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Rural Teacher Attitudes and Engagement with Computing and Technology

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The purpose of this sequential Case Study-Mixed Methods research is to explore rural teacher attitudes toward, approaches to, and engagement with making and computational thinking during STEM professional development and co-teaching learning experiences. Specifically, we examine the professional learning needs of two rural, middle school teachers as they engage technology. Using the lens of cultural historical activity theory, this paper examines the ways in which teacher attitude about computing shifted throughout professional learning and instructional practice. Findings show three broad themes that emerge surrounding teacher attitudes, approaches, and engagement with technology: Anxiety, Independent Learner, and Integration. Additionally, 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.

***Keywords*: computational thinking, middle school, mixed-methods research, professional development, teacher attitudes**

Current STEM education efforts are neither achieving equitable outcomes for all students, nor meeting the demands of the workforce (Bureau of Labor Statistics, 2014; NSF, 2013; PCAST, 2016). According to data, early educational experiences influence students' options for future careers by informing their sense of compatibility of their personal identities with STEM possibilities and academic preparation (DeWitt & Archer, 2015). For example, research from a longitudinal study (Tai et al., 2006) found that half of 8th grade students who identified with a STEM career ultimately earned a baccalaureate degree related to STEM while only one-third of students who did not identify with a STEM career graduated with a STEM related degree. This suggests a need to integrate STEM learning experiences into instruction that provides foundational knowledge, promotes interest and awareness of STEM career opportunities, and prepares students to be informed citizens.

Within STEM, computing is increasingly required across disciplines. This is seen in new fields such as chemometrics and computational biology. Accordingly, students need the support of educators in scaffolding both their and their students computing understanding to prepare for STEM career success in the future (Weintrop et al., 2015). Teachers also need the ability to develop student STEM identities during instruction (Margolis et al., 2015). Unfortunately, current computing experiences in education tend to not include authentic and meaningful integration that is relevant to STEM problems (Barron et al., 2003; Delgado et al., 2015; Pitman & Gaines, 2015). Additionally, the pedagogical content knowledge that allows teachers to engage students effectively, authentically, and meaningfully in integrated computing and STEM projects is lacking, resulting in limited development of the knowledge and skills necessary to build student pathways toward STEM careers that include computing (Hofstein & Lunetta, 2004; Kafai & Burke, 2014).

One way to support students in engaging computing is maker education, which allows youth to engage in computing and engineering while learning core disciplinary STEM classroom content using nontraditional materials such as electronic textiles (e-textiles) to build circuits that integrate with microprocessors (Peppler & Glosson, 2013; Tofel-Grehl et al., 2018). Through e-textiles, students incorporate programmable electronic components into fabric crafts as a way to understand circuitry instead of the traditional wires and breadboards. E-textiles utilizes materials such as conductive fiber and Velcro; light, sound, and pressure sensors; and LED actuators along with traditional fabric craft materials. Through e-textiles, students can work on authentic projects that are culturally relevant to them while developing physics knowledge and coding skills, which students desperately need to better prepare for future STEM careers.

However, implementing computational thinking tasks into instruction requires that teachers understand programming. It requires a familiarity with technology, computer science, circuitry, and the technological pedagogical content knowledge needed to support students in making sense of these components (Tofel-Grehl et al., 2022). However, teachers often report that they do not have the skills to engage students in STEM learning with computing (Searle & Tofel-Grehl, 2019). Thus, additional professional development is needed. This sentiment is also noted by Gaytan and McEwan (2010) who report that one of the main goals of professional development in the 21st century is to build the capacity of teachers to “integrate instructional technology into teaching practices effectively” (p. 77). 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).

Unfortunately for rural teachers, access to this professional learning can be an issue. Educators within rural communities typically receive less professional development than their counterparts in urban spaces for a wide range of reasons, including limited staffing, funding, and proximity to sources of professional development (Howley & Howley, 2004; Oliver, 2007; Rude & Brewer, 2003; Weitzenkamp et al., 2003). This is especially true for professional learning regarding integration of technology (Alexander et al., 2014; Jones-Kavalier & Flannigan, 2008; Nasah et al., 2010), which can affect the ability of teachers to implement STEM instruction.

