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Expansive Lenses to Examine Interventions (of) Moving Across Contexts

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Abstract: Learning sciences researchers, in correspondence with the increasing usage of design based research, increasingly tend to implement similar theories, curricula, tools, and even learners across different contexts like schools and out-of-school settings. Successfully navigating these movements and transitions involves understanding the dynamic relationship between our (researchers') imagined design's learning goals, and the goals and constraints of learners, educators, and other stakeholders mediating any implementation. In this symposium, we present a diverse breadth of work which highlight different design, analytic, and theoretical lenses to examine these transitions. This symposium aims to encourage researchers to consider such extensions of their work, and surface grammars of analyses that can help researchers involved in such work, through shared discussion across five different projects implementing and analyzing their different implementations in contrasting ways.

Introduction

As researchers and designers, we are often re-adapting similar activities for in-school and out-of-school settings. This is uniquely relevant to the learning sciences community for our inclination towards design-based research (Barab, 2006), and navigating and understanding the dynamic relationship between our (researchers') imagined design's learning goals, and the goals and constraints of learners, educators, and other stakeholders mediating any implementation (Fishman & Penuel, 2018).

We are especially interested in the journeys and challenges underlying projects that aim to implement similar designs, goals, or even concepts – broadly conceived of as any intervention (or reform) – in school settings as well as out-of-school settings. Building on Engeström's argumentative grammar for formative interventions (2011) – "(a) activity system as a unit of analysis, (b) contradictions as a source of change and development, (c) agency as a layer of causality, and (d) transformation of practice as a form of expansive concept formation" – we want to collate how this can provide an analytic lens to examine transforming the same intervention across different settings. In this symposium, we want to discuss different instances of interventions or developments that are conceived for, or repurposed across settings, and the different ways this adaptation is done.

This aims to build on prior work around how different out of school spaces are in general recognized for their affordances and limitations. In the span of work in this symposium we discuss a breadth of different agents and phenomena that can be noticed and inform our understanding of how moving across settings changes learning.

We present these submissions in a particular order which build upon and vary from each other in the scale and kind of trans-context phenomena they highlight, especially through the lens of Engeström's argumentative grammar (a, b, c, d) for formative interventions and activity systems (2009).

Tools: Our first entry highlights the design variations as enacted in *tools and materials* that are necessitated through the variations in *rules* imposed across different settings. This work also highlights how the division of roles (in terms of informal educators, teachers, and other enactors of curricula) remixes materials in ways that we should anticipate and design for. This analysis shows signs of thinking about interventions as

serving and being transformed in different activity systems, and especially surfaces how (grammar feature b) contradictions in settings can be a source of change and development.

Learners: Our second submission focuses on the learning that is enacted as learners themselves move across settings – and how their participation in creative activities in out-of-school spaces is often rooted in and initiates from identities rooted in the more familiar school settings. This is not seen as a drawback, but provides a lens to pay attention to how learners' movement and increasing familiarity with different identities itself is a productive form of learning. This piece surfaces a valuable lens of (grammar feature c) agency as a layer of causality, centering *youth/learner subjectivity*, but as always constituted through features of the new and old settings like overt and implicit community and rules present across these spaces.

Teachers and Families: Our third submission highlights a critical way of deepening the traditional *divisions of roles and labor* across *community* members. Providing out of school events that allow teachers to connect with their students' families helps teachers gain new lenses to consider their students' broader ecosystems, recognizing a fuller *agency* from their *parents*, and also engaging in these activities with parents – a peer group that they typically see as disconnected from their contexts – also deepens how they are able to perceive the disciplinary practices relevant to their instruction and teaching.

Institutions and **Materials as Bridges** across Contexts**:** Mirroring and extending our first entry, the fourth submission presents a focus on materials as constructed in response to different components of activity system(s) (like institutional rules, community members and division of roles) but as a bridge across contexts as learners move between and across settings (grammar feature a). At an overt intersection of the different lenses highlighted above, this work aims to support learners moving across settings and focuses on how to enable productive movements of the same in response to the complex interconnected and interacting networks that bridge these different settings.

Expansive conceptual development and transformation (grammar feature d)**:** Our last submission presents a heavily community centered re-adaptation of broad learning principles and ideas with varying amounts of similarity and connection between the same (including very adjacent and connected settings as well as completely distal and disconnected re-adaptations). This work surfaces how we as researchers can pay attention to community grounded translations and interpretations of our own ideas as a source of learning and transformation for our understandings and identities.

