Technology Entanglements of Pre-Service Teachers: A Socio-Material Analysis of Coherence in Technology and Teacher Education

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Abstract: Teacher education is increasingly of interest to the Learning Sciences. Also of interest to LS are the use, integration, and roles of technology in learning. We present initial findings of an empirical study examining the intersection of technology and teacher education. We view learning as a socio-material process of identity development in which the material and the social are entangled to mutually constitute the becoming of persons. We employ the concept of 'coherence' to analyze the ways in which pre-service teachers are positioned by, interact with, and experience technology both in their field placement sites and in their teacher education program by analyzing interview data of different constituencies related to teacher education. Our findings show that definitions of technology shape how constituencies see the role of technology in learning and where they believe technological expertise resides. Such views are consequential for the social and material organization of teacher learning.

Keywords: technology, teacher education, socio-materiality, coherence

Introduction

In the call for papers for the 2020 International Conference of the Learning Sciences, the organizers made explicit that teacher learning has not been a traditional focus of the Learning Sciences, but that our field is well-positioned to contribute methodologically and theoretically to teacher learning and teacher education. Technology, on the other hand, has been a routine topic in the field, including the theorization of technologies as cultural tools in learning processes and the continual design of new and innovative technologies for learning (Sawyer, 2005). In this paper, we couple the under-researched phenomenon of teacher education with the oft-researched subject of technology by presenting early findings of an in-progress study examining multiple facets of technology in relation to pre-service teachers, such as how technology is defined, used, and experienced in both university settings and field placements.

We hold a broadly socio-cultural view of learning and understand learning to be situated and mediated by cultural tools (Lave & Wenger, 1991). In our view, both persons and practices are co-constituted through activity and through this process of constitution both the knowing subject and the known object, such as technological tools, are constructed (Packer, 2010). Furthermore, tools not only mediate activity and participation (Cole, 1996), technological tools are directly implicated in identity development and shape the socio-material becoming of persons (Weidler-Lewis, Graville, & Polman, Under Review). Our socio-material position entails that while at times it is useful to distinguish between the 'material' and 'social' aspects of learning, the ability to differentiate the two is not *a priori* (Latour, 2005), and the social and material exist in an assemblage or "mangle of practice" (Pickering, 1995) in which neither can be sufficiently understood alone. Therefore, the challenge is to embrace the situated entanglement of the material and the social, and in this case, technology and praxis for pre-service teachers.

Pre-service teachers, those students who are soon-to-be educators, are in a unique position from which to study technology's relationship to teacher learning. They simultaneously participate in multiple organizations: both the teacher education programs in which they will be credentialed and the school districts where they gain expertise in the practical aspects of teaching. Prior research has shown that organizational infrastructure matters for teacher learning, but it has primarily focused on either K-12 instruction or higher education (Penuel et al., 2010), not both. Pre-service teachers engage in both levels: while university teacher education programs are tasked with preparing future teachers for the demands of K-12 teaching, they are dependent on the university's technological infrastructure and ideation. Little is known regarding the similarities and differences (i.e., coherence) between how technology is conceptualized and utilized in teacher education programs at the university level and out in the field in K-12 school districts and classrooms. Our work is exploring this gap.

Organizational coherence

Teacher learning and teacher decision making for instruction are important topics for understanding how to support and design effective learning environments (Cobb, Zhao, & Dean, 2009). Coherence is a meaningful aspect of teachers' work environment and has implications for teachers' learning (Desimone, 2009; Garet et al., 2001). Coherence refers to the conceptual and structural alignment of individual teacher goals with the broader goals of institutions, school districts, and state and national standards (Hammerness, 2006). Incoherence is when there is a lack of alignment or conflict between teachers' instructional goals and the broader goals of the organizational systems in which they are embedded.