Furthermore, rural teachers may also be less qualified and prepared from the start of their careers. Rural teachers tend to be hired from within their communities over generations, as it is hard to recruit and retain more qualified teachers from outside the community (Cowen et al., 2012). In fact, the more rural the school, the less hiring practices can be utilized to support improved classroom instruction of STEM due to the lack of candidates in the prospective hiring pool (Barrett et al., 2015). This exacerbates, among other issues, a lack of understanding in integrating STEM and particularly technology into instruction (Alexander et al., 2014; Jones-Kavalier & Flannigan, 2008; Nasah et al., 2010).

An additional piece to consider in shifting classroom instruction is teacher attitudes and beliefs. Research suggests that knowing teacher attitudes is critical for professional development, because teachers tend to teach what they believe is important (Bullough & Baughman, 1997; Pajares, 1992). On the other hand, Guskey (2002) suggests teacher attitudes toward a desired shift to instruction do not occur until teachers have tried a new instructional strategy and found evidence of positive student outcomes as a result. Either way, it appears that knowing educator attitudes toward using a practice “is critical for understanding teachers’ thought processes, classroom practices, [and] change” (Smith, 2002, p. 42). In this case, the practice is the ability to engage with technology in general and in the classroom.

Therefore, to improve STEM learning and career outcomes for students by increasing STEM instruction through engagement with technology and computing, this research focuses on exploring rural teacher attitudes, approaches, and engagement with technology. Gaining understanding of these teachers’ attitudes toward, approaches to, and engagement with technology, can inform the need for professional development in rural communities and the design of the professional learning experiences in order to scaffold rural educators’ abilities to include technology, such as e-textiles, in STEM education for their community of students. Accordingly, we pose two research questions:

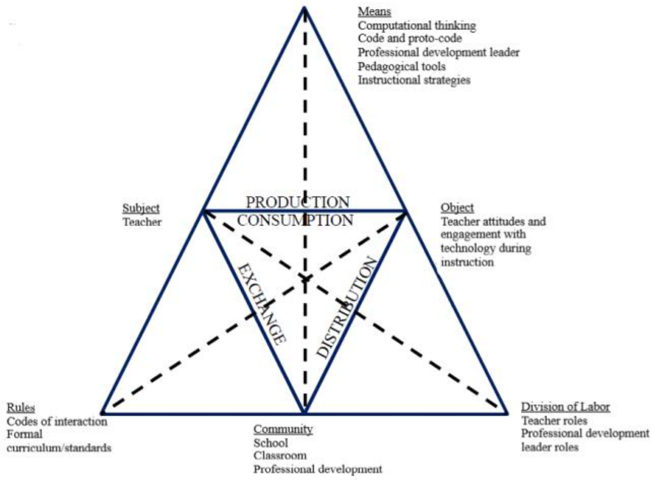
1. What attitudes do rural teachers express toward technology and computing both in general and within their classrooms?
2. How do rural teachers approach and engage with technology both during professional development and during classroom instruction?

Theoretical Framing

Through the lens of cultural historical activity theory (CHAT; Engeström, 1999), this research conceptualizes professional development in schools 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. These tools and signs are at times developed from within the activity system. However, members of the participating community, in this case the classroom, can also draw them in from other activities or prior experience (Greeno & Engeström, 2014). Thus, teachers may draw on their experiences with technology, computing skills, and other pedagogical constructs as tools to increase their abilities to implement technology into instruction. 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. We anticipate these practices will manifest as “crystalized operations” (Leont’ev, 1978) that are transparent to all community members (i.e., not objects of consciousness), because they facilitate modes of common meaning given the longevity of the existing computing curriculum. 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). Figure 1 illustrates the relationships that will frame the study.

Figure 1

Activity Framework for Professional Development



Note: (Adapted Roth & Lee, 2007)

Methods

To explore rural teacher attitudes toward, approaches to, and engagement with technology, this study uses a sequential CS-MM design that nests quantitative data analysis into qualitative analyses of researcher field notes and memos to surface themes in the data responsive to the research questions. These themes are then explored through reflective interviews with the participating teachers to enhance understanding of teacher attitudes, approaches, and engagement with technology.

