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Critical Innovators: How Teachers and Entrepreneurs Position Themselves as Technology Innovators in Schools

[Adam Papendieck](#) & [Joan E. Hughes](#)
The University of Texas at Austin

Teachers have been called upon to be more entrepreneurial in their approaches to change. However, the universities in which preservice teachers learn and the schools in which teachers practice tend to emphasize standards, accountability, and risk-management, while traditional entrepreneurial conceptions of innovation tend to promote risk-taking and the pursuit of disruptive change. In this interpretive qualitative study, the authors conducted semistructured interviews of 14 teachers, entrepreneurs, and teachers-turned-entrepreneurs, analyzing how they position themselves in terms of guiding interests, approaches to change-making, and orientations to power and the educational status quo. Findings revealed that innovators in schools must often work subversively and in an oppositional manner to make change. Teachers must position themselves beyond traditional roles as managers, consumers, and rote implementers of technology in preference of more creative and agentic modes of innovational leadership. Considering their critical emic perspectives, their professional ethic of care and their authority of expertise, the authors suggest that teachers could be developed as uniquely trustworthy agents of calculated risk-taking in change-resistant schools. They highlight measures that could be taken to better prepare and support them as critical innovators with technology, and draw implications for teacher education.

Teachers are critical drivers of innovation in classrooms (Darling-Hammond & Rothman, 2011; Ertmer, 1999; Ertmer & Ottenbreit-Leftwich, 2010; Hughes, 2005), and technology's role in the developmental pursuit of new educational possibilities is clear and fundamental (Feenberg, 1991) – so much so that the mere presence of new technology in educational contexts is often taken as evidence of real educational change. Yet, the substantive transformation of teaching and learning with technology is difficult and rare (Cuban, 2001, 2013; Sims, 2017). Processes of technological innovation on their own are no substitute for the contentious and difficult process of collective *values* innovation required to influence educational orthodoxies (Cuban, 2013; Sims, 2017; Tyack & Tobin, 1994). In addition, American teachers are busy with instruction (Darling-Hammond & Rothman, 2011) and seldom given the opportunity or authority to lead innovation (Fullan, 2007; Gabbard, 2016).

Perhaps the field of education must learn from teachers who figure out how to make change in schools with technology. The field should know how they compare as innovators to technology entrepreneurs, so they can be better prepared, supported, and celebrated as changemakers in contemporary American culture. The purpose of this study was to deepen our understanding of how and why teachers and entrepreneurs position themselves as technology innovators in schools.

Teachers as Innovators

There is little scholarship or guidance on how teachers are or should be systematically prepared to innovate with technology. They can enter the profession with little formal preparation as classroom technology innovators, often with a keen awareness of *why* change is needed and what it could look like, but little knowledge of *how* change can occur. Teachers may fundamentally accept and understand the importance of moving from direct instruction to constructivist approaches, for example, but struggle to make this change happen in practice (Cuban, 2013; Selwyn et al., 2017).

Furthermore, while preservice teachers may anticipate societal expectations for technology use within K-12 teaching, teacher education programs have been slow to integrate contemporary technology topics in teacher education programs. Even when they do so, preservice teachers tend to adopt more teacher-directed practices than student-centered (Clark et al., 2015; Hughes, Liu et al., 2016, Hughes et al., 2020). Teacher educators often perceive technology integration as a high-risk activity in cultures where research is emphasized, where security exists in status quo instruction, where administrative support is low, and where technology integration is envisioned as the isolated responsibility of the educational technology or learning technology faculty (Foulger et al., 2017; Jackson, 2012).

If technology integration is to change schools, teachers must be reliably prepared with the skills and beliefs that are required to drive that change (Ertmer & Ottenbreit-Leftwich, 2010; Hughes, 2013; Hughes, Liu et al., 2016; Tonduer et al., 2017). To this end, some preservice and in-service teachers may have been introduced to the day-to-day work of

technological changemaking and classroom problem-solving as reflective practice (e.g. Schön, 1984; Zeichner & Liston, 2013).

In terms of systematic design processes, some may have been exposed to processes of backward curriculum design (e.g. Wiggins & McTighe, 2005), instructional design models like Analysis, Design, Development, Implementation, and Evaluation (ADDIE; Molenda, 2003) and any number of approaches to the alignment of learning activities and assessments with (mostly predetermined) goals set by state or national standards. Teachers are taught to develop learning experiences that are deeper and more engaging, per popular conceptual tools such as Gagné's theories of learning and events of instruction (Gagné et al., 1992), Bloom's taxonomy (Anderson et al., 2001; Bloom et al., 1984), and Keller's (2010) Attention, Relevance, Confidence, Satisfaction (ARCS) design model of motivation in learning. To the extent that teachers are specifically prepared to use technology to improve teaching and learning, some teachers may have been exposed to technological pedagogical and content knowledge (TPACK; Koehler & Mishra, 2009), a framework for helping teachers think about technology, content knowledge, and pedagogy in an integrated way. They may happen to learn about the Replacement-Amplification-Transformation (RAT) Framework (Blanchard et al., 2016; Hughes et al., 2006; Roblyer & Hughes, 2019) or the PICRAT model (Kimmons et al., 2020) for evaluating the type and of impact degree technology may potentially have on teaching and learning, or the Substitution-Augmentation-Modification-Redefinition (SAMR) model used for similar purposes (Puentedura, 2006).

While these conceptual tools are useful for understanding what teaching and learning should look like and what technology integration might make possible, none of them explain *how* to change or reveal the role and position of teachers in carrying out such change. Furthermore, little research has investigated *if* or *how* these technology integration frameworks are used by teachers or teacher educators in their day-to-day practice (Kimmons & Hall, 2016; Voithofer & Nelson, 2021).

Entrepreneurs as Innovators

Many educational reformers are keen to draw upon commercial and entrepreneurial mindsets and approaches to innovation for application in schools. The language of commercial human-centered design (HCD), agile development, and lean startup models has become ubiquitous in the United States, including in the so-called helping professions like education, health, development, and social work.

Yet, entrepreneurship is itself a loose and evolving concept, as well as an emerging research domain. The canonical definition of entrepreneurial innovation provided by Schumpeter (1950) is the creation of new value via new combinations of production (p. x). Such combinations may arise from the introduction of new goods (products, technologies, and services), novel methods of production, new markets, new resources, or new ways of organizing productive activity. Entrepreneurs, notes Schumpeter, differ significantly from inventors in that they bring relevance to innovations by integrating them into practice.

While such canonical definitions of entrepreneurship frame value in terms of the market or exchange value of an innovation, contemporary social entrepreneurs have come to conceptualize value much more holistically in terms such as social wealth, total wealth, social justice, and the resolution of social problems (Zahra et al., 2009). More recently, the field of “critical entrepreneurship studies” (CES) has undertaken a critique of the way entrepreneurship has traditionally been viewed and cultivated as a white, male, individualist activity of unquestionably positive value (Essers et al., 2017b). Essers et al. (2017a) argued for conceptualizing entrepreneurship as a “social change activity that moves against the grain of orthodoxy in order to realize spaces of freedom and otherness” (p. 2). Their goal is to challenge and expand upon canonical understandings of what counts as entrepreneurship and who counts as an entrepreneur.

The more critical and collectivist perspectives on entrepreneurship that underpin the field of CES also resonate with contemporary postindustrial theorizations of entrepreneurship as a distributed property of entrepreneurial networks and service ecosystems (Lusch & Vargo, 2014) that coconfigure (Victor & Boynton, 1998) goods and services and blur the distinction between consumer and producer. We argue that the contemporary arrangements of social production (Engeström, 2007) demand a critical reimagining of the traditional roles of teachers and entrepreneurs in educational technology innovation. Rather than positioning commercial entrepreneurs as creators and teachers as mere consumers of technology, we see greater potential benefit in positioning them more as cocreative consumer-producers in educational service ecosystems.

In this article, we make the case that with appropriate preparation and support in either preservice or in-service professional learning contexts, teachers could bring unique value to processes of codesign (e.g., Roschelle et al., 2006) by virtue of, for instance, their deep classroom expertise, their emic perspective on school systems, and the authentic relations of care they have with their students and colleagues.

Teacherpreneurs

Scholars and changemakers, alike, have taken up the prospect of infusing school-based innovation with entrepreneurial notions and strategies of change. Berry (2013), for instance, envisioned a new generation of “teacherpreneurs” who “lead outside the classroom but do not lose their connection to students” (p. 309). But how do teachers and entrepreneurs relate as changemaking cultures, communities, and practices?

The universities in which preservice teachers learn and the schools in which they ultimately practice tend to emphasize standards, accountability, and risk-management, while entrepreneurial communities embrace risk, celebrate creativity, and pursue disruptive change. Teaching as a profession, meanwhile, is becoming more female (76%; Ingersoll et al., 2018), while fields of science, technology, engineering, and mathematics (STEM) entrepreneurship are characterized by persistent gender imbalances in the opposite direction (Kuschel et al., 2020), with one recent industry survey finding that only 26% of tech startups have a female founder (Silicon Valley Bank, 2020).