Structure of Symposium: Given this surfaced progression and contrast of ideas and analytical lenses across our works, we imagine presenting our works in short presentations of less than 7 minutes each (35 minutes). Following this, we aim to do a collective brainstorm including symposium participants and the discussant on how these different lenses can be applied to the other projects (approximately 25 minutes), and if there is a productive shared synthesis of these lenses that can be a product for all presenters as well as other learning science researchers to use in their projects considering cross-context learning experiences. Our discussant Nichole Pinkard brings tremendous experience to the space and discussion of creating and studying ecologies of learning for (marginalized) youth across a wide variety of contexts, which can powerfully enhance this discussion through surfacing many other practical concerns from the field, as well as theoretical perspectives which can enhance our analyses. We imagine the last 10 minutes for open-ended question and answer between the audience and the panelists.

Intersecting Sports and Technology Across Schools, Parks, and Community Centers

Vishesh Kumar, Marcelo Worsley

Our work aims to design culturally sustaining computing education experiences for youth engaged in sports and physical activity, through the use of various sports technologies and physical computing tools (Kapor Center, 2021). This work is rooted in enabling richer exposure and access to technology as users as well as manipulators and producers to youth involved in athletics spaces which are often seen as disconnected from most academic endeavors (Hodge et al., 2008). Relatedly, this also connects to expanding conceptions of computing practices and learning experiences – enabling youth to see competence in technology and computing as possible within the context of their sports practices, as well consider computing itself as a domain not exclusively for people with academic competence (Kendall, 2007).

Our implementations of these activities have spanned a variety of contexts including schools, parks, community centers, and a variety of other pop-up summer and afterschool programs. Our curricular activity design tends to span a variety of modalities including discussions about sports activities and related technologies familiar to youth; engaging in familiar physical activities (like running laps around a track, or shooting hoops on

a basketball court); repeating these activities with technological tools (like step counting wearables, or automatic sensor embedded score tracking balls); and then recreating these tools using programmable modules (like creating step counters using easy to program microcontrollers like micro:bits). Implementing such activity sequences in different settings has posed a variety of contrasting design constraints leading to minor and major variations in our curricula.

In Schools: *Space:* While finding classrooms and *spaces* to engage in conversations about and with different computing technologies *which also support free movement* for learners in a cross-contextual challenge, it is a more pressing constraint in schools. Schools tend to make stronger divisions between regular classroom spaces and educational conversation being engaged with "sitting down" learners, and physical education conducted in a dedicated gym space which is minimally oriented for extended discussions and conversations, and mostly centered around following drills and exercises or engaging in free play.

Time: This separation of space and practices also adds to the additional challenge of moving between different kinds of activities. For instance, schools would rarely allow students to access their laptops in a gym space, and moving large groups of students from a classroom to the gym takes a significant amount of time. This immediately affects the shape of our original curricular designs. Additionally, the nature of "dedicated discipline centered time periods" (while not unique to school and similar to many other educational programs) also poses a challenge in implementing deeply multidisciplinary curricula in schools.

Capacity: Additionally, being able to find *partner teachers*, specifically a library teacher who already engaged in computing exercises with her students, and a PE teacher willing to adapt her classes while also deeply collaborating with the library teacher at the same school – mediated through our researcher support – was an extremely critical component of a successful school implementation of our activities. Since the ideas of using such sports technologies as well as wearable computing tools for programming are unfamiliar in traditional PE or computer science teaching professional development, it is key to recognize and prepare for in-classroom small scale innovations being impossible without constant correspondence and partnership with teachers, as well as great flexibility in the expectations around the material covered since school teachers need to prioritize the requirements of the district, of their own school, and also their own prior expertises and preferences.

Assessment: Relatedly, these systemic requirements also frequently constraint or reshape the kinds of assessment and data collection made possible to identify student learning. While our partner teachers went above and beyond in responding to classroom survey and assessment design alongside us, we found it important to prioritize centering teachers' professional goals and requirements to also contain student participation around assessment through modalities and language that they are more familiar with and often presented with. These modalities help the assessment serve the teacher first, and also respond to other structural constraints like the time allotted and available, and student orientations to classroom activities in the spans they are asked to complete assessments.

