Reframing Middle School Mathematics Teachers' TPACK for Teaching A New Computer Science Curriculum: Researcher-Practitioner Partnership, Board Games, and Virtual Teaching Experiences

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Abstract: Recruiting teachers from diverse content specialties for teaching computer science (CS) in K-12 classrooms has been problematic. This first year of a 3-year project examined how a researcher-practitioner partnership (RPP) collaboration designed a new middle school CS curriculum using tabletop board games. The teachers planned and piloted the curriculum in 1-week, virtual learning CS camps. Research examined how the teachers' knowledge for teaching CS was reframed as a result of their RPP experiences. This study examined this knowledge through four Technological Pedagogical Content Knowledge (TPACK) components: overarching conceptions about teaching CS; knowledge of students' CS understandings; knowledge of curriculum materials; and knowledge of instructional strategies. Qualitative analyses revealed their knowledge was primarily influenced by their knowledge for teaching mathematics. Overarching conceptions of CS and student understandings limited the teachers' TPACK for CS placing them at the adapting TPACK level. These results directed the planning for the second year RPP efforts.

Introduction and Purpose

The federal Computer Science for All (CS for All) initiative has focused on accelerating decades-long efforts to move computer science into the classroom (American Institutes for Research (AIR), 2019). This AIR initiative recognized that all students at every grade level required rigorous and engaging instruction in computer science (CS) and computational thinking (CT). However, staffing classrooms with high-quality teachers has been an enormous challenge, since most recruited teachers have been from different content areas, such as mathematics. Researcher-practitioner partnerships (RPP) have emerged as a promising strategy for providing professional development for these teachers, where researchers and educators work as equal partners on the complex problem of teacher knowledge, practices and difficulties with both the curriculum and the instructional strategies that adequately engage students in CS and CT.

As for the specific CS K-12 instructional programs, though, many resources (as cited in the K-12 Computer Science Framework, 2016) have indicated that students' interests in CS have consistently declined from late elementary through postsecondary education, particularly with respect to underrepresented minorities and females. Moreover, the coding-centered approaches typically used in many of these curricula have frustrated students, discouraging them from continuing their interest in CS as a field of study. This problem has challenged computer scientists to design a better K-12 curriculum, one that better engages more K-12 students in exploring and understanding basic concepts of CS in a less frustrating manner than focusing on coding.

In Fall 2019 we began a three-year National Science Foundation project for developing a new middle school CS curriculum aimed toward disrupting the negative perceptions of CS by guiding 6th and 7th grade students in understanding basic CS concepts through the incorporation of non-electronic tabletop board games. Our RPP team is composed of university researchers and dual-language immersion middle school teachers. Over the nine month academic year, the team designed the CS approach for middle school learners using familiar tabletop board games to focus students on important CS concepts such as abstraction, representation, and algorithms without the use of a computer. The project researchers, a middle school vice principal, a 6th grade mathematics teacher, and a 7th grade mathematics teacher collaborated in the initial design of a CS elective curriculum for the upcoming 6th and 7th grade students. The summer months focused the RPP team on the instructional strategies for engaging students in the newly designed curriculum as each teacher prepared and planned to pilot the basic curriculum in one-week middle school summer camps, taught first by the 6th grade teacher followed by a one-week camp taught by the 7th grade teacher.

Unexpectedly, the COVID-19 pandemic shifted face-to-face camps to virtual camps. The teachers had at most two weeks to shift their instructional plans to provide three hours per day over five days where the students attended virtually through Zoom. The teachers had to shift their pedagogical thinking from face-to-face delivery to virtual experiences for engaging the students in learning about CS and CT through an application of board games where they interacted through the internet transmission organized and managed by the teachers.

Ultimately, a primary task for this first year project was to reframe the mathematics teachers' knowledge in preparation for teaching the CS curriculum. The key research question was initially framed with respect to this one year effort: What was the impact on the teachers' pedagogical content knowledge for teaching CS? However, with the sudden shift to virtual learning, the research question more properly was shifted to recognize the influence of the technology on their teacher knowledge: What was the impact on the teachers' technological pedagogical content knowledge – their TPACK? Four additional questions extended the examination as they prepared for, designed, and piloted the CS virtual camps.