Context and Participants

This article is part of a larger mixed methods study exploring rural teacher practices and professional learning around computing. The focus of the project was to build the capacity of teachers to include computational thinking in core STEM disciplinary classes.

Rural Hawaii (the Big Island) was selected as the site of this research because of the lack of teacher professional development on the island. The town in which the schools reside is located halfway between the two cities on the island. The workforce in this county is highly dependent upon local agriculture with a migrant population of 78%. Of the folks in the town, the native Hawaiian population is 31% with a 70% free/reduced lunch rate.

The two rural teachers participating in this study were selected for their prior teaching experience and availability during the COVID-19 pandemic. Amy (pseudonym) is a non-native, White woman who moved to the island eight years ago. She is National Board Certified, teaches middle school, and has been teaching for over 15 years. Jill (pseudonym) is a White woman who has lived on the island her whole life. She, too, taught middle school during the time of this project and has been teaching for over 15 years.

As an initial entrée to professional development, the teachers engaged in co-development of the curricular materials and projects over the course of three months. This co-design and development process involved teachers articulating topics and areas of interest that they wanted to improve within their classrooms and define spaces in which they could engage technology within their classes. Throughout this process the PD team engaged the teachers in iterative design and improvement of the projects in order to provide the teachers with scaffolded professional learning around each of the selected topics while simultaneously providing students greater opportunities to engage in computing within their schooling environment. After that three-month period of professional learning and co-development had concluded, teachers engaged in one-on-one professional learning over several days with the lead PD provider. A total of ten hours was spent together during this process. Teachers were trained on the specific projects they would be leading and constructing. The professional development model to be deployed in the classroom was also discussed and modified as needed. Due to the COVID-19 pandemic, several tweaks to professional development were needed. For example, while one of the test schools afforded the PD experience of multiple classes in which to model the instruction for the participating teacher, due to COVID restrictions, the second school was not able to structure their program this way. However, they were able to provide extended class periods which meant that the PD provider was able to model the lesson and then turn over instruction to the participating teacher. In both approaches, the PD provider prepared the teacher, modeled for the teacher, and then acted as co-teacher support person as they embarked on their first instructional experiences with the projects and computing. Both teachers received immediate and post-class feedback in order to support their instruction.

Design

This study utilizes a Case Study-Mixed Methods (CS-MM; Guetterman & Fetters, 2018) design, which draws upon the strengths of a case study design for exploration of a phenomenon in an authentic situation and affords the collection of data from multiple sources (Guetterman & Fetters, 2018). Additionally, it offers the ability to compare experiences with the phenomenon across multiple cases when more than one case is involved. Qualitative data collected from the cases were analyzed inductively and then quantitized (Saldaña, 2021) to gain “insight into whether the quantitative and qualitative results confirm, contradict, or relate” (Guetterman & Fetters, p. 914) to each other by elucidating patterns in the data through multiple lenses. This method supports deeper understanding of the phenomenon under exploration, which in turn helps the researchers to develop more focused questions to ask participants to confirm or disconfirm emergent themes.

Data Collection

Field notes were collected during professional development and the summer classes. Field notes were then open coded for this study from the perspective of the study’s research questions. As themes emerged through open coding, the researchers recorded these instances and other trends in the data through creating memos. Interviews were conducted following the mixed methods analysis of the field notes to confirm or disconfirm initial themes.

