and boys (n = 160). By relying on the genres of participation, we distinguished students' friendship-driven and interest-driven practices and identified six informal and three formal dimensions of SDP that constituted their informal as well as academic learning ecology. Based on the intensity of dimensions, three socio-digital participation profiles were uncovered: hanging out (n = 131), messing around (n = 116), and geeking out participators (n = 49). Students' digital skills were conceptualized as academic, artistic, and technical socio-digital competencies. On average, the students in the present sample participated more frequently in messing around and geeking out activities in school compared to corresponding informal practices, if recreational gaming is opted out. Regarding the participation profiles, there were no differences between girls and boys with respect to self-reported socio-digital skills; girls saw themselves as more competent with artistic and boys with technical aspects of digital technologies. The results suggest that innovative teachers can promote a more equal socio-digital participation and build young people's 21st-century skills through digital-pedagogical practices that are attractive both for girls and boys.

https://growingmind.fi

Broadening Computer Science, Coding, and Making in Schools Through Connected Learning After Teacher-Education Programs

Mirek Hancl (Osnabrück University) & Michael Brinkmeier (Osnabrück University)

In two projects, Coding and Making in Teaching (CMU) and Physical Computing in Schools (PhyCoS), different approaches to supporting computer science education in primary and secondary schools are implemented and evaluated. Both put a special emphasis on teacher training under the aspects of the connected learning framework. The project CMU conveys contemporary digital skills to teachers with and without prior knowledge in the field of Computer Science and Maker Education. The teacher training consisted of six MOOC sessions during which the participants got to know various tools with low entry and at no or minimal costs. These were accompanied by regional, blended learning workshop meetings. The project has been planned and implemented and will be evaluated under the following key questions: (a) How should teacher-training modules be designed for the digital world? (b) Which competencies are required of teachers? (c) How should these training modules be methodologically structured to ensure the elements of the connected learning framework? The project PhyCoS aims to help schools use digital devices such as the Calliope Mini in the classroom. Its main focus is on the networking of different regional actors. Teaching-students develop projects in university courses, which are tested and evaluated in regular classes and workshops accompanied by teachers. The material and ideas are improved during several iterations and different participating teachers. To enable students and teachers with no or little previous knowledge in programming to partake, the graphical programming language abbozza! is used.

https://www.informatik.uni-osnabrueck.de/arbeitsgruppen/didaktik.html

Designing Healthier Youth-Led Online Communities: Toward a Conceptual Framework

Krithika Jagannath (University of California, Irvine), Katie Salen (University of California, Irvine), & Petr Slovák (King's College, London)

Online multiplayer games, such as *Minecraft*, lend themselves as viable sites for promoting social and emotional learning (SEL) among youth. Players interact socially during gameplay by creating, collaborating, competing, and communicating with each other. They encounter conflict, both that engineered by the game and that created by players through disruptive behavior or social drama. For instance, players may provoke or irritate other players ("griefing"), steal others' game-based assets, or use offensive language. In attempts to limit and/or eliminate player-led conflict and curb toxic social behavior, server administrators (moderators) deploy various sociotechnical mechanisms, including enforcement of strict norms and the use of software controls to temporarily or permanently ban players from playing on their server(s). Research suggests that these mechanisms maintain a healthy online climate in games such as *Minecraft* at an opportunity cost for youth. Interpersonal conflict in play-based settings presents opportunities for youth to develop problem-solving skills, empathy, and interpersonal rapport. Through the careful integration of SEL strategies that originate in evidence-based programs in Prevention Science, we discuss an online afterschool program for youth ages 8–13 in *Minecraft* designed to help youth embrace and learn from conflict. We report select findings from a six-month pilot of the program wherein we observed youth practicing social competence, overcoming conflict, and creating a community guided by norms they developed and enforced. In this paper, we draw from the elements of connected learning and evidence-based strategies to develop a conceptual framework that supports the design of play-based online SEL interventions.

Who Benefits From Ethnic Capital?: Group Norms, Social Class, and Education Among Armenian Americans in Los Angeles

Oshin Khachikian (University of California, Irvine)

Sociologists show that the high levels of college-educated adults found in specific immigrant communities become a social resource, called *ethnic capital*, which is accessed in co-ethnic community organizations and promotes academic achievement for even the working-class descendants of these groups. But how does ethnic capital guide youth mobility? And does it benefit co-ethnic families who do not participate in these organizations? I investigate these questions through original, qualitative fieldwork with 42 working-class, second-generation Armenian Americans in Los Angeles. By comparing how social support for college preparation varies with organizational participation, I find that despite categorically converging with participants in graduate degree aspirations, nonparticipants access weaker mobility resources, which distances them from perceived ethnic norms of achievement and a symbolic belonging to the co-ethnic community. I conclude that how ethnic capital benefits families varies but favors those who already possess material resources to enroll their children in co-ethnic organizations.

https://www.tandfonline.com/doi/full/10.1080/01419870.2019.1635256?src=recsys

Korean Pop Culture Fans' Language Learning Through Use of Various Technologies

Hanae Kim (University of Illinois at Chicago)

The non-Korean heritage language learners at a four-year state university in the Midwest are excited to learn the Korean language and culture because of their interest in Korean popular culture. They come to their very first Korean language class with abundant knowledge of the Korean language and culture because of their active use of various digital technologies such as videos and websites, social media, and mobile applications. Because of the easy accessibility to various resources, many students are exposed to language learning opportunities, yet it is easily assumed by educators that the nonheritage students have lesser language exposure or knowledge in the Korean language than the Korean heritage students. Through interviews with four students from this university, I learned that these nonheritage students use various sources/materials from the Internet to learn and practice the language, such as websites and mobile applications. Second, online was their affinity spaces, where they can learn the Korean language and culture, make transnational and international friends, and present their identity as K-pop fans. Last, they constantly used their social media or instant messaging application to get the latest news on Korean popular culture, communicate with their friends and celebrities, and practice the language. These students shared that the Korean language class was a place for them to breathe in their busy college life because it was truly what they wanted to learn and that they will always seek more opportunities to practice and learn the language.

Mission HydroSci: Gameplay to Meet Learning Standards and More

James Laffey (University of Missouri), Justin Sigoloff (University of Missouri), & Joe Griffin (University of Missouri)

Mission HydroSci (MHS) teaches water systems and scientific argumentation toward meeting Next Generation Science Standards. *MHS* is a game-based 3D virtual environment for enacting transformational role-playing, wherein students must learn new knowledge and competencies in order to successfully complete the game missions. *MHS* was developed for middle school science as a replacement unit of about six to eight hours and uses analytics and a teacher dashboard to help teachers support their students. The *MHS* game provides an active learning environment for meeting these learning objectives by engaging students in a narrative about needing to investigate water resources and use scientific argumentation to complete missions critical to the survival and accomplishments of the members of their scientific enterprise. Along with the narrative gameplay, *MHS* includes learning progressions for water systems science and scientific argumentation, a visually exciting environment, substantial interaction and feedback, and applies transformational role-playing as an approach to integrate learning within gameplay. A field test using a randomized control trial (RCT) was undertaken in Winter 2019 to rigorously evaluate the impact of *MHS* game play. The RCT included 13 teachers and their classes across sixth, seventh, and eighth grades comprising 632 students in the *MHS* condition and 229 students in the comparison group. The results of the RCT show that students using *MHS* achieved statistically significant learning gains associated with their understandings of water systems, and the *MHS* students demonstrated statistically significantly higher gains for argumentation than students using the comparison curriculum (p value = 0.00; g = .21).

http://www.mhs.missouri.edu

Digital Tools for Social Engagement Around Reading: A Case Study of Bookopolis

Cindy Lam (Stanford University)

Reading is a fundamental skill that is critical for academic success. Beyond basic development, building expertise as a reader requires prolonged engagement, in which reading is used both for pleasure and as a resource for learning (Guthrie & Wigfield, 2014). According to previous literature, interest-driven learning and social motivation can foster this sustained reading engagement (Fink, 1995; Guthrie & Wigfield, 2014). The present research aims to study classrooms that use Bookopolis, a unique digital tool for reading affording both interest-driven book exploration and peer-based reading recommendations. Using a mixed-methods approach, this study will examine how third- to fifth-grade students and teachers use Bookopolis—specifically what drives peer-based reading recommendations and how this influences reading behavior. Social network analysis will be used to investigate what drives patterns of recommendation uptake among students, as well as whether these patterns predict changes in the diversity of genres and amount of books that students read. This method will be complemented by qualitative interviews with students and teachers to inform an in-depth understanding of Bookopolis usage in the classroom. The results of this study will contribute insights on how social digital tools might be used to support interest-driven reading engagement in young readers.

The Makerspace as Sanctuary: How Three Fourth- to Eighth-Grade Teachers in New Jersey Suburban Schools Are Thinking About and Implementing Making With Students

Bridget Looney (Montclair State University)

Makerspaces and related "maker" activities, including tinkering with circuits and microcomputers and creating 3D designs with CAD software, have begun to make their way into K–12 schools and classrooms. At the same time, teachers are faced with deciding which aspects of making are most beneficial and practical to employ with their students. This presentation discussed how three teachers in suburban New Jersey schools are interpreting and implementing making with fourth- to eighth-grade students. Participant interviews and multiple classroom observations provided insight into the thinking and practices of two public school STEM specialists and an independent school fourth-grade social studies teacher. Preliminary findings of this multiple case study (Yin, 2017) illustrated a range of thinking about making among teachers, from a top-down emphasis on following the iterative cycle of design to a bottom-up emphasis on making meaning through creation. Participants seemed to agree on the benefits of peer-to-peer interaction and less-structured "playlike" activities for early adolescents. In fact, the public school participants appeared to regard their STEM practices as a form of quiet protest against the climate of accountability that permeates public school teaching and the academic pressures their students experience. In their view, the STEM elective was a sanctuary for students. These findings could be useful to teachers, school leaders, and policy makers looking for ways to encourage and support the development of makerspaces and making in schools.

Using Virtual Reality to Mitigate Culture Shock in Short-Term Study Abroad

Brian McCommons (Drexel University School of Education), Monique Woodard (Drexel University), & Mikhail Miller (Drexel University)

As the diverse range of study-abroad options is increasing, universities are offering more short-term study-abroad options that range from one to eight weeks. Students participating in these programs often spend their initial days or weeks in the country working through the effects of adjusting to an unfamiliar environment—in other words, culture shock. This study aims to use virtual reality (VR) as a tool to reduce culture shock before participants depart for their short-term study-abroad trip. In this conceptual design, students participate in a hands-on and immersive VR experience that enables them to navigate various physical and social environments that are different from their home environment. These virtual simulations include getting from the airport to their hotel via subway, checking into the hotel, buying food at the market, engaging in proper work etiquette, and dining in a restaurant. Upon completion of this pre-trip VR experience, it is expected that the effects of culture shock will be mitigated; thus, students will be able to take full advantage of the study-abroad experience.

What Maker Assessment Should Look Like: A Closer Look at the Design Process

Yumiko Murai (MIT Playful Journey Lab), Yoon Jeon Kim (MIT Playful Journey Lab), Stephanie Chang (Maker Ed), Louisa Rosenheck (MIT Playful Journey Lab), & Peter Kirschmann (MIT Playful Journey Lab)

While there are many benefits of making and makerspaces, one of the greatest challenges of implementing making in K–12 schools is the question of how to assess collaborative, cross-disciplinary, and iterative making practices and outcomes. Traditional summative assessment strategies do not capture or assess the open-ended, iterative, and dynamic nature of maker-centered learning or projects. Many existing assessment tools for maker-centered classrooms focus on the final project or a portfolio. This poster reports on the development of principles for assessment in making and learning and describes assessment tools, the Beyond Rubrics Toolkit, that we have iteratively designed to envision

how maker assessment can capture qualitative and quantitative evidence during the process of making. We explore the question of how rigorous evidence of process-oriented, social, and exploratory student learning can be observed and collected in real time, without constraining or interrupting the rich, complex, and iterative learning occurring in maker education.

http://makered.org/beyondrubrics

A Comparison of Goal-Directed Interactions in Improv Performance and Collaborative Problem Solving

Anthony Phonethibsavads (Indiana University), Britney Klotzche (Indiana University), & Joey Huang (Indiana University Bloomington)

Improv performance and collaborative problem solving (CPS) are both dependent on successful collaboration, but the goals are different, yet interactions between individuals and contexts are similar. By using conversation-analysis techniques, we strived to highlight similarities between improv performance and CPS by examining the co-occurence of improv rules, shared mental models, and CPS. This study compared interactions within one adult improv performance rehearsal, three adult improv form-creation workshops, and two eighth-grade computer programming classes. Each group consisted of three individuals of mixed expertise (i.e., one advanced, one intermediate, one novice) and roles assigned to each participant. Despite differences in contexts and individuals, there were similar co-occurrences of consensus building, goal orientation, and accepting and refining of ideas.

Mapping of Computational Thinking Resources in Elementary School: Case Studies of Coding Interest

Rose K. Pozos (Stanford University)

Increasing diversity in the CS pipeline is a long-standing concern (Margolis, Estrella, Goode, Holme, & Nao, 2010) and part of doing this is creating equitable pathways to CS. The CS for All movement has generated excitement around the country and fostered new strands of research about computer science education and computational thinking. Yet there are still many open questions about computational thinking and coding interest with elementary school–aged children. Since learning is distributed across time and space, it often looks different outside of school from what gets evaluated in school (Barron, 2014; Barron & Bell, 2015). Understanding what early computational thinking looks like and where and how students are learning these thinking skills is critical to beginning to develop and test lessons and assessments. This poster presents case studies of coding interest that explore the resources that children in a low-income school in Silicon Valley have to engage in digital practice and learn the fundamentals of coding. The analysis uses a learning ecology framework (Barron, 2006) to contextualize the students' learning resources and interests, and to map connections between them across time and space. While school appears as an important node for computational thinking resources, students' interest in coding builds across time and space, and indeed becomes most evident when we look at their time outside of school, where students use their time to learn and explore through networked resources including YouTube and online gaming communities.

WeScratch: Creative Coding Online Gatherings

Carmelo Presicce (MIT Media Lab)

WeScratch are free online gatherings for everyone who wants to learn how to create projects in Scratch, with support, feedback, and encouragement from others. The poster describes how the online learning experience is designed and presents a few case studies, some early results, and ideas for future directions.

https://wescratch.media.mit.edu

CellEnergy: Demystifying Photosynthesis With Gamified Digital Curriculum

Katrina Schleisman (Andamio Games), Adam Gordon (Andamio Games), Christopher Desjardins (University of Minnesota), Hazel Shackleton (Andamio Games), Martin Michalowski (Andamio Games), Sehoya Cotner (University of Minnesota), August Schwerdfeger (Andamio Games), Nelson Soken (Andamio Games), & Barbara Billington (University of Minnesota)

CellEnergy is an iOS educational app we developed to teach the basics of photosynthesis and cellular respiration for high school life-science courses. Through our many exploratory interviews with biology teachers, photosynthesis was identified as a particularly difficult subject area to engage students with, both because of its abstract nature and the invisible cellular processes it involves. As such we thought it was an ideal topic to address through an interactive learning app. CellEnergy exemplifies a hybrid approach to learning apps, in which the focus is primarily on learning outcomes with gamelike elements incorporated to make complex processes visible in an engaging and a playful way. The activities in CellEnergy are based on multiple evidence-based learning practices, such as retrieval practice, spaced learning, and immediate feedback. Virtual labs provide inquiry-based learning and reinforcement of science practices in the context of photosynthesis. The sequence of activities centers around a narrative in which users grow and harvest plants in order to create a common snack, such as chips and salsa, highlighting the relevance of photosynthesis in students' everyday lives. Students use points earned to buy supplies and decorative features for their "outdoor kitchen," which provides a motivational incentive for completing activities and adds a layer of gamelike engagement. Our project culminated in a cluster randomized controlled trial that included more than 600 students in 22 high school biology classrooms. We demonstrated that using CellEnergy resulted in significantly greater learning gains in both photosynthesis concept knowledge and science practices knowledge compared to standard instruction.

https://static1.squarespace.com/static/54ca95ede4b0bd5bc08a85cd/t/5d8e82c64f33c836185b7a90/1569620682943/CellEnergy_poster_for_CL.pdf

Restorying Geek Identity: Reimagining Computer Science Connections With Youth of Color Through Collaborative Quilts

Mia Shaw (University of Pennsylvania), James Joshua Coleman (University of Pennsylvania), Yasmin Kafai (University of Pennsylvania), & Ebony Elizabeth Thomas (University of Pennsylvania)

As computer science (CS) education research seeks to create more inclusive learning environments for minoritized youth, researchers must consider how youth's identities impact their CS participation. Not only can stereotypes about CS negatively affect youth's sense of belonging in the field (Cheryan, Plaut, Davies, & Steele, 2009), but CS classrooms and technologies can reproduce dominant narratives that alienate youth from various marginalized identities (Ashcraft, Eger, & Scott, 2017). Responding to this issue, the "Restorying Geek Identity" project seeks to broaden participation in computing by creating access for groups who have historically and systematically been shut out of CS. While learning computational skills in programming and designing interactive paper quilts, youth of color draw upon their lived experiences to reimagine new connections and stories about computer science. Our poster details a monthlong workshop that took place at a local science museum's STEM program comprising high school–aged students, most of whom identified as students of color. Using video observations and voice recordings, students' reflective worksheets and artifacts, and student interviews, we explore the following research questions: (a) What happens when students use computer science skills and digital technologies to restory their CS identities? (b) What kinds of metanarratives about CS and computer scientists do students identify? and (c) What does the process of restorying look like? Findings for this project include the implications of integrating CS and critical literacies with youth counterstorytelling and the development of intersectional CS identities, particularly as they connects to research and pedagogy in CS education.