1. During design year one and the following summer training, what experiences helped the teachers in designing the virtual instruction for the summer pilot program?
2. What challenges existed for the teachers' implementation of their instructional plans during the summer virtual pilot teaching camps?
3. What experiences during the summer virtual pilot program provided the teachers with directions for preparing and planning for teaching the middle school CS elective curriculum in the upcoming school year, using either virtual or face-to-face learning experiences?
4. What challenges did these teachers see that other teachers might have in planning and teaching a middle school CS elective in virtual or face-to-face learning experiences?

Perspectives

Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006; Niess, 2005) describes teachers' knowledge as a specialized amalgam of technology, content, and pedagogy. In this study, the teachers' knowledge for teaching CS had to rebalance their prior theoretical knowledge and teaching practices for teaching mathematics with the emerging CS content and pedagogical knowledge from the RPP. Reframing their TPACK for a different content knowledge in a new virtual classroom environment required them to rethink, unlearn and relearn, change, revise, and adapt their plans for engaging students in learning. Thus, reframing the teachers' TPACK became an important research concern. Which experiences supported the shift in their knowledge for virtually teaching the new CS curriculum with middle school students?

Shreiter and Ammon (1989) proposed that attention to such challenges requires that teachers engage in a process of assimilation and accommodation toward the reconstruction of their personal experiences and understandings in learning the specific subject matter (such as computer science). They need practical experiences that support them in inquiring and reflecting on the ways that they confront their conceptions for teaching with a different subject matter content in the new virtual environments (Loughran, 2002; Schön, 1983). As they assimilate their emerging instructional conceptions, they must confront their understanding of the nature of the CS subject matter, the nature of the CS curriculum being taught through remote instructional experiences, and how students think and learn CS concepts in a virtual learning environment (Niess, 2005).

In this study the teachers were not previously prepared in CS nor did they have experiences using appropriate pedagogical tools for teaching this content (Chiu & Kuo, 2010; Stobaugh & Tassell, 2011). Yet, the study's task was to design and examine how these teachers prepared to teach in a virtual environment, testing their theories through practical experiences as they concurrently inquired into multiple pedagogical strategies for teaching the CS curriculum using virtual learning tools. In essence the teachers were engaged in reframing their TPACK for teaching middle school students CS. This knowledge then evolved through their *TPACK-of-practice* experiences (Cochran-Smith and Lytle, 1999) – (1) their action research into teaching CS in a middle school virtual environment in the pilot camps, (2) their reflective thinking about their teaching in this experience, and (3) their use of multiple artifacts as objects to think with as they designed their plans and implemented them in the CS pilot camps.
Three constructs were key to reframing their knowledge: specific experiences, discourse and critical reflection (Kreber, 2004; Merriam, 2004; Mezirow, 2000; Taylor, 2007). The educational context for reframing their TPACK required the identification of specific experiences to guide their emerging perspectives. Their experiences had the potential for helping them become more aware and critical of theirs and others' frames of reference with respect to teaching the content in a virtual environment. McGonigal (2005) proposed that such experiences trigger teachers as learners where they are presented with disorienting dilemmas, ones that confuse and intrigue them to consider the incorporation of different ways for teaching the content in a virtual environment. For these experiences to reframe the teachers' TPACK, they must be confronted with failure such that their current mathematical teaching knowledge is insufficient, and they need more information or a new approach to respond to the problems. As the teachers are confronted with disorienting dilemmas, they engage in critical reflection of their own frames of reference, specifically with respect to why they teach the way they do rather than how or what they teach (Kreber, 2004). These constructs guided the framing of the research questions.

The Study

This descriptive case study examined the teachers' knowledge development and pedagogical reasoning growth for virtually teaching the new CS curriculum. The inclusion of various technologies was an essential part of the virtual instruction, along with confronting a new content knowledge as they designed instructional strategies designed to engage learners in learning CS and CT. In essence, this study examined these teachers' TPACK as they reframed their teaching knowledge and planned for teaching the new CS curriculum for the middle school camps in the virtual learning environment. In this situation they had to shift their pedagogical thinking to design experiences to engage the students in learning about CS and CT through the application of board games via the virtual instruction mode.

