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Learning Across Boundaries: Educator and Startup Involvement in the Educational Technology Innovation Ecosystem

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This qualitative case study examined what educators and startups learned from each other when participating in a 4-hour educational technology (edtech) design summit, SlowPitch, which strategically facilitated boundary crossing conversations and activities among typically siloed constituents, such as educators, researchers, developers, investors, and students, in the edtech ecosystem. Participants included eight edtech startup founders or representatives, seven preservice teachers, and 18 practicing educators. Individual interviews were conducted during and after SlowPitch. Findings revealed educators (a) learned about edtech innovations, (b) engaged in teacher design thinking for integrating edtech innovations, (c) became aware of the voices and influencers within the ecosystem, and (d) learned about edtech startup development processes. Startups (a) learned how their edtech products would work (or not) in teachers' classrooms, (b) explored how to penetrate the K-12 market, and (c) generated ways to gain interest of potential users. This study illustrates value in broadening an ecological perspective on educators' work toward technology innovation and integration in school classrooms to consider edtech innovators and their innovations. The discussion suggests edtech learning in teacher education and professional learning can push farther than program wide and program deep in university and K-12 contexts to include experiences in the broader edtech ecosystem.

The *Future Ready Learning* national educational technology plan (U.S. Department of Education, 2016a) called for educational stakeholders such as "leaders; teachers, faculty, and other educators; researchers; policymakers; funders; technology developers; community members and organizations; and learners and their families" (p. 1) to work together to develop and use technology to improve education. Such a commitment to collaboration can be difficult when educational and professional contexts and processes separate the stakeholders involved in the educational technology (i.e., edtech) innovation ecosystem (Abdul-Jabbar & Kurshan, 2015).

Historically, edtech development of PK-12 products and services has sometimes been a siloed endeavor that ignores learning sciences research that, if considered, would improve the products and processes of innovation (Freeland, 2014; Iriti, Bickel, Schunn, & Stein, 2016; Veletsianos, Collier, Watters, & Joosten, 2014). The creation of products and services that do not solve needed educational problems faces critique (Abdul-Jabbar & Kurshan, 2015; Catalano, 2013; Cavanaugh, 2013a; Iriti et al., 2016; Tomassini, 2012) and may not be widely usable or adopted in schools where technological infrastructure varies widely, which may contribute to widening digital inequity (e.g., Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014).

Thus, considering *Future Ready Learning*'s call for educational stakeholders to have opportunities to lean and learn across boundaries of professional contexts and perspectives that might hone edtech resources is intriguing. While a range of programs or singular events have begun to provide exactly these boundary crossing opportunities, few empirical research studies have been undertaken to examine their outcomes.

This study examined what educators and startups learn from each other, the ties they form, and the resources they share when offered a chance to deeply engage with each other. The research context involved a specially designed edtech pitch event that strategically facilitated a boundary crossing opportunity through conversation *across* typically siloed constituents in the edtech ecosystem.

Literature Review

The EdTech Innovation Ecosystem

Educators and edtech entrepreneurs operate in parallel but often not in connection with each other (Veletsianos et al., 2016). They are also situated within a complex myriad of organizations, people, policies, and resources (or lack thereof). Kurshan (2016) introduced the concept of an educational technology (edtech) innovation ecosystem as involving key constituents, resources, and conditions that contribute to innovation:

An edtech innovation ecosystem refers to the collaborative efforts of key stakeholders to develop, adopt, and implement new products and services intended to improve teaching and learning. The individuals and organizations engaged in these joint efforts — including students, practitioners, entrepreneurs, investors, and researchers — represent a variety of skill sets and priorities, and their roles are often fluid.... The ecosystem is an entity that transcends individual organizations or institutions and yet is constituted by the individuals in those institutions, their ties to one another, and the resources they exchange. (p. 2)

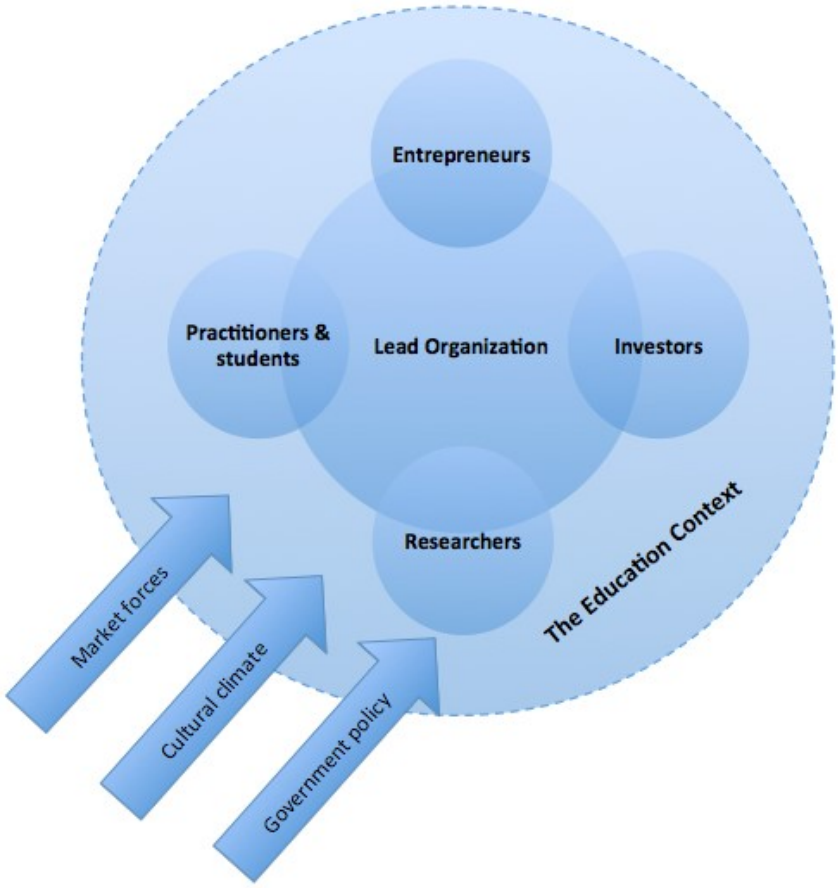

Figure 1. *The EdTech Innovation Ecosystem. Reprinted from "Breaking down silos, advancing innovation: Innovation ecosystems in education technology" by B. Kurshan, April 2016, paper presented at the annual meeting of the American Educational Research Association, Washington, DC. Copyright 2016 by B. Kurshan. Reprinted with permission.*

Kurshan (2016) used Figure 1 to represent the potential intertwining of constituents, resources, relationships, and conditions that contribute to the edtech innovation ecosystem. The ecosystem, as a global whole, is a compilation of many organization-based models, one of which is depicted in Figure 1. For any lead organization, such as an incubator, a government program, a company, or a teacher education program, that contributes to the global educational technology ecosystem, the elements within Figure 1 may be present or not, overlap, or take more or less precedence, depending on the organization's goals and priorities.

Resources and conditions set by the market, the cultural climate, or government policies can influence innovation. In the example of a university-based teacher education program, participation in the edtech innovation ecosystem could be influenced by (a) market forces such as available grant or foundation funding for research or curricular innovation or legislated budget increases or decreases; (b) government policies, such as the National Educational Technology Plan or state plans, or regulations, such as certification requirements, accreditation, or accountability; and (c) the cultural climate, such as a school

of education that is open to and supports experimentation and risk-taking or one that maintains a non-innovative status quo.

The global edtech innovation ecosystem can lead to high-potential innovations developed, disseminated, and adopted within teaching and learning, but Kurshan (2016) claimed that "more research is needed to understand how ecosystems in education technology are born and evolve and the steps that are needed to facilitate the process" (p. 7).

The Role of Educators in the EdTech Ecosystem

Educators often lack participatory roles and responsibilities in the edtech ecosystem and assume consumptive roles with little agency. For example, classroom educators have felt edtech developers and school/district purchasing processes do not consider teachers' and students' individual educational needs (Childress, 2013). Kurshan (2016) also described this challenge:

> ...in many cases, the purchasing customer is not the end user, meaning the individual teachers and students who implement and use the new product are likely to have had little input into the initial decision to buy it. This disconnect has significant implications for implementation (e.g., will the teacher/student buy into the process or get enough support to be able to use the product properly?). (p. 5)

Indeed, Bull, Spector, Persichitte, and Meier (2017) described how school administrators are unfamiliar with the need for content-specific or grade-level uses of technology. Thus, administrators often conceive of technology as a whole-school solution that serves all students and teachers similarly. Lengthy, bureaucratic school district procurement processes sometimes lead to high-potential apps or products never making it into a classroom to support student learning (Hodas, 2016; Horn, 2016; Tomassini, Bock, Venugopal, & Wickner, 2012; Villavicencio, Siman, Lafayette, & Kang, 2016).