Out-of-Schools: Moving these curricula to out of school contexts showed how the features described saliently above vary in out of school settings. Also, this transition also surfaced the role of *interest,* or learner *engagement* as a much stronger affecting factor that we did not directly or overtly experience in our work at schools.

Space: In informal settings, while our unique needs of a gym-like space alongside technological resources and tools presents a key constraint regarding the spaces we partner with, we have experienced fewer challenges rooted in the separation of space (for instance bringing laptops or tablets on the basketball courts) across out of school spaces.

Capacity: Not dissimilar to the nature of overworked teachers with limited capacity for adaptation and novel implementations, most programs and out of school spaces catering to under resourced youth (a primary goal and design constraint in an equity and justice centered project like ours) have a lack of access to well equipped facilitators and mentors to implement curricula, especially for extended periods of time. While this varies, many out of school spaces also have a lesser capacity than teachers to have sustained relationships with students and a recognition of their broader contexts. We do not have any specific response to this difference and are currently considering different ways of building deeper relationships in these spaces (Thompson et al., 2021) with youth, their families, facilitators in the space, and the activities they experience.

Interest (and assessment): Tied to the nature of formal assessments in schools, youth interest and engagement in out-of-school settings is often significantly changed through the different nature of assessments with significant stakes. School grades tend to often be valued as a social authentic marker of learning and competence from youth, which necessitates most school students to pay attention to the teacher in a way that is rarely induced in out of school settings. Here, some youth are extremely intrinsically driven to some specific activities that they attend for (for instance passion about specific sports at a sports after school program), and some are socially driven either through peers or parental decisions; or are intrinsically demotivated regarding

any specific activity (for instance talking about STEM at a sports camp which can continue to excite some learners but also polarize and induce disinterest in others). So far we respond to this diversity of youth participation by including space for prolonged participation in any of the intermediate activities for whichever youth have strongest affinity for. For instance, if some youth are strongly engaged with their favored sports experience augmented through our sports technology, and indicate disinterest from the following activity of programming the same technology, we try to let those learners continue playing the sport they are more interested in. This often creates a tension between other learners not wanting to sit down and code while their friends are still playing, but also creates space for and draws learners who might be particularly excited about the programming exercise after having used a technology.

Dreaming Beyond the Specter of Schooling in Expansive Co-Design Spaces

Michael Alan Chang, Thomas M. Philip

Towards dismantling dominant power hierarchies in schooling, researchers have sought to engage youth as key actors in re-imagining schools (Cammarota & Fine, 2008; Flores, 2008). Despite researchers taking critical approaches to participatory design, youth commonly advocate proposals that ultimately bolster standardized academic outcomes (Kirshner, 2010). In this paper, we share our journey running an out-of-school *Learning Futures Workshops* (LFW) with high-school aged youth of color. The LFW supported youth in dreaming expansively about schools and identifying how emergent artificial intelligence (AI) technologies could make those expansive dreams a reality. In this work, we frame co-design spaces as figured worlds (Holland et al., 2001) in order to better understand how youth conceive of new interventions and reforms for *ideal schools* based on identities situated in well-established cultural contexts, such as *existing schools*. Over the course of our workshop, we altered our co-design figured world to offer youth an expansive set of identities to draw from, and show how this created opportunities for youth to author new possibilities for schooling beyond the grammar of schooling. The conceptual exercise of moving from existing settings to the ideal settings posed challenges and opportunities that we detail here.

Figured worlds are described by Holland et al. as "a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (2001). We conceptualize out-of-school co-design spaces as a particular kind of figured world where the valued goal is to construct new figured worlds. Because co-design spaces are unfamiliar for most youth, where participants actively try on identities, including established identities practiced in *existing* figured worlds. These identities practiced within existing figured worlds exist within the context of a *space of authoring*, or a toolbox of practices and discourses that participants are constantly orchestrating. These spaces of authoring open and constrain possibilities around how actors respond to events within existing figured worlds; it is in this way that co-design participants develop their identities as agents of change, and determine how and in what ways existing figured worlds can be transformed to realize their hopes and dreams.