Indeed, the very cultural and epistemological norms of commercial entrepreneurial communities – which tend to be male-dominated, heteronormative and individualist (Ahl & Marlow, 2012; Essers et al., 2017b) – may stand in stark contrast to, for instance, feminist cultures and epistemologies of care (Beauboeuf-Lafontant, 2005; Delgado Bernal, 2001; Noddings, 2003) that characterize historically female communities of teachers, not to mention the highly managerial conceptions of teacher-leadership currently promoted in schools (Gabbard, 2016). What, then, could it mean for female teachers to innovate in an entrepreneurial fashion without necessarily innovating like male entrepreneurs?

Research Questions

This study was initiated as part of a broader qualitative investigation into the kinds of things that elicit and direct innovator activity and the characteristics and contexts of innovator activity itself. Building on an activity theoretical understanding of innovation as developmental activity that is fundamentally driven by contradiction (Foot, 2002; Miettinen, 1999), we proposed three research questions related to three practically and conceptually salient aspects of innovation:

1. *Interests*: What interests impel and direct innovative activity? By examining interests, we wanted to understand *why* teachers and entrepreneurs work for change.
2. *Approaches*: What situated developmental approaches do innovators report employing to drive change with technology? By examining approaches, we wanted to understand *how* teachers and entrepreneurs work for change.
3. *Orientations to power*: In what ways do the interests and approaches reported by innovators stand in tension or resolve contradictions with the educational orthodoxy? By examining orientations to power, we wanted to get a sense how teachers and entrepreneurs position themselves in different ways with respect to the orthodoxy to pursue different *degrees* and *rates of change*.

By attending to these aspects of innovation, we wanted to better understand, prepare, and support innovators based on why, how and to what extent they sought to innovate.

Method

Theoretical Framework

Three related frameworks informed our study design, data analysis, and interpretation. First, a cultural-historical activity theory framework (Engeström, 2008; Spinuzzi, 2017) was used to examine the self-reported technology innovation work of teachers and entrepreneurs. From an activity theory perspective, innovation can be understood as developmental activity that is fundamentally impelled and directed per different needs, motives and goals – or objects (Kaptelinin, 2005) – of activity. We took up this object-oriented and developmental conceptualization of innovation to surface and characterize innovator *interests* (per Research Question 1).

Activity theory also allowed us to characterize what we called innovator *approaches* (per Research Question 2) as situated activity that is mediated by different tools (conceptual and technological), rules (policies, standards, and norms), roles (responsibilities and divisions of labor) and communities.

Finally, the activity theory framework helped us locate and characterize contradictions, discontinuities, and tensions that emerged as innovators carried out their work, grappling with multiple, often competing goals, motives, and interests and struggling to coordinate different approaches in different contexts (Engeström, 1987). These contradictions fundamentally drive innovation (Foot, 2002; Miettinen, 1999), as innovators must learn to collaborate and reconfigure their social practices and material environments in pursuit of individual and collective goals and interests. Attention to contradiction allowed us to examine how innovators grapple with tensions and obstacles they encounter in changing the educational and institutional status quo (per Research Question 3).

As we were interested not only in understanding how innovators describe and develop their innovations, but also how they describe and develop themselves as innovators, we sought to understand innovation as both a practice and identity by examining stories of how innovators positioned themselves as changemakers in schools. We adopted a dialogic understanding of innovator identity as an ongoing process of discursive and material positioning (Deppermann, 2015), a process that must integrate and respond to a variety of goals and discourses sustained across different educational and entrepreneurial contexts. Stories of how innovators positioned themselves were treated as polyphonic (Bakhtin, 1984), that is, comprised of and answering back to the discourse of a variety of professional communities. Innovator identities were treated as complex, situated and dynamic projects that responded to and integrated different discourses and communities in different ways.

Finally, taking a cue from the emerging field of CES (Essers et al., 2017a), we wanted to think more clearly about technology innovation as a form of oppositional activity and move beyond a narrow market-oriented focus on the exchange value of innovation. In discussing how innovators positioned themselves with respect to the educational orthodoxy, our analysis invoked classic conceptualizations of oppositional behavior and transformational resistance (Giroux, 1983; Solorzano & Delgado Bernal, 2001). Giroux conceptualized resistance as combining an explicit critique of social oppression with substantive motivation for social justice. While all of the innovators we studied appeared to “cut against the grain” (Essers et al., 2017a, p. 2) of the educational status quo in some way, Giroux’s conceptualization of resistance allowed us to differentiate and evaluate the transformational potential of innovators and their innovations by calling attention to the degree to which they were rooted in social critique and involved action for justice.

Qualitative Study

We conducted an interpretive qualitative study (Merriam, 2009) of school-focused technology innovation using teacher/entrepreneur status to guide sampling and define embedded units of analysis (Yin, 2014).

These units of analysis, or groups, allowed us to interpret and compare (a) teachers, (b) entrepreneurs who are currently or were, at one point, teachers, and (c) nonteacher entrepreneurs in terms of aspects of their reported innovation. The groups also allowed us to consider innovator positioning (Deppermann, 2015) as a story or act of boundary crossing (Engeström et al., 1995), accounting for the motivations and experiences of individuals who transitioned from teaching to commercial entrepreneurship, for instance.

Participant Sampling

A purposeful sample (Merriam, 2009) of 14 participants, including six practicing teachers, four teacher-turned-entrepreneurs, and four nonteacher entrepreneurs, was recruited nationally via email, professional forums, and social networks. Recruiting information was posted on a study website and disseminated to educational technology-focused professional networks for educators and entrepreneurs via social media (Twitter and Facebook).

Table 1 provides an overview of individual participant characteristics and their group. The parenthetical letters after each participant’s pseudonym signifies their group: teachers (T), teacher-turned-entrepreneurs (TE), and nonteacher entrepreneurs (E).

Table 1
Participant Characteristics and Groups (Embedded Units of Analysis)

Group	Pseudonym	Professional Role	Description of Innovation
T. Innovative Teacher	Ariana (T)	Gifted Education Teacher	Various curricular and pedagogical innovations via a maker-space.
	June (T)	STEM Specialist	Various curricular and pedagogical innovations, many via iPad apps.
	Kristie (T)	Technology Integration Specialist	Various curricular and pedagogical innovations using technology.
	Erin (T)	Classroom Teacher	Innovative computer science curriculum.
	Amy (T)	Technology Integration Specialist	Various curricular and pedagogical innovations using technology.
	Jane (T)	Librarian and Specialist Teacher	Classroom connectivity interventions
TE. Teacher-turned-Entrepreneur	Sean (TE)	Current Classroom Teacher, PD Producer	Game design curriculum. Game-based learning networking experiences.
	Miles (TE)	Cofounder of EdTech Startup, Former Teacher	Platform for connecting students and classrooms globally.
	Nick (TE)	Cofounder of EdTech Startup, Former Teacher	Platform for helping students collect and analyzed water and energy data.
	Daniel (TE)	Cofounder of EdTech Startup, Former Teacher	Networking platform for connecting teachers.
E. Non-teacher Entrepreneur	Kyle (E)	Cofounder of EdTech Startup	SMS-based system for linking students, teachers and parents in conversation.
	Aaron (E)	Founder of EdTech Startup	Application-embedded commenting and feedback libraries for writing instruction.
	Keith (E)	CoFounder of EdTech Startup	Mobile device management and application curation platform
	Ken (E)	Founder of EdTech Startup	System for integrating physical manipulatives into digital simulations

First, we confirmed the participants’ professional status as practicing teacher and/or entrepreneurial founder through applicable school or company websites. Second, we confirmed that entrepreneurs had founded or cofounded an edtech company or service or that teachers had been

innovative in their use of edtech. To gauge participants' innovative work, we confirmed each participant's professional recognition as an innovator with technology in education through reviewing their professional experiences stated on their curriculum vitas, professional network sites, and public accolade or award announcements.

For example, June (T), Jane (T), Sean (TE) and Mark (TE) had been officially recognized by professional communities for their innovative work with technology. Ariana (T), Kristie (T), and Amy (T) had presented innovative work at professional conferences. Erin (T), Miles (TE), Nick (TE), Daniel (TE), Kyle (E), Aaron (E), Keith (E), and Ken (E) were active in local and national entrepreneurial social networks, where they were known to have designed and implemented innovative technological interventions in schools. Sampling was conducted over a period of 7 months concurrently with analysis and continued until data saturation was achieved within and across embedded units of analysis.

Data Collection

After Institutional Review Board review of all study protocols, semistructured telephone interviews (60-90 minutes in length) were conducted with each participant. An interview guide was used to prompt talk about (a) goals of education; (b) goals of innovation; (c) innovation practices, supports, obstacles and contradictions; (d) preparation as innovators; and (e) innovator identity. Interviews were professionally transcribed using the Rev.com transcription service. Transcripts were then checked for accuracy by the first author.

Interviewees were engaged in member-checking during successive interviews and sometimes via follow-up email interactions, whereby we would share data and interpretations back to the participant to seek their affirmation or disagreement. For each interviewee, artifacts related to their innovative activity were collected.

The recruitment, selection, and interview processes informed the identification of relevant artifacts. All artifacts, interview transcripts, and notes from member-checks, were added to a database forming the basis of a chain of evidence for analysis (as in Yin, 2014). We engaged in at least two validation strategies, as recommended by Creswell and Poth (2017): member-checking and peer review.

