

Rural Teachers' Computing Attitudes in their Classrooms

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Abstract: The purpose of this multiple case study is to explore teacher attitudes toward and engagement with technology as they participate in STEM professional development and subsequently enact instruction. Using the lens of cultural historical activity theory (CHAT), we examine the ways in which two middle school teachers in a rural community shifted their perspectives on technology during this process. Findings suggest that teacher attitude toward technology can be moderated through the means of a more knowledgeable other who scaffolds teacher learning and integration of technology, providing insights into the professional development needs of rural teachers.

Teachers and technology in STEM education

As seen in new fields such as chemometrics and computational biology, computing is increasingly required in STEM careers (Weintrop et al., 2015). Further, computational thinking is conceptualized as a foundational literacy for the 21st century (Grover & Pea, 2013). Because of this, students need the support of educators in scaffolding computing understanding that will help them prepare for STEM career success in the future. Accordingly, all teachers of young students need preparation to teach computing skills. Unfortunately, current computing experiences in education tend to not include authentic and meaningful integration that is relevant to STEM problems (Pitman & Gaines, 2015). Furthermore, the pedagogical content knowledge that teachers need to engage students authentically in integrated STEM computing projects is lacking. Thus, the teaching of skills necessary to support student interest and learning in STEM is not occurring (Kafai & Burke, 2014).

Implementing computational thinking tasks into instruction requires that teachers have familiarity with technology, computer science, and the pedagogy needed to support students in making sense of it (Tofel-Grehl et al., 2018). However, teachers often report that they do not have enough competence to engage students in STEM learning around computing (Tofel-Grehl et al., 2021). Thus, additional professional development is needed.

By building in professional development time for teachers to learn, reflect, and apply knowledge and skills related to computing and technology into instruction, teachers are supported to make the shifts necessary to change instruction to more authentic and meaningful STEM learning (Avci et al., 2020). Furthermore, research suggests that knowing teacher attitudes is critical for professional development, because teachers teach what they believe is important (Pajares, 1992). Additionally, knowledge of educator attitudes toward a practice “is critical for understanding teachers’ thought processes, classroom practices, [and] change” (Smith, 2002, p. 42). Therefore, to improve STEM learning and career outcomes for students, we must improve STEM instruction to thoughtfully integrate computing and teacher attitudes about such integrated teaching. Gaining this understanding can inform professional development designers in the creation of professional learning experiences that scaffold educators to include technology in STEM education for their community of students. Accordingly, we pose two research questions:

1. What attitudes do teachers express toward technology and computing within their classrooms?
2. How do teachers approach and engage with technology both during professional development and during classroom instruction?

Theoretical framing

Through the lens of cultural historical activity theory (CHAT; Engeström, 1999), this research conceptualizes professional development as activity systems within which teachers (subjects) and professional development (means) jointly endeavor to enrich teachers’ understanding of technology implementation in instruction, particularly teachers’ attitudes toward, approaches to, and engagement with technology (object). Integral to this activity structure are the tools and signs used to mediate the relation of subject to object. In this case these tools include teacher understanding of STEM instruction and pedagogical skills and strategies used in STEM instruction. The tools of teacher understanding of STEM and pedagogical skills are developed from within the

activity system but, they can also draw them in from other activities or experiences (Greeno & Engeström, 2014). Thus, teachers may draw on their experiences with technology and other pedagogical constructs as tools to increase their abilities to incorporate technology. Further, as members of the activity system community, teachers are likely to adopt and transform these tools and representations over time (Schwarz & Hershkowitz, 2001) as ways to support future students in their pursuit of learning outcomes. As such, teachers are likely to be more reflective about encounters with these conceptual tools as constructions of meaning new to their instructional design (Koschmann et al., 1998).

Methods

To explore teacher attitudes toward, and engagement with technology, this research uses a multiple case study design to analyze field notes and memos for themes in the data responsive to the research questions. These themes are then explored through reflective interviews with the participating teachers to enhance understanding.

Participants

On the Big Island of Hawaii, the rural town of Nui Huna is located halfway between the two cities on the island and has a 70% free/reduced lunch rate in public schools. The two teachers participating in this study were selected for their prior teaching experience. Amy (pseudonym) is a white woman who moved to the island eight years ago, is certified in multiple subjects, and has been teaching for over 15 years. Jill (pseudonym) is also a white woman who has lived on the island her whole life and has taught middle school for 10 years.

Professional development

Teachers were engaged in a faded scaffold of support for learning and practicing, working with students using STEM and computing skills and competencies. This approach emphasizes the importance of tracing, commenting, and explaining code as a means for developing understanding of these constructs as tools and signs (Lopez et al., 2008; Murphy et al., 2012). Working within the structures of a summer school schedule following initial workshop training, teachers experienced three different roles within the classroom whenever possible. During the first period of the day, teachers were observer learners, making projects alongside students. In the second period of the day, teachers stepped into the role of teacher with the support of the PD provider. At the close of the school day, teachers and PD providers debriefed on the day as well as previewed the coming day. This approach towards training teachers provided them both with the knowledge they need to engage these practices in their classrooms and immediate opportunities to practice teaching with supportive team members standing by. Because teachers often express anxiety or fear at engaging these new approaches (Howell et al., 2016), scaffolding their first coding teaching experience with their PD provider present allows teachers to professionally take risks and expand their abilities without fear of failure.

Design and data sources

This research utilizes a case study design to explore teacher attitudes and engagement with technology in an authentic situation as experienced with learning and implementing coding and computing into instruction.