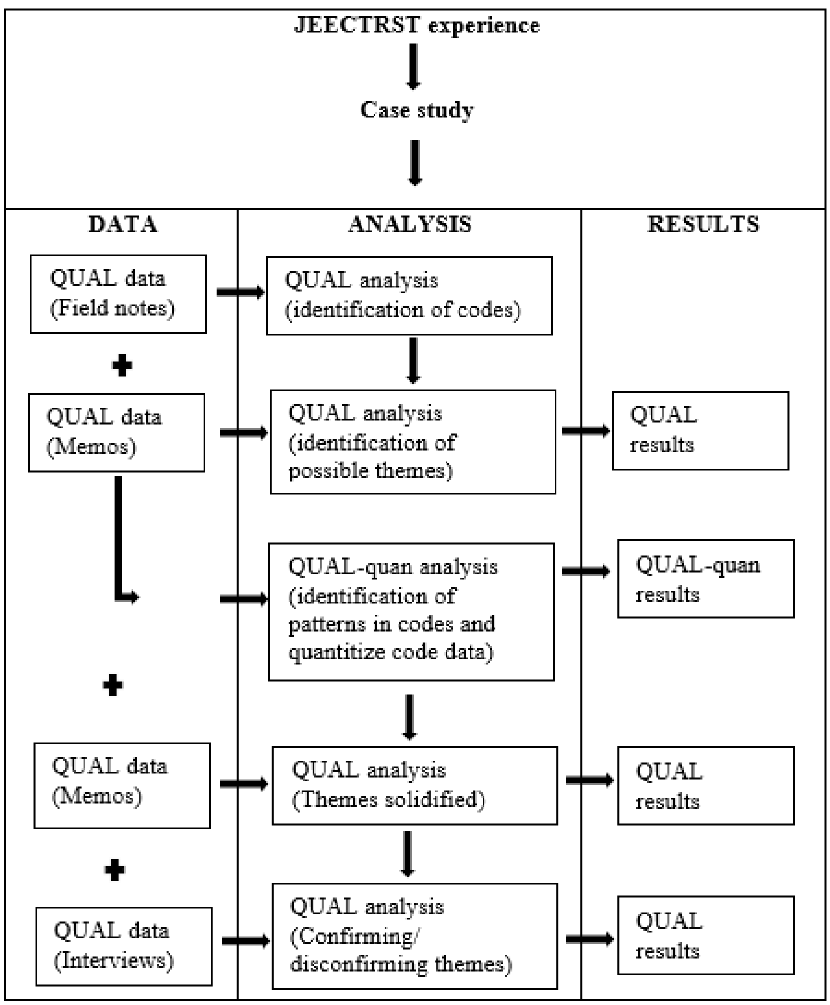
Analysis

Field notes were initially coded using open coding (Saldaña, 2021). Throughout the process, the researchers wrote memos to explain coding choices and processes as well as to document any emerging themes (see Figure 2). Frequency analyses were then applied to the qualitative codes to facilitate triangulation of inferences drawn (Greene et al., 1989).

Qualitative and quantitative data were compared to refine and solidify emerging themes. For the qualitative mixed methods analysis, the first-round codes were listed sequentially in the order they emerged from the text. The list of codes was then color coded to visually display any trends or patterns in the data. Additionally, codes were clustered into like categories. Finally, transcripts of interviews were searched for confirming or disconfirming evidence related to the themes (Saldaña, 2021). Also, transcripts were explored for any new themes that emerged in relation to teacher attitudes and approaches toward technology

Figure 2

Visual Display of Research Design: CS-MM



Findings

The initial codes from the field notes were first clustered into like codes where possible (e.g., Learning from mistakes=Learns quickly) and then listed sequentially to identify patterns as seen in Figure 3. The patterns were then described as possible themes. For example, patterns of multiple codes in Amy's personal learning and co-teaching data pointed out an overwhelming concern or anxiousness during learning and instruction (e.g., Teaching insecurities, Anxious focus on planning, Anxiety over learning about technology). This theme is Anxiety.