Further, school decision makers investing in hardware and software solutions sometimes have vague notions of what education problems the technology should solve and may not investigate the educational efficacy of the proposed technologies and, as a result, invest in resources that teachers do not want or are not efficacious for student learning (Cuban, 2001; 2013; Selwyn, 2011).

Government policies, practitioners, and researchers have begun to call for edtech entrepreneurs and educators to broaden their professional work and perspectives, what I refer to as "edgework" across professional boundaries, in order to contribute to collective efforts toward development and adoption of edtech innovations that positively impact students (Bull et al., 2017; Kurshan, 2016; U.S. Department of Education, 2016a). From a sociological perspective, edgework involves facing unfamiliar edges, barriers, or risks as well as finding or creating supportive bridges between professional practices (Lyng, 2005).

Many of the new programs working to open up communication between the various stakeholders in edtech involve university-based incubators (Abdul-Jabbar & Kurshan, 2015; Cavanaugh, 2013a; Stevenson, 2017; Wan, 2017), district-startup collaborations (Arnett & Clayton Christensen Institute for Disruptive Innovation, 2016; Hodas, 2016; Villavicencio et al., 2016), app or hackathon competitions (Cavanaugh, 2013b; EdSim Challenge, n.d.; Hodas, 2016; Holoubek, 2017; Villavicencio et al., 2016), and edtech startup pitches (Corcoran, 2016; Hodas, 2016).

While these various projects all collectively aim to bring together "entrepreneurs, investors, researchers, and education practitioners, with the goal of fostering innovations that can help schools" (Cavanaugh, 2013b, p. 8), little research is being conducted across these endeavors. Among the incubator initiatives, only Kurshan (personal communication, 2018) indicated that longitudinal research activities are underway at EDSi, an edtech incubator established at the University of Pennsylvania Graduate School of Education, but no research findings have been released or published yet.

There is limited evidence of a district/school collaborating with an app company to develop and scale up innovations to solve immediate and local problems. For example, the Leadership Public Schools CEO partnered with nonprofit edtech firm, Gooru, to advance personalized learning in the classroom through redesign and scale-up of the Gooru technology (Arnett & Clayton Christensen Institute for Disruptive Innovation, 2016). This collaboration was successful because

- it allowed instructional practices to guide technology development,
- it embedded the teacher who developed the personalized learning model into the Gooru edtech team,
- it frequently conducted classroom-based testing of new design elements in the Gooru product, and
- each organization prioritized the collaboration.

It remains to be seen how scale-up of Gooru to other school districts will progress and if similar gains can be achieved elsewhere.

On the other hand, an external evaluation of Gap App, a competition in which app developers created and submitted apps to fulfill identified educational gaps in the New York City schools found the process was not user-driven by the teachers who piloted the apps. Instead, the initial problem identification (which guided app development) was led by a firm external to the district and involved only a few teachers who were not the ultimate app users (Villavicencio et al., 2016). Thus, the teachers who piloted the apps had little agency in development conversations and were positioned to consume the built apps.

In New York City schools, Hodas (2016) noted that evening shark tanks, a type of pitch event where startups share their innovations with students, parents, teachers, and administrators and received feedback from these target adopters were the "most popular" (p. 4) among startups, but no evaluation data was provided to illustrate how these innovations might have impacted edtech product development or adoption into classrooms.

These emergent programs explicitly include educators within the edtech innovation activities with the aim of opening the edtech ecosystem to educational perspectives and needs from predominantly teachers and administrators. So far, the outcomes seem uneven at best and more unknown due to a lack of empirical research on these endeavors.

The intervention and a research focus for this study emerged within this context of this paucity of research examining the nature of "cross-sectoral endeavors" (Kurshan, 2016, p. 8) and an emerging emphasis on the need for teacher education to innovate (Bull et al., 2017). Thus, this research study examined educators' and startups' perspectives as participants in a specially designed edtech startup pitch competition described in the next section.

The EdTech SlowPitch Summit

The intervention for this research study was an edtech startup pitch innovation called SlowPitch, which was conceptualized by the author, a university professor of teacher education/learning sciences; co-designed with Sean Duffy, an edtech innovator who was also a former high school English teacher; and co-led at SXSWedu, an international conference on innovation and learning. My goals for SlowPitch were to

- bring the more isolated constituents of edtech innovation, educators and students –including school administrators, teachers, preservice teachers, K-16 students, and educational researchers – together with the more usual participants, such as startup founders, developers, and investors;
- slow down the conventional pitch process that typically lasts about 5 minutes to increase feedback, conversation, and learning by all participants;
- eliminate the competitive context; and
- emphasize edtech innovations specifically for problems of practice in teaching and learning.

Five edtech startups were selected by the SlowPitch team through a competitive review process that privileged edtech startups that supported subject-specific learning or students' hands-on learning (see Appendix A), as opposed to startups that offered administrative technologies. The startups reflected three categories of development: (a) early stage (ideation or concepting), (b) midstage (validation), or (c) late stage (growth and scaling) (Startup development phases, 2015).

By examining the application materials startups submitted, Sean Duffy and I ensured we had at least one edtech startup in each of the three categories, with the two other selections coming from any of the three categories. All five startups were women-founded, which was notable because data indicates only between 8% to 17% of startups have a female founder. Of female founders, about 30% focus on education (Data viz, n.d.; Teare, 2017).

Eleven mentors, including venture capitalists, educational researchers, edtech entrepreneurs/founders, developers and inventors, K-12 teachers, school leaders, and K-16 students, were selected (see Appendix A). Mentors were chosen for their experience in the edtech startup space as innovators, supporters, or users of edtech. Startups received bios of all the mentors and ranked their top five mentors, and each startup was assigned at least two mentors, with 1 being their top ranked mentor. Mentors received a packet about the startups and key questions generated from their matched startup.

SlowPitch was free for conference attendees, who self-selected to attend. The 4-hour SlowPitch summit included a series of 30-minute, sequential activities that actively involved all participants: the startups, the mentors, and the audience. A handout that described the startups, the mentors, and the SlowPitch activities was provided to all attendees.

EdTech Startup Demos. After a brief welcome, each participating startup had access to high-top tables on which they could show functioning apps, mock-ups, or other materials and answer questions related to their product or service. The conference audience and mentors freely visited with startup representatives and viewed their products. The demo facilitated individual efforts to gain targeted knowledge about all startups.

Mentor-Facilitated Roundtable Conversations. After the demos, startups moved to a designated roundtable, where they were joined by their assigned mentors. Audience

members were advised to join one of the five mentored roundtables of their choice. The mentors designed and facilitated the mentor conversation using information they had received prior to the event and the demo experiences. Audience members were encouraged to participate.

Startup Pitches. Next, each startup participated in a 30-minute pitch and Q&A session, including a 3-minute pitch followed by 27 minutes of conversation across *all* 11 mentors and audience members. At the close of each pitch, the audience completed a two-question survey asking if the startup (a) will penetrate the K-12 market and (b) will transform teaching or learning? Immediate survey results were shown to the audience. SlowPitch adjourned after closing comments and questions.

Methods

Theoretical Framework

This research was framed by an ecological perspective of the edtech innovation ecosystem and technology integration and adoption into teaching and teacher education, both of which acknowledge the complexity and interconnectedness of systems, people, and conditions that influence technology adoption and continuance in schools. Kurshan (2016) emphasized that edtech innovation occurs within an ecosystem of interconnected stakeholders, organizations, market forces, government policies, cultural climates, and educational contexts, as illustrated in Figure 1, and found it "a useful framework for explaining the interactions taking place in this [educational technology development and adoption] landscape" (p. 2).

In the context of this study, the designed SlowPitch event was the "lead organization" of the edtech system. The design of SlowPitch intentionally increased the educational stakeholders with its

- focus on K-12 edtech startups that focused on subject-specific teaching and learning,
- inclusion of preservice teachers as audience participants, and
- inclusion of educational professionals and students as mentors in order to examine educators' experiences in this aspect of the edtech ecosystem as well as educators' influences on edtech startups.

