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Research Article

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Exploring the effect of student-teaching on elementary student-teachers' math anxiety

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ABSTRACT

This mini-ethnographic study investigated the role of the student-teaching experience on removing student teachers' math anxiety. Data were collected from four elementary student teachers using semi-structured individual and group interviews during the second phase of their student-teaching period. Thematic content analysis was used to analyze data. The findings of this study showed that a productive and satisfactory student-teaching experience could remove student teachers' math anxiety. In addition, elementary student teachers' poor student-teaching experiences negatively affected their motivation in teaching. This study also found that the mentors' role was a vital part of student teachers' success. This study concludes that the teacher education department and the school district need to work collaboratively to develop every elementary teacher's math teaching skill.

Keywords: math anxiety, student-teaching, student teacher, mentor teacher

INTRODUCTION

Math is an essential part of daily life. Calculating time and money is a regular phenomenon in life. When someone buys something from the corner store, they need to count dimes and nickels. Even a cook needs math to mix the correct proportion of ingredients while making food. There is no engineer, scientist, or medical doctor without excellent math skills. Many people think that the most math they will need is for counting, but math is more than numbers and counting (Senor, 2019). Dunn (2019) argued that math develops one's problem-solving and critical thinking skills throughout life and that these math skills contribute to being good citizens who think rationally and logically. Therefore, math is needed for personal, professional, social, and civic lives.

Learning math skills at an early age is good for childhood development (Evans et al., 2015). In their longitudinal study, Evans et al. (2015) concluded that visual attention and decision-making skills are more advanced in children who achieve better math skills. Everyone wants their future generations to be good citizens and problem-solvers. Developing young people as inventors, scientists, and technology experts is a common expectation. The next generation cannot meet those expectations without a solid math foundation from elementary school. Only elementary teachers can form the children's future by giving them suitable math lessons. Since children start learning in elementary school, raising their math achievement in their early classes is of national importance (Outhwaite et al., 2019). Thus, "elementary math matters" as it gives children the foundation in math (Colgan, 2020). A solid bedrock in math from elementary school may provide children with a long-lasting and positive future trajectory (Gunderson et al., 2018).

Therefore, elementary teachers should show a positive attitude toward mathematics, as these early teachers can have a long-term effect on students' minds (Artemenko et al., 2021). Children often also consider these teachers as role models. Most students' future education is impacted by these teachers' motivation and attitude. Therefore, as Artemenko et al. (2021) found, if elementary school teachers are uncomfortable in teaching mathematics, it negatively affects students' math achievement. Many elementary in-service teachers have a high level of math anxiety, fearing both teaching and learning math (Ramirez et al., 2018; Szczygiel, 2020). The teachers' math anxiety negatively affects students' math achievement (Novak & Tassell, 2017). The result is that math is difficult and obscure for most elementary students (Dundar et al., 2014; Rudyanto & Ghufron, 2019; Sarabi & Gafoor, 2017) and "mathematics is like a lion" (Markovits & Forgasz, 2017) for them. This is evidenced in national tests: in 2019, only 41% of fourth-grade students passed math proficiency exam in the United States (National Assessment of Educational Progress [NAEP], n. d.).

Elementary in-service teachers' math anxiety negatively affects their students' learning outcomes in math. When these in-service teachers host elementary student teachers, they cannot guide them in teaching mathematics. In-service teachers' math anxiety also adversely impacts the experiences of student teachers, who are the mentees of those in-service teachers. Also, many

pre-service elementary teachers have math anxiety (Gonzalez-DeHass et al., 2017; Lorenzen, 2017; Morton & Dykeman, 2019). They try to avoid math, and often, so do their mentors. Thus, these student teachers complete their internship experience without proper coaching and guidance about teaching elementary school mathematics. They also continue to suffer from math phobia because the mentors have a long-lasting effect on the student teachers' in-service careers (Goldhaber et al., 2019). As the pre-service teachers move into full time teaching positions, they cannot show a positive attitude toward mathematics and struggle to motivate their students to learn mathematics. Furthermore, when they become mentors themselves, they cannot show math competency to their mentees. This cycle goes on and on.

The continual cycle of math anxiety between elementary in-service and pre-service teachers is a threat to math learning for elementary students. Thus, this study explored the student-teaching experiences of student teachers and how their student-teaching affected their math anxiety. Furthermore, this study observed how the mentors could play a role in removing student teachers' math anxiety. The findings of this study would be important for mentor teachers and teacher education programs to arrange fruitful teaching experiences that enhance elementary student teachers' math teaching skills.

THEORETICAL FRAMEWORK

The experiential learning theory (Kolb, 1984) is the only theory used in this study. Kolb's (1984) theory argues that experience provides better learning to the learners. Accordingly, when people have experience with a topic, it sticks on their mind, and they act following that experience. Kolb (1984) says that knowledge is created through the transformation of experience. When an individual grasps and transforms experience, that processes provide concrete knowledge. Kolb (1984) developed a four-cycle model for this theory to show how people learn. These cycles are, as follows: experiencing, reflecting, thinking, and acting. The first two cycles explain people's involvement in grasping and interpreting the experience. The last two steps illustrate how people transform their gained experience into action (**Figure 1**).

