

## Teachers' Conceptions of Technology, School Policy and Teachers' Roles When Using Technology in Instruction

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### ABSTRACT

This case study invested effort in capturing individual teachers' responses to their conceptions of technology and school policy on technology, and how they actually or intentionally used technology, to clarify what roles teachers played in the use of technology. The study indicates that the teachers' conceptions of technology and school policy on technology had an impact on how they actually or intentionally use technology. The roles teachers played in the use of technology are Learners, Leaders, Collaborators, and Designers.

**Keywords:** conceptions, technology, school policy, leaders, impact

### INTRODUCTION

In the current economic and educational context, there has been an increased emphasis on the technological components of teachers' professional development, because technological growth and increased emphasis on educational accountability have occurred in tandem (Donnelly, Dove, & Tiffany-Morales, 2002), for educational technology is essential in both teaching and learning mathematics (NCTM, 2000). Similarly, teachers' conceptions of technology and technology policies, relative to what those policies are, will have an impact on technology implementation (Knapp, 2002).

Although there is a growing body of research that suggests technology can enhance and improve learning (Jonassen & Reeves, 2001; CCSSM, 2010), there is no consensus as to how to implement computing technology to enhance and improve learning in the mathematics classroom. The effectiveness of technology will vary with situational variables (Johnston & Barker, 2002). Variations will be caused by goals and resources for instruction, the extent to which all learners' needs is considered, teachers' comfort and skill with technology, and the type of technology available (Johnston & Barker, 2002).

Introduction of various technologies into schools and classrooms throughout the past century has not altered basic patterns of teaching (Abrami, 2001; Albion, 2003; Kaput, 1992)—and this is precisely the challenge that confronts current proponents of technology integration. Even though virtually every other type of institution in the country has changed noticeably in the past 100 years because of technology, basic classrooms instruction remains relatively unchanged (Ruthven, 1996).

Though billions of dollars have been spent on technologies for schools, access to that technology continues to be labeled a major barrier to technology implementation (Niess, 2006). In some situations where technology is readily available, some teachers do not know how to take advantage of it, and still, others are against it (Niess, 2006). Also, research indicates that there still are some barriers for teachers to apply computing technology to mathematics teaching (e.g., Hew & Brush, 2007; Kilinc et al., 2016).

### PURPOSE OF THE STUDY

The purpose of this study was to analyze the teachers' conceptions of technology and school policy on technology, as well as the roles that they played in the use of technology. We expected to explore the relationships between the teachers' conceptions of technology and school policy on technology in the teaching and learning of mathematics, and the roles that they played when they integrated technology in mathematics teaching. The

#### **Contribution of this paper to the literature**

- The important aspects used to effectively analyse the teachers' conceptions of technology, school policy and teachers' roles when using technology in this study are categorized as follows: appropriate use of technology, instructional uses, educator's proficiency, and system support.
- The study indicates that the teachers' conceptions of technology and school policy on technology had an impact on how they actually or intentionally use technology.
- The roles teachers played in the use of technology are learners, leaders, collaborators, and designers.

research questions to be addressed in this study is: What are the roles that teachers played in the implementation process of technology in the classroom according to their conceptions of technology and school policy on technology?

## **THEORETICAL FRAMEWORK / LITERATURE REVIEW**

### **Teachers' Conceptions on Technology**

Thompson (1984) defines teachers' *conceptions* as their beliefs, views, and preferences about the subject matter and the teaching of that subject matter. Thompson examined the relationship between conceptions and practice and looked at properties of the participants' conceptual systems. She found that "the teachers' beliefs, views, and preferences about mathematics and its teaching regardless of whether they are consciously or unconsciously held, play a significant, albeit subtle, role in shaping their instructional behavior" (pp. 124-125). In the research conducted by (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012), the teachers' conceptions on technology include technology to deliver content and reinforce skills; technology to complement or enrich the curriculum; and technology to transform teaching and learning. Ertmer et al. (2012) explored the relationship between teachers' beliefs, teacher's practice and the role of technology. They found that teachers were able to enact technology integration practices that closely aligned with their beliefs. Recently, Kao's (2017) research indicates that the perceptions and the practices of technology usage of preschool educators are critical to the incorporation of the specific technologies used in preschool education. In addition, other scholars, such as Gonzalez and González-Ruiz (2017) claim that teachers' beliefs and sound technological pedagogical content knowledge (TPCK) together play important roles in effectively integrating technology in mathematics teaching.

### **The Barriers to the Use of Technology in Instructional Practices**

Teachers' instructional practices are greatly influenced by their conceptions but mitigated by other factors in the educational environment and the community (Thompson, 1992; Pajares, 1992). For example, two types of barriers were identified including first-order barriers (e.g., resources, institution, subject culture, and assessment) and the second-order barriers (e.g., teacher attitudes and beliefs; knowledge and skills) (Ertmer, 1999; Hew & Brush, 2007). In addition to the teacher beliefs, teacher attitude, knowledge and skills are relating to the use of technology in teaching practice. The assessment in the category of the first-order barrier also has an impact on the implementation of technology. For example, the study conducted by Muhametjanova and Cagiltay (2017) revealed that the category of the first-order barrier includes: lack of both hardware and software laboratories and the instructors' limited knowledge and experience with technology.