Figure 3

Visual Display of Coding Patterns/Clustering Data Segment

	Personal learning	Co-teaching
Amy	Teaching insecurities	Anxiety over learning about technology
	Teaching insecurities	Technology is lower priority
	Teaching insecurities	Technology is lower priority
	Teaching insecurities	Technology is lower priority
	Anxious focus on planning	Technology is lower priority
	Anxious focus on planning	Technology is lower priority
	Anxious focus on planning	Technology is lower priority
	Anxious focus on planning	Disconnect between teacher and students
	Anxious focus on planning	Anxiety over learning about technology
	Anxious focus on planning	Disconnect between teacher and students
	Anxious focus on planning	Teacher insecurities
	Excited about technology	Teacher insecurities
	Excited about technology	Technology is lower priority
	Integrating other content with technology	Lack of desire to plan, prepare, teach
	Excited about technology	Anxiety over learning about technology
	Excited about technology	Disconnect between teacher and students
	Excited about technology	Teacher insecurities
	Anxious focus on planning	Anxious focus on planning
	Anxious focus on planning	Anxious focus on planning
	Anxious focus on planning	Anxious focus on planning
Janice	Learns quickly	Focused on learning to teach technology
	Learns quickly	Independent teacher with own ideas
	Learning from mistakes=Learns quickly	Discovery learning=Teaching philosophy
	New to educator	Explicit teaching=Teaching philosophy
	"Frills free and efficient"	Explicit teaching=Teaching philosophy
	Structure supports learning	Ignore student technology learning issues
	"Frills free and efficient"	Discovery learning=Teaching philosophy
	Independent learner	Lack of attention to detail
	Independent learner	Explicit teaching=Teaching philosophy
	Independent learner	Positive attitude toward learning technology
	Independent learner	Independent teacher with own ideas
	Structure supports learning	Independent learner
	Lack of attention to detail	Independent teacher with own ideas
	Learns quickly	Technology is lower priority
	Lack of attention to detail	"Productive struggle"
	Technology is valuable and useful for learning	Disconnect between teacher and students
	Lack of attention to detail	Disconnect between teacher and students

A second theme surfaced from the data for Jill in 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. For example, in the initial codes, Amy demonstrated patterns of teaching insecurities, anxious focus on planning, and anxiety over learning about technology and was anxious about approaching and engaging with technology during both the personal learning and co-teaching components of the professional development.
2. **Independent Learning**: Desire for autonomy in learning. For example, in the initial codes for Jill, ideas of independence to choose the speed of learning (e.g., "Frills free and efficient") as well as independence to choose what to focus on during learning and instruction (e.g., Lack of attention to detail, Independent teacher with own ideas) emerged.
3. **Disengagement**: Disengagement with technology preceded disengagement with students. Specifically, the codes Technology is lower priority and Disconnect between teacher and students appear in tandem with each other in both Amy's and Jill's coding patterns.

Frequency analysis of the quantitized initial qualitative codes is depicted in Tables 1-2 for Amy and Tables 3-4 for Jill.

Table 1

Frequencies of Top Four Codes for Professional Learning: Amy

Professional Learning (n=45)		
Coding category	**Frequency**	**Percent**
Anxious focus on planning	26	57.8
Teaching insecurities	7	15.6
Integrate with technology into learning	6	13.3
Excited about technology	5	11.1

Table 2

Frequencies of Top Four Codes for Co-Teaching: Amy

Co-Teaching (n=42)		
Coding category	**Frequency**	**Percent**
Technology is lower priority	9	21.4
Disconnect between teacher and students	5	11.9
Teacher insecurities	5	11.9
Lack of desire to plan, prepare, teach	4	9.5

Table 3

Frequencies of Top 4 Codes for Professional Learning: Jill

Professional Learning (n=41)		
Coding category	**Frequency**	**Percent**
Independent learner	6	14.6
Learns quickly	6	14.6
Positive attitude toward learning about technology	5	12.2
“Frills free and efficient”	4	9.8
Lack of attention to detail	4	9.8

Note: Five categories are listed due to a tie in fourth place. Quotation marks indicate an in Vivo code.

Table 4

Frequencies of Top Four Codes for Co-Teaching: Jill

Co-teaching (n=53)		
Coding category	**Frequency**	**Percent**
Technology is lower priority	18	34.0
Disconnect between teacher and students	7	13.2
Teaching strategies for student learning	5	9.4
Independent teacher with own ideas	4	7.6

When comparing the quantitative data findings to the qualitative themes for convergence of evidence, similarities were found. First, the **Anxiety** theme was heavily noted in Table 1 (i.e., most frequent codes from professional learning: Amy) and was one of the top four codes listed in Table 2 (i.e., Most frequent codes from co-teaching: Amy). Additionally, codes seen in Tables 3-4 depicted the **Independent Learner** theme with four of the top five codes in Table 3 (i.e., Most frequent codes from professional learning for Jill) and one of the codes in Table 4 (i.e., Most frequent codes from co-teaching for Jill) reflecting this idea.