Curriculum Design for Level I and Level II Virtual Camps

The researchers and teacher-practitioners in the RPP worked together for 1-2 hours each month throughout the school year developing the 6^{th} grade curriculum. The focus of this year's efforts was on guiding the teachers in understanding important CS and CT concepts and getting feedback on incorporating tabletop games (such as Tic Tac Toe and Nim) in the 6^{th} grade curriculum emphasizing concepts of abstraction, representation, and algorithms. By the end of the school year during the first year of the research project, a new domain-specific programming language for the 7^{th} grade curriculum was developed by the CS researchers. This new language, called Board Game Language (BoGL), was designed as a language for programming tabletop board games (BoGL, 2020). As a programming language, it is primarily a functional language syntactically similar to Haskell (2019) but with a significantly simplified syntax and type system. Next, the collaborative RPP team directed their efforts in supporting the teachers' understanding of the language and developing the 7^{th} grade curriculum focused on extending the CS concepts toward translating game algorithms into BoGL programs. Prior to the pilot camps, the researchers and practitioners spent 40 hours over two weeks addressing issues or questions the teachers had about the conceptual development and the extension of algorithms into the more simplified BoGL programming language.

The plans for the five-day virtual camps were separated into two levels. The first level used board games to engage students in the CS concepts of abstraction, representation, and algorithms, thus in a non-coding, unplugged, approach. The second-level camp used the board games to extend the conceptual ideas but focused more on guiding students in translating their game algorithms into programs to be executed in BoGL. The teachers had access to the collection of the RPP work including designed lesson plans, presentation slides, and student worksheets created for the 6th and 7th grade curricula. The teachers were free to modify activities and material, add new material, or keep strictly to the lesson plans.

The initial design of these plans was for use in a face-to-face instructional model. With little time for preparation, the teachers had to redesign and implement the plans for virtual lessons in the one-week camps. They had had some limited experience teaching mathematics classes online during spring quarter. But, teaching the CS curriculum in camps that were suddenly switched to virtual learning environment resulted in a new experience for the teachers. For these camps, they used a Canvas studio site to house all information, including links for the schedule, introduction, Zoom, and Padlet. In recognition of middle school students' limited attention spans, they subdivided the three hour limit per day into three 40 minute sessions along with three 10 minute breaks and a 30-minute wrap-up conclusion. Both teachers used Zoom polls as a strategy for keeping the students engaged in the various 5-10 minute PowerPoint presentations. Additionally, they used other internet-based games such as Kahoot! Games (Kahoot, 2020) for students' brain breaks. Each camp began with playing a game such as Tic Tac Toe or Nim. Stories were used to engage the students as players in specific games. The students either played the games in pairs in breakout rooms or played as a class. Then they discussed the *representations* used in the game (such as X or O versus using different colored Lego figures) as they described the specific rules for the game. Often, activities guided the understanding of CS concepts. For example, for *abstraction*, the students were assigned to present three levels of abstraction that described themselves as a game player, where the final level was a selfie. The discussion then moved to the ideas of *abstraction* as identified in the different *representations* in the game. Eventually, the class was guided in translating the rules of the game into *algorithms* to clearly describe how the game was to be played. The language in the algorithms used control structures, such as IF-THEN-ELSE and WHILE statements, to explain how the game rules were represented as an algorithm for playing the game.

Teachers' Academic Preparation and Professional Teaching Experiences

The 6th and 7th grade teachers participated in the RPP throughout the year ending by piloting the two CS level virtual learning environments. The vice principal had specifically selected them because of their strength in teaching and excitement for learning CS, each with a solid mathematics content background for teaching at their specific grade level. The 6th grade teacher (Teacher A) had completed an elementary/middle level teacher licensure program, was a first year teacher teaching 6th grade mathematics, and taught the Level I virtual camp that emphasized exploring games with the non-coding, unplugged approach. The 7th grade teacher (Teacher B) completed a secondary teacher licensure program with an undergraduate major in mathematics and a graduate degree in teaching mathematics; he had taught mathematics in the middle school for six years. He taught the Level II virtual camp that focused on the design of game algorithms and translating those algorithms into BoGL programs.