### **The Roles that Teachers Play in the Use of Technology**

International Society for Technology in Education (ISTE) (2017) publishes the technology standards for educators. The standards assume the following roles of teachers play in the use of technology: 1). Learner. Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning. 2). Leader. Educators seek out opportunities for leadership to support student empowerment and success and to improve teaching and learning. 3). Citizen. Educators inspire students to positively contribute to and responsibly participate in the digital world. 4). Collaborator. Educators dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems. 5). Designer, Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability. 6). Facilitator. Educators facilitate learning with technology to support student achievement of the 2016 ISTE Standards for Students. 7). Analyst. Educators understand and use data to drive their instruction and support students in achieving their learning goals. Based on a case study, we are going to analyze the teachers' roles and their conceptions on technology and school policy on technology.

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## METHODOLOGY

The study invested effort in capturing individual teachers' responses to their conceptions of technology and school policy on technology, and how they actually or intentionally use technology, to clarify what roles the teachers played in the use of technology. The teachers' responses can be obtained from one 1-hour interview with teachers. We also have the data from the observations of their teaching.

### Research Site and Participants

Our study took place at Coffee Middle middle school, which is located in one of the southern states of the United States of America. Coffee Middle School has a total enrollment of 688 students. It is a Title I School having 430 students eligible for free lunch and 53 eligible for reduced lunch. The school has 52 teachers with a teacher student ratio of 13:2. The participants were mathematics teachers who were involved with implementing technology policy in the teaching and learning of mathematics. The study focused on sixth-grade mathematics teachers because they had recently acquired new technology that encourages the use of the computer. There was three-sixth grade mathematics teachers at the school: Jane, Alice and Mary (pseudonyms). All of the sixth-grade mathematics teachers were invited to participate in the study, and all agreed. Seventh and eighth-grade teachers were not invited to participate because we felt they would not add any additional insight. They had not yet acquired the new technology. According to Patton (2002), "...qualitative sampling designs specify minimum samples based on expected reasonable coverage of the phenomenon given the purpose of the study and stakeholders interests" (p. 246). Jane had been teaching 6<sup>th</sup> grade math for five years whereas Alice had been teaching for twenty-four years and Mary for thirteen years as well.

The engagement of multiple participants provided multiple perspectives, thus producing multiple sources of data that were used to cross check and verify emergent themes, which provided the basis for triangulation (Patton, 2002). Because we could not observe mathematics teachers' feelings or how they perceived and interpreted the impact of school policy on their implementation of technology into instruction; interviewing them was necessary (Merriam, 1998).

### Data Collection

We collected data about teachers' conceptions of technology and school policy on technology and use of computing technology for teaching and learning mathematics. Three teachers from Grade 6 were chosen for interviews. We believed that data from this grade level would give a good picture of teachers' views of technology and school policy on technology and their implementation. The study drew together information from various sources: one 1-hour interview with teachers combined with observations of their teaching.

Interview data were helpful because they allowed us to gain an insight into the conceptions about the technology of the interviewees. According to Patton (2002), the purpose of the interview is "to enter into the other person's perspective" (p. 341). Because we are interested in teachers' conceptions (beliefs, views, and preferences) of technology and technology policy, the interview method was appropriate. There were initial interviews and follow-up interviews based on an analysis of the initial interviews. These interviews were semi-structured with open-ended interview questions. We used information gained in the early interviews to make slight modifications to the protocol that we followed in subsequent interviews.

An interview protocol that included the targeted themes and topics, including questions about teachers' perceptions of the use of technology and the principals or other administrators' views on technology. The main purpose of these interviews as part of the original design is, to provide triangulation of data among the interview participants.

### Data Analysis

The data were analyzed using the constant comparison method (Strauss & Corbin, 1998). These methods of coding and recoding data throughout the data collection and analysis process informed that process and lead to categories, themes, and eventually to a theory that helped describe and explain the investigated topic which was, in the present study, "teachers' conceptions of technology and school policy on technology and teachers' roles when using technology in instruction."

After the initial interviews, we examined school-level records related to teachers' professional development. After the interviews were completed, we approached the data again and began the process of identifying constructs, categories, and identifying where applicable the dimensions of categories. To analyze participants' conceptions, we coded for categories around which the protocol had been designed, and looked for emergent categories.