Using Media to Support Early Science Learning

Megan Silander (Education Development Center), Naomi Hupert (Education Development Center), Philip Vahey (SRI Education), Claire Christensen (SRI Education), & Cindy Hoisington (Education Development Center)

What supports do parents need to foster science learning at home? We set out to answer this question by pairing a nationally representative survey with a qualitative study to investigate parents' perceptions of their role in children's learning, particularly science learning and particularly with the use of media. Most parents surveyed reported high levels of confidence in helping their young children with reading, mathematics, and social skills, while just over half of parents reported they felt very confident in their ability to assist their child in learning about science. Parents with less education were less likely than parents with more education to report that they felt very confident in their ability to support their children's science learning. An implication is that, in order to ensure that parents are comfortable with, and can support their children in using science media, developers of science media should design ways to boost parent confidence in science. Media can model or encourage everyday ways to engage children in science, provide relatable family science role models, and show that science can be about learning together rather than providing children with correct answers.

Developing Makerspaces in Libraries Throughout California: A Pilot Project With 10 Diverse Underresourced Public Libraries

Pamela Van Halsema (P Van Halsema Consulting) & Lisa Regalla (Regallium Consulting)

Developing Makerspaces in Libraries Throughout California is a pilot project from the California State Library in collaboration with the Bay Area Discovery Museum (Phase 1 and Phase 2), and Regallium Consulting (Phase 3). The project is establishing unique community-driven makerspaces in 10 public libraries in California. Participating libraries are geographically spread out across the state and were selected by prioritizing libraries that were underresourced as defined by budget, staffing, or serving a high-needs community. An essential component for the sustainability for these

library maker programs is to develop strategic collaborative partnerships, in which the library can engage with the local maker ecosystem, including education institutions, industry, civic groups, and government. In Phases 1 and 2 of the project, libraries conducted needs assessments, participated in training for maker education, launched prototypes, and made a plan for their makerspaces, which vary from a dedicated space, a mobile space, or a pop-up program. Each space includes a physical environment for making, local partnerships, and creative programming. In Phase 3, from September 2019 to July 2020, the makerspaces will launch and the planning tools and resources from the pilot will be refined, tested, and published in a toolkit that will include customizable resources to help future libraries build budgets, an action plan, a data-collection plan, a logic model, an elevator pitch, a program inventory, and a marketing plan to make mindful, data-driven, and intentional decisions when setting up their makerspace.

http://www.ccclibrarymakers.org/connectedlearning2019.html

Game-Based Learning: The Effect of Word Games and Elaboration on Learning Science Concepts

Elizabeth Veinott (Michigan Technological University), Warat Khaewratana (Michigan Technological University), & Shane Mueller (Michigan Technological University)

Word games (e.g., crossword puzzles) are used in a variety of educational settings to learn scientific vocabulary and develop scientific thinking. However, few controlled experiments examining learning in word games exist, and the focus of those few have been on immediate learning (Gaikwad & Tankhiwale, 2012; Whisenand & Dunphy, 2010). In this study, we make two contributions. First, we examine two factors found to be effective outside of games—desirable difficulty of clues (Bjork & Bjork, 2011) and elaboration (Craik & Lockhart, 1972) in a controlled experiment. Second, we test the phenomenon in a natural context of teams and after a 24-hour delay. Using a 3-word group x 3 study task (control, word game alone, word game and elaboration) within subjects, partial factorial design, 26 participants completed the task in teams. Elaboration involved a new hint for each word in the crossword. There was a main effect of study task on learning. Compared to their own performance in the control condition (what they do naturally), adding a word game and adding a word game plus elaboration improved participants' performance. These results were statistically significant and reflected large effect sizes (1.01 and 1.75, respectively) compared to the control condition. The findings provide some initial guidelines for best practices for educators and suggest that a small change could have a large impact on learning.

Does "Where" Matter?

Marina Wernholm (Linnaeus University)

I will present ongoing work with the introductory chapter to my compilation thesis, in which four studies address: different kinds of participation, participatory identities, characteristics of learning in digital gaming communities, and digital play as the "where" for children's learning—a theoretical conceptual framework for understanding digital play in modern childhood. The thesis will therefore add to the educational research field, taking interest in connecting children´s out-of-school learning experiences to their learning in school, by recognizing and building upon children's familiarity with digital cultures and digital literacies. The overarching research question of the thesis is: What aspects, from children's participation in digital play communities, appear to be of significance for connecting children's out-of-school learning experiences to their learning in school? The theoretical framing departs from Dewey's notion of experience, Lave and Wenger's theory about communities of practice, and their notion of legitimate peripheral

participation. Additionally, Wenger's conceptual framework provided an analytical tool with useful components (meaning, identity, practice, and community) for understanding and discussing children's experiences from learning in practice. By studying children's (8–13 years of age) actions and talk about actions in a variety of ways in different digital play contexts, in which the children are coming into presence as subjects, something significant can be said about what they actually experience and learn from participating in digital play. Results from the included studies will be presented as empirical models and as a tentative conceptual framework outlining children's pathways as participatory subjects.

https://connectedlearningsummit2019.sched.com/event/Seej

At Work and in Games: Case Study of Sandbox Video Game Behavior Reflecting Work Behavior

Sherry Yi (University of Illinois at Urbana-Champaign) & Christina Krist (University of Illinois at Urbana-Champaign)

In this case study, the author examines how a participant enacts and views transfer between one's job and gameplay in practice. Specifically, the thought process and problem-solving dispositions of Code Wizard, a lead mobile software developer in his 20s, are microanalyzed over an hour of *Minecraft* gameplay in which he builds an Iowa-themed roller coaster. The author argues that the participant displays similar behavioral patterns in-game as expected in his full-time job. The argument is not for a causal relationship, but that there can be a reflective relationship between playing sandbox games and one's career responsibilities.

Learning to Program While Learning English: Integrating Computer Science in an English as a New Language Course Through Personal Narratives

Marcos Ynoa (CUNY Graduate Center), Jeanette Marte (NYC Department of Education), Christopher Hoadley (NYU), & Sara Vogel (CUNY Graduate Center)

Just as learning to use a new language is more than memorizing verb conjugations and vocabulary, being computationally literate is more than ordering the keywords of a programming language with the correct syntax. It is about being an active participant in computational communities—creating, reading, and using code depending on the context and purpose. For this poster, we describe a co-created unit between a teacher and a researcher that integrates computer science into an English as a new language classroom, in which the teacher does not speak the home languages of her students. This unit approaches computational literacies by considering how language learning, and in particular, learning literacies with and through language, may provide clues for supporting students' participation in computing. Our approach is rooted in the philosophy of literate programming (that code is meant to be understood by machines and people) and a lens from bilingual education called *translanguaging* (bilinguals selecting varied linguistic, semiotic, and social features from unique language repertoires as they communicate and learn). We view code as a resource people use in constellation with other languaging practices to communicate with and for computers and other humans. Examples from classroom practice include an activity that guided students to narrate personal narratives orally that would transfer from a PowerPoint presentation to interactive projects in Scratch. These activities drew on a range of students' meaning-making practices, guiding them to put code in their own words and voices to participate in broader conversations.

http://pila-cs.org/

29. Showcases

Teaching Young People to Communicate (Better) Online

Michelle Ciccone (Foxborough High School)

Communicating online effectively, positively, and powerfully is essential for personal and professional success as well as for the forward movement of our democracy. This Showcase will explore best practices for addressing the online communication skills of young people, and will get you thinking about how you can explore this topic in your own classroom context.

Charge On! Fostering First-Year Persistence Through Digital Tools

Zoe B. Corwin (Pullias Center for Higher Education, University of Southern California), Tattiya J. Maruco (Pullias Center for Higher Education, University of Southern California), & Maria Romero-Morales (Pullias Center for Higher Education, University of Southern California)

University of Southern California's Pullias Center for Higher Education, the Get Schooled Foundation, and California State University, Dominguez Hills (CSUDH) recently piloted an approach to address the tenacious challenges of bolstering college student retention and success through a campaign called "Charge On!" The hybrid approach includes institution-specific content on a digital platform, a 1:1 textline connecting students with guidance experts, and gamification strategies intended to incentivize engagement. The campaign is designed to educate students about campus resources and cultivate skills conducive to college success in an engaging, meaningful, scalable, and cost-effective way. Specific objectives include: (a) bolstering a sense of belonging on campus; (b) building financial literacy; (c) promoting self-care; (d) cultivating study skills; and (e) fostering meaningful use of summer break. Research findings from the 2018–2019 academic school year document persistence outcomes, lessons learned, and potential for scale-up.

https://getschooled.com/toroschargeon

The Museum of Me: Exploring and Exhibiting Identity With the Video Game *What Remains of Edith Finch*

Matthew Farber (University of Northern Colorado), Paul Darvasi (Royal St. George's College), Susan Rivers (iThrive Games), & Michelle Bertoli (iThrive Games)

The Museum of Me high school English Language Arts unit leverages the rich interactive narrative in a commercial video game to support teens on a journey of self-inquiry by fostering social-emotional learning. The unit's centerpiece is *What Remains of Edith Finch*, a poignant narrative video game that tells the story of an 18-year-old girl's ostensibly cursed family history through the mechanic of exploring her childhood home, which has become a museum preserving the identities of her family members, most of whom have succumbed to tragic fates. The range of character vignettes in the

game provides an opening to discuss various aspects of identity: How objects can be used to define and perform identity; self-expression on social media; healthy and unhealthy coping mechanisms and the labels associated with them; family and social influences on identity formation; questions of diversity and sociocultural differences in understandings and expressions of identity; and the impact of choices on identity and questions of fixed versus malleable traits. The Museum of Me lessons (http://ithrivegames.org/museum-of-me/) were designed to support teens in a deep exploration of their own identities and reflection on what they share about their identities with others. Formative and summative assessments throughout invite teens to create multimedia expressions of their identities and those of the Finch characters as a form of active engagement and experiential learning. Across the unit's lessons, teens have opportunities to enhance their resilience in ways that respect and meet their developmental needs at this stage in life.

http://ithrivegames.org/museum-of-me/

Connecting Learners: Testing an Integrated Approach to Building Community Engagement

Andrea K. Flores (Harvard Graduate School of Education) & Dalia Abbas (Harvard Graduate School of Education)

In this presentation, we will discuss a test design for an integrated approach to building community in an online, personalized, foundational course being piloted this summer for students at the Harvard Graduate School of Education. First, we will discuss how we used learner journeys to visualize the learner ecosystem and identify hidden opportunities for community building that went beyond the boundaries of the learning-management system (LMS). Then, we will explain how we used these insights to arrive at our test design and explain the rationale for each facet of our approach. Finally, we will discuss any preliminary data we are able to gather from the pilot this summer as well as any questions and challenges that we encountered. Our aim is to leverage the connected learning community for feedback and recommendations to inform and iterate on the design for the next run of the course.

Designing Tools and Social Practices to Engage Families in a Learning Ecology to Increase STEM Participation Among Middle School Girls

Evelyn Flores (Northwestern University), Nichole Pinkard (Northwestern University), Denise C. Nacu (DePaul University), Sheena Erete (DePaul University), & Bo Ju (DePaul University)

As part of a larger effort to broaden participation of underrepresented middle school–aged youth in computing in one midsized city, we have been engaged in building a community of parents and caring adults in support of girls' participation in STEM. This work is centered on Digital Youth Divas (DYD), an out-of-school program that engages middle school girls in design-based engineering and computer science activities driven by a narrative story. In this presentation, we will highlight the design and rationale for tools and social practices intended to involve parents in the STEM learning experiences of their youth. Specifically, we will share details about the EL3 Parent Dashboard, and strategies we have used to encourage parents to learn about and reflect on their daughters' interests, skills, and activities. We will share insights that have driven our design decisions and present ideas and considerations for others who are engaged in community-based work to involve parents and families.

Manzanar Immersive: A Live Interactive Narrative Experience About Japanese American History

Randall Fujimoto (GameTrain Learning)

One of the most important lessons in U.S. history is about the Japanese American incarceration experience during World War II in which more than 110,000 Japanese Americans were uprooted from their homes and sent to live in American concentration camps in remote areas across the country. Most of us, especially students, learn about history through traditional media, such as textbooks, lectures, or websites such as *Wikipedia.* However, instead of being like traditional media, *Manzanar Immersive* is a live interactive narrative experience that shares important lessons about the Japanese American World War II history in a hands-on environment that combines the storytelling of immersive theater with the engaging nature of escape-game puzzles. *Manzanar Immersive* is a completely in-person, "empathy" experience in which teams of people collaborate to solve puzzles, complete activities, and interact with character actors as they proceed through the narrative of a Japanese American family living through the hardships of the wartime experience. *Manzanar Immersive* helps people of all ages learn about Japanese American history, culture, and values along with other learning skills, such as collaboration, communication, and empathy. *Manzanar Immersive* is designed to be a modular, mobile production that can be set up and used in various locations, including schools and museums. The entire production takes place in a single classroom space that is partitioned into separate areas. The design is intended to be used as a framework for educational live interactive narrative experiences about other learning content, including any K–12 and college academic subjects.

http://japantownproductions.com/manzanar-immersive/

Building History 3.0 Project

Randall Fujimoto (GameTrain Learning), Janet Chen (UCLA), Kim Bathker (Building History 3.0 Project), & Renee Tajima-Peña (Building History 3.0 Project)

Building History 3.0 is an interactive web project that uses the 3D construction and exploration online video game *Minecraft* to engage young people and the public with the historic meaning of World War II Japanese American incarceration camps. It was created to engage the public—especially young people—with the historic meaning of World War II Japanese American incarceration camps. It explores the ways different generations have reclaimed and interpreted these sites, not only as places of trauma, but also of community building, creative expression, and learning. The preservation, dialogue, and understanding of these moments in history are increasingly important for students to understand. Far more than a straightforward history lesson, Building History 3.0 encourages students to explore themes of civil liberties, democracy, immigration, and civic engagement. Young people sometimes perceive history lessons to be boring, placing emphasis on the memorization of facts, dates, and ready-made concepts. We aim to encourage young people to learn independently, investigate sources, think critically about history, and to analyze multiple perspectives. Building History 3.0 provides a platform for students to explore the balancing of national priorities with the rights of individuals and minority groups, the meaning of constitutional protections and the Bill of Rights in our daily lives, how democratic processes are strengthened or weakened during times of national crisis, and assessing the representation of racial and ethnic groups.

Design of Computational Thinking Curriculum for Multilingual Learners

Leiny Garcia (UC Irvine School of Education), Sharin Jacob (UC Irvine School of Education), Ha Nguyen (UC Irvine School of Education), Mark Warschauer (UC Irvine School of Education), & Debra Richardson (UC Irvine School of Informatics and Computer Science)

University researchers and in-service teachers co-designed a curriculum for computational thinking instruction to upper elementary students.The process was held under a research-practitioner partnership, in which researchers and practitioners investigated the state of computer science education in a district with a high student population of Hispanic, multilingual learners and of low socioeconomic status. Such findings were used to inform the adaption of a curriculum for computational thinking that meets the needs of the districts' culturally and linguistically diverse students. As a result, an online and open-source computational thinking curriculum was designed to align with computer science and literacy standards, provide linguistic scaffolding, include culturally responsive materials, and integrate inquiry-based approaches.

https://sites.google.com/uci.edu/uci-conectar-4th/level-1-curriculum-2-0

Yes, They Can Make That: A Study of Young Learners in the World's First Early Childhood Fab Lab

Helen Hadani (Bay Area Discovery Museum), Katie Kennedy (Bay Area Discovery Museum), & Elisabeth Sylvan (Berkman Klein Center for Internet & Society at Harvard University)

The Bay Area Discovery Museum's (BADM) research and advisory division investigated how young children's experiences in a fabrication laboratory (Fab Lab) impact their understanding of and interest in digital fabrication and how to best design makerspace experiences for children ages 4 to 10. This research focused on providing children experience with a 3D printer, laser cutter, and vinyl cutter. Nine 7- to 10-year-olds and 12 4- to 5-year-olds engaged in two respective age-appropriate Fab Lab programs. All participants completed a series of pre- and postassessments that investigated developmental differences in and effects of their Fab Lab experience on: (a) understanding of the three digital-fabrication tools; (b) self-efficacy with regard to digital fabrication; and (c) general impressions of their Fab Lab experience. Observational data were also collected, including photographs of children's projects and journals (notebooks for planning and reflection). Additionally, educators and parents were asked to complete a survey and/or interview on their views and experiences with early childhood makerspaces. Because of the novelty of digital-fabrication activities for children, this work will beneficially provide unique insight into young individuals' experiences in the world's first early childhood Fab Lab.

Thinking Sideways: Computational Thinking and Early Literacy in the Public Library

Claudia Haines (Homer [AK] Public Library) & Paula Langsam (DC Public Library)

We need diverse and divergent ideas to solve big problems. How do we prepare young children to be able to communicate and express themselves in a connected world? What are the key critical-thinking skills that young children

(ages 3–8) and their families need in order to understand, navigate, and create in all media formats? We use playful, child-led activities in storytime at public libraries to explore the relationship between early literacy and computational thinking skills. Creating low-stress, informal learning experiences supports young children as they become successful problem solvers, creative thinkers, and lifelong learners in informal education spaces.