Early in our LFW, we found that youth primarily drew from their well-established, durable identities from the figured world of schooling. The figured world of schooling, sometimes described as a grammar of schooling (Tyack and Tobin, 1994), is characterized by a series of historically robust instructional practices that serve to reinforce a hierarchy amongst students. Drawing from their identities as high achieving students, youth conceived of an AI-based agent that keeps "other" (e.g., lower-performing) students on-task, thus reinforcing the existing systems of authority that are common within the figured world of schooling. These AI possibilities initially advocated by youth were strongly in tension with our critical goals, where we hoped to create a space where young people could re-imagine powered relationships within classrooms.

In an effort to surface expansive possibilities, we brought youth to a number of relatable sites of everyday collaboration, including a cooperative house occupied by seventy university students. In the cooperative house, youth were introduced to *community agreements*, where all house members collectively constructed a set of beliefs about how they would occupy a shared space. By making the figured world of the cooperative house salient to the co-design space, facilitators opened up a variety of tools and practices that youth could deploy to author novel, liminal identities within ideal imagined figured worlds. Youth subsequently imagined a new AI-based technology that supported them in classroom conflicts, where the norms for the conflict would be jointly constructed and agreed upon by the members of the classroom community. In this manner, we demonstrate how imagining within co-design spaces is deeply shaped by identities in practice that youth invoke across a large swathe of figured worlds. While the specter of schooling looms large over this

process of re-imagining schools, we demonstrate how broadening the imagined spaces of authoring can open expansive possibilities for dreaming across disparate worlds.

"They Are Whole People": Consequential Transitions for Pre-Service Teachers Participating in a Family Creative Computing Program

Melissa Braaten, Ronni Hayden, Ricarose Roque

Introduction

Our design work focused on the different roles in a learning ecology and the consequential transitions of roles and practices across settings. In this particular case, we focus on pre-service teachers (PSTs) as they participated as facilitators in a culturally expansive and creative computing environment within an intergenerational, out-of-school setting. This paper presents findings from a project that documented the experiences of PSTs as they prepared for, facilitated, and reflected on their practices to support families from non-dominant communities in an implementation of the Family Creative Learning (FCL) program, a series of workshops that engaged families to create projects based on their families' stories. We use the concept of "consequential transitions" which emphasizes that "transitions are consequential when they are consciously reflected on, often struggled with, and the eventual outcome changes one's sense of self and social positioning" (Beach, 1999, p.114).

Data sources and analysis

We recruited PSTs from an elementary science education course taught by one of the authors at a school of education at a university in the Mountain West region of the US. Two PSTs signed up, Christine and Esmeralda (pseudonyms), who were completing their final semester of student teaching in local elementary schools in an urban area. Both Christina and Esmeralda grew up in the same urban area. Prior to the workshops, we supported PSTs in preparatory sessions where they engaged in case studies of past facilitator experiences, documentation practices, and activities with the computational tools that families would be using.

The FCL workshops were hosted at a public library in the same urban area and families were recruited from the local neighborhood by library staff. During the workshops, we collected ethnographic data that included observation through written field notes, photo and video documentation, and project artifacts. Our design team, including PSTs, recorded debriefs following each workshop that included discussions of facilitation practices and suggested design improvements for the next workshop. We also conducted post-workshop interviews with pre-service teachers and family members who had participated through the last workshop.

Findings

Through reflections in their field notes and post-workshop interviews, both Christine and Esmeralda came to understand families' identities and their own identities as teachers in more expansive ways than what was available in school settings. They voiced how in school opportunities to build relationships with adult caregivers and families were very limited (e.g. brief parent-teacher conferences to discuss children's progress). At best, teachers get to know parents as "so-and-so's mom or so-and-so's dad" rather than full people. Within FCL workshops, PSTs were engaging with children and parents across various activities and working with family members to create projects based on their family stories. Both PSTs shared a shift in perspectives in how they saw parents and families. For example, after observing and later supporting a father-daughter pair to negotiate ideas for their project, Christine shared her realizations that parents were fully human, people who have their own interests and identities and who need to be seen and heard too by their children. Esmeralda noticed the structures and facilitation practices within FCL that supported families to "come as they are" with their values, stories, and languages appreciated and welcomed. These structures included meaningful activities that allowed younger children to participate, facilitators like herself who spoke the families' languages, and activities that supported parents to explore their own ideas and curiosities with the tools.

In addition to developing more expansive views of families, teachers also engaged in STEM and tech-related identity work. Christine shared she felt a sense of accomplishment, not about a specific moment of coding, but about envisioning how a whole creative computing experience could be used to reconfigure relationships between teachers, families, and STEM-centric school activity. Esmeralda reflected on the power of seeing "so many smiling faces when it came to coding" and shared "personally my feelings towards coding have changed and it's really cool that I get to see families…producing some really beautiful projects that have to do with coding."