## RESULTS

### Jane

#### *Appropriate use of technology*

When asked, "In general, do you use technology; do you use calculators or computers in your teaching in any way?" Jane responded

*I don't personally; a lot of students use calculators. Some of them are used to using it in the elementary school, but I feel like if they can do it on paper, then once we can accomplish it on paper, then I'll allow them use calculators but not a whole lot. Now, technology, I use it in my classroom a lot. I use my ACTIVboard and a lot of times I'll pull up different math sites and games, and we'll play them on my PowerPoint that I use through ACTIVboard. Anything that can be done on the computer, I'll put it up on the ACTIVboard and we do it as a class because it allows all of the students to be able to participate instead of making sure I've got a computer for every single student.*

She was able to pull up something through the computer and then show it on the screen. She had a pen, which allowed the students to go up to the screen. She said,

*It's as if they had their keyboard and they could tap and do the stuff with the pen. So I don't worry about having a computer for every single student. We go to the computer lab, but that's only to do some practice for our CRCT1 test online. But other than that, I use my ACTIVboard.*

Her main use of technology was the ACTIVboard connected to the computer. She thought that was the appropriate use of the technology that she had, and she thought that was the best way to get her students to learn. When asked if she could envision using it in some other way. Jane responded:

*It can be used in other ways. ... We're hoping to be able to get what they call the little ACTIVboard, and that's a little device that you assign to each student and say, like if I wanted to give a quiz, which I do, but the only difference is now, I can't use the ACTIVboard. Now, if I give a quiz, I show it on the ACTIVboard, and they will write the answers down on a sheet of paper and turn it in. But if we get the ACTIVboard, they'll be able to press an answer A, B, C, D, and if they press the answer and I'll never have to take up a sheet of paper. Then I can go back to the computer later and pull up and see what student answered what and give a grade for that. But they don't have them here yet so...I'm trying to get them to get it.*

When asked, "So, you're pushing for the ACTIVboard? So, what is the process of trying to acquire that?" she answered,

*Well, we had a meeting with the...right now, here, only the sixth-grade math teachers have ACTIVboards. However, I had an ACTIVboard in my old school, I wrote a mini grant and was awarded an ACTIVboard at my old school, and so I already knew about it. And that's how they know about some of the other stuff, too, because I've told them. But, anyway, we had a meeting...*

She guessed that the county is in the process of trying to come up with some money to put them in all the classrooms and they're going to get the ACTIVboards for all the other math teachers and eventually get it for the science and social studies teachers.

When asked, "So, you were the one who was familiar with this more than any of the other teachers here?" she said,

*Yeah. The other teachers went to a staff development on it, but I guess because I had been working with it a little longer than they had, I knew other little stuff so...If I find a nice flip chart, I'll e-mail to them or if I make up a little flip chart, which is like a PowerPoint but they call it a Flip Chart for the ACTIVboard. But, yeah, I knew a little more about it than the rest of them.*

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<sup>1</sup> The Criterion-Referenced Competency Tests (CRCT) are a set of tests administered at public schools in the state of Georgia that are designed to test the knowledge of first through eighth graders in mathematics, reading and other subjects.

When asked, "How long did it take you to get comfortable with that technology?" Jane said, "When I first got it, my first six weeks of using it was just trial and error. I went to a couple of staff development classes in my previous county, and those classes taught you a lot about it and just playing with it, you know, just having that time to sit there and play with it and read and see what all it had. I'd say a good nine weeks. By Christmas break, the first year I had it, I think I could do a whole lot with it but there is still some stuff I'm not sure exactly how to do."

When asked, "But you feel comfortable enough with it to incorporate it into your instruction?" Jane said, "Oh, yes." When asked, "Do you use it most every day or how often?" Jane responded, "I use it almost every single day." When asked, "And when you're not using that, then..." Jane said, "We're testing (laughs) or reviewing for a test. Even when we are reviewing for a test, I use it." When asked, "When you use...so individual students do not use the computer, but you all use it as a class? Jane said, "As a class, yeah. Well, they may use it if they want to take an accelerated test, that's on the computer. They have to do that individually, and I know that in the other classes, they take them to computer lab to type papers or do a little research but...I haven't personally in math taken my class as a whole yet to the computer lab."

When Jane was asked, "Are they allowed to use the calculator on the CRCT test?" her answer is no. When asked, "Has that always been the case?" Her response was, "No, I think special education kids, if it is stipulated in their IEP, then they may but I think it's a bunch of controversy going on with that now but no, regular education students don't use calculators. When asked, "And they will not use a calculator on that?" she said, "Um uh (no)." When asked, "So, does that motivate you, not to use a calculator in your teaching?" she responded, "That's why I don't use it." When asked, "That's the exact reason?" She answered, "That's the reason why I don't because I don't want them to be dependent upon the calculator and then they can't use it on the test."

When asked, "If you had a choice to teach something...if that test wasn't there, and you had the choice to teach other things, do you think you might include more technology in your teaching?" Jane said:

*Yeah, I probably would allow my students, if they ... knew how to correctly use a calculator, then I would allow them to use it. But in my past, I noticed that when you allow them to use it, a lot of them don't know the correct way to even enter in the information to get the right answer. So, that was in my previous years ... so that's one reason why I didn't mess with them.*

Then asked, "If you were going to allow students to use a calculator, how do you think that they would use them and what would be an advantage of using a calculator against not using a calculator?" at which time Jane answered, "I guess the advantage would be once they know how to actually solve that problem on paper, let's say it's a four or five digit multiplication problem, then it would eliminate that time from them multiplying...you know, we could get maybe some of the work done a lot faster."