Similarly, we anticipated that participating educators might draw upon the school-based ecosystem that has been described in the literature as influencing teacher innovation and adoption (e.g., Bull et al., 2017; Ertmer & Ottenbreit-Leftwich, 2010; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Hew & Brush, 2007; Zhao & Frank, 2003; Zhao, Pugh, Sheldon, & Byers, 2002). The school-based ecosystem acknowledges influencing conditions for classroom technology adoption and innovation, including

- the innovator/teacher (knowledge of technology, pedagogy-technology compatibility, technology self-efficacy, teachers' beliefs and attitudes);
- the innovation/technology (distance from school culture, including colleagues and curricular expectations, scheduling, assessment practices; distance from available resources; distance from innovator's current practices);
- the school context (technology infrastructure, human infrastructure, organizational and social culture of the school); and
- local, state, and federal laws and policies.

Ultimately, edtech research and development can benefit from better understanding of the "load-bearing conditions" that can affect adoption and long-term adherence in use by educators (Iriti et al., 2016), which become more visible when edtech innovations are examined and used by their target users-educators.

Research Question

The study was guided by the following research question: What are educators and edtech startups learning from each other, what resources do they share, and what ties might they form when participating in SlowPitch?

This study focused on educators and startups for two reasons. The literature review identified that past interventions aimed to bring startup founders in closer proximity to educators, and little research has been conducted on such interventions.

Research Methodology

This research employed a qualitative case study methodology and focused on the SlowPitch event, an intrinsic case (Stake, 1995) due to its unique design for a startup pitch event. Within this case, the study aimed to identify educators' and startups' learning experiences that were facilitated by this boundary crossing conversational opportunity. This research was reviewed by The University of Texas Institutional Review Board. Permission was obtained from SXSWedu to conduct the study, and consent was gained from all research participants.

Participants

All startup founders and representatives, mentors, and audience members present at SlowPitch were invited to participate in this study. Eight of the 10 edtech startup representatives, seven preservice teachers, and 18 anonymous practicing educators (of 73 total anonymous participants in SlowPitch) participated (n = 33). All startup participants requested identification with the exception of Startup E.

We directly invited preservice teachers from a local university to participate in SlowPitch because (a) we knew from past experience that preservice teachers did not typically attend this conference, and (b) we wanted to explore preservice teachers' and in-service teachers' experiences in this edtech ecosystem context. Seven preservice teachers were available and agreed to attend SlowPitch. Each preservice teacher was provided a 1-day guest pass to SXSWedu, which enabled attendance. SXSWedu conference registration was complimentary for two startup representatives of each participating startup and for all mentors because they were considered conference presenters due to their participation in SlowPitch.

Data Sources

The data included three sets of interviews. Three research assistants conducted 2- to 4-minute anonymous participant interviews as SlowPitch participants left or during breaks. Questions included demographics, SlowPitch participation activities, learning experienced, and positive/negative personal or professional take-aways. I did not anticipate that the self-selected audience would be amenable to a longer consent procedure and follow-up interviews, so I chose an approach that enabled immediate collection of

valuable input using oral consent procedures from anonymous participants in the context of a fast-paced conference.

In the 2 weeks after SlowPitch, individual interviews were conducted with startup representatives and the invited preservice teachers, with whom I had conducted a paper-based consent procedure. For startup representatives, questions probed pitching experience, learning experience, and positive/negative personal or professional take-aways. Startup interviews lasted 15-55 minutes.

For preservice teachers, questions included demographics, SlowPitch participation, learning experienced, positive/negative personal or professional take-aways, and technology preparation for teaching. Preservice interviews lasted 8-21 minutes.

Data Analysis

Given the study's aim to understand educators' and startups' learning experiences in SlowPitch, embedded analysis (Yin, 2009) of a specific aspect of data was conducted. Specifically, the analysis examined themes of learning as educators and startup participants evidenced ideas and thoughts that edged across their own professional boundary toward consideration of the others' viewpoints.

Interview data were professionally transcribed and checked for accuracy and were analyzed using open-coding (Corbin & Strauss, 2015) and theory-based coding (DeCuir-Gunby, Marshall, & McCulloch, 2011), the latter generated from literature related to the study's theoretical framework (see Appendix B).

Codes were categorized into themes (e.g., aspects of what educators or startups learned during SlowPitch). For example, an educator learning theme, "knowledge of edtech innovations," was formed by data coded for 1a, 1d, 2c (see Appendix B), because the essence of the coded content centered on developing knowledge of edtech innovations. After themes were developed through the analysis, thematic memos were written. Each startup was considered an embedded case within SlowPitch, and coding and thematic memos were written for each startup.

Data representations (Miles, Huberman, & Saldana, 2014), such as Table 1 (see the Findings section) and Table 2 (pdf download) were then generated to assist further conceptualization of the analysis and findings. For example, Table 1 represents the themes of learning for educators in the columns "Areas of Learning" and "Representations in Data," and the "Boundary Crossing Queries" were generated to inform future practice. Table 2 displays the themes of learning for startups (i.e., first column) applicable to each startup case, which are arrayed in the table hierarchically by startup developmental phase. Such a representation facilitates further pattern analysis across the embedded cases.

The thematic memos and data representations then were used to write the findings and discussion. As expected for a qualitative study, the findings include rich descriptions from the participants' interviews.

Table 2
Cross-Case Matrix

	Startups				
	A, Block Solid Early-stage /Formation (Ideation)	**B, Wiki Talki Early-stage /Formation (Concepting)**	**C, DiscoverSTEAM Mid-stage/Validation (Committing / Validating)**	**D, Science Delights Late-stage / Growth (Scaling)**	**"E" Late-stage / Growth (Scaling)**
Educational Aspects					
How their product would work (or not work) for teachers or students in classrooms					
Functionality/usability of product	X	X		X	X
Teacher adoption: Ease of Use		X			
Teacher adoption: Time		X	X		
Teacher adoption: (Mis)match with current practice			X		
School culture: Scheduling			X		
School culture: Assessment/test			X		
How to penetrate the K-12 market					
Grade level or content area focus		X		X	
Administrative, leadership perspectives		X			X
Purchasing processes		X			X
Integration with LMS		X			
Diversification (or narrowing) of product for select educational venues/paths/settings	X	X		X	X
Alignment with district, state, or federal policies				X	
Startup Outcomes	Understood steps of bringing idea to fruition; must identify focus for product and prototype	Expand product to iOS; Redesign product to be easier to use by teachers; Design for LMS interoperability	Pivot from year-long projects to 4-weeks to accommodate teachers' adoption; Visits to schools to learn more about PBL	Investor interest; Incubator invitation; Narrow focus to single grade (e.g., pre-K) to align with state priorities	Rapid prototype of a new product / approach suggested and validated at Slow Pitch

Findings

The findings describe educators' and startup representatives' learning at SlowPitch. The educator section shares key themes that emerged across the data and relationships between data through a data representation. The startup section describes learning within five startup embedded cases and includes a cross-case matrix.

Educators' Learning at SlowPitch

The educators who participated in SlowPitch described four areas of learning: (a) new edtech innovations, (b) integration practices involving the edtech innovations, (c) the voices and influencers within the edtech ecosystem (including educators), and (d) the edtech startup development process (see Table 1).

Edtech Innovations. Educators expanded their knowledge of existing or emergent educational technology. For example, a teacher explained, "I definitely learned about what people are trying to get out there." A technology coordinator noted that it was "just nice to see what is coming down the pipeline, possible ideas and what companies are thinking about right now." An assistant principal said,

We are always looking to consider innovative ideas for education. We understand that technology is definitely the route that folks need to, at the very least, consider. So, the idea that there will be several different companies here pitching new ideas is exciting.

Preservice teacher comments include the following:

- "I learned a lot about where technology for education is going. Also, I think that learning more about resources [that] may be coming available is beneficial as a teacher."
- "I loved seeing the variety of companies and what they are offering. Great ideas that I look forward to seeing in my classroom."
- "I felt like this summit was really helpful, kind of narrowing in on some of the types of programs that we could be using."

A few teachers mentioned how the products introduced new educational content ideas. For example, a preservice teacher said:

> … for [Startup E], I hadn't even thought about bringing entrepreneurship into schools, which I think there's a lot of teachers [for whom] that may be a new idea, or something that really isn't discussed as much. I thought that was super interesting, just taking on that new perspective.