Mobilizing for Creative Learning: A Citywide, Ecosystem Approach

Marijke Hecht (University of Pittsburgh), Mac Howison (The Heinz Endowments), Esohe Osai (University of Pittsburgh), & Thomas Akiva (University of Pittsburgh)

What is creative learning? Which children get to experience it? How can we design the learning landscape for more equitable access and opportunity? We formed a research-philanthropy partnership between researchers from the University of Pittsburgh and program officers from The Heinz Endowments to address these questions. Our aim was to both describe the rich complexity of the creative learning ecosystem in Pittsburgh, Pennsylvania, and to help identify those system elements that are thriving and those that may be lacking. Using a collaborative process of regular meetings and open communication, we achieved a common project vision while accepting the diverging needs of research and practice. Creative learning is a process of and an approach to learning that includes art as well as other experiences where creation is central, such as making. Building on our team effort, we held eight focus groups with leaders of creative learning organizations (N = 38) and conducted two surveys—one for organizational leaders (N = 53) and one for educators (N = 83). We learned that the Pittsburgh creative-learning ecosystem is robust and contains more than 250 named organizations. We did not find that the size of an organization, based on budget, determined organizational centrality in the overall system; both large and small organizations were well connected. However, the ecosystem struggles with achieving equity in three areas: race, resources, and reach. Our team is continuing to work together to consider ways to address these inequities and forge a stronger creative-learning ecosystem.

http://tiny.cc/CLPgh

Practera: An Online Platform to Support and Scaffold Experiential Learning

Andrea Humez (Northeastern University) & Nikki James (Practera)

Experiential learning projects with real-world connections embedded into the curriculum help students recognize the relevance and applicability of their classroom learning to the STEM workplace, build awareness of the range of STEM career options available, develop the professional skills employers value, and expand their professional networks. At Northeastern University's College of Professional Studies, these virtual internships give students the opportunity to work on short-term, real-world projects to complement their academic work. Students are matched with sponsors from industry, who play the role of the client, supplying the project, setting expectations for deliverables, and reviewing the final product. The cloud-based Practera platform structures and supports such experiential learning programs to help everyone involved get the most out of the experience and promote student learning outcomes, sponsor retention, and educator best practices. This presentation shares case-study examples illustrating the kinds of scaffolding that may be needed to support learning during virtual internships, and how specific Practera features can provide or enhance such scaffolding. These features include customizable, individualizable learning content; peer- and self-assessment cycles to support teamwork skills and negotiation of team roles; sponsor-feedback loops; team chat; "pulse checks" designed to unearth potential collaboration issues; and real-time learning analytics that help educators monitor how the student/

sponsor collaboration is going and identify moments when support or coaching may be required. This work is supported by funding from the National Science Foundation under the Improving Undergraduate STEM Education program, IUSE Engaged Student Learning Development, and Implementation award 1725941.

http://www.practera.com

Adaptable, Scalable, Measurable: Using Story Builder to Create *Healthcare America,* an Immersive Newsgame

Juli James (The University of North Texas) & Sara Champlin (The University of North Texas)

Story Builder is an interactive game-design platform created to serve the ever-changing, complicated challenges of communicating news to the general public. In our fast-paced society, journalists must cover a variety of complex topics with a short turnaround. Additionally, it is critically important that general audiences can understand, interpret, and make use of the information presented through news outlets. Tools that support journalists' endeavors to disseminate information quickly—as well as immerse the public in ways that help increase their understanding of critical news content—are needed. In this project we developed a "newsgame" on a topic that is challenging for readers and journalists, but one for which news coverage can help educate diverse audiences—health insurance. This project showcases the benefits of the Story Builder platform, including the ability to make updates to game content quickly, such as in response to breaking news. The Story Builder is also designed to be used by any audience, including journalists who may not have programming backgrounds. Finally, through a second iteration, we tested an integrated survey function, which allows researchers to examine the cognitive and affective outcomes of the game. In this Showcase we will demonstrate what we did to create a game on a hotly debated topic, why this matters for society, and how others can use Story Builder for games on other critical topics.

Teacher and Artist Partnerships: Collaborative Design of Integrated Learning Experiences

Anna Jordan-Douglass (Makefully), Christine Torres (EPiC Elementary), & Carly Bogaards (EPiC Elementary)

Through a residency program organized by a local arts organization, classroom teachers partnered with a teaching artist to integrate the arts into a science curriculum focused on weathering and erosion. As a project-based learning school, the school partner was practiced at structuring interdisciplinary projects that map to standards. By adding outside expertise in digital media production, puppet design, and performance, the team was able to create a project that tapped into student interest beyond the classroom to engage learners in a project that had meaningful real-world connections. The result of the partnership was 50 second-grade students structured into six production crews, which each created a mini-documentary featuring puppet hosts and hand-built sets. The students engaged in the science and engineering practices to gather research, identify a real-world problem, and design a solution to that problem. They worked on every part of the production, turning their research into scripts, designing puppets and sets, performing their pieces, and editing to create the final video. Throughout the project they were not only deeply connecting with the science content; they learned how to frame their information to create an engaging and entertaining performance, while creating characters, sets, and props to support their writing. While this integration across content areas naturally

met standards, it also met another high-level goal for the teaching artist: to validate the power of well-structured collaboration.

https://www.youtube.com/watch?v=5S27WOS-juw

What Is a STEAM + Design-Thinking Activity? Designing Wearable Technology Accessories

Rie Kijima (University of Toronto), Kathy Sun (Santa Clara University)

This session examines how design thinking can be used as a tool to inspire girls toward STEAM fields. We will share about an immersive design-thinking experience that our team facilitated with three cohorts of middle school girls that engaged them in the various stages of design thinking (e.g., empathize, define, ideate, prototype, and test) to design a specific product for a particular user. Through engagement in and reflection on this activity, participants will gain understanding for why design-thinking activities have the potential to increase girls' interests in STEAM.

Mission HydroSci: Educational Game Meets the Classroom

James Laffey (University of Missouri), Troy Sadler (University of North Carolina), Sean Goggins (University of Missouri), Joe Griffin (University of Missouri), Justin Sigoloff (University of Missouri), Eric Wulff (University of Missouri), Andrew Womack (University of Missouri), & Wenyi Lu (University of Missouri)

Mission HydroSci (MHS) is a game-based 3D virtual environment for teaching and learning key concepts and knowledge of water systems as well as building competencies in scientific argumentation in ways that support meeting Next Generation Science Standards (NGSS). Meeting these new science education goals for middle school students requires rich learning contexts for exploring substantive science ideas through engagement in scientific practices. The *MHS* game provides an active learning environment for meeting these learning objectives by engaging students in a narrative about needing to investigate water resources and use scientific argumentation to complete missions critical to the survival and accomplishments of the members of their scientific enterprise. Along with the narrative gameplay, *MHS* includes learning progressions for water-systems science and scientific argumentation, a visually exciting environment, substantial interaction and feedback, and applies transformational role-playing as an approach to integrate learning within gameplay. This Showcase described *MHS*, represented our process for developing *MHS*, and presented some insights and lessons learned about the use of *MHS* in classrooms, including excerpts from interviews with 12 teachers who participated in a 2018 feasibility testing. Students achieved learning objectives at a statistically significant level and teachers reported that students were focused and engaged. An unexpected outcome was the number of teachers who reported an unusually positive social environment during gameplay and that some students who typically struggle in science class did surprisingly well and even became class leaders.

http://www.mhs.missouri.edu

SportsLab: An Online Platform for Connected Learning

James L. Larsen (EdGE at TERC), Teon Edwards (EdGE at TERC), Elizabeth Rowe (EdGE at TERC), & Jodi Asbell-Clarke (EdGE at TERC)

During the 2018–2019 school year, students from 30 U.S. middle school classrooms participated in the SportsLab Parkour Shoe Design Challenge (NSF/iTEST #1311901), a competition created and hosted on EdGE at TERC's SportsLab online platform for project-based learning. It featured a series of milestones and missions, set in a virtual environment, with a storyline and background on sport research, shoe design, and design thinking, and connected with real-world activities to encourage STEM, 21st-century skills, and career awareness. More than 280 teams participated, creating deliverables to exhibit understanding of related content, concepts, and skills. This SportsLab Challenge culminated in teams' submitting final deliverables—an Inspiration Board and Parkour Shoe Pitch—judged by experts in sports research, Parkour, and education. Top designs received prizes from our industry partner Nike. Results showed SportsLab: engaged a broad and diverse group of youths that leveraged students' real-world interests to foster their abilities and engagement in STEM problem-solving using online and real-world hands-on learning experiences; exhibited broad application in diverse education settings, demonstrating the program's ability to attract a range of audiences; helped students understand and envision expanded opportunity for themselves in the STEM workforce through its integrated digital narrative, videos, hands-on activities, and design challenge; and was highly motivating, even for those who did not see themselves as science learners. With industry involved in a digital transformation, the need is growing to fill jobs with a larger, more diverse population of skilled, motivated workers. SportsLab is a way to address this need.

https://edge.terc.edu

Bridges or Circuitry?: Changing How We Think and Talk About Connected Learning Through Strategic Frame Analysis

Kevin Levay (FrameWorks Institute), Lori Takeuchi (Joan Ganz Cooney Center at Sesame Workshop), Nat Kendall-Taylor (FrameWorks Institute), Andrew Volmert (FrameWorks Institute), & Kiley Sobel (Joan Ganz Cooney Center at Sesame Workshop)

To prepare for a 21st-century workforce, students are developing skills in science, technology, engineering, and math (STEM). But STEM learning does not happen only in the classroom; it also happens at home, in libraries, museums, and afterschool centers. Informal settings such as these are essential to learning, yet members of the public do not fully appreciate the value of STEM learning outside of school or understand the need to connect the learning that happens in different environments. How can advocates make a stronger case for connecting STEM education across settings? Through the Families Learning Across Boundaries (FamLAB) project, the Joan Ganz Cooney Center and FrameWorks Institute are attempting to shift how the adults in children's lives—parents, teachers, afterschool clubs and daycare providers, librarians, and other community-based organization professionals—think about where and when children's STEM learning occurs. In this Connected Learning Summit Showcase, we described the process and findings of our research on how to improve public understanding of STEM learning, and ongoing efforts in training key leaders in education, policy, advocacy, and the press/media to effectively communicate with constituents. We also shared an online toolkit based on the research that provides strategies for communicating about connecting STEM learning environments. The toolkit is available at https://www.frameworksinstitute.org/toolkits/wiring-up/.

http://joanganzcooneycenter.org/initiative/families-learning-across-boundaries/

Design, Disrupt, and Don't Forget to Play!: Game Development for Democratic Citizenship

Rosanna Lopez (SparkleLAB Design & Innovation Hub)

SparkleLAB Design and Innovation Hub was founded as a research and development space dedicated to transforming education. Its mandate: to help kids grow smart, kind, creative, and fun—with a knack for tech and the ability to combine content expertise, empathy, and out-of-the-box thinking to develop innovative solutions to some of the world's greatest problems. The Showcase presentation Design, Disrupt, and Don't Forget to Play focuses on one of SparkleLAB's afterschool programs, Gamemakers, designed for kids and teens between the ages of 7 to 18. The Showcase explores how a program centered on design, storytelling, experience architecture, and game development can also foster the values of responsible citizenship and critical making. As participants navigate their way through a story-centered curriculum set in a dystopian Philippines where play and games are outlawed, young people come to realize the value of play, the importance of civic participation, and the power of design to positively influence the world around them.

https://sparklelab.ph/gamemakers

What Happens When Student Passion, Interests, and Activism Collide?: Reimagine High School

Matsuo Marti (Civitas Education Partners) & Lahari Goud (Civitas Education Partners)

Civitas Education Partners (CEP) is reimagining schools. An overarching consensus of the Stanford University's 2017 policy forum on K–12 education was the need to transform the status quo in education. For the 2018–2019 school year, CEP piloted an innovative, startup learning experience for high school seniors at ChicagoQuest, a small high school serving students who are 90% Black, 7% Hispanic, and 90% economically disadvantaged. The Civitas Community Impact Experience (CCIE) emboldens courageous leaders to discover their unique talents, interests, and passions through inspired community projects, challenges, and opportunities. CCIE inspires, challenges, and prepares students to impact their communities and the world as consultants, designers, activists, and social entrepreneurs. Teams of high school seniors work collaboratively and use their passion, collaborative responsibility, and activism in order to solve authentic challenges pitched by community organizations, businesses, or student ventures. Through the CCIE experience, students learn and apply knowledge and skills associated with collaboration, complex communication, critical thinking, creativity, and project management, as well as other important 21st-century skills such as: being resilient, learning from failure, making quick adjustments, dealing with conflict, managing meetings, and networking and public speaking. As students master course competencies, CCIE students earn four high school credits: Senior English, Statistics, Global Studies, and Workplace Experiences. Results from the CCIE pilot indicate that deep learning and personal transformation happened on projects that connected student passion, interest, and activism. Not only did attendance and GPAs increase, but more important, students developed increased agency, identity, and competency.

http://CCIEChicago.org

From Concept to Classroom: Co-Designing and Implementing an Historical Inquiry Game as a Method to Foster Teacher Professional Growth

James Mathews (University of Wisconsin, Field Day Lab), David Gagnon (University of Wisconsin, Field Day Lab), & Peter Wardrip (University of Wisconsin)

As part of a cross-institutional game-design project, our team created a Teacher Fellowship program that engaged three cohorts of elementary school teachers in co-designing a history game for third- to fifth-grade students. The game, called *Jo Wilder and the Capitol Case*, is an adventure-style game in which players use historical-inquiry practices to locate and analyze a series of historical artifacts. The Teacher Fellowship program had several intersecting goals, including: (a) to produce a freely available video game that would get used in classrooms to develop students' capacity for doing history (Levsitk & Barton, 2015); and (b) to provide a professional learning experience that would lead to growth in teachers' knowledge, beliefs, and practices tied to the use of games and historical-inquiry activities in their teaching. To help us understand how teachers engaged with the fellowship, we used the interconnected model of teacher professional growth (Clarke & Hollingsworth, 2002). This model provided an analytic tool that helped us map the different pathways that teachers' professional learning took. In this presentation we will describe the Teacher Fellowship program, including the principles that guided how and why we developed it. We will also highlight components of the fellowship that teachers found most salient in relation to their own professional growth and explore how these shaped their beliefs, attitudes, and classroom practices. Finally, we will identify gaps that need to be addressed in future programming.

https://fielddaylab.wisc.edu/play/jowilder/

ARG-in-a-Box: Challenges in Designing an Anytime, Anywhere Science-Themed Alternate Reality and Augmented Reality Game for Middle School Youth

Judy Perry (MIT), Scot Osterweil (MIT), & Caitlin Feeley (MIT)

Alternate reality games (ARG) and location-based augmented reality (AR) games leverage their ability to overlay narrative along with a digital layer of information onto real-world contexts, allowing players to investigate real and fictional phenomena and offering players meaningful choices, making them ideal tools for engaging youth in science education. However, both genres can be challenging to implement in educational settings (e.g., schools, museums, and out-of-school programs), for both the game designer (e.g., requiring real-time behind-the-scenes facilitation of the ARG), as well as the game facilitator (e.g., customizing activities and/or the location-based AR game for their local setting). This paper describes a new approach, ARG-in-a-Box, along with the two goals of this project, (a) iteratively designing an "ARG in-a-Box" prototype that engages youth in scientific thinking through a series of related activities, and (b) describing the design and technological infrastructure necessary to support this anytime/anywhere approach.

Connecting to Place Through STUDIO: Mobile City Science

Erin Riesland (University of Washington) & Don LaBonte (University of Washington)

Our team set out to design and implement an afterschool curriculum that leverages spatial and locative technologies to explore youth connections to community and place. Situated in a recently revitalized HOPE IV neighborhood (Housing for People Everywhere) historically synonymous with crime and inequity, we worked with middle and high school youth as part of an afterschool STEM (science, technology, engineering, and mathematics) program. Youth were presented with a series of spatial "learning on the move" (Taylor, 2013) activities that made use of mobile technologies and were guided by undergraduate mentors. In the field, youth took immersive 360º photosphere images that were then uploaded into a virtual building space. Through our curriculum, we aimed to challenge rhetoric around technology's role as an agent of displacement and isolation. Youth worked collaboratively with near-peer mentors across technologies to re-present, create, and inscribe themselves into locative technologies that mediate place. Final projects combined common location-aware technologies and virtual reality (VR) creation software. Google Earth walks in VR inspired new perspectives of community while virtual painting provided a way to create 3D materials to add into the VR world-building platform. Together these mundane and novel locative technologies enabled youth to inscribe themselves back into place-making and place-learning technologies. Google Maps was used to trace and curate youth's real and virtual experiences and creations. Youth's immersive virtual worlds were shared using smartphones and Google Cardboard viewers.

Youth Voice: Expanding the Boundaries of "Public" in Public Media

Denise Sauerteig (KQED)

Youth voices have been taking and holding center stage in the national consciousness. In December 2017, *The California Sunday Magazine* published an all-teen issue—stories written by and about life as a teenager today. In 2018, *The New York Times* announced it was looking for student writers to "explore issues that you and your friends would like to see in The Times." And in the wake of the school shooting in Parkland, Florida, and the subsequent March for Our Lives movement, student voices have moved to the forefront of social media and broadcast media. KQED is broadening the concept of "the public" in public media, breaking through traditional boundaries and expanding youth voice on the airwaves. KQED's Youth Takeover began in April 2018 with a week of youth contributors from classrooms around the Bay Area taking over the airwaves. It expanded in April 2019 with educator professional development on media making and workforce development for youth on journalism media creation. This Showcase will present process and outcomes from the first two Youth Takeovers and discuss ways to scale up the work, while also engaging audiences in helping us redefine "public" and how youth voice can continue to reach mass audiences.

Meteor Writes: A Science Storytelling Workshop for Teens

Shoshi Shapiro (Field Museum) & Chris Bresky (Adler Planetarium)

Meteor Writes was a collaborative, four-day science storytelling workshop that brought together teens, educators, scientists, and artists from the Adler Planetarium and Field Museum. This pilot program explored the curiosity that art and science share, and it culminated in teens' sharing out two pieces of work in different mediums they explored throughout the week.

https://drive.google.com/file/d/0B8eO-7hpGFTeZXBtTmU3d3Z1TWhPTkhFQWhWMHlJV2dtbnBB/view?usp=sharing

Connected Learning in Rural Areas: Strategies for Implementation

Lance Simpson (Tuscaloosa Public Library) & Linda Braun (LEO)

Public libraries and other similar third-space community organizations have been ideal adopters of the connected learning framework. Dedicated to providing access and equitable learning opportunities, these institutions serve an important role in providing out-of-school education for children and teens. Through work with the IMLS-funded Transforming Teen Services: Train the Trainer project with COSLA and YALSA, library practitioners on the state and local levels have provided training around connected learning, computational thinking, and child and youth development to library staff across their respective states (Alabama, Maine, Minnesota, Rhode Island, and Wisconsin) through a yearlong pilot program that will soon be administered nationally. While the project's purpose has been to increase access to support and professional-development opportunities, it has generated great discussion around the following research problem: How do we deploy the connected learning framework as a viable means for shaping in- and out-of-school learning in the rural United States? Rural areas provide unique challenges in meeting the educational needs of children and teens, especially as it relates to connected learning, including a lack of public transportation, access to high-speed Internet, opportunities for engaged learning out of school, and more. Library staff from Alabama and Minnesota alongside the principal investigator for the project will provide observations from their respective states, including needs presented to them at the state and local levels. This team will facilitate a discussion to develop strategies to further inform current efforts to address the needs in a sustainable, replicable way.