Two types of coherence in education practice are explicated by the National Research Council: vertical and horizontal (NRC, 2001). Vertical coherence refers to the alignment and shared vision of improving teaching and learning between classrooms, schools, and districts; horizontal coherence refers to the alignment of practices and what teachers do, including assessment, curriculum, instruction and professional learning. For our purposes, we situate coherence for pre-service teachers in their multiple organizational contexts and in their socio-material entanglements. Therefore, vertical coherence of technology represents the alignment of a shared *vision* of teaching and learning with technology across spaces of practice for pre-service teachers including K-12 classrooms, individual schools, school districts, state organizations, *and* university settings; horizontal coherence of technology shapes how technology is *used* in curriculum, instruction, and professional learning. We seek to understand to what degree pre-service teachers experience coherence in 1) how the visions and definitions of technology are constructed in both their K-12 teaching experiences and university teacher education preparation; and 2) how technology is used and interacted with in both K-12 education and higher education?

Methods

This work-in-progress study began with identifying interacting constituencies at a large, public land-grant institution and nearby K-12 schools in which all research team members and invited study participants regularly engaged. The constituencies were chosen based on our perception of their role in assigning status to certain educational technologies in pre-service teacher education. We identified four constituencies: pre-service teachers, their partner teachers, faculty who teach pre-service teachers, and educational technology staff who regularly support faculty's use of technology. Next, we developed an interview protocol for each constituency using questions that scaffolded participants' responses, beginning with their perceived positioning and use of technology within university or school activities, to their definitions of educational technology. While specific introductory questions varied per constituency, members from every constituency were asked to differentiate between those materials or tools that they considered educational technology, and those that were not; we also asked about the use of such tools. This questioning strategy enabled us to learn about the contexts through which constituencies may come to privilege specific forms and uses of educational technology.

The analysis presented in this paper regards initial interview data collected from one member of each constituency: a pre-service science teacher working towards teacher licensure for grade 6 – 12 (Bella), her mentor teacher and middle school science teacher (Cliff), a faculty member in the teacher education program (Amy), and a member of the educational technology staff (Joe). All names are pseudonyms. Each author interviewed members from a different set of constituencies, and then reported their initial interpretations of the interview findings with respect to the research questions in research group meetings. These conversations fostered insight into connections between each constituency's definition of and practices associated with educational technology. Conversing about these connections was our way of "theming the data," a meta-analytic approach to understanding participants' identity formation and beliefs throughout the interviewing process (Saldaña, 2013, p. 176). We did not assume that participants had personal definitions of educational technology prior to the moment of the interview, but instead that through each interview, participants' notions of their constituency-identity and beliefs about educational technology were co-constructions influenced by the time, place, and relations in which the interviews were embedded. We synthesized the themes from the research team meetings. The interviews were then deductively coded according to these themes including how each constituency defined technology and their relationship to education technology and teacher education. We looked for coherence and agreement between each constituency.

In what follows, we present three areas of in/coherence that were identified among these constituencies. As this work is on-going, our goal is not to make causal claims or suggest that our analysis is complete; rather, we believe these areas provide a useful starting point from which to think about why coherence of technology in teacher education matters and to identify further questions and lines of inquiry.

Findings

The three areas of in/coherence we identified among our constituencies include: 1) the defining of education technology as a subset of tools to serve learning and education goals, 2) the depth of technological infrastructure

recognized as informing a learning ecology, and 3) who holds technological expertise in the learning ecology. Each area informs the others, but we argue that the most salient and consequential of the three, is the defining of what counts as education technology, for this informs not only what can then be seen as mediating teaching and learning and included as part of the infrastructure, but also what can count and be recognized as technological expertise for learning.

Consequential definitions of educational technology

Isolating the answers to the question of how each constituency defines technology makes apparent a basic level of coherence. Each of our participants see technology as a particular type of tool and, therefore, an educational technology is defined as a tool that reflects the participants view of education and their role within the learning organization. In Table 1, we synthesize the way each participant defines education technology, examples they provided of educational technology, and the role of such technology in teacher learning and teacher practice. Beyond the agreement of technology being a tool, differences emerge related to what counts as education technology and subsequently its role in teacher learning and teacher practice.