An arts educator said, "I learned what is the cutting edge right now. What new ideas are coming into classrooms and into education, which I didn't know before."

Other educators made connections between the new edtech products in SlowPitch and specific needs in their schools. For example, a high school instructional coach said, "Yes, the company that I was paired with [during the event activities] was very well matched. I hadn't heard of them before, and I think they are a good match for our school next year." A K-12 administrator used the experience to "gain a lot of new contacts that will help with starting a new PBL STEAM academy next year."

Table 1
Educator Learning

Areas of Learning	Representations in Data	Boundary Crossing Queries
Knowledge of edtech innovations	• Awareness of possibilities • Product-need matching • Springboard to other innovations	• What does this product do? • Does it solve any of my educational needs? • What other innovative products might I investigate?
Integration practices involving the edtech innovations	• "Teacher-thinking" for own classroom • Privacy and safety concerns with certain products	• Is this product different than what I already do or can use? • Does this solve a problem I have as a teacher? • What is the educational research underlying this product? • How does the product align with the curriculum? • How does the product align with school policies?
Voices and influencers within the edtech ecosystem	• Importance of teacher voice • Teacher input useful and startups grateful for input • Appreciation for being part of the conversation with multiple viewpoints • Influence of educational policy, legislation, innovation	• What is my role in the edtech ecosystem? • What can I contribute to the edtech ecosystem? • What can I learn from others in the edtech ecosystem? • What influences what in edtech and education?
Understanding edtech startup development processes	• Edtech share educational goals: improve education, solve problems, make it easy for teachers • Challenge of honing their product for classroom integration • Risk-taking and learning loops by startups	• What educational goals underlie the product? • Why is it difficult for products to get into schools? • What risks do edtech startups face? • What's the "just" right product and package that will be adopted?

Preservice teachers voiced some negative bias against the early-stage edtech startups without purchasable products, because they could not be immediately used. For example, one preservice teacher said, "…a lot of them were things are going to happen, maybe. Nothing was anything that I could put into practice right now I felt. I didn't really take too much away I could really implement right now…."

Further, a lack of control over student teaching or field placements and an inability to choose edtech for classroom use led some preservice teachers to indicate less learning or benefit. Another preservice teacher said,

> I saw [Startup E] and thought, "Wow, I definitely want to put that in my own classroom, and that is something I can see right now at my school." It just isn't feasible because I am a student teacher. I don't have access to that stuff.

Another preservice teacher explained, "Obviously I'm not going to get Science Delights for this class [her current field placement]. I don't have any money to bring it into this classroom."

Many preservice teachers saw the exposure to new edtech as "a springboard for me to look into more programs that I could be using for my students in my classroom." Others felt the knowledge might be useful for future technology integration, such as when a preservice teacher explained,

> If I did ever want to be really innovative and [use] that kind of technologies in my classroom, I would reach out to companies like these that exist. These things are there and resources that you can access if you want.

Another preservice teacher spoke about building relationships with participants at SlowPitch:

> I was able to talk with a lot of people who are connected into this idea of integrating technology into the classroom. I've been emailing some of them since then and continuing the conversation about how we can use these resources.

This preservice teacher recognized a difference between "just [learning] about the programs" versus "trying to look into them - that's what leads to further inquiry about what I can use in a classroom to support learning with technology in different ways than we typically do. Just typing or showing videos."

Both practicing and preservice educators developed knowledge of new edtech innovations (see Table 1). Practicing educators, who have more control over their instructional contexts, considered product-need matching, while preservice teachers tended to explain how or why they would not be able to use one of the edtech products due to their lack of agency and control in their student teaching contexts. However, preservice educators described how the exposure to these edtech products pushed them to investigate other innovations for their future profession.

Integration Practices With Edtech. While some preservice teachers expressed their immediate lack of agency in adopting edtech products, they still engaged in what one preservice teacher called "teacher-thinking that hadn't been triggered before, thinking

about how I might use it in my own classroom." Another preservice teacher described her thinking: "Part of it was, as a preservice teacher, thinking in a very real way how would I use something like this in my classroom." In the context of this teacher-thinking, preservice teachers raised critical concerns regarding adoption, such as privacy and safety issues:

> If Block Solid is a social app, like, where you can see that your friends have completed assignments, will there have to be some form that parents sign so that their child can be on that? It is something on the Internet, like where other people can see activities, and that does bring up safety concerns.

Another preservice teacher considered the distance of these innovations from her current practice or other available resources: "The first thing I thought about [was] 'Oh, well, how is it different than a FOSS kit?' Science Delights answered that question without me even having to ask it…." Another preservice teacher described her teacher-thinking that involved consideration of her school's technology infrastructure and resources, her curriculum, and the edtech's research base and success rates:

> What's interesting is thinking about going into my own classroom, what do I have access to? I mean I know [for] a lot of that, I'd have to apply for a grant or something, but going in and thinking about how this applies to myself and what do I want to consider and what are these companies thinking…. How that might apply to my curriculum? I guess just thinking about it, instead of walking into a class I've just come in and everything's been there. Thinking a little more about what I want in my classroom and what these people … the research behind what they're thinking and the success they're having.

A preservice teacher who examined the Science Delights product wanted descriptions or video examples of the products for curriculum alignment:

> I can make sure that it matches the lesson that I'm teaching the day before or the day after…. I would want to make sure they showed up when I needed them, as opposed to 3 months too late or 2 months too early.

Another preservice teacher described that she had to tackle a book club scheduling challenge for third graders in her preservice course, where she realized "Wow, this is actually a lot more difficult than I thought it would be." Yet, her exposure to Startup A's product made her think, "So that Block Solid's application itself…. It was just interesting to see how that technology and the ideas that they have really do… They really are trying to fit in what we need in the classroom as teachers."

One preservice teacher made the connection to practice when she explained,

> Wiki Talki was super interesting to me, too, because that's something that we could have used in one of my tutoring sessions. I thought that was super interesting, and I haven't heard of that one before, either. It's cool.

She acknowledged, "I think the overall thing for me was learning how about it could be implemented in the classroom, and some of them were more obvious to me than others."

In our data, only preservice teachers voiced these classroom-based "teacher-thinking" considerations. This pattern may be due to

- practicing educators' considerations of broader school-based goals (i.e., project based learning),
- practicing educators' internalization of such "teacher-thinking" because of their years of experience,
- the immediacy of teacher preparation, which calls upon preservice teachers to engage in classroom-based lesson planning, and/or
- a methodological limitation of the interviews, such that with more time practicing educators might have voiced "teacher-thinking."

Nonetheless, the preservice teachers' queries (see Table 1) were insightful and critically examined edtech products' affordances and limitations for instruction and learning.

Voices and Influencers in the Edtech Ecosystem. Teachers acknowledged pleasure that the educator viewpoint was being taken into account in edtech development processes. One teacher noted, "I think that it is important to have teacher voice when people are creating startups." A preservice teacher was pleased "that [teachers] can have a say in it [edtech products]." One preservice teacher was unsure "if I was taken seriously because I was a student teacher," but she concluded, "It sounded like a lot of them [startups] were interested in the things we had to say… I felt like some of the things I had to saying were useful." Another preservice teacher felt acknowledged,

> After talking for a while, they [startups] taught us a lot about what they were trying to do, and we were able to give them feedback as preservice teachers…. it turned out to be, she seemed very grateful for our help.

However, most educators did not focus on their specific role in the ecosystem, but rather, noted that they learned through the diverse and broad viewpoints and influencers in the edtech ecosystem, as represented at SlowPitch. One preservice teacher said,

> I thought it was cool because I've never been part of the startup community or anything entrepreneurial. It was cool to see how that works. How do they get feedback? Oh, that is a fun idea, but it would never work. Let's talk about this.

A higher education professor said, "The roundtable was really engaging with a lot of collaboration. … There was lots of different perspectives at the table which was really helpful to the entrepreneurs that are trying to develop their product." A technology coordinator in a school district appreciated the multiple viewpoints:

> It is fun to hear from the people that are building these apps, but it is also nice to get the perspective from all the people around the table all these different roles. The variety of ideas that exist out there really fascinating to me.

Similarly, an assistant superintendent for a school district acknowledged learning from

> the opportunity to share information with those that developed the concepts but also to listen to the other creative minds that were in there to their initiative and thoughts on what they have already done as well and piggyback in on past experiences.