Additionally, **Disengagement,** was observed in Tables 2 and 4 code frequencies, which reflect most frequent co-teaching codes for both teachers. It makes sense that this theme would be found in co-teaching codes only and not professional learning codes because it involves teachers working with students. However, it is interesting that this theme appeared in the data findings for both teachers.

Also of note, when comparing the quantitative findings to the themes from that qualitative data analysis, one top frequency coding category found in Table 1, Integrate with technology into learning, did not come to the researchers' attention during the initial theming process. This particular quantitative finding became important during the interviews and analysis that followed.

Interview Data Analysis

After completing the mixed methods analysis and generation of interview questions, follow up interviews were conducted with both participants to dive deeper into the initial themes. Findings from the data analysis of the interviews with both teachers consistently confirmed both the **Anxiety** and **Independent Learner** 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" all confirm that the **Anxiety** theme was present. Also, the **Independent Learner** theme was observed in the transcripts of Jill's interview through responses such as: "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 dynamics**. This was evidenced in the ways that the teachers focused and talked about them with the professional development and professional development provider. From the perspective of the professional development provider, the goal was to develop a sense of collaboration and co-learning with the participating teachers in order to manage their feelings of trepidation to engaging with computing.

The process of working with the teachers began months before the summer schools were held. During this time the PD provider met bimonthly with the participating teachers to develop projects and curricular materials that met their specific classroom goals. For example, one of the participating teacher's classroom instruction focused on biology and the turtles of Hawaii. To that end, she provided regular feedback and brainstorming efforts to the PD team to develop projects and materials that dove deeply into her content of interest for the summer program. The other teacher was interested in the developing student agency and interest around Hawaii's sacred spaces so she worked with the PD provider to develop the Advocacy Apps project, a student lead app program that taught students about land stewardship and advocacy for proper behavior on the island. In this way, early on the professional development providers ensured that teachers were codesigning and learning about the projects and curriculum they would teach in the summer. This made the transition into formal professional learning smoother and provided a more equal footing for both sides to learn from.

The teachers appeared to have the same joint learning expectations as the professional development provider. They expected the professional development provider to be a support for them and their instruction as both teacher and provider worked through instructional shifts together. For example, during Jill's interview she explained

> Well, I think [that] certainly having the person demoing [the coding] being an expert teacher is what you want, right, so I think you really need a vet, who's doing the demos because I've done that, right, where you've seen a teacher and you're like, oh boy. So having an expert or master teacher [is] beneficial.

Here we see Jill simultaneously recognizing the expertise of the professional development provider but also not feeling different or lesser because of it. In fact, she associates it with times that she has been the expert instructor and provided those models to other teachers. She goes on further to say "I had to rely a little on [the professional development provider] because we hadn't gotten [to that part of the lesson with the prior group]," which indicates her comfort with leaning on the PD provider as a resource. From Amy's perspective she noted:

> I want to learn things that I can use in my class…and that are addressing my needs. I know that sounds kind of selfish, but things that are addressing my needs and things that I want to do, like for instance, the app. That was something that I really wanted to learn how to do. [The professional development provider] was like super flexible in sort of just let[ting] me do that, let me learn that…I sort of got my inspiration from [her].

Because of the relationship between the teachers and the provider that allowed for the joint construction of learning, the dynamics of the professional development supported teachers to shift instruction. These dynamics were important moderators of teacher interest and engagement with computing and technology. By feeling a part of the design process and believing the PD provider was there to provide them service rather than direct them, these relationships created opportunities for adoption and risk taking for the teachers.

Another important piece of this relationship may be that both teachers and provider viewed the relationship as positive. This was noted in the interview with Jill as she explained "the most comfortable I felt were times when I had…viewed [the professional development provider] run into…issues with students when she was modeling [the instruction]. Then, I was better versed at how to solve this [issue]." Also, Amy added as a follow up to interview questions the comment "every time I asked [the professional development provider] for something, she [said] yes." It appears that both of these teachers felt positive about the relationship because they felt comfortable learning from the provider and asking her for help.