Data Sources and Evidence

Individual teacher case binders (Meyers et al., 2003) were compiled, containing the lesson plans, Powerpoints, worksheets and other materials for topics designed through the RPP, the teachers' lesson plans for each camp day, observer notes for each camp day, and observer notes for the one hour debrief reflection sessions following each camp day. Qualitative analyses of the case binders used a whole-to-part inductive approach (Erickson, 2006) to identify patterns and themes in the experiences, discussions, and reflections to capture each teacher's progression and outcomes from the teaching experiences. The case analyses documented each teacher's knowledge progression with evidence of their *TPACK-of-practice* experiences and online thinking framed with respect to the four TPACK components proposed by Niess (2005): (1) overarching conceptions about the purposes for teaching computer science concepts; (2) knowledge of students' understandings, thinking and learning in computer science; (3) knowledge of curriculum and curricular materials for teaching and learning computer science; (4) knowledge of instructional strategies and pedagogical representations for teaching and learning computer science.

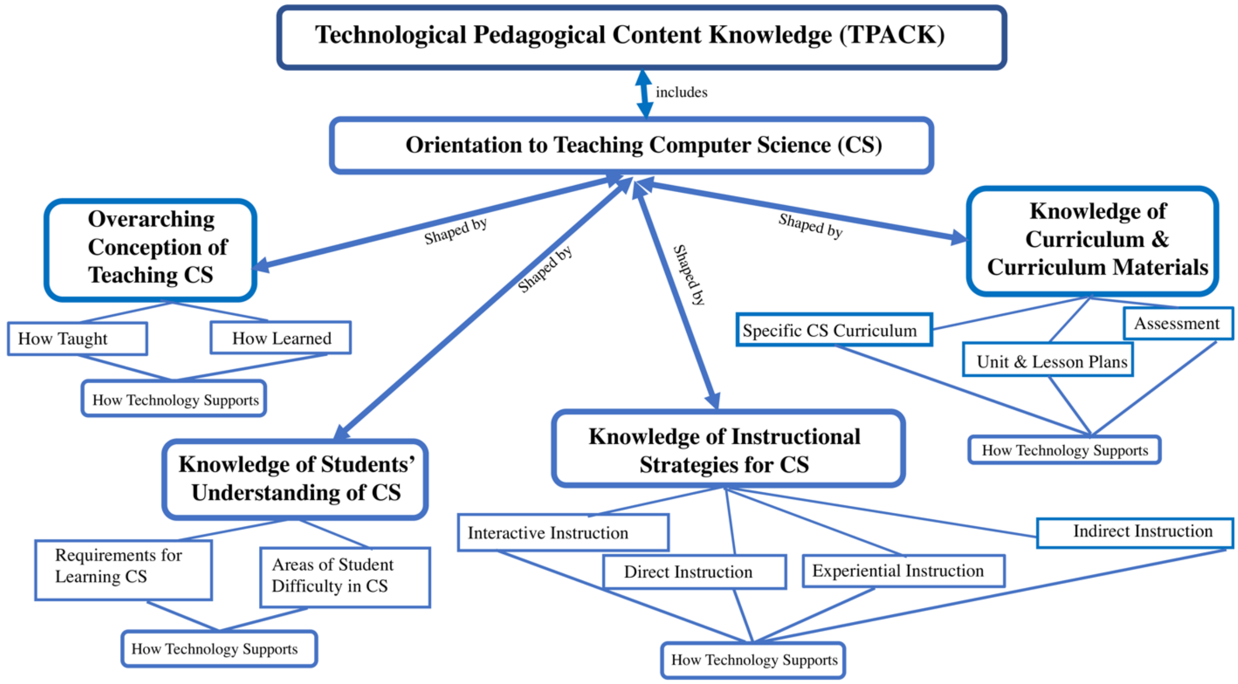

Figure 1. Central Components of TPACK's Orientation to Teaching CS

This description represented in Figure 1 guided the gathering of data and the examination of the individual cases with respect to the four central components for describing the teachers' TPACK with respect to teaching CS (Niess, 2013). For example, we used these components to guide the debrief reflections with the teachers. During those experiences we examined their thinking with respect to how CS is taught or learned and how technology supported that work. Similarly, we were interested in the teachers' assessments of the curriculum and curriculum materials and how the technology supported them in conducting those assessments. All of the reflections were loaded in the individual case binders for analyses. The case analyses ultimately guided the description of each teacher's TPACK and provided responses to the four research questions. Finally, the analyses of the cases were used to identify the TPACK level for teacher these levels (Niess et al., 2009) were framed as:

1. *Recognizing*, where teachers recognize connections among the content, pedagogy and technology for CS.
2. *Accepting,* where teachers have a favorable attitude toward the connections among the CS content, pedagogy and technology for CS.
3. *Adapting,* where teachers are able to incorporate activities in their teaching, featuring the connections among the content, pedagogy, and technology for CS.
4. *Exploring*, where teachers actively explore the integration of content, pedagogy, and technology in their teaching of CS.
5. *Advancing,* where teachers consciously evaluate the results of the integration of content, pedagogy, and technology in their teaching of CS.

Results

Analyses of the two teachers' efforts over the first year RPP efforts culminated with their action research when teaching CS virtually in the pilot camps. The description of the teachers' four TPACK components with respect to CS also led to the description of their TPACK levels. The examination ultimately provided responses to the four research questions and directions for the second year RPP efforts.

Teachers' TPACK Components

Both teachers' overarching conceptions about the purposes for teaching CS concepts were clearly revealed through their lesson plans for teaching the pilot camps. They were tasked with planning and organizing the classes for the camp days, which ultimately described their visions of the CS curriculum, and how it should be taught and learned. During the academic year, the majority of the content for the curriculum was designed and outlined by the researchers rather than the teachers. However, through this development work, the teachers were learning about CS through the prepared lesson plans that described how it might be taught. As they worked with these ideas, they provided feedback. Through this interaction with the researchers, the teachers shaped how they thought the ideas might be taught. However, their overarching conceptions became more clearly framed as they actually planned lessons for their camp instruction and as they interacted with students who were engaged in learning CS with the prepared materials. For those plans, both teachers relied heavily on the prepared materials and directions from the researchers rather than completely designing their own lessons. Clearly, their planned lessons reflected how they had learned the CS ideas. Teacher A used the Level I camp debrief reflective sessions to discuss future ideas for lessons as well as to gather suggestions from the researchers towards meeting the camp goals. In the Level II camp debrief reflective sessions, Teacher B described his concern that he did not have the full understanding of the CS concepts and was certain he had some misconceptions in his basic understanding of CS as he tried to guide students' progressions in the development of board game algorithms. While both teachers demonstrated and voiced clear overarching conceptions for teaching mathematics (their primary content area), at this point, both relied on their brief experiences with the CS curriculum which resulted in their uncertainty as to the primary concepts for the lessons as well as ideas for extending the concepts beyond what they taught in their lessons.

With respect to the teachers' knowledge of students' understandings, thinking and learning in CS, the length of the camps as well as the virtual nature of the camps proved to limit the teachers' opportunities to gather students' thinking and ideas. Both teachers expressed difficulty in helping students develop their understandings and thinking primarily as a result of the Zoom organization and capabilities. Whole class discussions were difficult to manage. The students typically had their microphones "off" so that their home noise did not interrupt the class while they were also able to periodically "hide" behind their avatars. The teachers had difficulty in observing students to see what or use the Zoom features to indicate reactions, such as "thumbs up" and "raised hand." The teachers' tried polling as a technique for getting feedback from the students but found that this form did not really gather the students' thinking about the ideas. Organizing students in small breakout rooms to complete a task was disappointing because the students did not interact easily. Collaboration rarely happened without extensive directions for getting the groups started. More typically, rather than challenging students to share their thinking with the class, Teacher A used virtual notecards to describe the concepts of representation and algorithm and followed with students working in breakout groups to summarize and apply these ideas. The virtual nature of the experiences also constrained Teacher B, since his preferred instructional strategy from his mathematics classes was where he presented ideas and used questioning to gather the students' understanding and thinking through breakout small group worksheets or tasks. Yet, he too had difficulties in engaging the students in small group collaboration and discussion. Furthermore, he explained that in mathematics he was able to engage students through questioning to guide their thinking as he had been teaching for a number of years and had a good sense of what they might be thinking. The only times that the breakout collaborations seemed to work was when several researchers were available to work one-on-one with a group to use questions to guide their developing ideas. They were then able to report to the teacher what they had heard from students during the debrief sessions. With this new CS curriculum, Teacher B indicated that he was unsure of the best way to be able to gather their thinking. He was caught in the dilemma of when to let them struggle with the ideas to enhance their learning and when to simply tell them in order to keep the lesson progressing.