A preservice teacher shared, "I liked all of the angles that people were coming from and how they're trying to make technology part of the classroom, which it's inevitable at this

point for us to not use technology." Another preservice teacher described how educational policy and state legislation could influence edtech:

> We started talking about the high quality pre-K program and how that might affect their company's growth in a positive way. So, it was nice to learn more about just that happening in Texas, because I had heard of it, but I hadn't looked much. So that was really interesting.

Similarly, another preservice teacher began thinking about the role of government policy, specifically about "how the curriculum legislation and then the small businesses are all connected." He felt the interconnections between legislated curriculum requirements (i.e., standards), curriculum provided through edtech products, and testing "seems like a circle somehow." He was "not really sure how" this all occurred but concluded,

> What I'm more curious about as well is, what influences what? So, is there ever a time where these small businesses come out with something that's so just fantastic that would help learning. Would that ever influence legislation or is the legislation kind of, quote, "end all be all" to what the market can potentially create, because of the certain restraints, or lack thereof?

Another teacher also said, "This summit made me think about the connection to legislation, specifically standards, and how businesses can generate positive relationships with the goal of improving academic success."

Both preservice and practicing educators recognized how multiple viewpoints, including their own educator voices but also innovators, businesses, educational policymakers, and political legislators, contribute to edtech development and adoption in schools. Their queries (see Table 1) recognized their role and contributions but also the ability to learn from others in the ecosystem.

Edtech Startup Development Processes. Finally, through these diverse, collaborative discussions, educators began to acknowledge the educational goals underlying the edtech innovations and the challenges and risk-taking involved in moving a product into the educational market.

Goals of edtech revealed. One teacher noted, "SlowPitch was personally satisfying to see people [from startups] who share my ambition to help people apply their education in a meaningful way." An undergraduate student, Mr. S, who was a mentor said,

> It is really interesting to know all the work that is going in to improve education.… These different startups … are trying to improve education and the whole idea of reimagining education … they are there to improve education. I think that is the big goal out there. So, I think that is what is really exciting.

A director of afterschool program acknowledged,

> It has been really interesting to watch and see the way they [startups] are solving these problems. Like how they are tackling with science toys and tackle an existing problem [with] solutions that are working in other spaces and putting them together. Pretty cool to see.

A preservice teacher noted the efforts the companies take to design ready-made innovations:

People are really trying to do this and making it easy for the classroom teacher, like doing these prepackaged things. That was interesting.... They're aligning with the [standards] and they're having assessments and they're supplying all the material. That was cool.

*School-based integration***.** Educators described collaborative discussions during SlowPitch that examined school integration challenges for the edtech innovations. For example, a preservice teacher said, "Talking with [Startup E] and seeing the ways that they're going into the schools, integrating curriculum, and we had a lot of discussion around just the ways we can integrate it into what is already there in schools." These discussions were more about understanding the startup's vision for how their product might integrate into school curriculum and educator suggestions regarding avenues for the startup's product to find its way into schools.

Risk-taking. A teacher noticed the risk-taking involved in edtech entrepreneurship, when noting,

> ...It was kind of neat to see a bunch of adults taking on those risks and pushing something forward that they don't know if it is going to get good feedback or bad feedback or if it's going to work or not going to work. I appreciated that.

Similarly, a district learning technology coordinator began to see the learning loops that entrepreneurs experience:

> This is one of those processes that no matter where you are at in the stage with your idea or all the way through to market, it is just there is nothing wrong, nothing bad because it's a continual learning loop. Iteration loop. Think a little bit in the eyes or shoes of the people that are trying to get these startups going. To see the world through their eyes.

A higher education professor acknowledged the difficult work startups are doing to innovate:

> My number one takeaway from listening to these pitches is how difficult it is to innovate in education. How the system, the Texas system, and the local school systems – systems, systems, systems – are so difficult to deal with as an innovation startup. I had a hunch that the school systems would be difficult, but today it really came out in all five pitches the difficulty, in fact, they all sort of laughed. It's just such an accepted problem.

One of the most challenging systems is district purchasing processes. Educators came to share and learn about how school districts adopt educational resources. One teacher recognized, "I have a new perspective on the challenges companies have in terms of getting into schools." A preservice teacher shared:

> If you actually go through the district [to acquire those types of products], they talked about multiple, how different districts deal with that. They get a budget for whatever they want, where other districts may say we all order from this specific company for our science kits. It was interesting to hear their knowledge of different districts and how materials for science may be acquired.

Likely the biggest risk for these startups is working so hard to create a product that educators like and want but not being able to "crack the nut" of school or district purchasing.

Through these conversations, practicing and preservice educators evidenced empathy – understanding the realities of the edtech startup founders. IDEO's human-centered design positions empathy as the first aspect of design thinking (Brown, 2008). Conceptually, a design process emphasizes the importance for the startups to engage in empathy and build understanding of the problems and realities of the target audience (i.e., educators) for whom they are designing solutions. Yet, in this data, the educators built empathy and understanding of the startup founders and their goals and the challenges and risks inherent in the innovation process.

Building mutual empathy between and among educators and startups (as well as all other stakeholders) may yield more productive design solutions and penetration into school markets, what Brown and Martin (2015) called "intervention design" or Yuan and Dong (2014) called "co-design." This finding raises "empathy for whom?" as an emerging question in design processes, a topic that needs further research.

Startups' Learning at SlowPitch

Startups (see Appendix A for descriptions) were at different product development phases, which influenced the information they sought and exchanged with educators. Thus, this section presents individual startup cases. A cross-case matrix frames the educational aspects startup founders edged toward examining, as represented in conversations with educators at SlowPitch (see Table 2).

Startup A: Block Solid, A Homework Self-Management App. Founder Jessie Shanks, a noneducator, received a wide "spread" of ideas from educators and others during SlowPitch. Shanks described how her teacher mentor, Ms. U, described, anticipated, and asked about issues regarding the product's use in the classroom based on Ms. U's experience.

Shanks received additional feedback and questions from mentors Mr. R, a high school senior, and Mr. J, a web developer. She explained, "Yeah, there were a lot of questions about functionality that we couldn't answer because we weren't really at that point yet.... They had a lot of questions for us." She acknowledged the need to consider the user audience and functionality:

> I do think that at the end of the day, with any app, you have to know what your potential audiences are, and you have to do different research to learn more about their point of view and what their usability might actually look like.

Shanks said the mentors "really asked us to think pretty deeply about what our goals or vision was. I did maybe expect a little more advice rather than just additional drilling from the mentor."

Ultimately, Shanks felt the ideas and feedback were somewhat problematic, providing too many potential paths that felt distracting to her, but she acknowledged she still had to think through and figure out a future path for her startup. She explained, "What I really learned more than anything are the steps to start bringing an idea into fruition, especially being at the earliest age of the process." As illustrated in Table 2, Shanks' boundary crossing conversations led her to realize the imperative of identifying the education needs that her

early-stage idea might solve, which could direct her product design path, and the subsequent functionality and usability of the product.

Startup B: Wiki Talki, an Oral Communication Platform. This startup's goal for SlowPitch was "to make sure that this product actually works and make sure that we got feedback from the potential user [so] that this can actually penetrate the K-12 market or ESL market" (Founder B1, Sawaros Thanapornsangsuth). The founders indicated that feedback from educators helped them learn the need for easy uptake of technologies, and they concluded their website backend was a hindrance for teacher adoption. Thanapornsangsuth said,

> This is a positive community for me to be in, and we actually feel that this place gives us sincere advice, because people who come here are from the ed[ucation] industry.... I think that's what's unique about SlowPitch, because people here are the ones who really care about edtech.

Thanapornsangsuth also felt the roundtable activity was "the most beneficial of the whole SlowPitch," because comments were leveraged from those in the field of education. She said that

> there was one person at our table who came from K-12 education and he is a tech director.... I really think that he knows the culture of K-12, and he could really reflect it back to the school and how his school would adopt our app.

Founder B2, Soo Hyoung Joo, described how "feedback from the audiences who might be the users, the potential users" was instrumental for them to refine their product and consider different educational settings for it. During the startup demos, they learned "the preparation time involved with using these products can really hinder the teachers from actually [being] willing to import these into their classroom activities." This feedback led the startup to consider how to reduce teacher workload while also still making the app functional and meeting needs of language learners. Joo acknowledged,

> There were really a lot of amazing ideas [during the demo], like being able to use and implement in different settings, not just in language classrooms. We had different needs, like an elementary school teacher who was saying that it would be amazing to implement it in their classrooms for any sort of speech practices and things like that. It was just a way to broaden our spectrum of using it. Also being able to reach out to the users, gaining the interest of the users.