Data Analysis

Interview transcripts and notes from member-checks were read and analyzed using a process of deductive and inductive coding (Miles et al., 2019). The first author led the coding, and the second author served as the peer reviewer/debriefer. The R package for Qualitative Data Analysis (RQDA; Huang, 2016), a computer-aided qualitative data analysis software, was used first to code for tensions/contradictions, tools, communities, rules, roles, goals and objects/goals/motives based on the activity theory framework (Table 2; Engeström, 1987). New codes were then inductively developed and applied to characterize the three aspects of innovation upon which this study was focused: interests (primarily

informed by coded stories of goals, motives, and objects of activity), approaches (primarily informed by coded stories of mediated and situated innovation tactics and activities) and orientations to power (primarily informed by stories of contradiction and tension).

Table 2
Initial (Deductive) Coding per Activity Theory Framework

Deductive Codes	Example Data
Object	“I liked that technology could open up the world to kids and allow them to kind of explore and create.”
Tools	“How could you make a Bebot do something that would teach a kid how to make change, or how to recognize the different coins, or maybe a game where they could do all those things?”
Rules	“We've tied our assessment structures to political, I don't know, I guess accountability, for lack of a better word, so that we've said that our schools are only good if we can show that every school in [the state] has 60% of their students mastering these specific items.”
Roles	“My job as a teacher now is kind of researching and taking these ideas that the kids have, or the things that they go, ‘We really wish we could do this,’ and figuring out how to make that available for them.”
Communities	“We have this group of game-based learning educators and we refer to ourselves as the tribe. It's a real affinity group.”
Contradictions	“I don't want to add features or functionality, or pollute the strength of my product to families, to teachers and kids, to either earn more money or to partner with someone else that doesn't make sense.”

The coding scheme (Table 3) involved the iterative development and reflexive revision of a set of types for each aspect of innovation. Ongoing analysis was used to guide ongoing sampling, adjust the emphasis of semistructured interviews and assess data saturation.

Interview data were phenomenologically grounded with a systematic review (Merriam, 2009) of publicly accessible primary and secondary digital artifacts of interviewee innovation using the same coding scheme and process for analysis. In the case of the entrepreneurs, these artifacts included product websites and publicly accessible interfaces for web-based innovations. In the case of teachers, these included secondary artifacts such as media reports and profiles of their innovative teaching work, as well as their presentations at professional conferences and other forums.

Table 3
Coding Scheme for Analyzing Stories of Innovation

Aspects of Innovation	Formative Deductive Codes (per Activity Theory)	Formative Inductive Codes	Emergent Types
Interests	objects	financial, job security, career, creative practice, management interest, risk, multiple bottom lines	Self
		students, school, investor, return-on-investment (ROI), parents, multiple bottom lines	Local
		justice, social/economic goals, equity, better world, environment, multiple bottom lines	Global
Approaches	objects, tools, rules, roles, communities, contradictions	opportunity, scale, platforms	Ecosystem opportunism
		networking, support network, community, social media	Networking
		design, pain points, empathy, iteration, HCD	Systematic design
		just make it, feedback, failure, test users, lean	Piloting
		trust, rapport, coaching, professional development	Coaching
Orientations to Power	contradictions	grammar of school, service orientation, transformation, new combinations, bureaucracy	Incrementalist
		agency, space, bureaucracy, isolation	Privileged
		rebel, resistance, bootstrapping, isolation	Rebellious
		resistance, equity, justice, bootstrapping	Critical

Findings

We present findings related to the different ways that technology innovators positioned themselves in terms of three aspects of innovation informed by our activity theory framework: interests, approaches, and orientations to power (see Table 3 for a representation of how theory influenced coding and identification of emergent types in relation to technological innovation). Interests generally stand for the goals, objectives, outcomes, and impacts that motivate innovators. By approaches, we mean the situated and mediated tactics, practices, and strategies that innovators reportedly employ to drive change with technology. We use the term orientation to indicate how innovators position themselves as change agents in relation to orthodox educational, professional, and cultural norms and power structures. Our purpose with this ontology of aspects is not to essentialize, pigeonhole, or simplify individual teachers or entrepreneurs but rather to elaborate the complexity and diversity in how innovators position themselves for change and to expand our overall conception of what should count and who should count as an innovator.

Interests

Overall, we found evidence of a wide variety of interests in the way that innovators described the goals, motives, and bottom lines driving their innovative activity with technology. We found interviewees describing multiple, often competing interests (a) at the level of the self, (b) at the local classroom and school levels, and (c) at a more global social level.

Self-Interests

Teachers and entrepreneurs, alike, described fundamental concerns for their own professional and personal development and livelihood as motivating their work as educational innovators. These goals of self-interest were sometimes harmonized and aligned with student-centered and social goals, but often existed in tension and often influenced the professional context in which they chose to work as innovators.

Many participants expressed financial goals. Aaron (E), an entrepreneur, was happy to be working in a for-profit context. He described himself as a “capitalist” and “an engineer at heart,” who could profit through the development of new value for students and teachers. He was able to produce “software at the right time that was used for accreditation by schools and [sell] the company and [get] a career out of it.”

Kyle (E), meanwhile, said he was drawn to a traditional teaching role because he wanted to help and work with kids, but he felt that he would not be paid enough as a schoolteacher. He resolved this tension by committing to make money as an entrepreneur first before ultimately transitioning to teaching full time in the future.

Jane (T), a teacher, felt that edtech startup communities — while exciting and innovative — were financially too risky for her. She saw school as a more secure environment in which to innovate and develop her student-

focused career. Also working inside school, Erin (T) noted the distinct appeal of technology “freebies,” trips, stipends and “fun” that came with participating in a university-based curriculum innovation program for which she had been recruited.

Self-interest was also expressed in terms of goals for personal and professional growth and personal satisfaction among both teachers and entrepreneurs. Innovators specifically declined opportunities for administrative and managerial advancement (and increased pay or financial stability) in favor of the opportunity and freedom to learn through their creative process of innovation.

Daniel (TE), for instance, had just completed his certification to become a principal when he decided to embark on his entrepreneurial venture. To him, the opportunity to pursue his entrepreneurial project felt fleeting and urgent, and he felt he “could always go back and become a principal” if he wanted.

Ariana (T), on the other hand, reported that she had absolutely no interest in management and continued to teach despite eventually investing in a doctoral degree in Teaching and Learning:

I went and got a PhD so I'd be a better teacher, not so I could go be some ... administrator that just enforces rules all day. I would be terrible at that. I'd be worse than the queen. ... As an administrator, I think you have to really be slow. You can't move fast. ... The whole idea of [my innovative teaching approach] is you try something, and you fail at it, and everybody in there has that same mentality of, “That was an epic fail. Glad you did that and I didn't. Let's move on.”

Ariana (T), June (T), Sean (TE), and other teachers were also strongly motivated by social recognition and a personal sense of belonging in a community of practice. They relished the opportunity to travel and present their innovative work at conferences, as Sean (TE) described:

I've grown to absolutely love building relationships in the greater education community. . . . I always say I want to surround myself by people that I want to be around, and I've created that. When I do travel to a conference or something, I'm with my people.

Finally, teachers and entrepreneurs commonly expressed a personal desire for independence and agency in their work with technology. They explicitly identified their ability to bootstrap their activities in schools as key to their innovational independence and agency. Entrepreneurs like Kyle (E) funded their startups with their own money, at least partly to maintain creative control of product design. Teachers like Ariana (T) and Erin (T) sometimes funded their conference trips with their own money, organized student fundraisers, and used crowdfunding networks like Donors Choose (<https://www.donorschoose.org/>) to support their innovative activity. Some reported accessing funds for innovation through grant programs, faculty development programs, and university-led studies and interventions.

Local Interests

Participants mentioned being driven by the interests of stakeholders and institutions in their local district and communities. All teachers and entrepreneurs expressed a concern for making school more interesting, meaningful, and engaging for students. Most teachers mentioned how important technology skills and new media literacies would be for students in preparing for the future workforce. June (T) made sure that her “students understand certain vocabulary, understand collaboration, iteration, digital citizenship and safety [and] understand their global presence and just how to communicate with others, local and abroad.” Ariana (T) integrated new media and technology not only to help prepare students for an emerging market, but also because she felt that technology is “what the kids are interested in.”

Entrepreneurs identified teacher- and parent-centered design goals as well. Kyle (E), a young cofounder of a small edtech startup focused on short message service (SMS) communication systems, hoped teachers, students, and parents would be able to leverage his system to catalyze a “good communication ecosystem,” noting “We’re about connecting families and kids. And that conversation is what we’re selling. That’s what we’re providing. That’s our service.”

Entrepreneurs were acutely aware of the tension between their self-interest in the market value of their innovation and the broader use value in schools. Kyle (E) described tensions in pursuing combinations of student-centered, social, and personal financial goals:

There’s shareholder value – or company value – over user value. And how do you balance those together to make them worthwhile for people like myself and other entrepreneurs, to make it worth our time and money to work on things for users in education and kids and families? We need return on our money.

Kyle (E) took great pride in being fundamentally “human-centered” in his entrepreneurial approach, indicating a strong commitment to the use value of his work in the long term:

I don’t want to add features or functionality or pollute the strength of my product to families, to teachers and kids, to either earn more money or to partner with someone else that doesn’t make sense or have the business pressure that [distracts from] our main mission.