She indicated that she would use the calculator as a time saver after students had already learned the process to solve the problem. She didn't think that she would ever let them use it when they are learning a new concept.

When asked, "Does the leadership here at the school, principal, assistant principal, the people that come to you with the plans that you are supposed to implement; do they promote the use of technology and do they have any particular view about technology?" Jane said, "My assistant principal loves these ACTIVboards. She's the main one, you know ... saying, "We've got to get them for these teachers, we've got to get them" so, yes, yes, I'd say definitely because she's striving and working hard trying to eventually get ACTIVboards for every single teacher here at the school."

The assistant principle was a "big" advocate of that type of technology. She was recently out of the classroom. She taught eighth-grade mathematics, and that was why Jane thought the sixth-grade mathematics teachers were the first to get the ACTIVboard technology. Jane said they used them on a daily basis and that was the main technology they used. It was adequate for her purposes.

When asked, "You're saying that there is no need to use a calculator because the students are not allowed to use them on the CRCT test?" Jane said, "That's my personal feeling. The other two teachers, especially the one on end, she allows her students to use calculators just because it saves a lot of time but ... I don't. I just don't want them to be handicapped by that calculator and then when it's time, and they perform, they can't because they are so dependent upon the calculator."

When asked, "How has the technology that you use changed what you do in the classroom from how you taught before you had it?" Jane explained how her teaching has evolved because of the integration of technology into her instruction.

*Before, I used my overhead projector all the time. Now, I probably don't even touch it much. I mean, I still instruct from the board but a lot of my instruction comes from the ACTIVboard, it's a time saver. Say, for example, if you did a lecture and we took notes, then if I put it on a flip chart, I wouldn't have*

*to write it four different times. I wouldn't have to get up there and write it four different times, I'd have it on a flip chart on a page, and I could just turn to that page, and it would save me a lot of time. Whereas before, you know, if you wrote on the chalkboard, you wrote it, the kids copied, you had to erase it and work out problems and then the next class you had to write it again, you know? It eliminates all that.*

When Jane was asked, "Do you have any directives coming from the administration as to how you should teach in the classroom?" her answer is no. When asked, "You pretty much can teach how you want to?" Jane said, "Yeah, I mean it's all about being an effective teacher. You know, they want you to be that effective teacher, and as long as you're doing what you need to do in the classroom, no, they do not come and say 'I want you to do this, this, this and that with your students.'"

### **Jane-Summary**

#### ***Instructional uses***

Jane uses technology in her classroom every day. She uses her ACTIVboard to pull up different mathematics sites and games and she, along with the class will play mathematics games on her PowerPoint that she uses through ACTIVboard. Anything that can be done on the computer, Jane can put up on the ACTIVboard and do it with the whole class. The ACTIVboard allows all of the students to be able to participate instead of each student having a computer. Whatever was on the computer would show on the screen, and there was a pen that allowed anyone to go to the screen and interact with it. Jane explains, "...it's as if they had their keyboard and they could tap and do the stuff with the pen, so I don't worry about having a computer for every single student." There were three computer labs within the school. Jane took her class to the lab once a week to do practice work for the CRCT; she explained: "We are going to the computer labs, but that's only to do some practice for their CRCT test online. But other than that, I use my ACTIVboard."

If she needed to work with manipulatives, to use some base ten blocks or fraction strips, she could pull them up on the ACTIVboard. Jane said: "...instead of getting them out and passing them out to ten or fifteen different students and they're playing with them. So, they can go up there, move the manipulatives on the board to solve the problem instead of passing out all of those manipulatives." She further notes that the program has a lot of different resources: "I can pull up a coordinate grid; I can pull up a number line, I can pull up a ruler, a protractor, a compass, and any manipulative you can think of."

#### ***Educator's proficiency***

Jane gives a good explanation of the professional development involved in the implementation of technology at her school. She explains it this way.

*Yeah. The other teachers went to a staff development on it, but I guess because I had been working with it a little longer than they have, I knew other little stuff so...If I find a nice flip chart, I'll email to them or if I make up a little flip chart, which is like a PowerPoint but they call it a Flip Chart for the ACTIVboard.*

#### ***System support***

Jane talks about the support of the administration in the implementation of technology. Her assistant principal loves these ACTIVboards and supports teachers using ACTIVboards. Her principal is very supportive as well.

### **Alice**

#### ***Appropriate use of technology***

When Alice was asked, "In your teaching, what do you think is the appropriate use of technology?" she gave me insight into what her conception of why we should take advantage of emerging technology. Technology can provide ways to give students visual stimulation as well as help them to learn in a variety of ways. Alice realizes that we have to teach through technology because "these kids need the visual stimulation and so I want my class up to date with technology, and I'm constantly asking the media specialist about sites I can go to or things I can do to make my class more up to date." She uses a computer to access educational resources and uses an interactive board to involve the class with interactive activities. Alice gives an example of how she uses computer technology in the classroom.