The founders also noted the benefit of meeting educators and district personnel. Thanapornsangsuth said,

> A lot of people from the school district were there. I've never really met anybody from school districts ... the administrative part of it. We haven't really had any background of it ... but seeing how school districts might be willing to embed this product into their LMS system or something like that. That was a totally new possibility that we haven't really thought of, so that also helped out, I think.

Thanapornsangsuth said SlowPitch "tested their commitment and after the session itself. It really gave us encouragement to focus more on the product." As an outcome, Joo said their "first priority has to be on iOS development... because it's quite clear that people turn off by saying it's only available to Android." Thanapornsangsuth also considered the next steps:

> It definitely helped us think through about what our next steps should be. I think many of the feedback included making the service more lenient so that the teachers can actually use it without a lot of preparation time, along with probably adding it to other LMS platforms. We never considered that possibly at all, but that would be really amazing if we can do that.

Overall, Thanapornsangsuth reflected on SlowPitch:

> Here, you really get to interact with the audiences, and in the end you get more, much more than you'd be able to get from a 2-minute pitch. I love the idea. And even the title of the summit, SlowPitch, is really different from what we would really do in business meetings. It's not just about money right? It's really about education, and we need to think through and process things even from the audiences.

The data in Table 2 reveal how Wiki Talki founders were drawn simultaneously to consider teachers' use and adoption concerns for their app as well as to discover new paths for development or app focus that might facilitate greater penetration into the education market.

Startup C: DiscoverSTEAM, a Project-Based Learning Platform. The founder, Sarah Jabeen, knew they "had to get their idea mostly in front of teachers to see if it was a good one" and wanted to connect with PBL (project-based learning) practitioners or theorists. Jabeen, a noneducator, was in the process of "trying to scale the concept" for her product. She described the value of her mentor, Dr. X, a PBL expert and educator:

> She was amazing; she was fantastic in terms of giving us feedback and ideas and actually pulling us and going, "Okay let's work on this, this and this," so we were really excited about all of that.... We specifically sought out people who could have given more insight in how PBL teachers function and how they think and also the theory of project-based learning and why it works and also help us figure out what parts of our theory might work and not work and what might scale and not scale. This part is obviously very crucial for a business, because otherwise you don't have a business.

Dr. X helped Jabeen understand the impossibility of yearlong PBL classroom-industry collaborative projects, with 4 weeks or less as more optimal for the classroom. Jabeen described this enlightenment:

> We thought that yearlong projects would be good, but we were told repeatedly by Dr. X that, "No, teachers are looking for something that finishes in four weeks." That could be a huge change for us, but we have to figure out how to factor that in because corporations, they want to [have longer projects], because of the amount of time it takes to curate projects and get them ready and then the fact of how long it takes to establish relationships between corporations and students. These two things feel counterintuitive, but obviously at the end of the day, if teachers are not willing to use them [projects] in the classroom, it's a no go. We are still trying to figure this out, I mean that kind of got us into the thinking like we really need to talk to some teachers. That's why we are going to [a high school] today and seeing what they think.

Dr. X and other educators also suggested that teachers could collaborate with DiscoverSTEAM on assessment rubrics and evaluation, which was enthusiastically accepted by the founder. Jabeen described the moment:

> I love the fact that Dr. X was, they [other educators] were all over the rubric and assessment and going, "Oh teachers will help you put together a rubric template that you can actually have on your platform," so other teachers can be useful. I'm like, "Oh my God, that's brilliant." I was really scratching my head with that one, and I was like thinking, "My God there are so many rubrics. How the heck am I going to finish it?" It's still not completely clear about this whole assessment thing. I really need to figure that out with more teachers and people who are PBL experts and evaluation and stuff like that.

The educator feedback led DiscoverSTEAM to a massive pivot, where Jabeen is reconceptualizing her product and relationships with companies from where the projects emanate. Jabeen also anticipated being able to work with Dr. X "a little more in-depth, which is fantastic" and had already planned a visit to the school where Dr. X worked.

Conversations with educators at SlowPitch, led the founder of DiscoverSTEAM to consider how teachers' needs, time, classroom practices, scheduling, and assessments were incompatible with her product, which ultimately required a significant pivot (see Table 2).

Startup D: Science Delights, a STEM Curriculum. This former-educator founder, Dr. Anita Greenberg, "always like[s] to talk to people who are in the classroom now." She said that feedback from educators allowed her to confirm how she "positioned the product as very turnkey, but also very flexible. From an organization standpoint, it makes the product a little more difficult," she said. During the mentored roundtable, she said that "…it's nice to hear that confirmation, especially from preservice teachers who are about to go into the classroom, about 'Yes, that's a good idea. Continue.' Even though that will be harder, continue to do it that way." Greenberg reported, "The reaction to features is really important for me, because that drives the cost. It drives a lot."

While some educators helped confirm her product, others like "professors and district level people" opened up new "business lines" where she could focus in the future. Greenberg described talking at length afterwards with one of her mentors, Ms. W,

> about really spending, probably, the next year solely on pre-K. That's really what the state is focusing on. Over the next year. I thought that was a really interesting take…. It would be a nice, easy thing for us to focus on as opposed to throwing everything at the wall and seeing what sticks.

She admitted that "focusing on a single grade level…was something she had never even thought of." In this interaction, Ms. W brought awareness of state-level legislated focus on pre-K education. During the Q and A portion of SlowPitch, mentor Dr. M raised the idea of MOOCs (massive online open courses). Greenberg said,

> I had never even heard of MOOCs where you had to buy a physical product to go with the class that you're taking. My first reaction to it, "There really aren't any MOOCs for these young kids." As I talked to him more about it and began to think about it more, I began to think of things like Khan Academy, which you can sort of categorize as a MOOC. A lot of the content that I have developed is really secondary content. It's just that the age group focus is younger.

While Greenberg learned from educators during SlowPitch, she also described the importance for investors and business side representatives to see and hear about her product within the "education-specific, education-rich" context of SlowPitch. Within her own startup team, Greenberg's business partner revealed how much he did not know about the school context and district, state, and federal laws and policies, based on conversations during the event. Greenberg said,

> I remember him [Partner D] saying to me after the summit, "At that round table, listening to you guys talk at that round table, you realize how much knowledge you have within the education world." He said, "The discussion that I had with preservice teachers and the district-level woman who was there – it's not just the jargon you use. It's the ability to understand the state level bureaucracy and how the federal level bureaucracy affects the state level policies. How all of that works." He said, "I never would have been able to do all that." We each have our specialties.

In addition, SlowPitch enabled these edtech ecosystem constituents to come together and, ultimately, convince investors of Science Delight's product viability:

> [Mentor] Mr. E works with [investment firm], which is one of the reasons he was there. [The firm] invests heavily in education. He's not an educator. He's an investor. He's a money guy. Him being able to sit down at the table with us and all those other people, with the teachers … and preservice teachers….We had the other mentor, an edtech person from one of the districts outside of [city]. Again, they gave him a perspective that was, this is something that would really work. I don't think I would have been able to convince any investors. I wouldn't have been able to convince them of it. Regardless of showing them budget, showing them numbers, showing them. It was much more powerful to have them be in that setting.

Greenberg also said, "It's been a little bit of a struggle [to get investors who are interested], I think, partially because it's an education product. SlowPitch put us over the edge." She reported that several investors indicated interest, and Mr. E, one of the mentors, "came up to [us] and said, 'Yeah, I want you guys to come to pitch to [investment firm].'"

Beyond interest by investors, Greenberg also reported that

> there was an incubator that was interested in Science Delights. They were able to come to the presentation. I'm actually going to start with them April first. The SlowPitch summit was really what solidified, what really convinced them that we could, that they could do a lot with Science Delights.

Through conversations at SlowPitch, Science Delights founder Greenberg fielded a few teacher usability concerns and predominantly benefited from ideas to narrow her product's focus (e.g., on current legislated emphasis on pre-K) or broaden the modalities that might involve her product (e.g., with a MOOC). Ultimately, the educator presence and participatory contributions legitimized her product's viability for investors and incubators who were present.