The entrepreneurs resisted the notion that a startup or private sector approach to innovation presented an unresolvable conflict between self and school or student interests. Indeed, two teachers-turned-entrepreneurs, Miles (TE) and Nick (TE), reported leaving the teaching profession not only for reasons of personal growth or finances, but because they believed they could have a greater impact on students and schools by working in a more supportive, dynamic, entrepreneurial innovation community.

Global and Social Interests

Three current teachers explicitly identified some form of social impact or duty as the fundamental motivation for their innovations. Reflecting upon her goal as a teacher-innovator, Kristie (T) laughed and said it was “to save the world.” Asked why she sought to change schools when it is so difficult, June (T) described a similar type of goal:

Because I’m out of my mind. Because our world depends on those of us who are out of our minds to provide rich experiences for the next generation. ... It’s about preparing the next generation if you want the world to continue, right?

While June (T) and Kristie (T) spoke of saving and continuing the world by engaging technology, Ariana (T) focused on how the world needed to be changed through innovation, noting that schools tend to “perpetuate the inequities that we have already.”

Some innovators explicitly linked local student-centered goals with more global concerns. Ariana (T) and June (T), for example, both described a distinctly Deweyan goal of arranging technology-rich experiences for students that would enable them to develop as good citizens in a contemporary digital democracy. Nick (TE) described the value proposition of his innovative work in terms of a “triple bottom line”: By helping students become better water and energy stewards, his product would create savings in the energy sector, savings that could be fed back into his startup and allow him to scale his systems to engage more students and have a broad impact on the environment.

His rationale for taking a for-profit approach was more pragmatic than ideological. As a small, new, innovative project, Nick (TE) believed it would be difficult to compete with the large, established nonprofits that were already active in educational spaces, and he viewed his for-profit income model as a way of sustaining his innovation without the need to compete for grants or compromise his vision to satisfy a donor.

Approaches

By attending to the stories that innovators shared about their day-to-day work of innovation with technology, we identified five approaches to technology innovation: ecosystem opportunism, networking, systematic design, piloting, and coaching. Again, these approaches are not meant to be mutually exclusive or essentializing, and individual innovators combined and moved between approaches.

Ecosystem Opportunism

Some of our innovator-participants were keenly aware of major technology trends and potential educational opportunities resulting from shifts in sociotechnical ecosystems, for example, the increasing adoption of productivity software-as-a-service in schools or the proliferation of tablets and netbooks in classrooms. Miles (TE) was able to foresee the potential of emerging virtual reality (VR) systems and the global

proliferation of mobile devices to develop new kinds of learning experiences. As a teacher-turned-entrepreneur, Miles (TE) found new pedagogical value in the VR ecosystem and used his knowledge and credibility as a teacher to articulate this value in a way that would appeal to educators and learners in schools.

In a similar vein, by paying attention to the evolving suites of productivity software being sold to schools, Aaron (E) exploited opportunities for new value through new affordances and efficiencies, while at the same time positioning his products for scaling:

Small-fry piggybacking off an ecosystem is a classic great move, and edtech is filled with wonderful ecosystems, and the world's getting more and more open, where you can build something and it can plug and play with lots of different things.

Shifts toward digital learning ecosystems also enabled new efficiencies in the collection and analysis of learner attributes and interactions. Entrepreneurs used digital learning ecosystems to harvest user data for usability improvements, which enabled them to track different types of learning and engagement outcomes and even to refine their understanding of the user-base for whom they were designing. For instance, Nick (TE) and his cofounder initially designed their home energy-monitoring platform for adult users, but it did not take off.

Then we got some advice one time, where somebody was like, "Who is using it? Don't worry about trying to convince people who aren't using it, but look at who does value whatever you've created right now." It was interesting, because we looked, and a couple of our most active users had .edu emails or k12.edu.

By monitoring user interactions and characteristics via his digital platform, an ecosystem opportunist like Nick (TE) identified an emergent user-base and refined the value of his application per an educational demand he had not originally recognized.

Teachers also leveraged the built-in affordances of hardware, software, and curricular ecosystems for change, but often with much less say in ecosystem choice. Many innovative teachers reported being marginalized from school and district decision-making processes related to tablet and software selection, for instance. Some teachers charged with technology integrationist roles were asked to conduct trainings and demonstrations with technology they would not have chosen to implement themselves. A day-to-day challenge for them was identifying and capitalizing on affordances of technologies that were not clearly useful to their colleagues and students in the classroom.

Networking

Most teachers and entrepreneurs explicitly credited social and professional networks for motivating and guiding their innovative activity. Sean (TE), a high school teacher and entrepreneur active in developing and popularizing game-based approaches to learning, described himself

as a committed “connected educator.” He cited the importance of his formative interactions on Twitter and at academic conferences in cultivating a strong national community of game-based learning innovators, teachers, and researchers. Networkers, like ecosystem opportunists, leveraged new affordances and collaborative efficiencies of the evolving sociotechnical landscape, innovating by connecting new people and ideas via social media professional networks.

Working via large social networks with global reach, like Twitter, connected educators pursued impacts beyond the schools in which they taught. Sean (TE) described being “very active in the game-based learning communities online through Twitter,” whose members were “very generous.” He said, “I think I’ve made a bigger impact on the broader educational community by being available to teachers globally that are looking at this kind of stuff.”

Though less active on social media, Erin (T) utilized more traditional conference-based and grant-funded professional networks to innovate, especially a grant-funded university-based professional collaborative. She was a member of a peer cohort of teacher innovators in the collaborative and was able to access mentorship, technology, training, and funding assistance to pilot the computer science (CS) program at her school and present it at conferences.

Ariana (T) and June (T) both mentioned how important it was for them to be able to attend conferences, not only to keep an eye on the shifting media and technology landscape as applied to schools, but also to present and compare what they learned with others. Ariana (T) said, “I’ve always presented what I’m doing in my classroom for other people to learn about and say, ‘Oh, I do something similar.’ To me, that’s the way that we learn.”

In engaging with innovators outside of their own schools and classrooms, teachers like Sean (TE) and Ariana (T) often had a wide variety of projects underway, and they reported being chronically busy. That said, they felt that their broader engagements benefitted their local classroom practice. Sean (TE) said, “The innovative things that I do outside of my teaching job come right into my classroom. It’s almost like it’s a form of professional development outside as well.”

Furthermore, teachers like Erin (T), Ariana (T) and Sean (TE) found professional networks and social media critical not only for learning about and sharing innovations, but for edifying their innovator identities. Sean (TE) and Ariana (T) both described how important networks were for finding and interacting with a “tribe” of like-minded educators. Networks provided a critical culture of support for innovators who often felt isolated, marginalized, and misunderstood in their schools. Regarding support for her new CS course, Erin (T) said, “I get it all through the collaborative, because they make sure that we network. ... We are a small school and we’re surrounded by other small schools.”

Entrepreneurs and former teachers like Daniel (TE), Miles (TE), Ken (E) and Sean (TE), meanwhile, also attended edtech meetups and networking events held at urban innovation hubs, including hackathons and pitch contests. They noted the important role that universities and edtech hubs

can play in linking schools and entrepreneurs, helping to bridge vexing cultural contradictions and ease suspicions.

According to Sean (TE),

Edtech companies need the feedback on every level of development from educators, students, et cetera, and educators are generally happy and excited to be involved in that, but there was a cultural gap there that people didn't know how to navigate.

Sean (TE) worked closely with a nonprofit focused on linking edtech companies and teachers more collaboratively and productively.

Systematic Design

Kyle (E), who completed a certificate program in human-centered design (HCD) at a private design school in a large urban area, was a deep believer in what he called the “design revolution,” the idea that complex and “wicked” problems related to, for example, health and education could be solved through formal design-thinking processes. Using the HCD processes he learned, Kyle (E) interviewed teachers, students, and others in an opportunistic, often guerilla fashion, sometimes even playing up his student status to get busy teachers to talk to him and inform his product.

Having no experience as a K-12 teacher to draw upon, Kyle (E) leveraged methods of what he called “ethnographic research” and “contextual inquiry” to systematically “empathize” with teachers, students, and parents, identify urgent problems as a starting point for the design of products and services, and articulate authentic use-value. This process yielded key insights that guided the design of his SMS-based communication system: (a) “cultural differences between parents and teachers lead to misaligned educational goals,” (b) “traditional methods of parent-teacher communication are obsolete today” and (c) “technology widens the gap.” These insights led to the choice of ubiquitous and low-barrier SMS technology for linking parents, teachers, and students in more authentic discussions.

HCD techniques were not only employed by entrepreneurs outside of the teaching profession. Even with over 10 years of teaching experience behind him, Daniel (TE) invested heavily in upfront ethnographic study of teachers and their challenges, interviewing over 25 teachers during initial service design phases. A former teacher, Daniel (TE) felt that this process allowed him to get outside of his professional assumptions about how schools operated, how problems should be framed, and what solutions were possible.

Piloting

Pilot-focused innovators, like systematic designers, were committed to a relatively specific innovation process. However, they moved early ideas and products into classroom practice as quickly as possible, as opposed to relying on meticulous upfront user research or ethnographic study. Nick (TE) used an iterative, interactive, feedback-sensitive process of

prototyping and deployment to learn about and adapt to the needs and goals of students and teachers in classrooms. He felt that his conviction to a “lean” and pilot-driven approach distinguished him from many other designers and entrepreneurs, who would be distinctly uncomfortable releasing a rough or incomplete product for professional use.