*If I want to go to just write on the board, I go to ActivStudio, the professional version of it and if I want a coordinate plane to use to teach maybe with the math lesson for that day, I can click on the coordinate plane tab and my whole board will be blue and white lines and it shows the x axis and y axis and I can teach using that and you can pull up your different backgrounds and things you need. It gives the kids another visual to use in the lesson. The old days, I would have to draw my x and y on the chart board and draw every line, and you know, plot my coordinates and then the next step we had, I had a poster board with the blue and white things on it. But now, all I've got to do with the ACTIVboard is clicking a button, and I've got my coordinate plane ready. And a ruler is on there; there's even a protractor on there, that's the seventh-grade standard so I'm not using it that much but there's a protractor, there are rulers, you can draw your angles in any shape you want. I mean, it's endless what it can do.*

When Alice was asked with "When you use it, does the administration require that or expect that or is it a decision that you. Here is her response:

*Oh, I'm sure it's a decision I'm making. I know that the administration and the Board members and the superintendent certainly would think that you were using it if they were spending that much money on it. So, yes, our administration is very in tune with technology, they are expecting us to use it, they are investing the money, they're looking for grants to get us the technology, and we're expected to use it and I see it as an improvement.*

One evening the board of education had a meeting in Alice's classroom. Alice along with the other sixth-grade teachers presented some things on the ACTIVboard, not just that you could use for math but they wanted them to see what you could for science and social studies and things like that, too. They presented those kinds of things to them. The teachers were successful in their presentation that night because the Board decided to adopt the ACTIVboard for science and social studies for the next school year. The goal is for everybody to get one in the school.

Also, Alice expressed how the sixth-grade teachers can use their computers along with the ACTIVboard to demonstrate lessons from the counselor. She explains how the computer can enhance communications with the counselor thus gaining administrative support.

When asked if she believed that the teachers and the district administrators agree with her view of how technology should be used in the classroom, and how it can help educators, she gave insight into how the technology was viewed in the school by teachers and administrators.

*The sixth-grade teachers are into it. I know that they agree with the way we use technology in the classroom. In fact, we have a meeting every week, and we bring in sites and our ideas for the whole online thing that we use quite a bit in class, things that we can use in our classroom because one teacher can't find everything to use. Now, the administrators, they are requesting that you turn in your content meeting sheets and concepts and the ideas that were discussed during that meeting so. ...I think they are on top of it, too. We probably just need to meet as a school more.*

When she used the technology, she used it through the computer basically and she felt that the students were more excited about learning, they could look at different views of a particular problem rather than if they just had the textbook.

When asked if she allows calculator use in your math class she responded this way; she expressed her conception of how the calculator should be used in the mathematics classroom. She also outlined how she disagrees with the State policy.

*Now I'm going to tell you. Georgia doesn't let our sixth grade students use calculators on the [CRCT] test unless they have an IEP statement that they can. I think that is wrong because not one part of our test is measuring computation. Our CRCT test is measuring concepts. If you understand the volume of a cylinder, if you understand how to find the surface area of a rectangular prism, okay? I can make sure my kids understand those concepts, but if I have a child that has a memory deficit and they cannot remember those multiplication tables and if I don't allow them to use a calculator in this classroom it holds them back. I think that's a mistake. I think the state of Georgia needs to let all sixth-grade students start using calculators in the sixth grade. I can understand not using them in K 5, "let's learn our basic facts, let's learn how to multiply, subtract, add, do concept problems and word problems without the use of a calculator" but when they get to sixth grade, it's time to pass out the calculators, allow every child to use the calculator and I think we can take math to new heights if the state would get away from the old way and say calculators are here, let's put them in their hands.*

Alice pointed out that when students went home and she went home, and there was mathematics to do, "...we're not going to sit there and do it the old fashion way, we're going to pull out a calculator to do it." She thinks that all sixth-grade students should have calculators. She expressed her disagreement with the calculator use policy by emphasizing, "Are we allowed to? No, but do I [use them in class]? Yes."

Alice tried to make time in her classroom for students to use calculators because she thought it was important that they understood a calculator, especially before they get to high school and they are expected to know how to work a scientific calculator. It will be a handicap if they have never had practice with a regular calculator. She had an inclusion class that includes children that had accommodations. The IEP allowed them to use a calculator. She had students that were on calculators and student that were not on calculators. The students using calculators had documentation stating they could use a calculator. It was not left to teachers which student could use calculators on the CRCT; it is not anything to do with the individual teacher, so they do not question the policy. The students and teachers know who is allowed to use a calculator on the test. She said, "... and it's no big deal, nobody even notices them anymore. I had to say that one or two times and that's it, it was over with, it was not an issue." She thought all students should use calculators and she tried to make time in her classroom for kids to use calculators during class time. When asked if she is a believer in calculator use in the mathematics classroom she expressed her belief in using that technology this way.