Ensuring Civic Engagement and Responsibility in Youth Media Programming

Soni Sinha (Free Spirit Media)

As the landscape of media and journalism constantly changes and we face unique local, national, and global issues, Free Spirit Media is using digital media and community reporting as a medium to transform society. Learn how Free Spirit Media's hands-on curriculum, reporters, and media makers are activating communities, encouraging civic engagement, and fostering responsible media creation and consumption. Look at the many ways that Free Spirit Media is empowering the next generation of civically engaged creators and leaders. Learn from staff and program participants about how the organizational structure and leveling-up process allows youth and young adults to excel within programs and establish careers in creative industries. See how heightened media skills, high-quality production, expert interviewing, and application of advanced technologies have helped youth make an impact throughout Chicago and receive national recognition, including an Emmy for Outstanding Achievement for Public Service Announcement. Gain more specific insights and curricular strategies from Free Spirit Media's community newsroom, the Real Chi. View how participants are pushing the boundaries of creative expression and impact journalism. Learn how to incorporate solutions-based and project-based learning in media programming. Also, be part of the actual media creation and journalistic process by refining the skills involved in storytelling, pitching a new idea, interviewing subjects, and preserving integrity in reporting. Use workshop takeaways in areas of civic and community engagement, inclusion, youth voice, equity, equality, and inclusion to enrich and inform your practices. Presenters will cover the impact and possibilities of media and distribution, and the intersection of youth development, education, community engagement, creativity, cultural awareness, and representation. Activities and breakout groups will focus on using media as a tool for solving issues of equity, equality, workforce development, and inclusion. The interactivity of this workshop is designed to allow attendees to personally experience Free Spirit Media programs and to help attendees benefit from programmatic learning.

http://www.freespiritmedia.org

Families@Play: Supporting Young Children's Understanding of Computational Thinking Through Unplugged Family Activities

Sinem Siyahhan (California State University, San Marcos) & Bekir Mugayitoglu (STEM Family)

Throughout the last decade, computational thinking (CT) has emerged as a set of concepts, practices, and perspectives (Brennan & Resnick, 2012) that everyone (not just computer scientists) needs to develop to participate in the 21st century successfully. While a significant amount of effort has been put into integrating CT across the pre-K–12 curriculum, an area that still needs further investigation is how we can support young children's understanding of CT in the context of the home. This workshop aims to address this gap by (a) inviting participants to learn about the unplugged CT family activities developed and tested by the researchers, and (b) engaging them in a design-thinking process in which they create their own unplugged CT activities for families with young children (ages 4 to 7). The workshop will conclude with a reflection on participants' experiences and a group discussion on the challenges of and opportunities for this area of research and development.

DC Storytelling System: Neighborhood Circulation of Civic Stories: How New Infrastructure for Storytelling Can Retain Local Culture and Build Community

Benjamin Stokes (American University), Hazel Arroyo (American University), Mitchell Loewen (American University), Tambra Stevenson (American University), & Olivia Williams (American University)

The right stories can anchor neighborhood identity, boost collective organizing, and strengthen the sense of belonging. How can cities invite residents to participate? This project investigates a transmedia "storytelling system" for neighborhoods, designed to circulate audio stories and digital photographs beyond institutional walls. Residents discovered the system at one of several neighborhood libraries, each featuring a "satellite exhibit" of a larger Smithsonian show on DC neighborhood history. Our design invited participation in a digital layer tied to physical sites. Most prominently, the system featured repurposed payphones, a storytelling truck, and a multimedia texting system to connect key locations around the city. The system recruited residents' own stories of neighborhood history, even as it circulated specific oral histories from city archives. Print media such as postcards proved essential for scavenger hunts and learning activities, shaping playful experiences around neighborhood stories. Rather than a game per se, the playful approach helped to open new space for conversation and story circulation. Over 18 months, the project demonstrated how connected learning at the neighborhood level can prioritize inclusion by balancing transmedia organizing with locally controlled platforms. As a provocation, this design helps to question some of the major assumptions about how mobile media should work for cities and community-based learning. What does it mean it we prioritize storytelling networks, rather than individualized learning or even individual empowerment? How can neighborhoods build their own infrastructure for storytelling and civic learning at the neighborhood level?

https://dc.storytelling.city/2019/10/05/our-model-cls19-connected-learning/

The MetaLiteracy Augmented Reality Quest (MARQ)

Andrew White (Rensselaer Polytechnic Institute) & Lillian Spina-Caza (Rensselaer Polytechnic Institute)

According to the National Center for Education Statistics (NCES), 14.6% of U.S. students from low-income families complete a bachelor's degree in less than 10 years. While some students can circumvent this, many students' time in college is prolonged by financial and academic difficulties from an inadequate secondary education. In addition, budget cuts have forced many schools to reduce staff, wages, and resources. Of the positions lost, the NCES reported a 15% decrease in librarian positions nationwide from 2009 to 2016, which risks students' access to materials, research skills development, critical thinking, and digital literacy. MARQ is an augmented reality game quest designed to guide students through the process of locating, evaluating, applying, and citing sources in the library. The application will lead students through the library, prompting the user to interact with the wide variety of information sources and formats that libraries provide. At different points in their library journey, students find hints on how to complete their "quest." Some clues (images, videos, and/or documents) are superimposed virtually via the game-device camera lens over the physical space. By using gameplay as a method to familiarize students with library resources and increase skill acquisition and retention, future increased usage of the physical and digital library could yield information that sparks novel ideas and leads to new knowledge creation. Development of MARQ also allows for data-collection opportunities with preliminary and concluding literacy tests to ascertain what skills are acquired through gameplay.

Education in an Era of Viral Deception: *NewsFeed Defenders*

Kelly Whitney (iCivics), Carrie Ray-Hill (iCivics), & Peter Paccone (San Marino High School)

What do good games and good journalism have in common? How do their differences actually help us use games to teach news-literacy skills? The team at iCivics will present on their new game, *NewsFeed Defenders*, and outline how a civics education site took a step into the ever-important world of news literacy.

Exploring STEM Impact and Engagement in Student-Led and Purpose-Driven Projects (Aka—Make With Data)

Cassie Xu (Lamont-Doherty Earth Observatory, Columbia University) & Nathan Holbert (Teachers College, Columbia University)

The Make With Data project, a collaboration between Teachers College and Lamont-Doherty Earth Observatory of Columbia University, aims to address the lack of diversity in STEM fields by engaging high school–aged learners in an informal setting that uses data and data science to identify a compelling local community challenge and to design and implement a solution. Using service learning and constructionism frameworks, we are studying how framing STEM practices as being a way of contributing to and improving one's community might increase interest in STEM fields. However, rather than create a one-size-fits-all activity that assumes a community problem, the Make With Data project aims to develop and study design frameworks for creating personally meaningful and learner-centric experiences and activities that can be deployed in a broad range of communities with similar demographics. By engaging students throughout New York City (NYC) in data-science practices with data experts to identify local challenges, we expect

students might develop strong personal connections to problems they identify and the solutions they create, which will in turn positively impact their STEM interests.

Conversational Agents as Educational Video Co-Viewers for Young Children

Ying Xu (University of California, Irvine) & Mark Warschauer (University of California, Irvine)

Science television shows or videos are an important source of informal education and enrichment for preschool-aged children in the United States, who spend an average of two hours daily on screen media at home or in other nonschool settings. However, the educational benefits of television shows have long been limited by programming that does not allow children to interact with the content in any true sense. As such, many studies have suggested that family members co-view video with children and provide scaffolding, although this practice is not common, especially for children in lower socioeconomic households.To maximize the benefits of time spent on screen media, this project leverages an intelligent conversational agent (CA)—an on-screen character capable of mimicking social interaction—to add social contingency into children's experience watching science videos. Specifically, the interactive character asks children questions that intermittently pause the video, priming children to engage in science inquiry practices, and offers contingent feedback that varies based on children's responses. A small field test showed that children enjoyed the interactive viewing experience and actively engaged in the scientific reasoning with the CA. This finding suggested that CA could potentially be an effective video co-viewer for children, with the goal of enhancing engagement, learning, and oral language skills. Implications of the current work and future directions will be discussed.

https://www.digitallearninglab.org/Conversational-Agents-for-Young-Learners/

Networked Narratives: Digital Alchemy, Take 3!

Mia Zamora (Kean University)

Seeking to transform what is possible in the real world via a fictional community and exercising collective civic imagination, Networked Narratives, or #NetNarr, is a three-year experiment in "digital alchemy" (http://netnarr.arganee.world). In Spring 2017, 2018, and 2019, Mia Zamora and Alan Levine conducted an open online connected course that has been co-located at Kean University in New Jersey and the University of Bergen in Norway. Although the course has always included traditional university students, it also has a following of "open participants" who do not share the same institutional affiliations. #NetNarr-ians have considered the darkness of the open web (i.e., exploring questions regarding the effect of data tracking, algorithims, AI and machine learning, the attention economy, and filter bubbles) and they have also sought the light (participants have inhabited personas, remixed digital media, and explored the role of multiple identities in networked spaces). #NetNarr has included "virtual field trips"—live video visits with international artists and scholars to explore the latest in digital storytelling, electronic literature, digital poetry, and fanfiction. In addition, the #NetNarr community has explored cryptography, bot making, interactive fiction, #netprov, and collaborative web annotation with Hypothesis. This Showcase will account for the development of #NetNarr as an open storytelling community, as we consider the intersection of co-learning, networks, civic imagination, pedagogy, and digital writing/making. What was successful; what has failed? It will feature new selections of digital artifacts and networked writing as well as key "takeaways" from the experiment.

30. Symposia

Fair Play: Designing Accessible Games and Digital Experiences

Harley Baldwin (Schell Games), David Lowenstein (PBS Ready To Learn), Dennis Ramirez (Twin Cities PBS), Joan Freese (Twin Cities PBS), & Shannon K. Bishop (PBS Kids)

Contemporary educational media producers aim to create equitable products that are accessible to audiences with disabilities. Using academic frameworks, such as universal design for learning (Center for Applied Special Technology, 2012) and other research-based best practices, as well as practical examples from industry, producers are broadening product and program design, production, and outreach/distribution. Producers from PBS Kids, Schell Games, and Twin Cities PBS will share their teams' processes and perspectives for making media projects more accessible to children and adults with disabilities. They will share examples from their work as well as successes and challenges for enhancing experiences for all audiences. Learn effective, practical, and innovative approaches for expanding audiences with equitable tech-centered engagement.

Scorpions, Snakes, and Crocodiles: Pitfalls and Aggressions to Avoid When Promoting a Diverse and Inclusive Culture of Collegiate Esports

Jason Engerman (East Stroudsburg University) & Anthony Betrus (SUNY Potsdam)

Collegiate esports is growing at a phenomenal rate and holds potential benefits that educational institutions are drawn to, such as developing leadership, communication, and team-building skills in our young adults (Mott, 2018; Seminski, 2018). The current work on inclusion in esports program development emphasizes sophisticated plans for codes of conduct, task forces, staff recruitment and training processes, and welcome arena events (Amazan-Hall et al., 2018; Wu, 2017) to enhance diversity and inclusion. These sound strategies, however, can fall short of fully speaking to current internalized pitfalls and aggressions present within the esports landscape. Players, fans, coaches, managers, and administrators can often exacerbate inclusionary growth unknowingly and against their own best interests. The current symposium will not only address these biases (both visible and hidden), but also provide remedies and prevention techniques, ensuring the promotion of a sustainable, thriving, diverse, and inclusive culture of collegiate esports. The two presentations in this symposium will display practical experience from five universities, including ongoing research from three universities that include data on inclusive esports camps and workshops. The presenters include three female esports captains, three esports directors, two researchers, and one former professional esports player. The focus will be on providing in-depth player and fan data that report firsthand accounts and experiences, along with data from a National Science Foundation grant supporting STEM competency development for at-risk youth through esports activities.

https://docs.google.com/presentation/d/1XqmgPg6G5DryPzuu6_icIEnICUWGYNlZZu4JKyQqLxw/edit?usp=sharing

Connected Learning Experiences: Understanding Creativity, Materiality,

Artistry, and Affect in Computing

Deborah Fields (Utah State University), Yasmin Kafai (University of Pennsylvania), Anna Keune (University of California, Irvine), Kylie Peppler (University of California, Irvine), Lindsay Lindberg (University of California, Los Angeles), Mia Shaw (University of Pennsylvania), James Coleman (University of Pennsylvania), Maggie Dahn (University of California, Irvine), David DeLiema (University of Minnesota), & Theresa Tanenbaum (University of California, Irvine)

Researchers have only recently started to investigate the phenomenology of learning to code. That is, little is known about students' emotional experiences with the process of learning to code and furthermore, how to design environments that support their affective, creative, and artistic experiences with computing. At the same time, we must not forget to consider depth and rigor in learning to code. Instead, we must consider how to provide and study more holistic coding experiences, incorporating the social, emotional, cognitive, and creative aspects into those experiences. In this symposium we bring together scholars focusing on four different projects in which arts and computing converge. They consider the role of computing in traditional material arts, how students bring in unexpected means of creativity to physical computational domains, and how to facilitate a conscious reflection of emotion in computing through art making. What does it mean to be creative and expressive in computing and how can educators support that? Keune and Peppler discuss fiber crafts as an origin point for computational thinking; Lindberg and Fields share how students connected lived community experiences into imagined spaces in e-textile murals; Shaw and Coleman relate the ways students of color restoried their geek identities in computational paper crafts; and Dahn and DeLiema describe debugging as a source of artwork and emotional expression. In the end, Theresa Jean Tanenbaum draws on her expertise in narrative, play, and digital technology in bringing together the various elements from each presentation into a holistic consideration of learning experiences in computing.

Game Data Analysis to Understand Players, Design, and Learning

David Gagnon (University of Wisconsin), Vishesh Kumar (University of Wisconsin-Madison), Erik Harpstead (Carnegie Mellon University), Elizabeth Owen (Age of Learning), Dennis Ramirez (PBS), & Stefan Slater (University of Pennsylvania)

This session intends to provide CLS attendees with a survey of how researchers and designers are working at the intersection of video games, educational data mining, and notions of connected learning. In the first part of the symposium, participants will hear of several projects that are using data generated from gameplay to describe and understand their players and how the resulting analysis provides new insights for game design and new ways to describe learning and knowing enacted within games. The session will conclude with a demonstration of an educational data-mining process using live data from national audiences playing a middle school science game in schools. The panelists and audience will discuss and critique each step of the process, from the validity of the events being recorded to the player models that are constructed from the data.

Dungeons & Dragons, Distributed

Jeffrey B. Holmes (Arizona State University), Earl Aguilera (California State University, Fresno), & Kelly M. Tran (High Point University)

This symposium explores the diverse learning pathways and movements different players take around the tabletop role-playing game *Dungeons & Dragons* (*D&D*). We use a conceptual framework we call distributed teaching and learning systems (DTALS), which complements and extends the connected learning framework by emphasizing the range of designed and emergent teaching resources learners encounter around complex problem spaces such as *D&D*, and how movement across these contexts (sites, people, time) is crucial in understanding the deep and uniquely shaped learning that occurs for different learners. During the session, we include audience participants in a streamlined *D&D* play session to highlight multiple perspectives for analysis and to highlight key features of the DTALS framework, including how the game master and players negotiate and customize learning pathways to fit their specific needs and interests. The session design includes the use of designed teaching resources (game manuals, game master knowledge) and "planted" resources that player-participants may discover; we also invite them to use tools and resources at their disposal Internet browsers, Twitter, other audience members, etc.). Each of these resources connects to the *D&D* activity and forms a network of people and things that participants may (or may not) use, uniquely shaped and enacted for each player. Ultimately, this session highlights the role of learners as co-designers and the critical but often underexamined role of teaching across contexts in order to expand the important insights of the connected learning research agenda.

Notes as Nodes in Connected Learning

Jeremiah Kalir (University of Colorado Denver), Christina Cantrill (National Writing Program), Mia Zamora (Kean University), Kira Baker-Doyle (University of Illinois at Chicago), Gardner Campbell (Virginia Commonwealth University), & Nate Angell (Hypothesis)

Web annotation draws upon centuries-old practices of adding marginalia, information, and commentary to books and other print manuscripts, and it extends this layer as an interactive feature of the web, turning digital texts into discursive contexts. Despite growth in the use of web annotation among diverse learning and professional contexts, a need persists to describe and document how web annotation mediates collaboration, learning, and knowledge production. This symposium featured a moderated conversation about the relationship between web annotation and connected learning. A panel comprising five educators and researchers working in K–12, higher education, and open-learning contexts addressed questions about design principles, collaboration patterns, and learning practices associated with their use of web annotation across multiple projects and learning environments. Featured projects—including the Marginal Syllabus (http://marginalsyllab.us/), Networked Narratives (http://netnarr.arganee.world/), and Augmenting Intellect (https://framework.thoughtvectors.net/)—have all used the free, open-source web annotation tool Hypothesis (https://web.hypothes.is/) to mediate collaboration and learning among students, educators, and professionals. Featured panelists included Christina Cantrill (National Writing Project), Mia Zamora (Kean University), Kira Baker-Doyle (University of Illinois at Chicago), Gardner Campbell (Virginia Commonwealth University), and Nate Angell (Hypothesis). Panelists responded to questions about: (a) the design practices that meaningfully supported and sustained collaborative annotation for connected learning; (b) the various forms of collaboration, including discipline-specific and civic, afforded by web annotation; and (c) the learning practices and outcomes engendered by open and collaborative web annotation. The conversation was moderated by Remi Kalir (University of Colorado Denver).