Startup E: K-12 Entrepreneurship Curriculum and Professional Development. This startup came to SlowPitch "trying very hard to learn as much as possible about the education industry, especially the sales side of it, and how to go to market and understanding our clientele, our customers more" (Partner E1). They valued and wanted more access to administrators, principals, and district heads:

> ...The more administrators you can get, like educators, but administrators, that one district, one school, at all different levels, would be very helpful. Their point of view is very powerful, we would love to know more about that. Anybody that works in a school. (Partner E2)

They spoke about "crack[ing] how you get into a school district" (Partner E2) as an enduring challenge. They found that the demo portion of SlowPitch led to greater visibility and awareness with educators.

> During the demos ... a lot of the people we met there were, be it instructors or school administrators, they're just people that are generally interested in what we were doing. After they talked to us, almost immediately [they] wanted to sort of follow up, or "How do I get this in my district? How do I get this in my school?" That was great just for awareness. (Partner E1)

They acknowledged that "because the way our product works, we get teachers generally excited about it, but they're not normally the end purchaser, just because of how schools work" (Partner E1). During the mentored roundtable, they reported the "helpfulness" of the combination of their mentors, Dr. M and Mr. T, teachers, and administrators present:

> ...One of our biggest struggles personally as a company has been - we have a great pricing, long-term sales strategy for school-wide communication, but it's a very slow process.... How do we combat that? How do we take that slow process and kind of speed it up? While we were talking to them, they actually gave us some solutions for that, that we could immediately validate due to teachers at the table, which was pretty great for us. (Partner E1)

The immediate educator-based validation of a mentor-suggested purchasing model led Startup E, immediately after SlowPitch, to engage in rapid prototyping new packaging to push their product into schools:

> That actually led to a product design that week that we're now trying to demo out to get into some teachers' hands pretty quickly. That's a huge one for us. That was probably our biggest development. We're trying to do some sort of in-school kit model now and actually create free lesson plans for that, just so that's kind of our way in. (Partner E1)

Overall, Startup E felt "SlowPitch definitely built our confidence.... I think, at this point, it was just what we needed to hear and the support that we wanted to hear, and the comradery that we needed. It was at the right time." (Partner E1)

Startup E fielded few teacher usability issues and predominantly interfaced with district administrative leaders who provided purchasing models and ideas for market penetration. Educators were able to validate these ideas, which led to the startup to begin prototyping a new market penetration approach immediately after SlowPitch (see Table 2).

Startup Cross-Case Analysis

Table 2 presents evidence that the boundary-crossing conversations and interactions at SlowPitch led these startups to learn primarily (a) how their product would or would not work in preK-12 classrooms, (b) how to penetrate into the preK-12 market, and (c) how to gain the interest of potential users. Educators led startups A-Block Solid and B-Wiki Talki, both on the earlier side of development, to focus on product functionality and potentialities

in and for education. Yet for Wiki Talki, which had a functioning prototype, there was greater depth to suggestions and concerns, and the experience of the founders, Thanapornsangsuth and Joo, culminated with an agenda for product redesign.

Founder Jabeen of Startup C-DiscoverSTEAM learned that her product, as designed, would not be adopted by teachers in schools. Thus, her learning focused around aspects of teacher adoption and misalignment with school culture, and she realized a major pivot was required. Startups D-Science Delights and E had marketable products for sale, but they showed commitment to monitor educators' perceptions of their products' functionalities. Most of their learning focused on penetrating the market, gathering ideas for new educational lines for their product (both D and E, or transferring educator validation into future investment and incubation (Startup D).

Discussion

Educators' edtech innovation work already involves complex influences within classroom, school, district, and national education agendas (Fullan, 2015; Zhao et al., 2002). This study illustrates value in broadening educators' work involving technology innovation and integration in school classrooms to consider edtech innovators and their innovations. This broadened ecological perspective can be considered an edtech ecosystem (Kurshan, 2016) within which educators are now positioned.

Educators face a rapidly changing context for technology adoption and use in schools, with more available innovations, some even in beta form, and most of which have not undergone any educational research of instructional or learning efficacy (Bull et al., 2017). Further, these educational technology innovations are not value-neutral (Stager, 2015), including examples of innovations reflecting corporate reform agendas toward personalized learning (Roberts-Mahoney, Means, & Garrison, 2016) and illustrations of how teaching and learning shifts as technologies and corporations become more involved in educational contexts (Loveless, Sullivan, Dredger, & Burns, 2017). Thus, educators and edtech innovators must consider the value and purposes of educational technologies (Roberts-Mahoney et al., 2016) in addition to the "how, why, when and with whom a particular use of a technology supports learning" (Bull et al., 2017, p. 4).

Spinuzzi (2014) described a shift from considering value laden in a marketable good (i.e., a technology, an app, a software) to *use-value* that is cocreated by entities involved in the transaction (i.e., design of technology or adoption of technology). When educators have more participatory agency in edtech innovation, negotiations around use-value may occur.

Within the context of the SlowPitch experience, this study identified that both educators and startup representatives were leaning in and learning from each other through boundary crossing conversations and experiences in ways that expanded their respective perspectives on educational technology. Educators' queries (see Table 1) grappled with the "how, why, when and with whom" for classroom technology integration as well as inquired into the edtech startups' educational commitments and goals. They considered edtech in light of their own resource-rich or resource-poor educational contexts, the curriculum and standards, legislated policies, and school culture.

In the SlowPitch summit, educators said that the five edtech startups' products supported, rather than derailed or undermined, their own educational values toward improving learning and solving educational problems. Obviously, exposure to different startups would lead to different determinations of educational values and goals. Most important,

educators acknowledged values and goals of edtech and probed the influences and influencers in edtech and education.

The startups' learning at SlowPitch was product centered, in which they heavily weighed the product usability, issues that would prevent educator adoption of their products, and tactics to penetrate the K-12 market (see Table 2). Through educators' queries and sharing, startups began to map the resource context within which educators' decision-making and adoption occurs. Startups B-E identified actionable tasks in response to educator feedback during SlowPitch, such as Wiki Talki creating an iOS app, DiscoverSTEAM reducing projects from 1 year to 4 weeks' time, Science Delights focusing on one grade level, and Startup E developing a new product package. The SlowPitch startups' openness to agile development contrasted with other teacher-developer initiatives like the *Gap App* evaluation in New York (Villavicencio et al., 2016), which found that teacher suggestions related to app content were not implemented by developers because suggestions conflicted with other teachers' suggestions, with the company's goals, or the company's expansion plans.

The data in this study did not reveal that startup participants considered their own educational commitments, goals, or values during this boundary crossing experience. The educators seemed to express similar educational commitments with these five startups, so they may not have critiqued or explicitly questioned the startups' commitments.

Ultimately, the data indicated that educators and startups valued each other. Educators were eager to learn about new innovations, and startups were eager to meet and hear from educators. Some startups indicated they had never talked with administrators or possibly even teachers prior to SlowPitch, and many of the educators said they had never engaged or met edtech startup entrepreneurs before. Both educators and startups indicated that they developed new professional ties, such as educators building new contacts and new innovation resources and DiscoverSTEAM founder Jabeen visiting a high school for further educator support, such as rubric development for her product.

The case study of SlowPitch illustrates a boundary crossing experience that contributes toward meeting Bull et al.'s (2017) recommendations for the preparation of leaders and teachers to use learning technologies. SlowPitch's selection process prioritizing startups that developed content-focused and learner-focused innovations helped maintain a pedagogical context that broadly reflected research in the learning sciences. SlowPitch did not include specific learning goals for participating educators. The data revealed, however, that educators expressed queries reflecting a "learning how to learn about new technologies" that involved deep analysis of edtech innovations' propensity to solve educational needs, advance learning, and align with curriculum or school culture.

These boundary crossing queries (see Table 1) reflect critical evaluations that productively support finding, evaluating, and choosing edtech resources, a crucial skill for educators (Karolcík, Cipková, Hrusecký, & Veselský, 2015; Lee & Cherner, 2015; Roblyer & Hughes, 2019). Educators mentioned building ties with other educators and startups that potentially could serve as a professional learning network into the future. Finally, various types of educators were involved in SlowPitch, including preservice teachers, classroom teachers, principals, superintendents, technology specialists, and higher education faculty, which means all levels of educators were potentially building similar take-aways through this boundary crossing experience.

In terms of educator preparation for the use of learning technologies, the conceptualization of SlowPitch and this case study's findings reveal the learning benefit of engaging educators in a broader edtech ecosystem over one set only within higher education and preK-12

schools. While teacher preparation shifts from a one-course model to a "program wide and program deep" model (Bull et al., 2017; U.S. Department of Education, 2016b), preparation should transform even further toward ecosystem-wide models.