Table 1: Participants definition of technology, examples, and role in learning

	Definition of Education Technology	Examples of Education Technology	Role of Education Technology in Teacher Learning
Bella (Pre-Service Teacher)	"I think it would be defined as a tool that helps to instill a productive, like purpose in the classroom."	Personal computers, Specific software that supports content knowledge (e.g., PHET simulator)	Technology is to support instruction and content acquisition
Cliff (Mentor Teacher)	"Any tool that helps me teach and helps students learn."	Whiteboards, chromebooks, parent portal, probeware	Technology supports instruction, communication, and professional ability
Amy (Teacher Ed Faculty)	"I would say some kind of tool that makes learning easier."	Whiteboards, lms, lightbulbs, digital tools, communication tools	Technology supports instruction, learning environments, and apprenticeship
Joe (Ed Tech Staff)	"It's being able to, for a faculty member to take technology and use it as a tool for education our students or doing research."	Networks, all forms of software, classroom configurations including tables and chairs	Technology undergirds all learning environments and its role is determined by participants.

Our data suggest that Bella has the narrowest definition of technology; this is reflected in both how she positively identifies technology and how she describes what is not considered technology for learning. For her, educational technology is for keeping students on task, anything that deviates is not educational: "I see kids all the time type in for comics on Google and then they're reading comics, all during class so that's not educational at all." On the other side of the spectrum Joe sees technology as informing all aspects of learning design, from instruction to the physical layout of classrooms; it can play any role in a learning environment. Cliff and Amy define technology more loosely than Bella, but not as broadly as Joe. These differences influence the depth in technological infrastructure our constituencies recognize, which is consequential for defining who has access and authority in these infrastructures.

Depth and configurations of technological infrastructure

Amy and Bella confine that which is included in education technology to a relationship between an instructor and a student. Bella sees technology in both her classroom placement and in her classes as an undergraduate as in service to the content of the class, further, the teacher makes decisions regarding its best use. Amy has a broader conception of the role of technology as it can mediate more than delivery of content including technology as a useful tool in course management including learning management systems and class communication software such as ClassDojo. She also sees greater potential for university technology to enable apprenticeship learning for pre-service teachers through virtual classroom spaces and other forms of coaching and mentoring. Cliff shares similarities with both Amy and Bella in that technology supports his instruction but it is also how he communicates with parents and is part of his own professional development; however, he has a limited view of technology's role in supporting Bella's teacher learning. This creates incoherence for how technology might support Bella's apprenticeship in her classroom placement and in her education courses. Joe sees educational technology as supporting any myriad of configurations of faculty work, including their research; in this way he coheres with

Cliff's understanding as technology as supporting one's professional identity as an educator outside of classroom instruction; but this goes unrecognized by Bella.

Technological expertise

Who is seen as being part of the technological infrastructure bears on who can be seen as a technology expert. Bella, Amy, and Cliff locate the majority of expertise with the instructor, whether this be the instructor in the K-12 setting, or the instructor in the pre-service education classes. When asked who should be the decision maker regarding technology in the classroom, each constituency stated that it was the instructor alone. However, each constituency recognized that it is often the case that students know more than the instructor regarding particular technologies. For example, Bella said that none of her students need help working with computers, while Amy said that pre-service teachers routinely show their mentor teachers how to use particular software. When asked if educational technology staff have a role in supporting instruction, Amy said, "No, not at all." Bella saw staff as merely those who "fix" computers. Joe on the other hand took pride in how he was able to inform faculty's use and integration of technology; he stated, "being able to help faculty use <technology> to the fullest extent is probably something that I really feel is very important and take pride in knowing that we're able to help faculty do that."

Discussion and conclusion

Although these findings are preliminary, they surface important questions related to expertise, access, and power surrounding technology in teacher education programs that we intend to explore further. First, those with the most knowledge on how technology materially functions (e.g., Joe) are the least likely to be seen as supporting instruction even though they pride themselves on providing this knowledge to support educators. Second, students at all levels are presumed to have technological expertise by their teachers and we question whether this is warranted, and wonder what happens to those students who lack this expertise or understanding. Whose responsibility is it to fill in students' gaps related to knowledge and/or access to technology? Finally, the data suggests that more than just teachers and students are implicated in the social configurations of technology. Parents, staff, and administrators are overlooked. We think it remains an open question as to how decision making power should be distributed across the technological infrastructures of pre-service teachers to best support these social and material configurations.

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