Cultivating Creative Learning Communities Across Contexts: Opportunities, Challenges, and Potential Paths

Yumiko Murai (MIT Media Lab), Carolina Rodeghiero (MIT Media Lab), Lily Gabaree (MIT Media Lab), Carmelo Presicce (MIT Media Lab), Marian Muthui (MIT Media Lab), & Yusuf Ahmad (MIT Media Lab)

In today's rapidly changing society, the ability to think and act creatively is becoming recognized as an essential skill. A growing number of educational initiatives are promoting creative learning—in which children learn through making projects that build on their interests, in collaboration with peers, through a process of tinkering and experimenting. This session provides participants with a variety of perspectives on creative learning initiatives around the world: Brazil, Italy, Japan, Kenya, South Africa, and the United States. The presenters share their experiences facilitating creative-learning initiatives in their local contexts. Although these initiatives grow out of the shared learning philosophy, they are taking different approaches—from grassroots organizing of local workshops and festivals to facilitating online communities where educators exchange ideas and resources. By highlighting diverse strategies, challenges, and opportunities, we seek to engage participants in a conversation on how we can collectively cultivate creative-learning communities across the globe.

https://www.media.mit.edu/groups/lifelong-kindergarten/overview/

What's Art Got to Do With It?: Arts Integration Models as a Foundation for Connected Learning

Jessie Nixon (University of Wisconsin-Madison), Anna Jordan-Douglass (Makefully), Emily Schindler (University of Wisconsin-Madison), & Nathan Wheeler (University of Wisconsin-Madison)

The connected learning scholarly community has looked through a variety of lenses to understand how people learn in networks. There is much more to understand about how networks develop, how to sustain them, and further, how we can leverage these networks for teaching and learning. Modes of arts integration offer a useful scaffold for expanding networks of social capital for teaching and learning (Yoon & Baker-Doyle, 2018). In this symposium, authors will present four separate case studies that showcase different ways to capitalize on existing resources for arts integration, and thereby awaken learners to the rich network of resources, institutions, and tools for creative learning. In addition to showcasing a range of modes for networked teaching and learning through the arts, these case studies show work taking place in a variety of settings, including an informal, community-based youth program for video production, a partnership between formal teachers and teaching artists, and a teacher professional-development community that takes place in a children's museum makerspace. Together, these case studies tell the story of how arts integration represents an important foundation and source of expertise for the development of networks for creative learning.

Struggle, Frustration, and Equity in Making and Connected Learning: Key Perspectives and Strategies on Reframing Failure Into Productive Struggle

Jessica Parker (Exploratorium), Stephanie Chang (MakerEd), Jean Ryoo (University of California, Los Angeles), & Colin Dixon (Concord Consortium)

This symposium explored ways to reframe failure into productive struggle in creative learning contexts. Presenters began by highlighting research and key strategies for supporting productive struggle in making-oriented education. This was followed by a hands-on, challenge-based activity in which participants took on roles of learners and observers. The last half of the symposium included facilitated conversation in which small groups shared about their experiences learning/observing, refined and built on the research-based key strategies and structures shared by presenters, and reflected together on the role of struggle and frustration in connected learning. This symposium provided an opportunity for attendees to connect the latest research to practice, explore a making activity that they could bring to their own learning contexts, face challenges in creative processes while reflecting on the metacognitive and emotional experiences youth undergo, and consider new ways to support learners through challenging moments.

http://www.tinyurl.com/CLS2019Struggle

Three Approaches to Exploring Twin Cities PBS Educational Game Telemetry

Dennis Ramirez (PBS), Momoko Hayakawa (PBS), Betsy McCarthy (WestEd), Melissa Cheung (WestEd), Mingyu Feng (WestEd), & Matthew Berland (University of Wisconsin-Madison)

Current technology allows researchers to collect gameplay data with an unprecedented level of resolution. Mouse clicks, state transitions, and other user interactions (both inside and outside of the game) can be recorded, stored, and analyzed. With access to this wealth of data it is important to determine which data are useful, and how to make use of this data in ways that will ultimately inform and improve student learning. This symposium explores three approaches used to collect, visualize, and interpret telemetry produced by students playing a game created for *Hero Elementary*, an upcoming educational television show and suite of educational activities developed by Twin Cities PBS's (TPT) Ready to Learn program. This session will comprise three parts, during which the authors will summarize their role in the project and their approach to collecting or analyzing gameplay data.

Developing a Youth Esports Federation: A Case Study of Connected Learning in Action

Katie Salen (University of California, Irvine), Jessamyn Acebes (UCI Esports), Tom Turner (Orange County Department of Education), & Constance Steinkuehler (University of California, Irvine)

The North American Scholastic Esports Federation (NASEF) is both a sports program and a model for the design of connected learning environments. The league meets students where they are by tapping into a gaming interest. It helps youth connect this interest to relationships and opportunities through a near-peer coaching program, school-based clubs, associations with professional esports organizations, and a standards-based curriculum. Most critically, it was designed with the understanding that youth learn and develop an interest over time, across settings, and in partnership with others. This symposium will explore how NASEF was conceived, from the beginning, as a connected learning intervention. Rather than thinking of the league as a program, the team charged with its design, implementation, and support has viewed the league as a set of learning experiences loosely organized around a shared vision. Founding organizations include the Samueli Foundation, Orange County Department of Education, University of California, Irvine (UCI), OC STEM Initiative, and Connected Camps. Participating groups from UCI include UCI Esports, the Connected

Learning Lab, the School of Information and Computer Science, and the School of Engineering. Collaboration among these various stakeholders has helped grow the league into a thriving platform linking researchers, educators, parents, esports players, game companies, and sponsors together in pursuit of genuinely engaging, resilient, and relevant learning opportunities for youth. From its founding mission to its design and associated research agenda, the federation has shown a deep commitment to systemically supporting youth in pursuing their interests, developing meaningful relationships, and offering access to opportunity.

https://nasef.org

Designing Connected Learning: From Research to Resource

Katie Salen (University of California, Irvine), Sam Dyson (Chicago Learning Exchange), Rafi Santo (CSforALL/Telos Learning), & Kiley Larson (Kansas City Social Innovation Center)

The evolution of connected learning has been powered in part by a partnership between design, research, and practice. Efforts to identify, build, support, and study connected learning environments have been fueled by teams of designers, educators, youth, and researchers working together in a spirit of experimentation and iteration. In moving from research to practice, what kinds of guiding theories of design are needed? What kinds of tools and supports are required? Helping youth equitably access and navigate connected learning requires attending to the features and affordances of the learning environments in which they engage. Removing obstacles and barriers, enabling connections to peers and caring adults, creating connections across settings, and enabling future learning opportunities are all part of this work. This symposium will profile three resources developed by veteran members of the connected learning community, created to help guide the design of connected learning environments, programs, and platforms. They include A *Connected Learning Design Framework* (Katie Salen), *The Connected Learning Guide* (Sam Dyson and Kiley Larson), and *Brokering Youth Pathways*: A *Toolkit for Connecting Youth to Future Pathways* (Rafi Santo).

Scaled Platforms for Kids' Creativity

Katie Salen (University of California, Irvine), Champika Fernando (Scratch Foundation), Alan Gershenfeld (Eline Media), Leah Hanes (TwoBit Circus Foundation), Genevieve C. Johnson (Roblox), & Allisyn Levy (BrainPOP)

What does it take to scale innovative platforms designed to ignite and nurture kids' creativity? What kinds of market forces must be considered? What are the keys to sustainability? This panel brings together some of the brightest minds behind platforms such as Roblox, Scratch, BrainPOP, Gamestar Mechanic, and TwoBit Circus to discuss what has worked (and what has not!) in bringing their creative tools to scale.

Digital Diversity: How Social, Cultural, and Real-Life Circumstances Shape Youth Digital Media Practices

Katie Salen (University of California, Irvine), Mizuko Ito (University of California, Irvine), Henry Jenkins (University of Southern California), & S. Craig Watkins (University of Texas at Austin)

While we often think of "digital youth" as sharing common experiences, research is increasingly highlighting the diversity of youth experiences online. Understanding the differences between youth digital participation is as important as understanding how digital technologies have shaped a generation. This emphasis on diversity and difference is particularly important given trends toward political polarization, the proliferation of platforms and affinity networks, and with higher-cost and higher-bandwidth forms of digital engagement such as virtual reality, augmented reality, and 5G networks on the horizon. A broader palette of forms of online participation and affiliation offer new avenues for validating interests and identities for diverse youth. At the same time, these trends open up risks of new kinds of digital participation gaps, echo chambers, and political polarization. Jenkins, Ito, Salen, and Watkins will explore a set of cross-cutting issues around factors mediating youth digital practices, the importance of social relationships and networks in supporting and sustaining youth interest and engagement, and the critical challenges posed by technology, diversity, and equity. Questions include: How do social, familial, economic, cultural, and political factors shape youth digital participation? How do diverse forms of online affiliation and participation support youth agency, voice, and learning? What are the threats to equity and democracy suggested by this diversifying landscape of online participation? What can youth organizers, educators, researchers, and designers do to amplify the benefits and mitigate against the harms of diversifying digital participation?

From Computational Equity to Computational Justice: Critical, Culturally Relevant, and Social-Impact Computing Education

Rafi Santo (CSforALL), Michael Lachney (Michigan State University), & Sara Vogel (CUNY Graduate Center)

How should we think about computing education and its relationship to justice? While dominant equity frames around computer science (CS) education center on making CS learning accessible to all youth ("for all") and especially underrepresented groups ("broadening participation"), these frames have notable limitations when it comes to questions of justice. There are, however, many research and practice initiatives in formal and informal digital media spaces that share a commitment to justice—from antiracist design tools to sociotechnical economic empowerment—as a core value, with distinct visions and differently grounded approaches. In this structured poster session, computing education researchers and practitioners will share examples of different justice-centered CS education projects. We analytically group these projects into three "families": (a) computing education for social impact (technology as a means of promoting social change); (b) critical computational literacies (technology as subject of critique and site of resistance or remix); and (c) culturally responsive computing (computing as situated practice in cultural context). This session will explore the divergences and convergences within and across these "families" of justice-centered computing education, promoting interrogations of the dominant pedagogical and methodological assumptions around CS teaching and learning. By challenging these established boundaries, we aim to radically reimagine who, where, and what counts as computing education across all sites of learning and cultural participation.

Exploring Identity Construction in Virtual Reality Systems

Meredith Thompson (MIT), Danielle Olson (MIT), Dan Roy (MIT), & Pablo Ortiz-Lampier (MIT)

Research has shown that learners' real-world identities and virtual identities have a significant impact on educational outcomes. The process of establishing a virtual identity can not only reveal aspects of a learner's real-world identity, but it can also influence the way he or she interacts with a piece of educational technology. In this symposium,

we will ground a discussion of virtual identity in three immersive, educational artifacts: *Cellverse* (Thompson, Wang, Roy, & Klopfer, 2019), *Passage Home* VR (Olson, 2019), and AIRvatar (Harrell & Lim, 2017). *Cellverse* is a cross-platform, collaborative game in which pairs of students diagnose and treat a diseased cell. With respect to identity, the aims of the work are to support learners' self-image as scientific thinkers, to support the development of a professional identity, and to support the legitimate peripheral participation in a community of practice. *Passage Home* VR is an interactive narrative VR game that operationalizes a novel computational model of racial and ethnic socialization (RES) (Hughes et al., 2006) as a step toward improving approaches to virtual race and ethnicity representation in video games. AIRvatar is a tool for monitoring, collecting, and storing telemetry data developed to study real-world and virtual identity phenomena. As part of the NSF-backed Computing for Advanced Identity Representation project, AIRvatar was used to study the impact of virtual identities on educational outcomes. During the workshop, attendees created avatars using AIRvatar, engaged with interactive system demos of *Passage Home* VR and *Cellverse*, and engaged in a discussion of the power and challenges of virtual identities.

Reclaiming Your Space in STEM: Supporting Nondominant Youth Through Creative Expression With Representation and Cultural Resonance

Jaleesa Trapp (MIT Media Lab), Britney Johnson (MIT Media Lab), & Linnea Bostrom (Industrial Design Engineering and Art High School)

What does a scientist look like? An engineer? Do they wear braids and gold hoop earrings? Do they collect sneakers? Is Beyoncé their favorite artist? What does their job look like? Do they fight for environmental justice? Do they design clothes? Allowing nondominant youth to see themselves as engineers, computer scientists, chemists, physicists, mathematicians, and so on—who embrace their personal interests—is revolutionary. Having a pathway into a STEM education and career can lead to access to a healthy lifestyle that includes wealth, stable housing, the ability to afford proper health care, and eliminates violence. Allowing nondominant youth to discover what they are capable of creating is giving them the power to change their lives. In this symposium, we explore how to break down barriers for nondominant youth interested in STEM by providing culturally and socially relevant examples of what is possible and feasible steps to entering and sustaining a STEM career. We discuss how to be purposeful in setting up equitable learning spaces that allow STEM exploration. Additionally, we encourage youth who already have representation in STEM fields to practice allyship. It is necessary to provide dominant youth with a framework to use their privilege to support their nondominant peers in order to see a lasting shift in representation within STEM education and careers.

Assessment in Library Makerspaces: Opportunities and Challenges

Peter Wardrip (University of Wisconsin), Tim Carrigan (Institute of Museum and Library Services), Stephanie Chang (Maker Ed), Jordan M. Smith (Buffalo and Erie County Public Library), Rebecca Millerjohn (Madison Public Library), Caitlin K. Martin (Northwestern University), Eric Reyes (Chicago Public Library), Ephran Ramirez (Chicago Public Library), Lisa Brahms (Children's Museum of Pittsburgh), Annie McNamara (University of Pittsburgh), Vishesh Kumar (University of Wisconsin-Madison), & Sam Abramovich (University at Buffalo)

More and more libraries are offering learning experiences through making and makerspaces. As this momentum continues—as well as that for hands-on learning experiences in general in libraries—practitioners need ways to develop strategies, tools, and frameworks to assess learning and engagement in maker-based learning experiences for a variety

of reasons, such as program/practice improvement. This symposium brings together individual presentations of researchers and practitioners designing assessments with library staff for work in their makerspaces as well as presenters addressing national-level perspectives. The audience participants will gain understanding of the strengths and challenges of three specific projects as well as engage in discussion with others about this work.

The Future Is Now: Games as Assessment

Dan White (Filament Games), Scot Osterweil (MIT), Louisa Rosenheck (MIT), & Peter Stidwell (FableVision)

Our symposium is structured around how games can not only cultivate but assess future-facing skills (popularly known as 21st-century skills). Our discussion will consist of three pillars—*The Problem:* Today, there exists growing awareness that the future will require of us "noncognitive" or "21st-century skills." However, school as it is currently structured militates against developing these skills. Standardized testing emphasizes individual achievement over collaboration. Siloed instruction does not promote synthesis of ideas from different domains. And a growing trend of treating education as vocational training favors narrow skills over broader understanding. Once we have established the landscape of existing hindrances to the cultivation of 21st-century skills, we will begin to explore examples of how games can help to modernize the teaching and assessment of these competencies. *How Games Can Help*: Next, we will discuss how games can be used as tools to both promote and assess key future-ready skills through the lens of four unique titles developed by FableVision Studios, Filament Games, and the MIT Education Arcade. *Challenges Ahead:* After an in-depth exploration of the examples detailed in Part 2, our panelists will assess what the future holds for game-based learning in terms of future-facing skills assessment. How do we assess these key 21st-century skills in ways that are accountable? How do we convey to game players that these skills are transferable to the real world? Our panel of experts will ponder questions such as these as they prognosticate what lies ahead for game-based teaching and assessment of future-ready skills.

Connected Learning Across Sociocultural Borders: Designing to Support Immigrant Parents

Marisol Wong-Villacres (Georgia Institute of Technology), Wendy Roldan (University of Washington), Jason Yip (University of Washington), Carmen Gonzalez (University of Washington), Betsy DiSalvo (Georgia Institute of Technology), Alexander Cho (Connected Learning Lab), Ricarose Roque (University of Colorado Boulder), & Emily Roden (ReadyRosie)

This symposium brings together researchers and practitioners to share cutting-edge initiatives that support immigrant parents' participation in connected learning environments. From a connected learning perspective, it is essential for young people to have the support of a network of peers, teachers, and parents facilitating their pursuit of personal interests or passions, as well as their ability to link these experiences to academic achievement. While there has been a growing interest in exploring the role of parents in these networks, we are just beginning to understand how parents from nondominant backgrounds such as immigrants and refugees fit in this picture. These groups' differences from the norm often keep them in conditions of extreme information poverty, complicating their ability to harness resources for advancing their children's lives. Against this background, in this symposium we highlight the strategies of resilience and unique funds of knowledge that immigrant parents have developed that might serve as an inspiration for connected learning initiatives. This symposium will feature five approaches to supporting immigrant parents as connected parents,

varying from exploring the potential of intergenerational parent-children online interactions, to articulating the precise role of technology in the information ecology of immigrant parents, to methods for designing and deploying assets-based interventions for these parents. We conclude by opening the discussion to the audience about how to expand the vision of connected learning to populations with nondominant information and technology practices.

31. Tech Demos

Voices Heard and Unheard: Practicing Equity in Managing Whole-Class Discussions

Amanda Aparicio (Massachusetts Institute of Technology), Justin Reich (MIT), Garron Hillaire (MIT), & Meredith Thompson (MIT)

When directing a class discussion, teachers must consider many factors: Who speaks? For how long? And what type of questions are they asked? In this Tech Demo, participants will experience a simulation called Managing Whole Class Discussions designed to give teachers the opportunity to manage a whole-class discussion. We will then reflect and discuss in-simulation actions using the EQUIP tool (Reinholz & Shah, 2018), an analytic framework for "quantifying" equity in a class discussion to promote teacher reflection. Participants will also look at data visualizations of simulated data to give feedback for future design iterations.