He was aware of the risk of failure in such pilots, but he was comfortable with the risk and valued failure as a way of learning. The risk or inconvenience (to students and teachers) in using his product was justified, from his perspective, in that he was transparent about the product’s state and function, and he was responsive to user demands for improvement and change.

In fact, according to Nick (TE), involving teachers in the design and piloting of his innovation often led to critical and surprising formative insights, insights that may not have been achieved by even a well-trained and seasoned user experience (UX) designer. UX designers were not always attuned to learning as a key design goal.

When we were designing our [home water and energy monitoring app initially] for a homeowner or for an adult, the whole idea was, how do we make it super easy, simple, take away all the work, so like an adult ... [can] ... take their phone out of their pocket, and, boom, here is the answer, super sleek? That’s it. I think a lot of developers think like that. ... All of their user experience training is that way.

When working with teachers to adapt the app for educational use in schools, Nick (TE) found that students sometimes entered data incorrectly, for instance, by misplacing a decimal point leading to errors of magnitude. While the professional UX designers with whom he worked wanted to “build an algorithm that could detect and correct that issue,” the teachers told him, “Actually, would you not do that?” A former teacher himself, Nick (TE) realized that what the teachers saw in this error was an opportunity for students to think critically about their data, and to learn even more by troubleshooting anomalies and trends that look wrong:

Technology-wise, you could probably almost autocorrect when you misspell something. Instead, what the teacher brings to technology in that way is, “Maybe, actually, we should stop building, and just allow it to be an opportunity for learning rather than something that gives kids the answer.”

In general, pilot-driven innovators innovated in real world classroom settings and held their innovations with a particularly loose grip, listening closely to users, that is, teachers and students. Ken (E) and Sean (TE) both developed “minimum viable products” outside of schools, and then radically adapted them when they moved them in schools. After presenting an early prototype of a manipulative for teaching concepts of sound propagation, Ken (E) was willing to undertake a complete redesign for an entirely new curricular unit, developing a new manipulative focused on teaching concepts of land surface erosion. He did this redesign because teachers told him how his product could be made more useful.

Coaching

Innovators operating as coaches took a human developmental approach to innovation, working to strengthen human technological capacities in education over time. They worked in a collaborative fashion with practitioners to translate the affordances of new technologies and new thinking into terms, strategies, and interventions for classroom innovation. Coaches often combined knowledge of technology with practical teaching knowledge and a commitment to advocacy and the emotional support required for change.

As a teacher and technology specialist, Kristie (T) positioned herself as both a cheerleader and as hands-on tech support for teachers struggling to implement technology for change. Kristie (T) brought her colleagues new ways of teaching, sometimes promoting changes for reasons of efficiency and sometimes for transformation, but always working closely with teachers to integrate tools she found.

June (T), meanwhile, exemplified the collaborative nature of the coaching approach to innovation. She spent part of her time teaching in her own classroom and part of her time working in the classrooms of others. As a coach, she talked about advocating for teachers in the district and school meetings about technology decision-making, bringing a teacher perspective and an understanding of pedagogy. She noted that the boundary-spanning work of collaborative change often required her to “speak multiple languages” and confront difficult cultural differences and oppressive power dynamics, for instance, between traditionally male-dominated IT (instructional technology) and predominantly female academic communities.

June (T) reported having to struggle to be heard in school and district discussions of technology innovation, not only because of traditional institutional limits to their teacher roles, but because they were women, and their IT departments were largely staffed by men who did not respect the innovational expertise or authority of female teachers:

Other challenges have often been being the only female or female of color in technology and trying to have my voice heard, and administrators who still trust the white male in the group, even if they're not academic, as to what's the best software to buy or hardware to buy. ... I have been in scenarios where even when I'm saying, “but I'm [a leader of an important educational technology professional society],” or “I won an award,” or “I'm an Apple teacher,” it's still, “Ask so and so [white male].” Why would I ask him? He's not a teacher; he's the director of the department. [They will say] “But his background is IT.” [I say] “He doesn't teach! Why am I asking him?”

According to June (T), technology in her school was so thoroughly positioned within the domain of white, male IT that female teachers — many of whom she said felt intimidated by technology — tended to defer automatically to the “single white male” from IT, despite the fact that he would be unlikely to be able to speak her language. She acknowledged, “It's just that that's where the knowledge base comes from, because there's so

few of me.” Male teachers and former teachers also experienced tensions with IT departments — related, for instance, to issues of procurement — but they did not report having their authority or identities as technology innovators ignored or challenged in this way.

In addition to their close work with and advocacy for classroom teachers, some teachers like Ariana (T) also reported coaching students in their approach to innovation:

I’ve been saying to my kids, “Go down to the second grade team and ask them what they would want to teach with a Bebot.” The second-grade team said, “We’re studying money.” I say to my kids, “How could you make a Bebot do something that would teach a kid how to make change or how to recognize the different coins, or maybe a game where they could do all those things?”

Erin (T) talked about how important her students were to her own learning in the use of technologies that were largely new to her, and Sean (TE) referred to himself as a co-learner with his students. Echoing sentiments expressed by Ariana (T), Sean (TE) said,

A perfect day for me is when I could sit at home and work on tinkering around with things that I want to, [and] at school, I’ve created this environment where I’m learning essentially within from the kids, aside from all the stupid paperwork-y kind of extra stuff.

While entrepreneurs valued feedback from students, they did not mention such close collaborative relationships with students, relationships that would likely be difficult for them to establish and sustain as outsiders. While coaches often helped students and colleagues design solutions for problems in context, they did not necessarily take a systematic design approach. Rather, their insights emerged from embedded, emic understandings and institutionalized connections to the work and learning contexts of those with whom they collaborated, and their creation and integration of technology innovations depended upon trust and rapport. The emphasis was on collaborative, collective development of new skills and practices within the context of the professional work that teachers and students engage. Coaches listened closely to peers and colleagues about challenges, worked in a collaborative fashion to plan new solutions, supported peers in developing their practice, and advocated for them to receive resources and support.

Orientations to Power

Innovators positioned themselves in different ways with respect to the educational authorities and norms that reinforce the status quo. By characterizing these orientations to power we can differentiate their innovative activity in terms of degree and pace. Four orientations that emerged in our analysis are characterized as follows: incrementalist, privileged innovator, educational rebel and critical innovator.

Incrementalists

As integral members of and stakeholders in hierarchical school communities and bureaucracies, it is perhaps not surprising that teachers would be particularly wary of bringing the walls down around themselves through innovation. Far from classic Schumpeterian notions of creative destruction, many teachers talked about their work of innovation as a slow, institutionally coordinated process of retraining and retooling. Ariana (T) likened her school to the factories in which her father worked as an engineer in the 1950s and suggested that she was working in a similar fashion to gradually retool the educational environment.

Amy (T), meanwhile, invoked a health-and-fitness metaphor for her approach to change in the classroom: “So it’s, like, instead of drinking four Diet Cokes, maybe you just are now having one. So, like, instead of them always doing a worksheet, like, now we’re doing some worksheets and some apps.”

As an incrementalist, Amy (T) worked to retrain herself and her colleagues through small changes to teaching practice, seeking simple steps in the right direction. This kind of careful, school- and classroom-specific changemaking was not necessarily easy or gratifying work — it is in many ways the nitty gritty of changemaking, and teachers were perhaps uniquely positioned to be effective. Amy (T) noted that her preparation as a teacher and insider perspective on the classroom helped her immensely with this slow, highly contextualized, practice-based work of change.

Some entrepreneurs with whom we spoke were incrementalists as well. Daniel (TE), an entrepreneur with a background as a teacher and training as a principal, was not particularly keen to disrupt the function or goals of school, *per se*, but rather to support improvement over time by linking teachers more closely via his professional networking platform. Aaron (E) meanwhile sought primarily to bring new efficiency to writing instruction with his tech tools for structured feedback. Keith (E) pitched his mobile device management system as a way for schools to limit and carefully control distractions and the potentially disruptive possibilities of mobile devices in the hands of students.

Privileged Innovators

Innovators often found the individual agency required for innovation by operating in special technical or curricular spaces, such as gifted programs, makerspaces, enrichment curricula, grant-funded projects, and external collaborations. Within the context of a school, these innovators operated in a privileged fashion with either tacit or explicit support of authorities and managers. Entrepreneurs who operated via contracts or agreements with school or district administrators or IT departments were privileged *de facto* as innovators, even if they got little traction in schools. Teachers, on the other hand, managed to position themselves with privileged innovational authority in a variety of ways.

Sometimes teachers gained innovational authority through the sanctioned occupation of special school infrastructure. Both Kristie (T) and June (T),

for example, mentioned how schools are under increasing pressure to market themselves as high-tech, open-learning environments, giving rise, for example, to the proliferation of campus makerspaces. Like media rooms and computer labs before them, these makerspaces have not yet been fully integrated into the status quo educational practices and learning standards which organize schools, and they may often be assigned or ceded by administrators to certain teachers as special innovation projects (see, for example, Harron and Hughes, 2018). Describing her situation in the makerspace, Ariana (T) said,

I was a little bit ahead of the curve. [My principal] was very much like me when she was a classroom teacher. She and I worked well together, me being a gifted teacher, her being a classroom teacher, so she's very supportive of what I'm doing. She's behind what I do 100%, and she just is sort of like, "Go do whatever. Just go. Just go. Just don't break any laws. Go."