Analysis

We analyzed fieldnotes, interviews, and audio recordings from professional development and classroom instruction. Data sources were open coded to explore the study's research questions. As themes emerged through open coding, we recorded these to creating memos. Follow up interviews were then conducted to member check or explore further emerging themes found within the data. After completing initial coding analysis, follow up interviews were conducted with both participants to dive deeper into the initial themes.

Findings

The initial codes from the field notes were listed sequentially to identify patterns. The patterns were then described as possible themes. For example, patterns of multiple codes in Amy's personal learning and co-teaching data (e.g., Teaching insecurities, Anxious focus on planning, Anxiety over learning about technology) pointed out an overwhelming concern or anxiousness during learning and instruction. This theme is Anxiety.

A second theme surfaced from the data for Jill. Specifically, the codes Learns quickly, Independent learner, Independent teacher with own ideas, "Frills free and efficient", and Lack of attention to detail all converged around the notion of autonomy in learning. This theme is Independent Learning.

Additionally, when analyzing the code patterns for both teachers, the code Technology is lower priority seemed to precede the code Disconnect between teacher and students. This theme is labeled:

Disengagement.

Hence, the following initial themes emerged in relation to the teachers' attitudes toward, approaches to, and engagement with computing:

1. **Anxiety:** Overwhelming concern toward learning and instruction. In the initial codes, despite her many years of experience, Amy demonstrated patterns of teaching insecurities. She was anxious with a focus on planning. She articulated anxiety regarding learning coding and was anxious about approaching and engaging with technology during instruction.
2. **Independent Learning:** Desire for autonomy in learning. Jill shared ideas of independence to choose the speed of learning and independence to choose her focus during instruction.
3. **Disengagement:** Disengagement with technology precedes disengagement with students. Despite their interest and willingness to engage technology within their classrooms, Amy and Jill also both demonstrated a disengagement from technology or seeing themselves as teachers of technology.

Interview data analysis

Findings from the data analysis of the interviews with both teachers consistently confirmed both the anxiety and independent learning themes. For example, during the interview, Amy responded: "I've always had a hard time conceptualizing coding...the idea that I had to learn this and then, and then like possibly have to answer questions in like help [of students]" and "You're presented with new things and asked to do new tasks that you don't know how to do, you're anxious about it", which confirmed the anxiety theme. Also, the independent learning theme was observed through comments like when Jill said: "I have low exposure [to technology], but I'm kind of comfortable fiddling. I mean, I feel bad if I do something wrong, but like I'm not scared of it" and "I like to have time working independently through something...just because I don't like the pressure of like going too slow, going too fast, that kind of stuff." Of note, through interview the teachers did not perceive their own disengagement but rather focused on the value of the professional development.

When considering the attitudes expressed by teachers both in general and within their classrooms, it appeared that the relationship between the teacher (subject) and their attitudes toward computing with technology (object) were moderated by a specific means (professional development). Amy's initial attitude toward computing and technology was one of anxiety. However, during the interview, she relaxed and was optimistic when discussing time spent in professional development. Specifically, she expressed that the professional development provider was able to answer her questions and provide her with the tools she needed to be successful teaching.

Jill's expression of independent learning also appeared to moderate when discussing the idea of implementing computing into her classroom instruction. She expressed her desire to have help learning how to integrate computing into her curriculum. She felt this could be accomplished by means of professional development. Jill's independence was observed most robustly in the projects during which she engaged most carefully within the professional development. In other words, her independence was mediated by the professional development and her attention to it.

In both cases, the professional development served as means to moderate teacher attitudes by supporting teachers as they developed their knowledge of computing. The dynamics of this moderation resembled action as a more knowledgeable peer that supports others in developing through what Vygotsky (1978) termed the zone of proximal development. For both teachers, their ultimate desire was to enhance and deepen their content knowledge. They approached and engaged with technology from the perspective of using it to effectively teach content. Integration was a critical reason for their engagement with technology, which prompted the creation of a new theme- *Integration*. This replaced disengagement as a theme because it better explained teachers' reasoning. Specifically, computing was an instructional approach that provided these teachers a way to further student understanding of their content knowledge.

Overall, all three themes suggest that getting teachers to engage with the tools (computing and technology) required or will require a more knowledgeable other (Vygotsky, 1978). This allowed Amy to feel confident and secure in integrating computing and technology into instruction and can allowed Jill to see how to integrate computing and technology more fully into her instruction in ways that deepen and enhance the content. It appears the most important moderating factor for teachers to consume and produce with computing during professional learning experiences was the professional development provider (mean). This person provided the means for helping teachers feel confident, capable, and able to implement the new strategy into instruction.

Discussion

This paper showcases the beliefs and experiences of teachers seeking to engage in teaching with technology. Of all the means engaged by the teachers in this study, it was their experiences of the professional development that drove their beliefs about technology. Specifically, we see shifts from anxious and avoidant behaviors to accepting and engaging behaviors that manifest as a function of relational interactions that shift the distribution of labor from isolated engagement with technology on the part of the teacher to a cooperative effort between the teacher and the professional development provider. When asked, the teachers felt that this shift was possible for them because of the support of the professional development provider. This speaks to the value and importance of slow and tailored professional learning for rural teachers.

By meeting teachers where they are *and* fostering their ability through engagement with their interest, professional development provides a unique opportunity to serve as both peer and more knowledgeable other within the space of their own learning. While the beliefs and attitudes experienced by teachers are often shifting, finding means that can facilitate shifts in belief can better support technology engagement and adoption within classrooms.

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