Mobile Responsive Training Packages to Enhance Distance Learning

Zoe Baptista (Education Development Center)

This Tech Demo outlined how staff at Education Development Center (EDC) are using a simple authoring tool to repackage our live webinar events, conference calls, and email communications into streamlined online training bundles for our audience. These supplemental online training packages have helped support a blended learning approach in our self-paced online trainings that historically have been broken up into disparate pieces. These user-friendly packages enable our audience to find all the materials for their training in one easy-to-access link. It is all organized and customized for each audience so they can quickly locate the webinar recordings (if they miss a live event), handouts, online toolkits, conference call-in information, videos, podcasts, website references, and more. EDC staff curate the information and materials in each supplemental training package for each distinct audience so they have a more tailored training experience with minimal effort on our part. It does not cost much; it does not take a lot of time or programming expertise to build; it is mobile responsive; and, we can quickly and easily update the online content in real time. This session explained how these packages have helped us deliver our curriculum much more easily and efficiently to our virtual audiences and streamline communication to these audience members. Above all, this approach is a perfect example of how EDC develops innovative delivery mechanisms for capacity building in response to the needs of our audience.

https://sched.co/Segc

Social Media TestDrive: Enhancing Social Media Literacy Through Experiential Learning in a Social Media Simulation

Yoon Hyung Choi (Cornell University), Amanda Purington (Cornell University), Philipp K. Masur (Johannes Gutenberg University Mainz), Janis Whitlock (Cornell University), Dominic DiFranzo (Lehigh University), & Natalya N. Bazarova (Cornell University)

Social media literacy is a vital but rarely taught skill set for today's youth. To address this problem, we have developed an innovative social media literacy–education platform called Social Media TestDrive. This tool provides youth with a safe place to learn about and experience social media without the potential negative impacts of being on a real social media site. Social Media TestDrive features a social media simulation that provides a realistic but protected environment for learning. Each educational module offers multiple opportunities for learners to discover key concepts and to practice social media skills and mindful decision making. Education occurs through demonstrations of prosocial behaviors, guided activities in which learners can practice skills, exploration on the social media simulation's time line through free play, and reflection. Topics specific to social media literacy are covered in our educational modules, such as online privacy, self-presentation, and cyberbullying. The main goal of Social Media TestDrive is to enhance core media literacy competencies in middle school youth who are on the brink of engaging in the world of social media. To this end, the program aims to impart skills and self-efficacy for prosocial behaviors on social media platforms and to develop the ability to critically evaluate social media, including message quality, credibility, and consequences.

https://socialmediatestdrive.org/

Election Lab: Where STEM Meets Civics

Stuart Criley (Indelible Learning) & Jasminka Criley (Indelible Learning)

Election Lab combines math and civics in a game-based learning platform for middle and high school students. It opens the eyes of learners to the hidden but strategic role of STEM professionals in increasingly data-driven presidential campaigns. The games present learners with one of several actual election scenarios from recent history—from landslides to very tight races. The game design is a hybrid of a board game and computer, leveraging advantages of both formats. The physical board game uses large, high-resolution electoral maps and manipulatives; provides a hands-on experience; uses an intuitive and accessible format for planning and executing campaigns; and increases accessibility for English language learners and others who may not benefit from traditional presentations of math concepts. The accompanying computer speeds up play with an interactive display that updates after each state battle; automatically calculates the electoral vote totals for each candidate; and most important, captures gameplay data for later statistical analysis and discussion. The result is a novel informal learning program that uses math to understand strategies used in elections, and that uses data generated from gameplay to allow learners to think like statisticians. Elections come alive when they are played, driving history learning. Finally, experiencing an election from the point of view of a campaign strategist, and understanding the convoluted mechanics of the Electoral College firsthand, will engage future voters, especially for populations that have historically low voter participation.

Super Word: A Voice Game for Children With Communication Impairments (CwCI)

Yao Du (University of California, Irvine), Adriana Meza Soria (Department of Informatics, University of California, Irvine), Katie Salen Tekinbaş (Department of Informatics, University of California, Irvine), & Andre van der Hoek (Department of Informatics, University of California, Irvine)

Communication impairments affect approximately 10% of U.S. youth between ages 3 and 17, and therapy practice remains a major challenge for children with communication impairments (CwCI). Two major factors contribute to this challenge. There is a lack of parental support to connect what children learned from schools and clinics with parent-child activities in the home setting, and existing therapy materials and activities need to be facilitated by adults. Connected learning acknowledges the complex and interconnected character of the spaces in which children develop communication skills and recognizes the diverse settings in which learning happens (Ito et al., 2013). To leverage the ubiquitous voice technology Amazon Echo for a connected learning experience for CwCI, we designed *Super Word*, an Alexa game that allows children between ages 3 and 6 to participate in voice-based language activities at home. Drawing from a series of vocabulary and sentence tasks from conventional language assessments, *Super Word* uses multiple types of auditory stimuli (e.g., sounds, rhymes, and definitions) to elicit voice-based responses from children during gameplay. We present our game prototype in the technical demonstration and discuss the upcoming plan for usability evaluation and field deployment. Future work aims to extend this novel interaction using conversational agents (such as Amazon Alexa, Google Assistant, Apple Siri, etc.) via commercial smart-home speakers to develop game-based speech and language applications, thereby bridging the disconnection between formal learning environments (e.g., school and clinics) and home.

Constructing Haenyeo: Defamiliarization and Sensemaking in the Serious Game-Design Process

William Dunkel (University of California, Irvine) & Minerva Wu (University of California, Irvine)

Sensemaking occurs at both fronts of visual cognition—creation and interpretation. We explore the first front of visual culture cognition, the work of designers and artists, by developing the game *Mermaids of Ieodo*, which represents in an analog card game the traditional cultural practices of the Korean Haenyeo, diving women of Jeju Island. Game elements intend to capture themes in Haenyeo practices, including meditative engagement with nature, cross-generational interaction, historical influences on the community, ecological preservation practices, and ethical attitudes toward technology. Through the process of defamiliarization (Bell, Blythe, & Sengers, 2005) and making strange the process of creating a visual cultural artifact, we aim to break down the first front of how visual culture is read. By participating in the process of creating a visual culture artifact and cataloging our design choices, we are able to interrogate the construction of an East Asian cultural experience. Situating this traditional practice in an analog card game allows the game to engage with both the technological and traditional imaginaries that Korean culture operates in.

Passion to Purpose

Mindy Faber (Convergence Design Lab Columbia College) & Margaret Conway (Convergence Design Lab)

Convergence Design Lab's Passion to Purpose (P2P) is a free open-source and delightful online tool that lets learners flex and grow their civic-imagination muscles. Users are guided through a series of fun prompts (e.g., What do you geek out about? What do you want to protest?). With the aid of a built-in randomizer, they land on an unexpected "How might we question." Think of it as a brainstorming tool on steroids that helps learners land at the starting gate fully prepared to launch their own inspired project for media action and civic change. Created and coded by an intergenerational team of educators and creative technologists at Columbia College's Convergence Design Lab—P2P is built for formal and informal educators who want to spark creative ideas and help learners turn their intrinsic interests into extrinsic actions that can mobilize their peers and communities. Passion to Purpose is the first gamelike module in an integrated suite called the Civic Imagination Toolkit being developed by Convergence Design Lab. Our mission is to help educators cultivate learner agency and civic participation using design thinking and connected learning principles. The toolkit includes a facilitator guide that allows educators to easily adapt the tools for a project-based learning classroom or workshop contexts.

Global Game Jam NEXT: A Curriculum for STEAM Learning

Matthew Farber (University of Northern Colorado)

Global Game Jam is the world's largest game jam and until recently, targeted adults. Considering the potentially significant role of games and game development as educational platforms, in 2018 Global Game Jam launched GGJ NEXT, for youth aged 12–17. Now, GGJ NEXT has been iterated for Year 2, held in July 2019. The goal of GGJ NEXT is to establish a model and curriculum for students anywhere to learn basic game-development skills (programming, art and design, storytelling, in combination with communication, collaboration, and planning) as a basis for STEAM education and within the context of an exciting global effort that can bring youth together from different countries and continents. Considering the younger target group, our high-level criteria distinguishing GGJ NEXT from GGJ were: (a) providing free and rich yet flexible educational content, and (b) flexibility in event organization to match the needs and constraints of various schools and organizations. The goal was to create not just a global event but a comprehensive framework including a free and flexible curriculum aimed primarily at teachers, and an efficient content-generation and distribution system. Curriculum content modules were made by a global group of volunteers in Fall 2017 and Winter 2018, and then iterated in Winter 2019 for the second GGJ NEXT. Each module included a video plus optional material, such as lesson plans or best practices (https://ggjnext.org/teach). The overall curriculum was hardware and software agnostic and did not promote any particular platform.

https://ggjnext.org/

Immersive Learning Experience Design (ILXD) Workshop

Jim Kiggens (Adtalem Global Education)

In this Tech Demo, attendees experience using the immersive learning experience design (ILXD) model first-hand by playing the *ILXD Alchemy* board game that was developed to introduce the model in a conference setting and timeframe. The ILXD model incorporates tools to leverage VR/AI to improve flow and foster empathy, methods to promote sensemaking and constructivism, and analytic processes for measuring learning outcomes. The ILXD design model can be used immediately by experienced developers to improve learning outcomes in VR/AI, while providing a framework that novice developers can use to inform and structure their research and training to improve their skills

and literacy regarding immersive learning. Workshop attendees receive access to a dedicated VR/AI experience that demonstrates each of the tools and processes in the model. Additionally, attendees receive access to an online course that provides additional resources, references, and connects developers in a learning community regarding the model. The Engaged Learning Technologies team at Adtalem has been presenting the ILXD model using the *ILXD Alchemy* game at conferences and professional-development activities since September 2018. The workshop is intended for key stakeholders in designing and developing immersive learning for higher education. Previous experience with VR/AI is not required, but experience in learning design and delivery is strongly recommended.

Brianna's World: Game-Based Skill Training for the Human Service Workforce

Walter LaMendola (University of Denver) & Judy Krysik (Arizona State University)

Brianna's World is an interactive game designed to facilitate competency development among people whose profession demands working with disruptive family situations. The player selects an avatar and is immersed in a work situation in which he or she is asked to respond to a referral from a local school for a family home visit. Competency development includes engagement with a diverse set of characters, cultural competence, interviewing, and strength-based assessment. The game also rewards players' demonstrations of empathy, respect, and authenticity in their interactions. During the Tech Demo, the designers will display visuals of the game and provide an overview of the collaborative scenario-development process. Specifically highlighted is how the game was designed to dynamically and interactively appraise the player responses to characters and situations and receive feedback. Perspectives on *Brianna's World* gameplay will be shared, including those of graduate students and instructors. The Tech Demo will also present the design of the postgame experience, called Thrive Cast, that offers access to an ongoing collaborative learning community dealing with competency development and strength-based assessments.

LifeStory

Rose O'Leary (University of California, Irvine)

LifeStory is a flexible interactive learning-game framework that incorporates mobile technology, game technology, learning, ecology, North American indigenous epistemologies, and science education. Users of *LifeStory* are encouraged to take on the perspectives of nonhuman actors in ecosystems as they play through prepackaged life stories of nonhuman characters or build their own playable stories. It can be used in concert with outdoor education, indigenous science, indigenous knowledge systems, digital storytelling, and mainstream science-education initiatives. *LifeStory* enacts STEAM (STEM plus Art) learning in an interactive user-directed game-building environment. It also encourages perspectives of the natural world that are empathetic, engage systems thinking, and enact North American indigenous epistemologies.

Building on Youth Interests With Coding: New Resources in Scratch 3.0

Kristin Osiecki (MIT Media Lab, Scratch Team) & Natalie Rusk (MIT Media Lab, Lifelong Kindergarten Group)

We will highlight strategies for supporting creative learning and computational thinking across interest areas. With the launch of the new version of Scratch, there are a variety of free learning resources available to support youth in exploring their passions through creative coding. We will share the new library of Scratch tutorials that show how to create a wide range of projects, from making animations that talk aloud to creating interactive motion games using video sensing. Come to talk over what is available with Scratch team members, provide feedback, and learn how to use these new resources to support playful experimentation and individualized learning.

https://scratch.mit.edu/

Equitable Design Pathways: Building an Opportunities Portal on DiscoverDesign.org—How an Online Portal Seeks to Bridge the Equity Gaps in Architecture, Construction, Engineering, and Design Spaces in the K–12 Connected Learning Context

Edgar Edge Quintanilla (Chicago Architecture Center)

Architecture, construction, engineering, and design (ACED) fields are in the midst of an equity epidemic. According to the National Council of Architectural Registration Board (NCARB), only one in five architects identify as ethnic minorities while just one in three architects are women. To address this equity, in July of 2018 the Chicago Architecture Center (CAC) and the American Institute of Architects Chicago (AIA Chicago) partnered to convene, document, and describe the K–12 architecture and design education opportunity landscape in Chicago for in-school and out-of-school contexts. The project, which has culminated into a landscape report, sought to answer basic questions about access to architecture education available to Chicago youth. Findings in the report aim to better understand the pathways available within the architecture and design education ecosystem. Issues addressed lend insight into how connected learning practitioners are working to enable connections across professional, informal, and academic settings. The 2019 Connected Learning Summit will be the first opportunity for CAC to share the findings of this report with a key community of practice. In addition to the report, CAC will be showcasing a prerelease version of the online opportunities portal built as a result of the data collected in the initial report. CAC will share initial wireframes, user-experience mockups, and a working prototype of the DiscoverDesign.org Opportunities Portal with the CLS community. The objective of sharing this work in progress is to share insights learned and gather feedback for continued development.

Design Tools for Engagement

Liz Radzicki (Participate) & Julie Keane (Participate)

At Participate's Tech Demo station, we invite you to dive into our Sustainable Development Goals (SDG) Design Clinic. Supported by an online community of practice, educators design learning experiences for their students that integrate academic skills, global competencies, civic action, and innovative problem solving. Play with our SDG Design card decks to develop ideas for service-learning projects. Get inspired by stories of young people working to solve some of the most pressing challenges of our time. Join virtual discussions with educators all over the world who are building their practice by exchanging ideas, stories, resources, and feedback. Explore the future of networked professional development.

Shadowspect: A Creative Geometry Game–Based Assessment

Louisa Rosenheck (MIT Playful Journey Lab)

Shadowspect (shadowspect.org) is a geometry-based puzzle game that assesses 3D geometry skills, spatial reasoning, creativity, and persistence using movement and manipulation of 3D shapes. It has been developed as an experimental environment that supports exploration and creativity with assessment principles integrated into the design and development process from the start. Academically, it targets Common Core standards in high school geometry and three-dimensional objects. In addition to the academic standards, the game mechanics are designed to assess persistence, creativity, and spatial reasoning. During gameplay, *Shadowspect* captures potentially meaningful data and interactions that will be used by researchers to build assessment machinery implemented within the assessment system. Because there are multiple ways to solve the more complex puzzles provided in *Shadowspect*, each individual will have a unique methodology for reaching the same solution, and these rich and varied action sequences are captured as well. *Shadowspect* accumulates these data not only to understand what players already know and can do, but also the diverse variety of ways that they demonstrate their skills. Researchers can use this data to discover patterns of thinking and interaction beyond the targeted constructs being assessed.

http://shadowspect.org

Pairing Active Play With Programming Using Unruly Splats

Emily Wilson (Unruly Studios)

At Unruly Studios, our mission is to change the way that teachers and students think about coding and to bring active STEM play to all types of classrooms. We have developed Splats, superdurable programmable buttons. Splats are programmed to light up, make sounds, and sense when they are stepped on. With Splats, elementary and middle school students can create their own games using our block coding language and then play them with classmates! Splats bring movement and collaboration to the classroom and gym—all while introducing fundamental STEM concepts. Splats are being used by students of varying ages and needs in a variety of learning spaces: classrooms, gyms, libraries, innovation labs, makerspaces, and out-of-school contexts. Stop by the Unruly Tech Demo to play some of our favorite games and even try making your own!

Space Explorers: What-If Hypothetical Implementations in *Minecraft*

Sherry Yi (University of Illinois at Urbana-Champaign) & H. Chad Lane (University of Illinois at Urbana-Champaign)

The goal of what-if hypothetical implementations in *Minecraft* (WHIMC) is to develop computer simulations that engage, excite, and generate interest in science. WHIMC leverages *Minecraft* as a learning environment for learners to interactively explore the scientific consequences of alternative versions of Earth via "what if?" questions, such as "What if the Earth had no moon?" or "What if the Earth were twice its current size?" Learners using our mods are invited to make observations and propose scientific explanations for what they see as different. Given ongoing discoveries of potentially habitable worlds throughout the galaxy, such questions have high relevance to public discourse around space exploration, conditions necessary for life, and the long-term future of the human race. Studies in our project

are occurring across three informal learning settings: museum exhibits, afterschool programs, and summer camps. Our research is driven by the following research questions: (a) What technology-based triggers of interest have the strongest influence on interest? (b) Which contextual factors are most important for supporting long-term interest development? (c) And what kinds of technology-based triggers are most effective for learners from audiences who are underrepresented in STEM?

https://whimc.education.illinois.edu

3D Models and Interactivity: Going Beyond Text-Based Game Learning

Chuanli Zhou (Iowa State University)

Educational use of new technologies can transform online learning through the inclusion of interactive learning environments. In Agriculture at Iowa State University, we apply game-based learning to introduce undergraduate learners to the microbiology world. This Tech Demo compared two types of game-based learning modules: text-based game learning module before redesign, and interactive game module after resdesign done via Articulate Storyline and embedded 3D models. Course redesign procedures and best practices were introduced as well as the challenges, followed by a discussion on how games can enhance teaching and learning effectiveness. The participants had opportunity to visually feel the difference and compare the two types of game-based learning modules.

32. Well Played

Adaptive, Personalized Learning for Little Engineers: STEM Play With the Cat in the Hat Builds That App

Abby Jenkins (PBS KIDS Digital), Sara Sweetman (University of Rhode Island), & Jennifer Borland (Rockman Et Al)

This session invites the audience to go, go, go on an adventure with The Cat in the Hat through an in-depth look at the development of The Cat in the Hat Builds That app, an adaptive, playful learning experience based on the PBS KIDS series, *The Cat in the Hat Knows A Lot About That!* Developed under a Ready To Learn grant to the Corporation for Public Broadcasting and PBS through the U.S. Department of Education, this app is designed to engage preschoolers in science inquiry and engineering design, promote positive mindsets and attitudes in science and engineering, while teaching core science concepts and practices. Observing, documenting, building, improving, reflecting–these are all actions that we purposely designed play experiences around. Second was to create an adaptive and personalized learning experience. This app empowers preschoolers through personalized play and guides preschoolers through adaptive play, in which the games tailor to an individual learner's progress. Last (pending research availability), we will discuss the multiple research agendas we are conducting to help us see the overall efficacy impact of the app through its inquiry and engineering curriculum and approach, adaptive and personalized learning, and last, how it might impact a preschooler's overall view on science.