Privileged innovators sometimes enjoyed higher levels of agency by operating outside of the core curriculum. In Sean's (TE) case, he taught high school computer science, web design, programming, game design, and digital storytelling — all elective courses:

I'm not confined to the same accountability in that way. ... It's not that situation where I teach math, and I need to get the kids to perform on a standardized test and all that. I'm grateful that I'm not in that whole scene.

In the case of Erin (T), agency resulted from a strict division of labor at her small school and an expected high level of individual responsibility. Working in a small rural school, she said, "I am the science department. They let me do pretty much whatever I want as long as I raise the money." The school needed her to innovate: "Computer science is underfunded, and it is under-taught in [my state, and] they are doing everything they can to reach out and get people the information so that they can teach."

It is critical to note that teachers were often quite self-conscious about the special latitude and space they were sometimes given by administrators, and at times, they reported needing to be careful of the tensions this kind of privileged agency created with their fellow teachers who did not enjoy such freedom. Adding a caveat to her discussion of principal support, Ariana (T) said,

If I have to ask her [my principal] for permission, then she'll have to tell me, "You have to do lesson plans like everybody else. You have to do this." But if it's more on the level of, "Just go. I trust you. I know what you're doing. Go do it," then it's better. You don't want everybody to know. ... I am isolated, but partly that's because I don't tell everybody at my school that I don't have to do lesson plans. They all have to do lesson plans.

In Ariana's story, it becomes clear how even sanctioned, privileged innovator positioning can lead to a certain kind of tension and isolation in schools.

Educational Rebels

Unlike incrementalists and privileged innovators, some teachers and entrepreneurs worked to enact their visions of what education should look like without the support of the powers that be. Innovative teachers often characterized themselves as risk-takers, iconoclasts, and rebels. Rather than having the agency required for innovation granted to them, they independently assumed it or wrestled away from, for instance, male-dominated IT departments.

Further elaborating on the tensions, she experienced with the "single white males" in her IT department, June (T) reported that she once took the liberty to commandeer and put into immediate classroom service a large quantity of iPads that had been purchased by her school but were sitting, unused, in the basement. She described this action as a risk — she did it without asking the permission of her supervisor — and she felt that this kind of day-to-day risk-taking and calculated rebellion was essential in her approach to change in the accountability-oriented environment of bureaucratic stasis in which she worked. Similarly, Erin (T) suggested that her own impatient pursuit of change and novelty at school was probably annoying to colleagues and administrators, half-joking that “the teenagers [at school] relate to me, I guess, because we’re all on the same wavelength, but adults don’t like me.”

Ariana (T) also perceived herself as a rebel, brazenly dispatching her students to codesign lessons for application in other teachers’ classrooms, resisting lesson planning herself, and brushing off much of the work of reporting on learning and outcomes: “I don’t have time to document.” She worried about the downsides of her rebelliousness: “I’m worrying that, locally, I am not super popular, and locally, I cannot find a lot that feeds me.” She believed her fellow teachers viewed her as “too big for her britches” or “so ‘out there,’ it’s not even helpful to talk with her.” Her status as something of an educational rebel in her school was distinctly isolating.

Meanwhile, some entrepreneurs, like Nick (TE) and Kyle (E), reported taking a guerrilla-style approach to marketing their tech in schools. Rather than going through formal IT procurement processes, they marketed and delivered their products directly to teachers, effectively sidestepping district- and school-level technology plans, policies, and protections that were often seen as onerous, slow, and out-of-sync with their own development and start-up funding cycles. These marketing tactics were aimed at creating grassroots demand for their products, exerting pressure from the bottom-up on those district and school personnel who were empowered to determine the academic technology ecosystem.

Critical Innovators

Like educational rebels, critical innovators tended to understand and approach innovation as oppositional, that is, as work that goes against the grain of the status quo. However, their goals and actions with technology were explicitly linked to broader social and ethical concerns and issues. To the extent that these innovators bucked school norms and or acted

rebelliously, they oriented and justified their oppositional behavior in relation to global interests in social change.

Miles (TE) indicated his desire for social change in terms of a “triple bottom line” of profit, student empowerment and environmental impact at scale. June (T) desired to use technology to expose her small-town students to “people who don’t look like them and don’t worship the same deity as them,” and Miles (TE) used technology to link students in classrooms from around the globe. While these three innovators oriented their innovated work per broad goals of social change, they were not explicitly critical of the way that technological innovation feeds into an oppressive society.

Ariana (T), meanwhile, engaged technology in a way that included a critique of its potential downsides. She cultivated a “hacker culture” of open design and innovation in her makerspace, modeling open-source values of collaboration and critiquing the often socially deleterious outcomes of intellectual property struggles. Not only did she emphasize student-centered, interest-driven modes of learning, she decentralized the management and maintenance of the makerspace itself, putting it in the hands of the students.

She described a vision for a radically flat maker community, casting herself as a colearner with her students. She often mentioned how much she depended on her students to figure out how technologies worked and to mentor each other. In this sense she moved the makerspace tools — and indeed, her whole educational innovation process — much more into the hands of the students themselves, allowing them to follow their own interests and priorities, and engaging them as codesigners in a novel curricular space.

Yet, Ariana (T) did not simply provide students access to the technology in the makerspace. She engaged her students in Socratic discussions about the role of technology in their lives, combining, for example, makerspace robotics work with discussions of privacy and equity concerns related to artificial intelligence technologies. In this way, Ariana (T) engaged students in both the use *and* critique of technology and in the development of the intertwined social and technological literacies necessary for a better society.

Discussion

This section returns to our three research questions: What does attending to these aspects of innovation — interests, approaches and orientations to power — reveal about why, how, and to what extent teachers and entrepreneurs say they innovate? We compared some key aspects of innovation using a descriptive data display matrix (Miles et al., 2019; Table 4) and have drawn implications for teacher educators.

Table 4
Comparison of How Teachers and Entrepreneurs Position Themselves as Innovators

Entrepreneurs	Teachers
Interests (Why Innovate?)	
<ul style="list-style-type: none"> - More explicitly polymotivated. - Used values-sensitive language of <i>multiple bottom lines</i> to talk about and weigh diverse self-, local and global interests. 	<ul style="list-style-type: none"> - More tacitly polymotivated. - Emphasized local (student, school) and global (social) interests. - Did not emphasize financial self-interest.
Approaches (How?)	
<ul style="list-style-type: none"> - Commonly described model-based (e.g. HCD) and pilot-driven (e.g. “lean”) approaches to design and innovation. - Students and teachers described as users and sources of feedback, but rarely as substantive co-designers. - Reported using networks like meetups and ed-tech conferences for learning, marketing, and developing relationships and reputations with educators. 	<ul style="list-style-type: none"> - Described collaborative coaching approaches to innovation. - Reported co-designerly relationships with both teachers and students. - Learned “multiple languages” to work with both teachers and IT personnel. - Reported sometimes needing to separate and hide their innovator roles in hierarchical, authoritarian schools. - Used conferences and professional networks for information sharing and for professional and emotional support not found in their schools.
Orientations to Power (To What Extent?)	
<ul style="list-style-type: none"> - Sometimes reported incremental innovation focused on retooling the way the schools already work for better efficiency and quality. - De facto privileged innovator status was gained through contracts and formal relationships with schools and IT departments. However, such contracts were often difficult and time-consuming to put into place. - Entrepreneurs reported circumventing slow and restrictive institutional procurement processes, marketing directly to teachers. 	<ul style="list-style-type: none"> - Often positioned as incrementalists, working in a collegial, minimally disruptive and collaborative fashion with other teachers and students. - Efforts to more deeply influence educational systems, values and pedagogies often resulted in marginalization. - Privileged positions with innovational authority created tensions with other teachers who did not enjoy such authority. - When innovational authority was not accessible, teachers sometimes

Entrepreneurs	Teachers
<p>- They also reported pushing back against marketized power, for instance, by maintaining a “human-centered” innovation ethic and resisting “featurism” desired by investors.</p> <p>- While entrepreneurs worked hard to align value propositions and scale their work for global and ecological change goals, a clear critique of how technology reinforces an inequitable or unjust status quo was not found in their stories.</p>	<p>reported innovating rebelliously, disguising their actions from colleagues and leadership, and sometimes breaking rules and roles.</p> <p>- Some teachers positioned themselves as <i>critical innovators</i>, combining a caring and teacherly motivation for better, more equitable, more just futures with a critique of how technological change often reinforces inequity and oppression.</p>

Why Teachers and Entrepreneurs Innovate

By carefully attending to innovator interests, we found both teachers and entrepreneurs to be polymotivated, positioning themselves per diverse goals of self-, local, and global interest. Furthermore, we found that their goals and interests often compete and give rise to contradictions and tensions in innovation. Unlike teachers, however, entrepreneurs made use of the notion of multiple bottom lines to explain and weigh conflicts of interest that inevitably arise when treating schools simultaneously as public projects and as markets for their technological products. They dealt with primary contradictions between use value and exchange value (Engeström, 1987, p. 102) by differentiating and weighing values and interests of multiple stakeholders, for example, shareholder value, company value, user value, value to self, and value to society and the environment.