Alice believed in students using calculators starting in the sixth grade. She thinks calculators enhance their understanding and learning of concepts. The fact that they are not allowed to use calculators on the CRCT is not a rational policy. She believed calculator use in the classroom would not have a negative impact on their test result. Alice does not think that they will be hindered by using a calculator in class and then at test time. She said,

*The calculator didn't hold them back, they passed their benchmark test without a calculator, but they used a calculator in the classroom. I mean, our benchmark, we have benchmarks every four and a half weeks, and it is preparing them for the CRCT, and that's my proof that hey, they learned this task with the calculator but they took this benchmark without a calculator, and they still were able to do it.*

Alice finished the interview by expressing her desire for our children to exceed and to do well and she doesn't think they should be held back by outdated things and that we need to make changes in trends and look for technology and whatever we can to do to give our kids every benefit possible. "So that we won't just be thought of as a rural town, that we would have all these up to date things that a wealthier county might have."

### **Alice-Summary**

#### ***Instructional uses***

Alice uses the computer in combination with the ACTIVboard on a daily basis. She did not use her Whiteboard anymore because she used her ACTIVboard for her teaching and everything she wrote was on the ACTIVboard. She did mathematics on the Internet and in the computer lab with here students. Alice indicated that mathematics on the Internet and in the computer lab might be a form of play. She sometimes used the Internet and computer lab to reward students for good work. She also did activity days when she was ahead of the other sixth grade teachers in her lessons. She stated, "We were doing the math on the Internet and the computer lab playing that day." She also stated, "I try to use technology daily any way I can think of using it. ...I realize that we have to teach through technology because these kids need the visual stimulation and so I want my class up to date with technology."

#### ***Educators' proficiency***

Alice constantly consults with her librarian because she believed the librarian was more up to date on the new technologies. Alice wanted to see what she could do to make her class more up to date. The sixth-grade mathematics teachers had a meeting every week. In these meetings, they brought in Internet sites and their ideas. As Alice puts it, "In fact, we have a meeting every week, and we bring in sites and our ideas for the whole online thing that we use quite a bit in class, ...It's going to take teachers working together and collaborating and using what they find together. Our sixth-grade math teachers work well together."

#### ***System support***

Alice said that the administration, the Board members, and the superintendent believed that the sixth-grade teachers were using the computers and ACTIVboard technology because they were spending a great deal of money on it. Consequently, the Board of Education had its meeting in Alice's classroom so that the teachers could demonstrate the effectiveness of the technology. The Board adopted the ACTIVboard technology, so Alice believed that the sixth-grade teachers were successful in demonstrating the effectiveness of the ACTIVboard technology

when combined with the computer. Alice stated that because of their successful demonstration The Board decided to purchase the technology for the seventh and eighth-grade mathematics teachers. She emphasized, "But that's the goal-for everybody to get one in the school."

## Mary

### *Appropriate use of technology*

Mary has a view on the appropriate technology implementation for mathematics education. She does not use calculators in her instruction in sixth grade because she thinks students are still learning the basics. But she believed calculators should be used in seventh and eighth grades even though they were not used on the CRCT test. Her reason for allowing calculators in the seventh and eighth grade was because to use the calculator to do a problem "you have to know the steps." Another reason for allowing students to use them in the "higher levels" was to prepare them for high school where they use graphing calculators in some of the mathematics classes.

*Mary: I think calculators are good. We don't normally use calculators in sixth grade because students are still learning the basics, your addition, subtraction multiplication and division; we are still trying to work with them on that. We use them very little here in sixth grade. As far as seventh and eighth grade, I think they do need them even though they can't use them on the test. You have to know the steps to use the calculator anyway. You have to know the steps to work on a problem before you can use the calculator, so I do believe in letting the higher-level students, seventh and eighth grade use them. And then, also, it gets them prepared for using them in high school. Other things, computers, yeah, computers are good. A lot of the software that goes on the computer, they're good for extra work and also this year is the first year with the SMARTBoard, the kids enjoy the SMARTBoards.*

When Mary is asked, "Do you use the computer a lot?" Mary said, "Yes, I have mine on every day, we do warm ups and everything on them, and it gets the kids more involved."

When asked, "So, it is more or less like a demonstration?" Mary said, "Demonstration, yes, and then we got new textbooks this year, and we've got programs to go along with them. The kids can get up and go to the SMARTBoard; they enjoy just touching it and seeing what happens, they enjoy the sound, so it is real good for the kids to get involved."

When asked, "You don't use the computers at all in the classroom?" Mary said, "Yes, when we have them do projects ... more or less ... playing games or if we find a good website ... well, the computer ties into the SMARTBoard. We can bring things up on the computer, and it shows up on the SMARTBoard, and we can let them do work on the SMARTBoard from the computer. It works together."