Shima: Measuring Risk Propensity With Virtual Reality

Grace Lin (University of Oregon, University of California, Irvine), Emily Sumner (University of California, Irvine), Angelica Sheen (University of California, Irvine), Roldan Melcon (The Cosmic Whale), & Susanne Jaeggi (University of California, Irvine)

Because of their immersive and motivating nature, video games have emerged as a new way of measuring psychological traits, such as risk-taking. Virtual reality (VR), in particular, affords the salience that traditional measures lack. In this presentation, we showcase *Shima*, a VR game that combines free exploration with decisions along the way, and players' gameplay experiences that help fine-tune our design for later iterations of the game. Specifically, the players enter with the story line that they are photographers with the explicit goal of documenting creatures on an island. Equipped with only a virtual camera and some film, players try to take the best pictures they can without being attacked. With limited film but little time pressure, players can carefully strategize how to approach each monster to maximize their points. Observational and interview data confirm the salience of the VR landscape but also suggest superfluous design features that could be removed.

https://docs.google.com/presentation/d/1YyV5O-wUkf65ZjmQYJU2nRc-Ns226-4V9QebGeNwk24/edit#slide=id.g62d9f71727_1_17

"Losing Is Fun": An Exploration of Player Motivation in *Dwarf Fortress*

Erica Holan Lucci (Rutgers University) & Joseph Lucci (Ridgewood High School)

This session will explore the various factors motivating players of *Dwarf Fortress*, a self-consciously unapproachable, unforgiving, and unwinnable game that has nevertheless managed to attract a dedicated fan base whose motto is "Losing is fun." The game, centered around ordering a group of dwarves to build a settlement to ensure their own survival, features an inscrutable ASCII art design, abstruse user interface, no tutorial, and the inability to restart from a prior saved game upon being defeated. In spite of all of this, *Dwarf Fortress* has developed a cult following since its release in 2006. We will consider why that is, and in particular the motivational impetus of learning from one's mistakes, the appeal of existing within a procedurally generated world and contributing to its intricate history, and the nearly unprecedented freedom afforded players by the game's fully open-ended sandbox format.

Unboxing Games: The Many Uses of *Europa Universalis IV*

Magdalene Moy (Drexel University)

Despite the prevalence of games used for teaching and learning, many barriers still exist that constrain how teachers and researchers use games. An unexhaustive list includes the lack of teacher buy-in and experience, time restrictions, and appropriate resources to facilitate classroom gameplay. As a result, the effectiveness of using games in classrooms remains case specific. This session describes multiple entry points for teachers and researchers to operationalize games beyond just gameplay. Specifically, *Europa Universalis IV* and its associated affinity spaces will be used to show how game-map modes can be immersive and interactive, customizable and personalized, and engage students in learning without requiring gameplay. *Europa Universalis IV* is a historical grand-strategy game that has been previously studied in high school and undergraduate classrooms for teaching world history. The player controls a nation from 1444 to 1800 through the age of discovery, reformation, absolutism, and revolutions. *Europa Universalis IV* also provides the player with options to start at different time points and to create customizable nations. Additionally, the game has dozens of map modes that allow a player to interact with the world from many perspectives, including political, diplomatic, religious, economic, and geographic. This demonstration provides an overview of gameplay, how to use *Europa Universalis IV*'s many interactive maps and various game mechanics with and without gameplay, as well as providing links to additional online resources. The objective of this session is to advance the affordances of games by demonstrating the many ways games can facilitate learning as educational tools.

https://docs.google.com/presentation/d/1nCYcGNRkROfVPL8M8l82hU4McRMK0Ylfz0jlFnKtRKU/edit?usp=sharing

Critical Role-Play: Transforming Dominant Narratives Through *Dungeons & Dragons*

Kelly M. Tran (High Point University), Earl Aguilera (California State University, Fresno), & Jeffrey B Holmes (Arizona State University)

While digital media such as video games are often the focus of many conversations about the changing nature of life, learning, and play in today's society, the popular press and academic scholarship alike have highlighted the

established and still-growing influence of analog role-playing games (RPGs) such as *Dungeons & Dragons*, or *D&D* (Ewalt, 2014; Jahromi, 2017). The purpose of this Well Played session is to invite participants to experience a more critically conscious approach to tabletop role-play that aims to resist, subvert, and ultimately transform dominant narratives to create more inclusive and meaningful experiences for diverse groups of players (Flanagan, 2009; Freire, 1970). While many praise *D&D* and similar role-playing game systems as powerful possibility spaces for encouraging creativity, fostering camaraderie, and promoting deep learning, a growing body of scholarship has begun to identify issues of privilege, power, and oppression that are perpetuated by the design features of such game systems, supporting materials, and even player communities (Garcia, 2017; Trammel, 2014, 2016). In particular, we draw on theories of social identity, positionality, and cultural production to frame our own experiences of developing and playing through an East Asian–themed *D&D* campaign, in which we actively sought to resist stereotypical, Orientalist, and colonizing perspectives (Gygax, 1985). Drawing on our own funds of knowledge and cultural assets, we seek to engage participants in critical conversations about issues of identity, culture, and power within *D&D*, and to explore avenues for creating more representative, responsive, and sustaining experiences for an increasingly diverse population of players.

33. Workshops

Lowering the Floors for Remixable Learning Design

Yusuf Ahmad (MIT)

Designing creative, connected learning experiences often requires more preparation than traditional approaches to teaching and learning. While some resources exist to support designers and educators, it remains difficult to adapt and remix existing resources. In particular, it can be challenging to understand the context in which a resource or activity might have been used or the rationale behind design decisions, raising challenges to adaptation to other contexts. In this workshop, participants will explore ways to design for remixability, that is, to approach learning design in ways that encourage and facilitate sharing and adaptation of resources. In particular, participants will prototype design approaches that might lower the floors for sharing, remixing, and opening up the thinking behind learning designs. They will have the chance to workshop their prototypes and to reflect on tradeoffs, tensions, and principles that might guide future efforts to design for remixability.

Using Transformational Game Design to Amplify Youth's Voice and Support Their Social and Emotional Skills

Amanda Armstrong (New Mexico State University-Learning Games Lab) & Barbara Chamberlin (New Mexico State University-Learning Games Lab)

During the summer of 2018, the Learning Games Lab at New Mexico State University offered two weeklong programs for high school students, which used game design as a method to explore social and emotional growth. In partnership with iThrive, the resulting learning experiences blended the transformational design framework (Chamberlin & Schell, 2017), social and emotional learning content (Rivers & Schlichtmann, 2017), and knowledge gained from 17 years of youth summer sessions at the NMSU Learning Games Lab. During the sessions, youth played and evaluated games, explored specific content areas that were important to them (such as suicide, PTSD, and math learning), engaged in design and prototyping activities, and pitched a game at the end of the week. This CLS workshop presented content, activities, and takeaways from conducting those game-design summer sessions. In the workshop, the presenter showed video clips explaining the transformational design process and its three steps: (a) identifying the change(s) for the learner, (b) brainstorming activities that lead to that change, and (c) determining how a game can facilitate those activities (Chamberlin & Schell, 2017). The presenter paired these clips with hands-on activities for the audience based on lessons from the summer sessions. These tasks prompted members of the audience to reflect on their thoughts, feelings, and experiences, list activities they performed to create a specific change, and discuss how games change a player. After they completed each activity, the presenter shared youth's responses and takeaways. The workshop's slides can be found on the Learning Games Lab's website:

http://learninggameslab.org/

Making Spaces: Insights and Tools for Shifting Pedagogy and Practice at Scale

Stephanie Chang (Maker Ed), Alison Bank (Children's Museum of Pittsburgh), & Lauren Penney (Maker Ed)

The Making Spaces program, led by Maker Ed and the Children's Museum of Pittsburgh, aims to develop a national strategy to sustainably integrate making into schools across the country in order to shift pedagogy and practice. The program employs a model in which multiple participating schools partner with a nearby regional hub, such as a museum or library. As part of the program, which now encompasses 21 hubs and more than 200 schools, a consistent set of tools and resources are leveraged, adapted, and used by hubs and schools to support professional learning and development around maker education. These tools can, and have, been used for practice, evaluation, and research in museums, libraries, and schools around the country, including a foundational set focused on visioning and planning any sort of maker-oriented programming, space, or curriculum. Visioning provides a scaffold and centers the institution's values as a way to define the "why" behind making and the "how" to implement. With more than three years of data, we are seeing clear evidence of the outcomes and impact that hubs have experienced and had on their communities, both local and national, aligned with our theory of change and supporting stories of programmatic impact, which include models, modes, and elements of professional development and sustained support offered by hubs to create lasting and valued change in their communities.

http://makered.org/making-spaces

Living and Learning in the Wild: What We Learned Exploring Artificial Intelligence, Ethics, and Education

Beatrice Dias (CREATE Lab-Carnegie Mellon University), Michelle King (Western Pennsylvania Writing Project), Jessica Kaminsky (CREATE Lab-Carnegie Mellon University), Jordan Mroziak (CREATE Lab-Carnegie Mellon University), & Ani Martinez (Remake Learning)

The future of artificial intelligence (AI) innovations has societal and ethical impacts. Bringing a variety of perspectives and voices into dialogue now will help us in responding not only to our present moment but also in shaping our collective futures. The relationship between technology innovation and education is often one of creator/subject, with teachers and students used by developers to gather "feedback." We believe that students and teachers have the right to join the ethical debates raised around artificial intelligence and humanity, that the technology community has a responsibility to hear their voices, and that only through mutual examination of these big questions will we be able to shape a future that prioritizes technology in service of humanity. This presentation brings together members of the learning ecosystem in Pittsburgh, a hub for technosocial experimentation around the dissemination of AI in community settings, to discuss a recent series of public forums. These community discussions have served to center questions at the intersection of artificial intelligence, ethics, and the education landscape. Our workshop offers a sampling of activities, thought experiments, and deep-inquiry experiences from these community forums as a means of expanding the conversation and broadening our collective understanding of these critical issues.

https://drive.google.com/drive/folders/1DrCSwryuacbLUYw60Q30vVIqaF_XucxW?usp=sharing

Mapping Personalized Learning in Schools

Gerald Dryer (University of Wisconsin-Madison), Changee Lee (University of Wisconsin-Madison), Jessica Arrigoni (Wisconsin Center for Education Research), & Arlene Strikwerda (University of Wisconsin-Madison)

Personalized learning is a pedagogy mediating between the systems of schools and the way that students learn. The practices of personalized learning give agency to students as designers of their own learning. However, the actual distribution of these practices across classrooms, schools, and districts is not well understood. Further, the impact of specific practices within the pedagogy are as yet undescribed. The Mapping Personalized Learning survey (MaPL) seeks to gather data to inform practice, leadership decisions, and wider research. Based on the Comprehensive Assessment of Leadership for Learning survey (CALL), the MaPL survey is a research tool designed with three purposes: (a) to give formative feedback to educators to improve their practice, (b) to give educational leaders data to inform supports and systems, and (c) to give researchers a clearer understanding about the ways in which PL is being implemented. The survey design "maps" teachers' practices on a continuum ranging from traditional to highly personalized, using descriptive language to describe the next steps for growth. Teachers take the survey in a professional learning community, and through discussion and reflection on their practices, improve instruction. Leaders use aggregated survey data to understand the depth of practice and the strength of networks of practice within schools. Systems and policy can be designed using data about practices. Researchers can use data from multiple districts to understand implementation across contexts, and data from the pilot study have already identified policies constraining practice. Future work will investigate correlations between specific practices and achievement data.

http://bit.ly/cls-launch

Designing for a Global Community of Learners

Chris Garrity (MIT Media Lab), Yusuf Ahmad (MIT Media Lab), & Champika Fernando (MIT Media Lab)

Scratch (https://scratch.mit.edu) is a programming language and online community where millions of people from around the world create and share interactive stories, games, and animations. Scratchers come from many different cultures and backgrounds, speak more than 60 languages, and have widely varying interests. In this workshop we focused on three challenges we faced in designing for this global community: (a) supporting a growing global online community, creating safe spaces for meaningful interactions, and empowering participants to express themselves; (b) balancing fidelity to the values and spirit of Scratch while empowering volunteer translators to decide what is "right" for their cultures and communities; (c) crafting resources that can be adapted and translated for contexts ranging from rural Kenya to inner-city Chicago. Participants, including teachers, researchers, and game developers, brainstormed around these and other challenges from their experiences. Highlights from the discussion were: (a) Prioritize localization from the start of a project. Design for at least two languages to ensure the infrastructure for translation is built into the system during development. In cases where participants tried to add new languages after releasing in only one language, they were unsuccessful. (b) Communicate context in ways that empower translators to adapt language, idioms, and so forth. For example, jokes or words such as *clear* don't necessarily translate simply, and people need to feel empowered to substitute something appropriate for their language or culture. (c) Create strategies for developing the infrastructure to localize and translate. These varied from ways to recruit volunteers to using "personas" to understand the different communities involved in localization.

https://scratch.mit.edu/about

Connected Learning Guide: Putting Theory Into Practice

Gina Grant (Chicago Learning Exchange), Kiley Larson (Kansas City Social Innovation Center), & Sam Dyson (Rita Allen Foundation)

The Chicago Learning Exchange has developed a *Connected Learning Guide* that translates that research into a one-stop reference for educators, mentors, and other youth-serving professionals. Connected learning is a model for youth engagement and includes a set of powerful design principles based on research into the kinds of experiences that sustain and deepen youth learning. Engagement matters because it is the key sign of a person's motivation to learn. Attendees will use the *Connected Learning Guide* as a tool to reflect upon their own practice, to identify their strengths, and to gain some practical guidance in areas where they would like to build their knowledge and skills. In the spirit of connected learning, this workshop will help you learn from and contribute to the wisdom of your peers. Registrants are encouraged to familiarize themselves with the guide before the workshop. Find the latest version of the guide at:

https://chicagolx.org/resources/connected-learning-guide

State of Sound: Recording Community

Jason Evans Groth (North Carolina State University Libraries) & Alexander Valencia (North Carolina State University Libraries)

State of Sound is a North Carolina State University Libraries initiative. It invites the NC State sound-making community to share its work and hear the work of others. Whatever sounds the community is making—music, podcasts, oral histories, anything recorded with intention—is welcome to be shared. Understanding and practicing recording sound can lead to stories and ideas being shared to wider audiences faster, can foster creative collaborations, can showcase innovative work, and can build communities of sound makers who motivate one another to develop media-communication skills. In this workshop, two North Carolina State University librarians will lead attendees through hands-on activities that make use of innovative and accessible sound-making and recording technologies and practices. The first activity—Songwriting in 15 Minutes—will result in everyone in the room writing, recording, and sharing a song to State of Sound in a very short time. The second activity—Making Music With Music—puts attendees behind the decks in a DJ workshop, showing how records and recorded sounds are accessible instruments that can be remixed to share new ideas. All technology will be provided. At the end of the workshop, attendees will have a greater understanding of and appreciation for accessible sound making, sharing, and recording technologies and practices. They will see how stories can be told and how creative work can be showcased using these accessible technologies. And they will see how the State of Sound model inspires community, collaboration, and creativity through sound making.

Fiber-Crafting STEM Learning

Anna Keune (University of California, Irvine), Naomi Thompson (Indiana University), Lillyanna Faimon (Indiana University), & Kylie Peppler (University of California, Irvine)

In the history of technology innovation, fiber crafts have played a prominent role. One notable example is the Jacquard loom that inspired the use of punch cards in the first programmable computer in the 1940s (Plant, 1995). Other examples

of the tight interconnection of scientific innovation and fiber crafts include modeling hyperbolic planes through crochet in mathematics (Henderson & Taimina, 2001). Despite the tight coupling, fiber crafts are frequently associated with less valued domestic practices. One prominent exception is e-textiles, which can foster learning of computer science and engineering concepts (Kafai et. al, 2019; Peppler & Glosson, 2013). Still, it remains underexplored how nonelectronic fiber crafts can be leveraged for high-quality STEM learning with ramifications of who and what is recognized as STEM. The workshop was organized as a make-test gallery walk around three main STEM themes: (a) computer science, (b) engineering, and (c) mathematics–with multiple crafts that facilitated playing with STEM concepts. The craft activities correspond with each of the three STEM areas. For computer sciences, activities included weaving a skip or lace pattern as well as embroidering a twisted square pattern to explore computer science concepts, such as conditional statements, variables, and parallelism. For engineering, activities included folding a basket, creating a doll skirt, and animating a twisted square to materialize spatial visualization as well as to sew 3D rotations and hinges. For mathematics, activities included weaving on a frame loom, pleating a bag, and crocheting a circle to explore mathematics principles such as slope and multiplicative proportional reasoning.

http://creativitylabs.com

City Settlers: Sustainability Education Through Embodied Participatory Simulations in Classrooms

Vishesh Kumar (University of Wisconsin-Madison) & Mike Tissenbaum (University of Illinois at Urbana-Champaign)

In this hands-on workshop, participants played *City Settlers*—an immersive and interactive participatory game in which players consider sustainability, interdependent ecosystems, interpersonal relationships, resource management, trade, and divergent forms of collaboration, while working to build a thriving and successful [virtual] city. *City Settlers* involves negotiations among team-based managers of cities in a shared mixed-reality universe, where participants work to acquire resources, grow their city, and manage progress while striving to achieve their own self-determined success. It is designed to be played in a classroom where sections of the classroom have overlays of virtual resources and space to establish and expand their cities. Because there is no single win condition—with groups deciding what matters to them for their city to be successful—players discuss within their own team (i.e., their city) how they want their city to grow, and they collaborate or negotiate with other cities to achieve these goals. *City Settlers* is a hybrid digital-physical game with some aspects of the game—such as trading, how pollution spreads, and how resources are used—tied to where players are physically situated in the room, creating a uniquely immersive, embodied, and personally relevant form of gameplay.

https://visheshk.github.io/citysettlers/

Making Observations: Identifying Values of Learning to Support Evaluation

Caitlin Martin (CKM Consulting), Eric Reyes (YOUmedia, Chicago), Ephran Ramirez (YOUmedia, Chicago), Peter Wardrip (University of Wisconsin-Madison), & Lisa Brahms (Children's Museum of Pittsburgh)

Spaces where youth and teens have opportunities to make and learn things they care about on their own time have proliferated in formal and informal settings. These spaces are often messy and busy and although there may be common goals and practices, they are highly unique from place to place and community to community. Young people are

doing amazing things, developing friendships and identities, and making and sharing artifacts and knowledge, but there are very real concerns about who is learning and being supported and potential inequities related to gender and marginalized youth. Revealing what is working and what is not to inform the design of better and more equitable maker programs and spaces can be difficult. There are also expectations and assumptions about what success or learning looks like in these environments that may not reflect the intentions and values of the organization, educators, or local community. In this session, educators and researchers from YOUmedia Chicago, the Children's Museum of Pittsburgh, and the University of Wisconsin-Madison will facilitate activities for participants to learn more about measurement through observation, remixing and adapting existing observation tools and resources, and to reflect on potential purposes of measurement and observation in unique settings, especially in ways that inform decision making at individual, collective, and organizational levels.

https://www.makingobservations.org/

Playful Projections and Programming

Ryoko Matsumoto (The Exploratorium), Deanna Gelosi (The Exploratorium), Lily Gabaree (MIT Media Lab), Kristin Osiecki (MIT Media Lab), Eric Schilling (MIT Media Lab), Simona Cavalieri (Reggio Children Foundation), & Federica Selleri (Reggio Children Foundation)

In this workshop, participants will explore playful and immersive digital projections and use Scratch code to craft an interactive story or narrative. Participants will actively bridge physical and digital worlds by using projectors, webcams, and Scratch to program playful interactions, using common tools and technologies available in many learning environments. With these tools, participants interact directly with the projected animations through their bodies and other materials, and they will collaborate to create transformative, full-body immersive environments. The workshop will provide participants with a context in which they can reflect on how a playful attitude can drive exploration, curiosity, and learning in the physical and digital world. At the end of this session, we will facilitate a conversation about how this experience fits into everyone's unique learning contexts and discuss different approaches to the use of digital and analog technologies and their possible hybridization. This workshop is hosted by a collective of educators and researchers from diverse learning environments who have a common curiosity for immersive, mixed-reality experiences. We are educators from the Exploratorium, the Scratch team at MIT, Reggio Children Foundation in Reggio Emilia, and Future University Hakodate in Japan.