Implications and contributions

We found the concept of "consequential transitions" in noting the powerful shifts experienced by PSTs when reflecting on: (1) their perspectives of families as "whole people," not just knowledge about family engagement; (2) their own selves in STEM and computing; (3) their ability to name and identify what structural features of FCL supported them in their engagement with families. Our inclusion of pre-service teachers has implications for the kinds of experiences that are provided for PSTs during their education, especially experiences with families and with out-of-school organizations to engage in alternate possibilities, perspectives, and roles as educators. In our next steps, we plan to document the pre-service teachers' experiences as they move back and forth between their field experiences in classrooms and move onto their professional careers as teachers. Despite these powerful transitions, after they completed their SoE program, Christine and Esmeralda reflected having a hard time imagining what they could implement in practice in their school experiences from their FCL experiences. We recognize PSTs themselves are in less powerful positions as newcomers to systems and structures that dominate interactions between teachers and families. We plan to design scaffolding experiences for PSTs as they transition into school experiences from FCL.

Connecting OST and In-School Settings to Support Learning Transitions

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Introduction

Learning sciences research often views learning ecosystems as a constellation of in- and out-of-school partners. Less frequently do we theorize or design for transitions between in- and out-of-school experiences. In the example of STEM learning, considerable interest is placed in learning experiences that spark STEM interest. But, once interest is sparked, how do we design and develop sustainable ecosystems (which necessarily must span in- and out-of-school experiences) to support learning across a lifetime? This paper examines the work of an interdisciplinary team of educators and learning scientists leveraging the research-based connected learning framework (Ito et al., 2013, 2020) to identify effective community-based strategies for STEM transitions across settings, and using design based research to amplify and spread effective practices across coordinated state networks.

A key element of connected learning environments is how educators and program leaders make connections across settings so that youth can build on their interests to access additional programming, interest-driven communities, and future learning pathways. Through specific design principles and strategies, including (a) coordinating learning between settings, (b) brokering new learning opportunities, (c) using openly networked infrastructures, and (d) making learning visible, this project iteratively co-designed and developed strategies for educators and program leaders to more effectively support youth in connecting their early interests into lifelong and lifewide learning. These design principles for connecting learning across settings take shape through specific choices educators, program leaders, and youth make to support learning in and across their respective settings, whether or not those choices are an explicit part of a program's design. Examining the transitions between learning experiences provides the field with a more equity-oriented and learner-centered approach to supporting young people's learning across settings and over time.

Data sources and analysis

This project examined the transition between learning experiences within the context of middle school girls' learning trajectories across STEM learning settings. In partnership with STEM Next-affiliated Afterschool State Network alliance (which includes in- and out-of-school partners) and the coordinated initiative, Million Girls Moonshot (MGM), we were able to view coordination across settings and the broader ecosystem and trajectory of STEM learning. We systematically studied how five state networks (i.e., Nebraska, Alabama, Pennsylvania, Florida, and Massachusetts) built upon and improved girls' transitions between STEM experiences, which involved interviews with 25 field leaders and youth from across the network, and multiple cycles of iterative co-design with network and program partners. At the start of the project, networks identified strategies they would like to use to connect youth to future learning opportunities. Partners iteratively worked with the research team over the course of a year to refine and implement strategies for making STEM transitions between settings. Two exit and interest surveys with over 70 network members helped capture the impacts of this work on over 5,000 youth.

Findings

Eight initial examples for successfully promoting STEM connections surfaced within the network as a result of our DBR approach to community-engaged design, falling across the four design principles of the *making connections* area of the connected learning framework: (1) a wraparound model to bring together cross-sector organizations; (2) coordinating between out-of-school (OST) and school programs; (3) coordinating between community and OST programs to support community-based STEM projects; (4) supporting brokering work of near-peer mentors; (5) helping adults broker connections to STEM-based entrepreneurship opportunities; (6) helping adults get family and youth buy-in into STEM programs; (7) developing an openly networked infrastructure to help youth find STEM programs; and (8) supporting youth in using an open portfolio for STEM work.