To the question, "Do you believe that technology is beneficial to the students?" Mary responded, "Yes, right now, because this is just a different generation of kids now. I mean, they can't sit still for two minutes and so this is a way of getting them up and moving them around, getting them involved. They like video games; the computer is more like a video game to them, that's how they look at it. So, yes, computers and technology is very beneficial in a mathematics classroom."

When asked, "Do the principal, vice principal, Board of Education...do they support technology in any way you can think of?" Mary said,

*Oh, yes, oh, yes... right now they're writing all kinds of grants trying to get the SMARTBoards in all the classrooms. Sixth grade got them this year; seventh-grade math is going to get them next year. They started with the math department, and they are going to go with the science next and then implement language arts and social studies. So, they're trying to get all computers in all the rooms and SMARTBoards in all rooms. So, yeah, they are very supportive of the SMARTBoards and computers. We just got a new computer lab last year, and so we've got three computer labs that we can have access to.*

When asked about the other teachers at the school, whether they are enthusiastic about technology, computers, and if she hears negative or positive talk about using computers and calculators, Mary reported that she hears mostly positive comments about technology. She noted that the one negative was there are not enough computers in the classrooms. This was the only negative concern that she noted. This was what she said.

*Yes; mostly positive things about computers. The only thing is maybe in a classroom, you know, we only have like two computers in a classroom, that was the only negative thing I see about it but like I said, they just got a new computer lab and so now you have access, there are 30 computers in there and so it is enough for a whole class.*

Mary thinks that technology is the big thing now and it does help in the learning process and middle school. She can see the difference in some of her students. She puts it this way, "because everybody just can't do...a lot of them can't do book work, they have to get up and work for hands on, and so I can see that technology is a big help." She has some special education students that she has to let use the computer. Mary explains, "They know how to do the work but their problem solving or just regular computation, they can't multiply or divide but if you give them a calculator, they know how to do it on the calculator and so that helps them out." She thinks that technologies such as computers, SMARTBoards, and calculators are very important in a middle school setting.

### **Mary-Summary**

#### ***Instructional uses***

Mary thought that technology was "the big thing" and it did help in the learning process in middle school. She saw the difference in some of her students. She said "...because everybody just can't do...a lot of them can't do book work, they have to get up and work for hands on, and so I can see that technology is a big help." She had some special education students that she had to let use the computer. For other regular students, Mary explained that the students know how to do the work but their problem solving or just regular computation, they can't multiply or divide but if you give them a calculator, they know how to do it on the calculator, and so that helps them out. She thought that technology, all these computers, SMARTBoards, calculators are very important in a middle school setting.

#### ***Educators' proficiency***

Mary talked about how the computer and SMARTBoard worked in combination to engage the students. She explained,

*...if we find a good website...well, the computer ties into the SMARTBoard. We can bring things up on the computer, and it shows up on the SMARTBoard, and we can let them do work on the SMARTBoard from the computer. It works together.*

#### ***System support***

Mary outlined how the school system supported and was implementing technology in her school. She explained that they're trying to get all computers and SMARTBoards in all the rooms.

## **CROSS-CASE ANALYSIS OF THE TEACHERS**

The sixth-grade mathematics teachers at Coffee Middle School used the computer, in combination with the ACTIVboard / SMARTBoard daily. They did mathematics on the Internet and in the computer lab with their students. Anything that could be done on the computer could be placed on the ACTIVboard / SMARTBoard through the computer and teachers could thereby work with the entire class. The ACTIVboard/ SMARTBoard allowed all students in the class to participate without each student using a computer individually. All three teachers used the computer in their classroom this way. They used it in their lectures, and they let students come up to the board to demonstrate their understanding of concepts or to work problems. The teachers thought technology was the "big thing" and it did help in the learning process in middle school. The teachers thought that technology, computers, ACTIVboard/ SMARTBoard, and calculators, were very important in a middle school setting.

Mary had a view on appropriate technology implementation for mathematics education. She did not use calculators in her sixth-grade mathematics classroom because she thought her students were still learning the basics. However, she believed that calculator use was appropriate in middle school classrooms, but not appropriate in the sixth-grade classrooms except in some special cases. She had some special education students that she had to let use the calculator. She said that the special education students knew how to do the math on the calculator and so using the calculator helped them out with their math.

Alice tried to provide time in her classroom for students to use calculators because she believed it was important that they understood a calculator, especially before they get to high school when they are expected to know how to work a scientific calculator. She thought all students should use calculators and she tried to make time in her classroom for students to use calculators during class time. However, she spent time working on the basics during the first part of the school year at which time her students were not allowed to use calculators. Alice indicated that mathematics on the Internet and in the computer lab might be a form of play, but none of the other teachers mentioned the computer in that context. She sometimes used the Internet and computer lab to reward students for

good work. She also did activity days when she was ahead of the other sixth-grade mathematics teachers in her lessons.

Jane indicated that she would use the calculator as a time saver after students had learned the processes to solve the problems. She did not think that she would ever let students use the calculator when they are learning a new concept. The fact that students could not use calculators on the CRCT was a motivator for Jane not to let them use calculators in her classroom. She did not want students to become dependent upon the calculator and then not be able to use it on the CRCT.