The teachers' knowledge of the curriculum and curricular materials for teaching and learning computer science was guided by their interactions with the RPP as they responded to the lessons the researchers designed. For their camps, both teachers relied primarily on these prepared materials. Teacher A was successful in breaking the curriculum into smaller pieces to match the students' needs. She augmented the game aspect of the curriculum with existing websites such as MathIsFun and Tabletopia for multiplayer tabletop games to provide students with more interaction. For writing algorithms from game rules, she designed some new worksheets and Powerpoint slides to guide the students in creating an algorithm for Tic Tac Toe. Teacher B only somewhat relied on the Powerpoint slides to introduce the concepts. He primarily used an electronic whiteboard to explain the concepts, keeping the students in pairs using worksheets and programming activities. For both teachers the challenge of having to teach virtually forced them to use the prepared materials rather than designing their own because of their unfamiliarity with the CS curriculum. Their efforts were primarily focused on activities to keep the students engaged in the virtual format.

The teachers' knowledge of instructional strategies and pedagogical representations for teaching and learning CS was confounded by the virtual teaching format with which they also had little experience. Teacher A used technology as a way to remotely facilitate interactions and collaborations for designing game algorithms along with synchronous game play of the tabletop games. She did use Google docs for collaborating on worksheets in Zoom breakout rooms and did have some students share their desktops from the group work. Her culminating activity asked students to write down all the words they now associated with computer science. Then, she collected the words and created a word cloud to share with the students. *Algorithms* and *representations* were the two most commonly used words by more than 50% of the students. Teacher B relied almost exclusively on the whiteboard to guide the students in algorithm development. After his presentation, he had students work in small breakout rooms to prepare algorithms that described the game rules. But again, this strategy was fraught with difficulties in getting students to collaborate and share their thinking. For closure, the students returned to the whole class view to share their algorithms. In essence, the virtual environment was not conducive for the discussions that he hoped to have.

Response to Research Questions

The analyses of the cases supported responses to the four research questions. The experiences that the teachers viewed as helping them design the virtual instruction were those from the spring term of the school year virtual teaching for their mathematics classes. This period allowed them to gain experience with the tools: Canvas and Zoom. The experiences also solidified their understanding of the importance of breaking the time into smaller instructional pieces and providing activities to actively engage the students in the learning. In other words, the teachers underscored the importance of prior preparation to guide the design of the planned virtual instruction.

The teachers were challenged in multiple ways to implement their instructional plans during the summer camp virtual pilot teaching. Both teachers struggled to identify appropriate strategies to gain access to students' thinking and understandings. Initially, they thought organizing students in small breakout rooms for collaboration and completion of tasks was a reasonable strategy. Establishing the multiple groups and assuring that all groups understood the task did not work well. Without the teacher presence in the group, the students simply seemed to wait for instructions, rather than connecting with each other about the assigned task. The students did not quickly determine someone to assume the leadership role. They had not learned how to use the technology to share their worksheets. Typically, the collaboration deteriorated to individual students working on their own worksheet without discussion and collaboration. The teachers assumed at least one student would take the lead but that only happened if the group happened to have more outgoing students. Even if the teacher gave detailed instructions for identifying a group leader, the students rarely followed those instructions. They simply waited until the teacher came to their group and guided them into the collaboration. A second challenge was the teachers' lack of CS knowledge about the concepts they were teaching. They were unsure of which concepts needed more activities and variety to assure students were understanding the ideas and were able to apply the ideas. A third challenge was the desire for class discussions. The teachers struggled with asking appropriate questions ask for encouraging the students to share their thinking with the class. They found that they could ask students to supply numerical or short responses in the chat. Other times they might ask students to use the "reaction" feature to show if they understood an idea. But they struggled with the virtual environment for engaging the class in discussions to gain a better understanding of their thinking and understanding.