Key findings included: (1) Through implementation and refinement of these making connection efforts, the state networks reported gains in connections to future STEM learning. Networks reported a 37% increase in the number of new connections made to future STEM learning during Phase 1 of the project–over 864 connections to future STEM learning opportunities. (2) The participating state networks saw a marked increase in capacity. While deploying these new and refined approaches, networks reported a 39% (n =+1,235) increase in youth participants, drawing in over 51% (n = +647) more girls. (3) The national MGM networks and programs employ a wide range of nascent practices for making connections that can be leveraged for higher impact. Practices are interconnected and mutually reinforcing, and network administrators self-reported intense motivation (i.e., each strategy is of interest to more than 75% of the state network) to adopt and/or refine one or more ways for making connections highlighted in this project.

Implications and contributions

This paper centers on advancement of theory and knowledge of how connecting learning across settings can broaden access and deepen engagement with STEM for girls. As the field continues to make progress on how to design culturally relevant STEM learning environments for historically marginalized groups, what has received less attention is how to effectively connect and coordinate between these efforts. Typically, STEM programs, both in and out of school, lack connections and coordination across programs and settings. This study offers critical insights and models for how to support inclusive and equitable STEM ecosystems that knit together culturally relevant approaches, focusing specifically on the connections between programs and settings. It also contributes to theory and evidence for how to build effective alliances, networks, and initiatives that serve educational equity and inclusion goals.

Constructionism through the Prism: A Spectrum of Education Implementations in Thailand

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Sometimes an educational reform is not a specific technology, activity, or curriculum but rather a philosophy. Such is the case in our study of the implementation of constructionism in Thailand. In the late 1990s, an emerging organization in Thailand, the Suksapattana Foundation (meaning “study and development” in Thai), initiated four years of collaborative work with Seymour Papert in an effort to learn and apply constructionism in their country. While they partnered with Papert and leaders visiting from MIT for four years, they continued implementing constructionism in creative ways across many local sites for the next 20 years and continuing.

In this paper we consider the range of implementations of constructionism specifically in education contexts: public and private, formal and informal. Pizmony-Levy (2011) provides a useful metaphor for considering the ways that local implementations can vary: educational reforms are refracted through the “prism” of individual nation-states, local ministries, and institutions (p. 604). Applied to implementation of constructionism in Thailand, we ask, *how was the educational philosophy of constructionism refracted through local institutions in developing different “colors” of implementation? What, if anything, was held in common across implementations? What institutional and individual factors shaped each implementation?*

Part of a larger study of the Suksapattana Foundation’s (SF) implementation of constructionism since 1997, we draw on interviews with 23 people (several more than once) from five sites along with several leaders of the foundation, totalling 47 hours of interview data gathered in-person from 2017-2020. Analysis focused on each individual institutional case of implementation of constructionism, attending to origins, endings, transition points, leaders, influences of various institutions (school, educational ministry), and explicit and tacit applied values of constructionism. Below we briefly describe diverse, 6-20 year long constructionism interventions across different areas of Thailand.

Primary School 1: "Traditional" constructionism implementation. One teacher who attended some constructionism workshops using Microworlds was inspired to implement it in her classroom. With some used computers provided by the SF, she began to teach units on Microworlds (and later Scratch) with her 5th grade class. Over time the entire school slowly adopted the idea and embraced the idea of doing creative projects under the ethos of "constructionism." We call this the traditional model because it most mirrors constructionism implementations around the world which tend to focus on students using digital technology to create interest-driven projects (Holbert et al., 2020).

Primary School 2: Teacher Agency. Here the main instigator was a principal who took to heart the idea of learner agency and met with her teachers to engage in conversation about how to implement constructionism. The teachers chose to group by grade level and work together to do an implementation each year. For instance, the third grade decided to use one month to focus on student projects around cooking traditional foods. When the principal left, constructionism implementation ended, but at least one teacher deeply internalized it and has applied it in other work.

Primary School 3: Indigenous Knowing. A leader of the SF was visiting a school in the Hill Tribe area of Northern Thailand, one locus of the country's indigenous population. Here he met a teacher who had self-developed a beautiful pedagogy where students learned math and Thai (a second language for most students) by studying rice fields and other local work. The leader recognized constructionism in this teacher's work and simply celebrated and acknowledged it, helping the teacher win some awards that led to local recognition and acceptance of his unusual pedagogy.