By modeling productive struggle with computing and technology, the professional development provided gave teachers a better sense of how to scaffold such challenges within their own instruction. These scaffolds again acted as moderators for the teacher attitudes towards engaging technology and computing within their own teaching. Both teachers focused on the value of the relational dynamics of the professional development process. The aspects of joint creation of learning and positivity that spurred an ease of working together emerge as critical components of professional development.

Therefore, when considering the attitudes expressed by teachers both in general and within their classrooms, it appears 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 appeared to relax and be more optimistic when discussing time spent with the professional development provider. Specifically, she expressed that the professional development provider was able to answer all her questions and provide her with the tools she needed to integrate computing and technology into her curriculum.

For Jill, her expression of being an independent learner also appeared to moderate when discussing the idea of implementing computing into her classroom instruction. She expressed the desire to have help learning how to integrate computing into her curriculum. This, too, could be accomplished by means of a professional development provider. 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 provider served as means to moderate teacher attitudes by supporting teachers as they developed in their learning of computing and technology. 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 (Salomon & Perkins, 1998; Wertsch, 1992).

For both teachers, their ultimate desire with learning about computing and technology was to enhance and deepen their content knowledge. Thus, 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 the **Disengagement** theme because it better explained teachers' reasons for viewing technology as a lower priority. Interestingly, this also explains one of the most frequent codes for Amy's professional development (See Table 1) in the quantitative analysis, Integrate with technology into learning. In hindsight, this code was an indicator of a larger theme:

3. **Integration**: Computing deepens or enhances learning in the content. Specifically, computing is an instructional strategy that provides a way for teachers to support effective and efficient student understanding of 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 allowed Jill to see how to integrate computing and technology more fully into her instruction in ways that deepen and enhance the content. Therefore, it appears the most important moderating factor in allowing teachers to consume and produce computing and technology during professional learning experiences was the professional development provider. This person provides the means for helping teachers feel confident, capable, and able to implement the new strategy into instruction.

Discussion

This article showcases the beliefs and experiences of rural teachers seeking to engage in teaching with technology. Of all the means experienced by the teachers in this study, it was their relationships with the professional development experience and the professional development provider that moderated their beliefs about technology. We see shifts from anxious and avoidant behaviors to accepting and engaging behaviors. 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. Given the paucity of professional development offered to rural teachers, it may be that these relationships have stronger moderating influences on teacher attitude and belief.

Our research suggests that providing professional development for rural teachers within their home contexts coupled with a collaborative approach to engagement fosters teacher engagement and interest in teaching computing and engaging technology in their classes. Professional development provides a unique opportunity for rural teachers to serve as both peer and more knowledgeable other within their own classrooms as they develop their own learning. While the beliefs and attitudes experienced by rural 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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Appendix

A1. Guiding questions and Key Construct for the Reflective Memo:

Guiding questions:

1. How has our work centered the problem of developing powerful learning experiences for youth (in and out of school) that ignite interest in STEM and computing and develop career connections?
2. What kinds of local partnerships can make that more of a possibility? (Penuel et al., 2020).

The **key constructs** involved in these memos are

3. Bridging: facilitating connections with initiatives and other operating parts of the partner organizations.
4. Buffering: creating protective spaces for those working in the project that keeps possible contradictory guidance, policy, or leadership at bay.
5. Shared tools involve development of tools used for asynchronous, ongoing collaboration, including capturing decisions and feedback for improvement. (Yurkofsky et al., 2020)
6. Informal support: Ongoing work that helps partners as they implement youth learning experiences that are not captured in other representations of the partnership. Ex. Helping with a technological issue.

About the Authors

Melissa P. Mendenhall, MA, is currently pursuing a PhD in Education, Curriculum and Instruction, Concentration in Science Education from Utah State University after completing a Master of Arts, Teacher Education, Integrated STEM emphasis from Brigham Young University. Her main research interest includes finding ways for all students to access effective STEM instruction. As the Elementary Science and STEM Specialist for the Utah State Board of Education, Melissa hopes to build the capacity of educators to scaffold disciplinary literacy in students, thereby providing them with the knowledge and skills to participate in STEM discourse and prepare for STEM career pathways if they so choose.

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