In addition to program width and depth, preservice and in-service learning programs should create opportunities for educators and teacher educators to engage within the edtech innovation ecosystem to support boundary crossings that will benefit educators and edtech entrepreneurs. Formats for more boundary crossing experiences could include

- replications of SlowPitch held at universities, schools, districts or conferences,
- explicit participation of educators in local edtech meet-ups,
- edtech startup guest speakers or webinars in coursework or professional learning experiences,
- school district office hours for startups (e.g., Hodas, 2016), and
- reverse field trips, where startup personnel visit schools (e.g., Hodas, 2016).

Future Research

As educator learning experiences expand toward ecosystem-wide models, future research can examine how such experiences build and engage educators' agency within edtech, including startup-based activities but also in school or district-based edtech processes. For example, research might examine how educators build and use educational evaluation frameworks for educational technology and learning technology resources in boundary crossing experiences and also later in school-based contexts, where they must choose and evaluate edtech resources for adoption. How do educators' evaluation frames consider aspects of the education-industrial complex and neoliberal education reform? Do teachers become part of district- and school-based edtech evaluation processes?

As might be expected, some educators could adopt new edtech resources after boundary crossing experiences, and research should also examine how (or if) such teachers engage in evaluating the instructional or learning impact of the adopted resource. Research could also investigate the nature of relationship-building and joint work between educators and startups. Are different types of educators valued or needed at different stages of startup development? How do (and should) educators and startups receive "credit" for significant, shared work inspired or facilitated through boundary crossing?

Author Note

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Appendix A
Description of Participating EdTech Startups, Products, Representatives, and Assigned Mentors

Startup and Stage (Startup development phases, 2015)	**Description of Product/Service**	**Founder(s) and Startup Representatives Biographies**	**Assigned Mentors and Biography**
Startup A – Block Solid Early-stage /Formation (Ideation)	Block Solid is a planning web app for upper-elementary and middle schoolers that empowers kids to self-manage the homework process. Traditional planners focus on the due date. Block Solid changes that focus. Using Block Solid, students move step by step through the process of planning for and completing their homework: breaking assignments down into manageable blocks, scheduling when to work on these blocks, and tracking their own progress as they see their assignments through to completion.	Founder A, Jessie Shanks, is a Full Stack Developer with experience in non-profit operations and project management. She holds a B.A. in Anthropology. Adviser A is a digital marketing strategist and has editorial experience at major newspapers.	**Mr. J**, Male, Web developer (HTML, CSS, JavaScript) and consultant. Startup evangelist at major technology corporation. **Mr. R**, Male, High school senior student who has experienced a 1:1 laptop learning environment since sophomore year. **Ms. U**, Female, Certified elementary and middle school teacher. M.A. in Learning Technologies. Earned awards for innovation within her district.
Startup B – Wiki Talki Early-stage /Formation (Concepting)	Wiki Talki is a peer feedback platform for oral communication. The mobile app automatically shares users' recordings with three peers who engaged in the same communication task. Peer comments are collected in the resource bank backpack. Wiki Talki helps learners to autonomously engage in learning, be more mindful about their communication, which can eventually lead to self-directed learning.	Co-founder B1, Sawaros Thanapornsangsuth is a Thai national and was a doctoral student in Instructional Technology and Media in the United States. She holds an M.A. in Computing in Education and a B.A. in English Language and Literature with a minor in Entrepreneurship. She has experience in project management, curriculum and multimedia development, educational research and app development. Co-founder B2, Soo Hyoung Joo, a Korean national and former middle school teacher, was engaged in Masters level graduate student in Applied Linguistics/TESOL in the United States. She holds a B.A. in English Education.	**Dr. I**, Female, Professor of Educational Technology at a state university. PK-8 teaching experience in computers and English language arts. **Mr. S**, Male, Undergraduate college student. Major in Multidisciplinary Studies. Has served on various strategic planning and educational improvement committees.

Startup C - DiscoverSTEAM Mid-stage /Validation (Committing/Validating)	DiscoverSTEAM provides an online, project-based learning platform that lets high school students collaborate on challenges provided and developed by corporations. Corporations provide standards-aligned STEAM challenges and Industry Experts, who serve as mentors and subject matter experts for student projects. Students get hands-on experience working on relevant STEAM projects. With built-in communications, project management and evaluation functionalities, students will develop a unique, project-based skills portfolio that can inform future college majors and internship opportunities.	Founder Sarah Jabeen has experience running global startups, and she specializes in human-centric design for business growth, customer experience, user design, and marketing. She holds a B.S. in Ecology, a M.B.A. in Entrepreneurship, and a Certification in Management of Non-Profit Organizations. Adviser C is a co-founder of an Education Project Management Consulting firm. Her specialty areas include project management and implementation and management of technology for school districts. She is a former classroom teacher. She holds a B.A. in Mass Communication/Media Studies and a M.Ed. in Elementary Education.	**Dr. X**, Female, Certified 11th grade physics and Algebra 2 teacher; Manager of the high school Robotics team. Expert in project-based learning (PBL). **Dr. G**, Female, Executive Director of a large School District Educational Foundation. Robotics coach in First Lego League (FLL) and First Technical Challenge (FTC) divisions.
Startup D – Science Delights Late-stage /Growth (Scaling)	Science Delights has developed a turnkey, hands-on, STEM curriculum for early elementary students. One of the few companies developing specifically for this age group, Science Delights builds on a young child's natural engagement with STEM concepts. Aligned to state and national standards, Science Delights' supplementary curriculum gives teachers a flexible resource to teach STEM to young students in a safe and purposeful way.	Founder Anita Greenberg holds a Ph.D. in Curriculum and Instruction, a Masters of Teaching, and Bachelor's degree. She has 15 years of experience as an educator, teaching students of all ages. She has developed curriculum and assessments at an international educational publishing company. Partner D is a businessman, advisor, and entrepreneur. He holds a BA in Film and Television with additional coursework in mechanical design and mechanical engineering.	**Ms. W**, Female, Director of Instructional Technology at a large school district. **Mr. E**, Male, Investor. Started venture capital firm in 1996.

Startup E Late-stage / Growth (Scaling)	"E" offers the only suite of standards-aligned K-12 Entrepreneurship curriculum and professional development. They partner with schools and non-profit organizations to provide a tailored package of in-school, after-school, and summer enrichment programs. Through project-based learning and engaging web-based activities, the curriculum connects STEAM concepts to real-world problems and brings college-level entrepreneurship to the classroom. The curriculum concludes with a shark-tank style Pitch Day where students present their products.	Founder E (nonparticipant in research) has a Ph.D. and M.S. in Biomedical Engineering and a B.S. in Mechanical Engineering and a Postdoctoral Fellowship in Technology Commercialization. She has worked within the areas of innovation and entrepreneurship within higher education and organizations. Partner E1 is the Vice President of Innovation and Technology. He has experience in marketing, innovation, technology, and online public relations. He holds a B.S. in Business Administration. Partner E2 is the Vice President of Operations. Her expertise is in human resources, business development, and talent acquisition. She holds a B.A. in Human Resources.	**Mr. T**, Male, Co-founder and CEO of edtech company that targets students' literacy development. He has experience as a teacher, trainer, program manager, and educational entrepreneur. **Dr. M**, Male, Professor of Innovation at large state university. He is a technology inventor and entrepreneur.

Appendix B
Codebook

1. Innovator/teacher

a. Knowledge of technology and enabling conditions

b. Technology self-efficacy

c. Teacher beliefs, attitudes

d. Pedagogy (beliefs)-technology compatibility

2. The innovation/technology project

a. Distance from school culture

i. Colleagues & expectations

ii. Scheduling

iii. Assessment practices / test culture

b. Distance from available resources

c. Distance from innovator's current practices

3. The school context

a. Technology infrastructure: Facility, network, equipment resources

b. Human infrastructure

i. Hardware and software and technological support staff, policies, procedures

ii. Professional learning opportunities

c. Organizational culture

i. Leadership

ii. Time (teacher)

iii. Risk-taking environment

iv. Existing policies

4. District, state, federal laws, policies

a. State/federal standards – technology, content

b. Laws or legislation

c. District, state or federal continuous improvement plans / vision plans

5. Edtech entrepreneurship

a. Ideation

b. Development

c. Sales