Current teachers, on the other hand, did not explicitly articulate their self-interests in terms of market value or personal monetary gain, but preferred to focus on the use value of innovation at the local (student, classroom, and school) and global (social) levels. To the extent that teachers talked explicitly about their self-interests, they limited discussion to basic notions of job security, professional growth, recognition, the fundamental satisfaction they derived from working creatively and agentically with technology, and sometimes access to minor stipends and technology freebies.

Teachers may be culturally and institutionally restricted from speaking of the goal and value of their innovative work in terms of individual self-interest or market value. Stories from Ariana (T), June (T), and Erin (T) revealed they felt judged by peers and colleagues for their exceptional pursuits, privileged status, and expanded individual agency that they gained because of their innovative practices. Ariana (T) believed her colleagues viewed her as “too big for her britches,” while Erin (T) felt she was probably perceived as “annoying” by her peers. Neither male teachers

nor entrepreneurs reported feeling isolated, restricted, or judged as innovators in the same way as the female teachers.

It may be that teaching, as a gendered profession that is traditionally normed per a feminine culture of care (Beauboeuf-Lafontant, 2005; Noddings, 2003), and schools, which are notoriously authoritarian (Gabbard, 2016), normalizing, and disciplining (Anderson & Grinberg, 1998; Foucault, 1975), do not recognize or support innovational goals and interests of teachers that are not explicitly student focused or socially minded, especially if such innovation leads to individual distinction or perceived rewards.

For example, a lengthy article in the *New York Times* (Singer, 2017) described several teacher-innovators' classroom practices, but raised ethical issues concerning these teachers' ambassador relationships with technology companies that may involve special access to the technology for their schools, sponsorship for presenting at professional conferences, or payment for offering teacher workshops. There is certainly room for overseeing conflicts of interest in the workplace (note one teacher had already negotiated 10 days of unpaid leave to conduct her innovation practice). Yet, the overall tone of the article and the public commentary was dismissive of the expansive innovative work these teachers were accomplishing, what one of the teachers called "two full-time jobs," despite it seeming to have benefited the teacher's professional practice, the learners in the schools, the school infrastructure, and the edtech companies through precious teacher input.

How Teachers and Entrepreneurs Innovate

In attending to innovator approach, data suggest that entrepreneurs employed technical language about systematic processes of design and pilot-driven innovation. Teachers, on the other hand, did not tend to speak in terms of such systems and models for innovation. Neither did they speak in terms of the models for technology integration to which they may have conceivably been exposed in teacher learning programs, like TPACK, RAT, or SAMR.

While recent scholarship has highlighted how little is known about how teachers or teacher educators deploy such models in their day-to-day practice (Kimmons & Hall, 2016; Voithofer & Nelson, 2021), our findings suggest that teachers may not use them or at least do not reveal them in their stories of innovation. Rather, their stories reveal that teachers more commonly drew upon their practical teaching experience and their relationships with students and other teachers to take on a distinctly developmental role in changemaking, what we have called a coaching approach.

Teacher coaches brought knowledge of day-to-day teaching practices and a productive collegiality to innovation. Their emic perspective on classrooms and close relationships with children even enabled them to develop codesigner relationships with students, as in the case of Ariana (T). Entrepreneurs did not report such close relationships with children or

even teachers as codesigners, suggesting that this may be a unique innovational strength of teachers.

As critical scholars of entrepreneurship have documented (see Essers et al. 2017b), traditional entrepreneurial conceptions of innovation tend to position it as a heroic, individualist, white, male endeavor, while female innovators and innovators who operate in more collaborative and collectivist modes, like the teachers with whom we spoke, are often overlooked or discounted. Restrictive and gendered assumptions about what counts and who counts as an innovator were apparent in the experiences reported by female teachers. June (T) was a teacher who struggled to work across gendered boundaries around technology in school, learning to speak multiple languages in support of more productive and equitable technology decision-making. It is notable that when teachers or former teachers were involved in systematic design processes, as in the case of Nick's (TE) platform for analyzing home water and energy use data, the teachers were able to identify valuable pedagogical opportunities that were not obvious to commercial designers.

The Scope and Significance of Innovational Change

While examining innovational interests and approaches provides a sense of why and how certain innovators go about their work, it is only by examining an innovator's relationship to the powerful educational orthodoxy that the potential scope and significance of the change they are working toward can be examined. Both teachers and entrepreneurs position themselves as incrementalists. For teachers, who often report constrained innovational agency and minimal control over their technological ecosystem, a gradual, iterative retooling and making-do with technology presents itself as an uncontentious mode of change-making.

Rather than creatively disrupting schools upon which they immediately depend for professional community and job security, they rather approach innovation as bricolage (Levi-Strauss, 1966; Zahra et al., 2009), working in a more collaborative, pragmatic, and less socially isolating fashion. Research has shown incremental change often occurs within "the grammar of schooling," in other words, within a school's engrained educational format and goals (Cuban, 2013; Hughes, Boklage et al., 2016; Selwyn, 2011), such as when Amy (T) described reducing the number of worksheets to include a few apps, yet her lessons and goals remained constant.

At the same time, other teachers engaged technology in ways that challenged the educational status quo more deeply and immediately. In our analysis we have seen how teachers like Ariana (T) situated themselves in special positions outside of the normal curriculum and relatively free of restrictive accountability measures, like reporting requirements and standardized assessment. Via these privileged innovation spaces — like makerspaces and gifted programs — teachers pushed back on norms with a degree of innovational authority granted by their managerial leaders (Gabbard, 2016). Yet, the fact that such innovation occurs in these privileged spaces leads to inequity, whereby only select students have access.

For example, Hughes et al. (2017) identified more extensive innovation within elective environmental and health science courses than within the annually tested and required mathematics courses. In addition, these privileged innovators sometimes experienced tensions with their peers, as they were seen as having exceptional status and agency in the highly disciplined school hierarchy. Entrepreneurs did not report this type of internal pushback from teachers against exceptionalism.

At times, teachers positioned themselves in outright rejection of managerial authority in school, rebelliously flouting rules and professional norms. In such cases, innovation can be understood as a form of “oppositional behavior” (Giroux, 1983, p. 260) and, potentially, as critical resistance. In June’s (T) case, this rebellious orientation was at least partly rooted in an awareness of the value of her innovator role and how it was being curtailed by what she viewed as a dismissive and ineffective IT leadership.

When Ariana (T) flouted engrained professional norms and expectations at her school, she justified her oppositional behavior with a general critique of the way that technology tends to reinforce social inequities and worked to establish a more just culture of innovation in her makerspace. In this sense, Ariana’s (T) oppositional behavior combined both a critique of oppression and a motivation for social justice and could, therefore, be understood as form of transformational resistance (Solorzano & Delgado-Bernal, 2001). She used technology in an oppositional manner, not only to resist and retool traditional school infrastructures and practices, but to affect change more deeply, at the level of values and culture.

Entrepreneurs, for their part, reported rebelling less against the institutionalized power of the schools for which they designed and more against powerful financial interests of funders and venture capitalists, who valued schools and classrooms too narrowly as mere markets for technologies and technological services. Entrepreneurs sometimes worked critically and “against the grain of the orthodoxy” (Essers et al, 2017a) by prioritizing the use value of their innovative work over concerns for market value, resisting, for example, pushes for potentially lucrative but essentially useless featurism in their products.

Implications for Teacher Education

This section discusses how our analysis of interests, approaches and orientations to power can help teacher educators think about better preparing preservice and in-service teachers to become innovative changemakers. We introduce three actions:

1. Broadening and legitimizing roles for teachers in innovation work.
2. Guiding teachers in innovation and changemaking through systematic processes.
3. Anchoring innovation and changemaking in transformational/critical perspectives.

Broadening and Legitimizing Roles for Teachers in Innovation Work

At the most basic level, our analysis suggests that we have a problem of imagination when it comes to teachers' roles as innovators. Educational researchers, teacher educators, school leaders, and educators, themselves, could begin to better chart leadership pathways and roles for teachers that are more innovational than managerial, roles intended to influence rather than reinforce stasis and status quo. We have found that while many teacher-innovators are deeply interested and engaged in improving their educational practices and craft — often through networked learning communities — even this focus on practice-level innovation often left them marginalized or delegitimized as innovators. The teaching profession is missing a valuable opportunity for teachers to be supported as designers and producers/coproducers of technology innovations rather than narrow implementors or classroom integrators.

In teacher education, we could frame teaching as a continuum of teacher-driven, school-focused, community-engaged innovation leadership activities that play out across the education landscape. Teachers could be prepared to work across this innovation continuum from the level of the classroom, to the school, to the district, to community, and to broader educational ecosystems, including professional online networks, conferences, collective impact initiatives, edtech meetups and startup ecosystems.

Teacherly developmental coaching relationships and practices could be better surfaced, described, and legitimized as influential modes of innovation. Teacher educators may begin by presenting teachers with detailed cases of teacher-led innovation in practice across this continuum, providing more opportunities for educators to envision this as legitimate work and develop themselves as innovational leaders.