Summer Technology Workshops. A former principal created a small foundation to support teachers and students in Southern Thailand by sponsoring summer workshops. These focus on creative uses of digital technology, such as maker education, and do not require changing the school curriculum since they take place over the summer. The SF helps provide or connect leaders for some of these workshops.

Private School: Radical Constructionism. Frustrated by the resistance of many schools to providing time and flexibility for teachers to implement constructionism, some SF leaders created their own private school where learner interests and student-created projects were the entire focus of all learning. Teachers were hired from other careers (not from teaching colleges) to disrupt traditional norms of top-down, hierarchical teaching models. As the school grew, it moderated some of this radical implementation through interactions with parents' college entrance worries and school certifications, but as of 2020 still reserved at least 3 days a week for student projects.

Across these implementations we see a great deal of flexibility and innovation. The pioneers of constructionism might be a teacher, a principal, or foundation leaders. Leaders met resistance from existing school models, policies, curricula, and traditions. They each found different niches of application, from what would easily be recognized elsewhere as "constructionist" with digital tools to more ground-up approaches that focused not just on learner agency but teacher agency and tapping into local and traditional knowledge. Researchers were not a part of any of these implementations, though the SF played a variety of roles, from introducing leaders to the constructionist philosophy, to providing materials, to connecting people with resources, to simply celebrating and publicly acknowledging good pedagogy that defied local norms. Perhaps what stands out the most is that nowhere did SF tell leaders what constructionism was or how it should be implemented. Like Papert and Harel (1991), they instead engaged leaders in developing their own (constructionist) projects and valued leaders as learners with agency, interests, and local needs. The Thai constructionist community provides a provocative case of culturally responsive revision and application of an educational reform by people from across the society of a Global South, developing country.

References

Barab, S. (2006). Design-Based Research: A Methodological Toolkit for the Learning Scientist. *Cambridge University Press*.

Cammarota, J.J., & Fine, M. (2008). Revolutionizing Education: Youth participatory action research in motion.

Engeström, Y. (2009). From learning environments and implementation to activity systems and expansive learning. Action: An International Journal of Human Activity Theory, 2(1), 17-33.

Engeström, Y. (2011). From design experiments to formative interventions. *Theory & psychology, 21(5),* 598-628.

Fishman, B., & Penuel, W. (2018). Design-based implementation research. In the *International handbook of the learning sciences* (pp. 393-400). Routledge.

Flores K. S. (2008). *Youth participatory evaluation : strategies for engaging young people* (1st ed.). Jossey-Bass.

Hodge, S., Burden, J., Robinson, L., & Bennett, R. (2008). Theorizing on the stereotyping of Black male student-athletes: Issues and implications. *Journal for the Study of Sports and Athletes in Education, 2*(2), 203-226.

Holland, D., Skinner, D., Lachicotte. W, & Cain C. Identity and Agency in Cultural Worlds. *Cambridge, MA: Harvard University Press, 2001.* 368 pp.

Kapor Center. (2021). Culturally responsive-sustaining computer science education: A framework.

Kendall, L. (2007). " White and Nerdy": Computers, Race, and the Nerd Stereotype.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, W., Rhodes, J., Salen, K., Schor, J., Sefton-Green, J., & Watkins, S.G. (2013). *Connected learning: An agenda for research and design*. Digital Media and Learning Research Hub.

Ito, M., Arum, R., Conley, D., Guttiérez, K., Kirshner, B., Livingstone, S., Michalchik, V., Penuel, W., Peppler, K., Pinkard, N., Rhodes, J., Tekinbaş, K., Schor, J., Sefton-Green, J., & Watkins, S. C. (2020). *The Connected Learning Research Network: Reflections on a decade of engaged scholarship*. Connected Learning Alliance.

Kirshner, B. (2010). Productive Tensions in Youth Participatory Action Research. *Teachers College Record: The Voice of Scholarship in Education, 112*, 238 - 251.

Thompson, N., Ju, B., Erete, S., Nacu, D., & Pinkard, N. (2021). Sustaining Community and Relationships with Black and Latina Girls in an Out-of-School STEAM Learning Program during a Global Crisis. *In Proceedings of the 15th International Conference of the Learning Sciences-ICLS 2021.*. International Society of the Learning Sciences.

Tyack, D.B., & Tobin, W. (1994). The “Grammar” of Schooling: Why Has it Been so Hard to Change?