The teachers clearly indicated that the piloting of a small set of the curriculum was the most useful direction for preparing and planning for teaching the middle school CS elective curriculum They felt the one-week experiences helped them identify how students might react to specific activities. The shortened experience helped them learn to use the technologies for the virtual learning experiences and gave them direction for their more extended curriculum lesson planning. They also felt that the researchers' lessons provided important directions and by teaching those lessons they were able to identify places where more instruction would be needed.

The teachers declared that having a good CS knowledge was vital for other teachers for their planning and teaching CS. That knowledge was considered essential for designing lessons for either face-to-face or virtual experiences. That knowledge was seen as needed for determining how to scaffold activities, tasks and assignments to enhance student engagement and learning. New teachers need more than access to lesson plans. The lesson plans need support materials that explain the concepts and why the concept is being taught at a particular time. They also need sample assessments for each of the units. They need opportunities to examine and explore the ideas, design new activities, and test the ideas with students for both face-to-face and virtual learning experiences. Ultimately, new teachers need opportunities to explore the conceptual interactions (beyond the limited curriculum they would be teaching); they need to design instructional strategies for framing students' knowledge for programming in BoGL.

These lesson plans need to incorporate careful scaffolding of the CS concepts toward the development of algorithms prior to moving to any coding experiences.

Significance

This study contributes to the knowledge for reframing a teachers' TPACK with respect to teaching a different content such as computer science. The first year of the 3-year RPP process began the process of identifying appropriate professional development activities for reframing teachers' TPACK where they have opportunities to assimilate and accommodate conceptual understandings in support of making important CS connections as well as appropriate pedagogical reasoning strategies for teaching CS. At this point in the process, the teachers' TPACK for teaching CS was best described as an adapting TPACK level. At this point, the teachers relied primarily on their teacher knowledge for teaching mathematics to guide their planning for lessons for the camps. They had limited background in CS and thus relied on the researchers in the RPP for helping with the identification of the primary concepts and the specific content in the lesson plans.

The analysis revealed key guidelines for the second year of the RPP professional development work. While the teachers now will be planning and teaching the full CS elective game-based curriculum with 6th and 7th grade students, they will be engaged in both enhancing and extending the curriculum they had taught in the pilot camps while also determining additional instructional strategies for guiding student learning in the virtual environment which was required given the pandemic. To support this work, the RPP monthly meetings need to engage the teachers in designing new lessons using the game-based approach. Recognition of the teachers' adapting TPACK level suggested the need to work toward extending their overarching conceptions about the purposes for teaching the CS concepts, both how it is taught and how it is learned. They need more experiences than simply teaching the same curriculum, class after class, in order to reframe their TPACK. Rather than being given the objectives for a lesson, they need to be challenged to consider how the objectives are connected with other ideas in the curriculum. While having access to a set of pre-planned lessons, the teachers need to be challenged to examine how the lessons fit with other lessons along with identifying and designing questions and other activities for extending students' understandings and thinking. To accomplish these ideas, a teacher-research pairing might be useful for developing future lessons and units, where the partners develop the plans, the teacher teaches the plan while the researcher observes, and the pair debriefs, reflects, and rework the plans. This partnership might be used to provide the teacher with a better understanding of the CS concepts as well as the scaffolding of activities to build the concepts. Such a paired-partnership might provide opportunities that would support them in reframing their TPACK for CS and guide the teachers in moving to the next TPACK level - exploring. Such exploration of new CS concepts might also consider adding multiple tabletop games (such as the SET Card Game and Connect Four) giving them additional opportunities to examine game rules and translating them into algorithms that might eventually lead to BoGL programs. In essence, this study showed that reframing teachers' TPACK for teaching CS through the RPP process requires more guided opportunities focused on reframing the teachers' knowledge towards developing the amalgam of content, pedagogies and technologies, particularly during this time of virtual education.

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