Research-based cases exist. For example, educators are learning, leading, and coaching within networked (offline and online) professional learning communities (Prestridge & Main, 2018) such as Edcamps (Carpenter & Linton, 2016), in communities of practice like the in-person conference of the International Society for Technology in Education and the online Discovery Education Network (Trust & Horrocks, 2019), and in hashtag spaces like #RemoteTeaching during the COVID-19 pandemic (Trust et al., 2020).

We also have models of innovation via research-practice partnerships (RPP) between schools and universities. For example, Scharber et al. (2021) described four cases from a 7-year RPP that depict teachers engaged in creative risk taking and failure as they learned and developed technology integration practices, and Howard (2013) even offered an analysis of risk from teachers' perspectives to help them support emerging technology use in practice.

Other cases have highlighted the expanded role that preservice and in-service teachers offer within edtech development. Preservice and in-service teachers offered crucial insights for edtech startups in the

SlowPitch experience conceptualized by Hughes (2019). Schools have partnered with app companies to develop and scale innovations to solve local challenges (Arnett & Clayton Christensen Institute for Disruptive Innovation, 2016; Villavicencio et al., 2016), and schools have hosted evening shark tanks in which students, parents, teachers, and leaders judge startup pitches (Hodas, 2016).

This sampling of case studies could be used to develop more sophisticated understandings of and models for ways schools recognize and support teachers as innovational leaders, for instance through new innovational roles, changemaking programs, innovational routines, infrastructure, and relationships in and out of school. Case studies of teacher-led changemaking in complex school contexts could be used to engage preservice teachers in critically reflecting upon the variety of competing individual, local and global goals and motives of innovation and to develop a more sophisticated way of speaking, thinking, and acting in pursuit of change in school.

With teachers' insider understandings of the operations of schools and the experiences of students, their core knowledge of pedagogy, and their fundamental roles as caregivers and curators of growth experiences for students, teachers are perhaps better positioned than any other professional group — including professional entrepreneurs — to weigh risk and potential value in emerging technologies and methods in schools.

Guiding Teachers Through Systematic Processes for Innovation and Change-Making

Teacher-innovators' work can appear to be effortless (McGinnis, 2017) and, at least in the stories from our sample, to lack explicit use of systematic processes of design and pilot-driven innovation. Because much of the hard work that teacher-innovators do tends not to be explicit or visible — possibly because the work has already become intuitive — we suggest teacher educators guide new teachers in learning and practicing a variety of different approaches to innovation and changemaking relevant to school contexts.

Teacher educators could engage preservice teachers in learning about the broader sociotechnical ecosystems in which we all work and live, providing them with a higher level (and critical) perspective on technology landscapes and how they shift, such as those reported in the Common Sense censuses (Rideout & Robb, 2019; 2020) or EDUCAUSE's *Horizon Reports* (Pelletier et al., 2021).

Even more specifically, teachers should begin to understand how contextual conditions, such as leadership, policies, infrastructure, safety concerns, and efforts for equity and justice, shape the environment and influence what educators can accomplish (Hughes & Roblyer, 2023; Roblyer & Hughes, 2019). Understanding sociotechnical ecosystems and contextual conditions provides teachers with key knowledge to develop questions to ask school leaders and teachers to gauge the potential support for innovation in a school environment — questions that can be used in interviews for teaching positions. Preservice teachers can also conduct a

contextual case analysis at their field sites to gauge the enabling and disabling conditions for innovation. Then, for instance, through speculative design exercises (Dunne & Raby, 2013; Ehret et al., 2019) that ask teachers to reimagine a future classroom under different technological conditions, they could develop their vision of how technology can be used to realize better educational futures. This kind of work would prepare preservice teachers to innovate through ecosystem opportunism.

Teacher educators can help teachers think and work with models for systematic design and piloting, whereby teachers emerge not just as consumers of educational technologies, but as knowledgeable producers of innovation, such as new lessons, curricula, programs, or educational resources. Teacher education programs need to demystify the changemaking and innovation process, guiding new teachers in how to do this work systematically. Lesson design activities that are guided by design models (e.g., Chai et al., 2017; Hughes & Roblyer, 2023) are optimal, especially when they are iterative and involve collaborators. Teacher educators could also expose teachers to some of the conceptual frameworks and models for guiding and sustaining innovation, including various approaches to systems change, HCD, lean and pilot-driven innovation, and participatory action research.

By helping teachers learn how to engage in the day-to-day work of leading innovation with technology, we hope to legitimize teacher innovation practices and make them more widespread. As this happens, histories of identifying and minimizing risks (Howard, 2013) may be transformed into a future of creative risk-taking (Scharber et al., 2021). When teacher educators establish more legitimate roles for teachers to innovate and guide teachers in more systematic design approaches to innovation, we can imagine more opportunities for preservice and in-service teachers to engage in systematic innovation and changemaking with a wider variety of collaborators.

Anchoring Innovation and Change-Making in Transformative and Critical Perspectives

Our final suggestion for teacher educators is to help teachers develop a professional theory of technology that can guide their innovation work, what Hughes and Roblyer (2023) called a professional rationale for educational technology. Such a theory or rationale influences the kind of innovation work a teacher will take up. Our stance is that such a theory should be anchored in transformative and critical perspectives (Feenberg, 1991; Greenberg et al., 2021; Philip & Olivares-Pasillas, 2016; Selwyn, 2011; Watters, 2021).

Teacher education programs might also look to scholarship on critical entrepreneurship to inform their approaches to developing teachers who engage with technology in ways that “move against the grain of orthodoxy in order to realize spaces of freedom and otherness” (Essers et al., 2017a, p. 2). Curricula must highlight the fundamentally oppositional nature of innovation in highly normed and normalizing schools. Teachers should be sensitized to how they are positioned and how they orient themselves to power through their work with technology in ways that either sustain,

reinforce, or interrupt how schools operate internally and as part of broader society.

Building on Feenberg (2004) and Giroux (1983), for instance, teachers could be taught to approach technology innovation as a critical-creative changemaking activity that combines a critique of the way the technology and schooling reinforce an inequitable social status quo with clear action for social justice. More clearly framing and teaching technology innovation in this way would help us better identify, develop and support the kind of critical innovators and critical innovation practices that are capable of disrupting the stubborn and oppressive “grammar of schools” (Tyack & Tobin, 1994; see also Selwyn, 2011) and substantively changing what schools do in pursuit of democratic goals of equity and social justice.

We see great potential in creating opportunities for teacher-innovators to develop a more speculative view on education as they build their own professional theories. Through creative exercises that engage teachers as abductive thinkers (Cross, 1999) and critical and speculative designers (de Freitas, 2017; Dunne & Raby, 2013; Ehret et al., 2019; Ross, 2017), they could explore (utopian and dystopian) possibilities of emerging technologies and develop a uniquely valuable insider’s vision of good technological futures in school. These opportunities for critical-creative speculation on technology and the future of education could help develop the kind of teacher leaders called for by Barth (2001), Blair (2016), and Hughes and Roblyer (2023): teacher leaders who know what they believe in, can articulate their theories, and construct better futures with technology.

Limitations

It is important to note that we examined stories of innovation, not innovation practice. However, without naively presuming that what innovators *say they do* is exactly what they *actually do*, we believe the diversity of interests, approaches and orientations to power that we have identified in these stories can help us think about how innovators might be better prepared and supported in practice.

It is also important to point out that we did not systematically seek a socioculturally representative or diverse sample within groups of teachers and tech entrepreneurs. The entrepreneurs with whom we spoke were all male, while six of the seven current teachers were female. We interviewed one teacher and one entrepreneur who identified as Black. While our sample may ultimately reflect some general demographic imbalances observed in these fields in terms of direction, the study likely misses useful stories from, for instance, pioneering practitioners from historically marginalized groups. As our sample is neither particularly large nor clearly representative, we do not make claims of statistical generalization to broader populations. Rather, we focus on particularizing our understanding of innovation within our conceptually delimited sample groups.

Conclusion

The aspects of innovation and innovator positioning described in this study are neither mutually exclusive nor all encompassing. However, they are useful for rethinking who gets counted as an innovator in school and society and what counts as an innovation. Given the relatively superficial historical impact of technological innovation on teaching and learning practices in schools (Cuban, 2013), a deeper questioning of prevalent assumptions about the identities, practices, and values of innovation will be essential to preparing and supporting innovators who can truly influence the persistent grammar of schools (Tyack & Tobin, 1994; Selwyn, 2011).

For researchers, we hope this study of innovator positioning in schools can highlight a productive new link to emerging scholarship on social and critical entrepreneurship (Essers et al., 2017b; Zahra et al., 2009) and stimulate a discussion of what it might mean to prepare teachers to be both innovative *and* critical. For practitioners — both tech entrepreneurs and teachers alike — we hope these diverse aspects of innovator positioning may be useful reference points in understanding and developing their own innovator identities and practices. For teacher educators, professional developers, and school leaders, we hope this study can stimulate discussion about better programs and supports for teachers to become competent and confident leaders of technology innovation and inspire mindful self-reflection regarding the depth of innovation within teacher education and professional learning contexts (Ellis et al., 2020). We need more teachers and teacher educators with the innovational authority and critical vision to make real change in school.

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