The sixth-grade mathematics teachers at Coffee Middle School use the computer in combination with the ACTIVboard/SMARTBoard daily. All three teachers in the study used the computer in their classroom this way. They used it in their lectures while letting students come up to the board to demonstrate their understanding of concepts or to work problems. The teachers thought that technology was an absolute necessity to aid students in the learning process in middle school.

As for calculator use, the teachers were divided on the issue of whether calculators should be used in the sixth-grade mathematics classroom. Alice provided time in her classroom for students to use calculators because she believed it was important that they understood a calculator; especially before they get to high school when they are expected to know how to work a scientific calculator. Jane did not allow her students to use calculators in the classroom. She did not think that she would ever let students use the calculator when they were learning a new concept. The fact that students could not use calculators on the CRCT was a motivator for Jane not to let them use calculators in her classroom. She did not use calculators in her sixth-grade mathematics classroom because she thought her students were still learning the basics. However, she did believe that calculator use was appropriate in middle school classrooms, but not appropriate in the sixth-grade classrooms except in some special cases. Mary did not use calculators in her sixth-grade mathematics classroom because she thought her students were still learning the basics. However, she did believe that calculator use was appropriate in middle school classrooms, but not appropriate in the sixth-grade classrooms except in some special cases.

## FINDINGS

The major findings of this study are that teachers' conceptions of technology and school policy on technology, had an impact on technology implementation. The impact on technology implementation was largely affected by how the policy encouraged or discouraged the teachers in their efforts to use computing technology (computers and calculators) in their mathematics teaching.

Other findings indicate that participants' conceptions and understanding of computing technology's educational roles evolved from simple tools for productivity and motivation to diverse and advanced roles for learning concepts and developing thinking skills. Those findings are consistent with the results of the study carried out by Aydin, Mehmet and Vanderlinde (2016). They argued that the technology should be used for "instructional purposes, as a mediator of teaching and learning". The findings of this study also indicate that the participants' conceptions of technologies' educational roles, which are supported by district policy, are as: Simple tools for productivity and motivation, a medium through which concepts are learned and thinking skills are developed and tools to help develop critical concepts related to teaching with technology, including teachers' roles, pedagogy, and students' characteristics.

## DISCUSSIONS AND IMPLICATIONS

We propose future professional development and associated research that concentrates specifically on teachers who already commit to technology use in their classrooms such as the teachers at Coffee Middle School. The focus of such programs would be one of augmentation rather than initiation. To this end, more effort should be put into effective use and integration of technology into the mathematics classroom.

Only one of the three participants performs the role of "Leaner." In order for the benefit of new technological innovation to be realized, mathematics teachers need continuous and relevant training and support. As technology rapidly advances, this need will most likely continue. If teachers perceive that there is enough time for training or that the availability of technological resources is appropriate, they will make an effort to obtain the technology training they need and desire. Furthermore, there must be an obligation to plan and coordinate staff development in ways that will promote change in teacher practice.

Although much research has been documented on showing that teachers' conceptions (attitudes, belief, and preferences) are important, more should be done on how to encourage mathematics teachers to integrate computing technology into their teaching. Training should support the innovation of technology as a tool that makes teaching more efficient and not as just another layer in the curriculum.

Although all three participants are “Collaborators,” a mentor-supported model could be used for professional development in technology to enable teachers to receive the additional support they need to facilitate change when implementing new strategies. Research needs to be conducted over a longer period to check sustainability, as well as to investigate the types of follow-up support needed by teachers. The effective mentor-supported professional development could be successful in increasing the integration of technology in the mathematics classroom when the training is relevant and encourages the integration of technology into the curriculum.

None of the participants is “Facilitator.” Teachers should also help develop students’ abilities to use technology. As ongoing advances in computing technology occur, the implementation of this technology should be studied in efforts to achieve continuous improvements in technology implementation policy and mathematics education. The policy about the assessment plays a key role in whether technology is used in the classroom. This has verified that one of the six barriers categorized by Hew and Brush (2007). More research related to ways of improving administrators’ attitudes and beliefs in the area of computing technology implementation needs to be conducted. Teachers should be made aware of the technologies and software tools that are available to them and their students through mentoring and support during and following professional development.

## LIMITATIONS

This study was designed to gain insight into teachers’ and administrators’ conceptions of policy and its impact on technology implementation. It was a quest to determine what the policy is and to what extent the participants had embraced it. The analysis presented in this study did not offer a policy implementation model or make generalizations about the policy process or the technology implementation process in education. Neither did it explore the participants’ prior experiences that may have contributed to their conceptions. The study did not investigate the process of choosing hardware or software titles, the appropriateness of software titles, the teachers’ level of technology use ability or the teachers’ technology pedagogical knowledge for teaching mathematics. Rather, it presented an account of the understanding of technology policy “always under construction” and applied sense-making perspectives to the study of technology policy as a process.

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