How to Develop Digital-Citizenship Dispositions

Kelly Mendoza (Common Sense Education) & Carrie James (Harvard Graduate School of Education)

How do you teach students to use technology responsibly to learn, create, and participate? How do educators teach students to avoid the risks and harness the rewards of digital media? Working with schools and educators over the past decade, Project Zero (PZ) at the Harvard Graduate School of Education collaborated with Common Sense Education to apply their research on media in kids' lives into a free K–12 digital-citizenship curriculum. The latest research from PZ reveals that digital citizenship needs to be grounded in pedagogical strategies that support not only skills, but dispositions, or "habits of mind." Dispositions are ongoing tendencies that guide thinking and behavior. Just as we teach kids to "stop, look, and listen" when crossing the street, teaching dispositions helps guide behavior in their everyday lives. In January 2019, Common Sense Education and PZ published a research report in which they identified a set

of five core dispositions of digital citizenship that young people should embody in all domains of life (in person and online). Common Sense Education revised and updated its curriculum to develop these core dispositions through a set of "promising pedagogies," including thinking routines, authentic activities, and digital dilemmas. In this workshop, participants get an overview of the five digital-citizenship dispositions and core topics of the digital-citizenship curriculum, and they try out a series of activities using promising pedagogies designed to develop these dispositions, which they can apply in their own work with young people.

Design With Purpose: Rapid Prototyping, Design Thinking, and Digital Badging for Engagement and Equity

Maggie Muldoon (Mouse)

In this workshop, participants will practice human-centered design by engaging in a fun, hands-on microcycle of the process, using fellow workshop participants as design subjects. Using Mouse's Design League program as a model, participants will practice meaningful information-gathering strategies, or "problem-finding skills," learn to frame questions for brainstorming, hone their creative ideation skills, and create a rapid prototype of a product idea using craft supplies and digital tools and gift it to their user/fellow workshop participant. We will also be exploring ways to meaningfully capture and leverage this kind of student design work and learning using badges and digital portfolios. This workshop will be highly interactive, hands-on, and insightful for educators who are interested in incorporating human-centered design skills into their own content development or directly into student practice. It will also be informative for those interested in using badges as a credential, a tool to improve access to higher education for underrepresented youth or students who may have unique strengths and abilities best highlighted by a portfolio system when compared to traditional pathways for entering higher education.

Amplifying Youth Voices Through Video Production: An Interactive Workshop

Jessie Nixon (University of Wisconsin-Madison), Megan Monday (PBS Wisconsin), Alyssa Tsagong (PBS Wisconsin), Elis Estrada (PBS Newshour Student Reporting Labs), & Robin Mencher (KQED)

In the current media climate, where news sources are deemed "fake" and where youth are often portrayed in a negative light, it is essential that we provide youth with the space to share their stories. As youth recognize that their peers, citizens, and stakeholders are ready to listen, they can fight negative stereotypes and reframe themselves as passionate agents of change. Our interactive workshop scans the world of youth digital-video journalism, providing first-hand experience with curriculum, tools, and programs designed to increase critical media-literacy skills and civic engagement. As our organizations continue to expand capacity and range through creating new digital tools and bridging new communities, we offer this workshop as an opportunity for conference attendees to explore innovative moves in digital journalism and propose methods for continuous improvement. We will begin with a lightning-round pitch from three youth video-production programs, PBS Newshour Student Reporting Labs, Wisconsin Public Television and the Click Youth Media program, and KQED and *Above The Noise*. In its pitch, each organization will provide an overview of its program and share a current programmatic challenge. Attendees will then choose two groups to visit during the second part of the workshop. The lead from each group will engage attendees in a problem-solving dialogue around the programmatic challenges, pooling attendees' expertise for meaningful solutions.

Beyond Screens: Creating With Multisensory Technologies in the Classroom

Kristin Osiecki (MIT Media Lab, Scratch Team), Lily Gabaree (MIT Media Lab, Lifelong Kindergarten Group), & Alethea Campbell (GE Brillian Career Lab)

Go beyond the computer screen and engage learners in many modalities of technological creation. In this workshop, participants will experiment with a range of tools and techniques for creating multisensory learning experiences that incorporate art making and technology. We will create with light, sound, textures, motion, scale, electronics, and code—and learn the practicalities of cost and creation in the classroom. As a group, we will reflect on our explorations and discuss connections across subject areas. You will walk away with new ideas and learning resources to use in your classroom.

https://docs.google.com/document/d/1Zp9xelNaRbWOC2m8tkVJwLyqhiJgOX3ojU7giaC5SOY/edit?usp=sharing

Adapting Measures of Connected Learning for Formative Evaluation

Bill Penuel (University of Colorado), Vera Michalchik (Moore Foundation), Amanda Wortman (University of California, Irvine), & Sari Widman (University of Colorado Boulder)

In this workshop, participants will adapt tools for evaluating connected learning in library spaces, community programs, and schools for purposes of formative program evaluation. Formative evaluation focuses on gathering data for reflection and improvement, and it can help programs become more responsive to the goals and concerns of participants. As part of the workshop, participants will be introduced to the suite of tools developed as part of the Longitudinal Study of Connected Learning of the CLRN, and we will show how these have been adapted for use in library settings. These include tools for identifying youths' interest-related pursuits across settings, characterizing the degree to which learning environments support the principles of connected learning, and proximal outcomes of connected learning such as civic engagement. In the concluding part of the workshop, we will share strategies for making use of data related to youth interest and experience in informal (library) settings.

Design Games: A Playful Approach to Cultivating Designerly Thinking

Luis Pérez Cortés (Arizona State University), Elisabeth Gee (Arizona State University), & Taylor Kessner (Arizona State University)

Steve Jobs famously said that realizing we can change and influence the world around us—realizing the importance of design—is perhaps the most important thing. In this workshop, we introduced the concept of *Design games*, a playful approach to cultivating designerly thinking and creative collaboration that we developed as part of the NSF-funded project called Play in the Making. Design games engage learners in collectively playing and modifying (or "fixing") incomplete or unplayable analog games with the goal of enhancing appreciation of games as designed objects, people's capacities as potential designers in a variety of settings, and the nature of design as a complex social activity. Design games are an alternative to involving learners in creating completely new games, a process that can often be too time-consuming or challenging for learners with little or no formal design experience. Design games can also be used as an introduction to design thinking, for example in maker environments, or as preparation for other game-design

activities, including the creation of digital games. In this session, we presented the concept of Design games, involved participants in playing a Design game, and demonstrated strategies for encouraging critical reflection on their Design game experience. After this interactive experience, we facilitated a discussion of how Design games might be adapted for use in different educational settings for various purposes. We welcomed educators with any level of experience to join us for a playful, team-oriented, and thought-provoking workshop.

https://www.youtube.com/watch?v=QMYjeaf9CkE

Random Encounters: Statistics With a Sense of Adventure

Jordan Rashid (University of California, Irvine), Ryan Stokes (University of California, Irvine), & Jonathan Lui (University of California, Irvine)

Random Encounters (RE) is a dynamic random number generator, cloaked in an role-playing game (RPG)–style interface. It was created to improve education in statistics and experimental design the following three ways: (a) Rewarding students for applying new methods in creative or exploratory ways. Rather than demonstrating knowledge of statistical methods on a multiple-choice exam with prespecified hypotheses and artificial data, students are taught to infer useful relationships in the virtual world. These inferences demonstrate knowledge to the educator, but more important, they demonstrate the usefulness of statistical methods to the student. (b) Providing students access to "big data" and a personally significant context for interpreting results. Rather than practicing new skills on unrealistic data with arbitrarily named variables, students collect their own data, based on their own interests. This makes the numbers relatable. Furthermore, the data are exported in a format requiring organization before the test of inference. This allows students to practice an essential part of data analysis, which is almost always excluded from introductory courses. (c) Practice communicating quantitative results broadly and to peers with shared interests. Rather than taking multiple-choice exams for course credit, students gain "peer recognition" by contributing to a growing body of evidence called The Royal Library. Contributions are simple—an abstract stating the research question, null hypothesis, and nontechnical conclusion; a description of the methods for collecting data and testing the null; and a figure with caption that clearly supports the nontechnical conclusion.

Learn to Build Robust, Low-Cost, Solar-Powered Digital Libraries for Deployment at "Forgotten Schools" in Rural Zimbabwe

Bob Rollins (USACF) & Manning Sutton (Apprendre Sans Frontières)

The importance of education is well known; across sub-Saharan Africa the picture remains shockingly bleak. This workshop focuses on real-world solutions. We will create portable, robust digital libraries for schools and communities in locations without Internet and/or electricity. Based on a Raspberry Pi computer and using other low-cost, simple off-the-shelf parts, we will make learning centers using a "Bridge Pi" device that provides local access to freely available curated content via a WiFi hotspot that can serve dozens of people simultaneously. Participants will learn first-hand how to build this surprisingly easy, accessible, and low-cost answer. Teams will build from two alternative designs to highlight the iterative design process. Devices made during this session will subsequently be brought to Zimbabwe, reaching hundreds of students and teachers.

Immersive Literacy Workshop: Adult Capacity Building in the Reach Every Reader Project

Louisa Rosenheck (MIT Education Arcade) & Scot Osterweil (MIT Education Arcade)

Adults are the most important resource for impacting the lives and early literacy skills of young children. However, the most effective methods for supporting early literacy do not necessarily come naturally, and adults may face barriers they are not even aware of, such as bias and a lack of empathy. The adult capacity-building team within the Reach Every Reader project has developed a set of immersive experiences with varying levels of technology, with the goal of researching in what ways these media can scaffold the learning of best practices in supporting young children's literacy development. The presenters shared their co-design process with local parents, which resulted in a collection of ideas for how digital experiences could support literacy at home. They described one such digital tool in development, a voice-controlled shared-reading app for adults and young children to scaffold dialogic reading practices. And they presented demos of 360 video experiences that expanded adults' conception of literacy in the home and built empathy with children who struggle with dyslexia and other reading difficulties. Finally, the workshop included facilitated discussion around the best use of technology in adult capacity building for early literacy, along with other applications for the tools presented.

Creating Media With and for Youth That Does Not Suck. Come Help Public Media Continue to Work With Youth and Foster Connected Learning Experiences

Denise Sauerteig (KQED), Hillary Wells (WGBH), Keena Levert (PBS SoCal), & Megan Monday (PBS Wisconsin Education)

The Corporation for Public Broadcasting has been funding a professional learning community for eight public media stations to convene, brainstorm, and collaborate on innovative ways to make media with and for youth. Each station is exploring unique partnerships with youth in its community, resulting in media that reach a large audience. This work promotes youth voice while also providing opportunities for youth to be contributors to the programs at their local public media station. KQED, PBS SoCal, Wisconsin Public TV, and WGBH will engage in an open roundtable discussion about the work they are doing with and for youth around creating quality content that does not suck. Attendees will help these public media stations work through obstacles in their programs with youth, brainstorm effective strategies for media making in partnership with youth, and incorporate best practices from connected learning research and programming. Come and be part of engaging youth voice in public media at this open forum and workshop. You will have the opportunity to contribute to youth programming that reaches millions of people.

Family and Community Learning: Multigenerational Learning With Public Media

Devon Steven (Corporation for Public Broadcasting), Lavanya Mohan (PBS), & Susanna Grimm (PBS SoCal)

PBS KIDS Family and Community Learning (FCL) is a series of workshops that engage families in active, hands-on learning experiences. Designed for families with kids ages 3–5 or 5–8 (and younger/older siblings), the workshops use creative play and exploration to introduce kids and grown-ups to digital and tangible tools that can be used to develop knowledge, practices, and perspectives. Through child-led activities and experiences, the workshops aim to foster collaboration, communication, and problem-solving skills among family members. PBS KIDS FCL was designed and developed as an integral component of the 2015–2020 Corporation for Public Broadcasting (CPB) and Public Broadcasting Service (PBS) Ready To Learn Initiative for implementation by local public media stations and their community partners. The primary focus of these initial FCL series was science, technology, engineering, and math (STEM), but the model can be adapted to address other topics. The model was inspired by and built upon the Family Creative Learning work led by Ricarose Roque at the MIT Media Lab. Ricarose's work explores ways to engage families in multigenerational content creation and invention using media and technology. To learn more about the original Family Creative Learning work, please visit http://family.media.mit.edu/. This session: introduced participants to the PBS KIDS FCL model; demonstrated how PBS KIDS FCL aligns with the priorities of connected learning; stimulated ideas for multigenerational learning opportunities; provided ample time for rapid prototyping and sharing of new FCL series by attendees; and, crowdsourced troubleshooting for roadblocks related to recruitment, engagement, and retention.

https://www.pbslearningmedia.org/collection/pbs-kids-family-community-learning/

Disrupting the Rhetoric of Personalized Learning

Kristen Turner (Drew University), Bud Hunt (Clearview Library District), Christina Cantrill (National Writing Project), & Paul Allison (Lehman College, CUNY)

All around us, schools, districts, vendors, and other learning organizations are making investments in "personalized learning" (PL). But what is personalized learning? Is connected learning (CL) personalized learning? This workshop invites participants to join us in an exploration of the intersection between personalized learning and connected learning. We will look at examples from a variety of learning situations to unpack what the CL framework can bring to conversations about PL. We will start by examining student work connected to badges and from portfolios from Youth Voices (youthvoices.live, lrng.org/o/youth-voices) and hear from teachers about its context. Using an adapted looking-at-student-work protocol for small groups, we will ask questions about the products created. Then, using the data generated in these conversations, we will facilitate a whole-group discussion of the role of connected learning in the conversation surrounding personalized learning. Some questions we might consider: How do personalized learning and connected learning intersect? What is the role of a caring grown-up in creating good CL/PL experiences? How are we working to design personalized learning experiences that reflect the CL framework? What are next steps we can take to advance the field of personalized learning in the direction of CL? If warranted, the group will collaboratively build an argument for CL as a bedrock of any PL program.

About the ETC Press

The ETC Press was founded in 2005 under the direction of Dr. Drew Davidson, the Director of Carnegie Mellon University's Entertainment Technology Center (ETC), as an open access, digital-first publishing house.

What does all that mean?

The ETC Press publishes three types of work:peer-reviewed work (research-based books, textbooks, academic journals, conference proceedings), general audience work (trade nonfiction, singles, Well Played singles), and research and white papers

The common tie for all of these is a focus on issues related to entertainment technologies as they are applied across a variety of fields.

Our authors come from a range of backgrounds. Some are traditional academics. Some are practitioners. And some work in between. What ties them all together is their ability to write about the impact of emerging technologies and its significance in society.

To distinguish our books, the ETC Press has five imprints:

- **ETC Press:** our traditional academic and peer-reviewed publications;
- **ETC Press: Single:** our short "why it matters" books that are roughly 8,000-25,000 words;
- **ETC Press: Signature:** our special projects, trade books, and other curated works that exemplify the best work being done;
- **ETC Press: Report:** our white papers and reports produced by practitioners or academic researchers working in conjunction with partners; and
- **ETC Press: Student:** our work with undergraduate and graduate students

In keeping with that mission, the ETC Press uses emerging technologies to design all of our books and Lulu, an on-demand publisher, to distribute our e-books and print books through all the major retail chains, such as Amazon, Barnes & Noble, Kobo, and Apple, and we work with The Game Crafter to produce tabletop games.

We don't carry an inventory ourselves. Instead, each print book is created when somebody buys a copy.

Since the ETC Press is an open-access publisher, every book, journal, and proceeding is available as a free download. We're most interested in the sharing and spreading of ideas. We also have an agreement with the Association for Computing Machinery (ACM) to list ETC Press publications in the ACM Digital Library.

Authors retain ownership of their intellectual property. We release all of our books, journals, and proceedings under one of two Creative Commons licenses:

- **Attribution-NoDerivativeWorks-NonCommercial:** This license allows for published works to remain intact, but versions can be created; or
- **Attribution-NonCommercial-ShareAlike:** This license allows for authors to retain editorial control of their creations while also encouraging readers to collaboratively rewrite content.

This is definitely an experiment in the notion of publishing, and we invite people to participate. We are exploring what it means to "publish" across multiple media and multiple versions. We believe this is the future of publication, bridging

virtual and physical media with fluid versions of publications as well as enabling the creative blurring of what constitutes reading and writing.