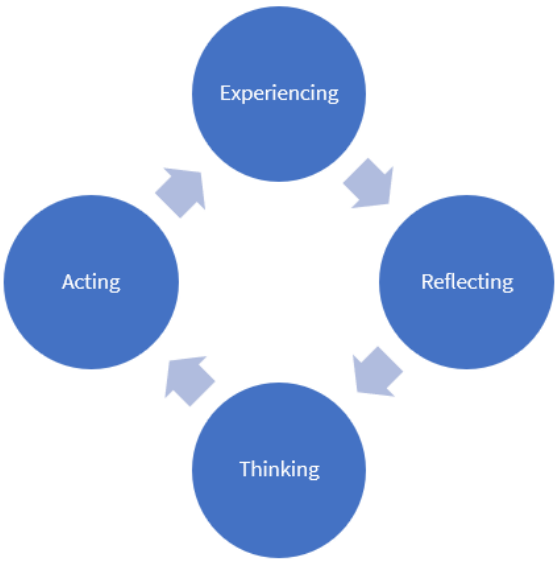

Figure 1. Kolb's (1984) experiential learning theory cycle

Student-teaching is a practical experience for prospective teacher candidates, and they learn by getting hands-on experience under the supervision of in-service teachers in a school setting. According to Uddin (2021), during student-teaching, a teacher candidate first observes their mentor's teaching; then they shadow the mentor; co-teach with the mentor; and eventually take more responsibility in teaching, planning, dealing with students, classroom management, and all other teaching-related activities. As such, the student teacher is entirely connected with Kolb's (1984) cycle of experiential learning. Specifically, first, they watch how their mentor teaches and then they reflect on their observations to prepare themselves for teaching. After that, they co-teach with the mentor. Before and after co-teaching, they think and about their grasped and reflected experience of observation and co-teaching along with the mentor's feedback. And lastly, when the student teacher takes full responsibility of teaching and teaching-related activities, they act based on their experience, reflection, and thinking: all parts of Kolb's (1984) experiential learning theory.

This study used the experiential learning theory as a lens to explore pre-service elementary school teachers' learning on teaching mathematics from their student-teaching experience watching their mentors' teaching, from practicing in the classroom under the supervision of their mentor, and from the mentor's feedback. This theory also guided this study to understand how the participants' math student-teaching experience helped them to be confident in math teaching.

Research Question

RQ: How does math student-teaching impact elementary student teachers' math anxiety?

METHOD

This study was a mini-, or focused, ethnography. Ethnography is a qualitative approach that studies culture to understand human behavior (Harwati, 2019). When an ethnography focuses on a narrow area of inquiry with limited time and money, it is a mini ethnography (Fusch et al., 2017). Similarly, White (2009) stated that an ethnography focusing on a specific area of investigation to explore the culture and interaction of people is a focused ethnography. This study qualifies as a mini- or focused ethnography for a few reasons. First, the area of this study was narrow as this study focused specifically on elementary math student-teaching, which is a small part of the elementary student-teaching experience. Second, this study followed only four student teachers from one university's elementary education program. Finally, this study collected data for 16 weeks. These limitations support the use of a mini- or focused ethnography.

Participants and Location

This study took place in a university located on the east coast of the United States. After getting IRB approval from the university, the researcher contacted student teachers who were in their Phase II of student-teaching. Only four participants from the elementary teacher education program agreed to be the participants. Three were female: Sara, Brea, and Kam (pseudonyms). The fourth participant was male, and his pseudonym is Mark. Sara, Brea, and Mark student taught at Hudson Elementary School (pseudonym), and Kam was placed at Potomac Elementary School (pseudonym). Sara was placed in fourth grade, Brea was in second grade, and Mark and Kam were in third grade. Sara and Brea did not like math; math was their least favorite subject to teach. However, Kam and Mark liked math, and math was their favorite subject.

Data Collection

13 semi-structured (DeJonckheere & Vaughn, 2019) individual interviews were conducted throughout the semester to collect data. Interview times varied from 30 to 40 minutes. A flexible interview protocol and supplemental follow-up questions based on participants' comments provided open-ended opportunities for participants to explore their thoughts, feelings, experiences, and beliefs. Also, three group interviews (at beginning, middle, and end of the semester) were conducted, and each group interview lasted over an hour. In the groups, the participants engaged in meaningful and interactive conversation with each me and each other. Zoom was used to conduct and record all individual and group interviews. The system also transcribed the recorded interviews.

Data were collected in fall 2020 during the COVID-19 pandemic. The school was physically closed, and student-teaching was virtual. Though the university approved my IRB proposal, the school district did not. School authorities did not allow access to their virtual classes for observation. Thus, data collection relied solely on interviews with the participant student teachers.

Data Analysis

An inductive approach for content analysis was used to analyzed data following its four steps (Bengtsson, 2016) to analyze the interviews and focus groups' data. The steps include: decontextualization (identifying meaning and creating code), recontextualization (comparing with the original data), categorization (identifying homogeneous groups), and completion (realistic conclusion). This analysis revealed the following final themes:

1. Student teachers' mixed attitudes toward math
2. Positive attitude toward math student-teaching
3. Unsatisfactory solo math teaching
4. Mentors' support in math student-teaching
5. Changed attitude toward math

Positionality

In qualitative research, a researcher's personal values might influence the data collection, data analysis, and presentation of results (Dean et al., 2017). The researcher had 20 years of K–12 teaching and administrative experience, including teaching high school math for 9 years. Currently, the researcher is working to develop K-12 teachers and administrators. So, he remained aware of his positionality while conducting this study and used his experiences as a resource to enrich this research process.

RESULTS

Student Teachers' Mixed Attitudes Toward Math

In the first individual interview with each participant, demographic information was collected. In that interview, they also shared their viewpoint and feelings about mathematics. Sara and Brea both had a negative attitude toward math, as math was their least favorite subject. On the other hand, Kam and Mark exhibited strong positive viewpoints about mathematics.

Sara said she did not like math because it was a complex subject for her. But she realized that she had a lack of math content knowledge and needed to learn it to teach elementary students. She said,

> "My favorite subject was social studies and history in K-12 because it was easier for me to remember dates and names. But I don't like math, physics, chemistry and so on. Math is a very complicated subject. Now, I have to work on it. I have to do

> some extra work for it. My counting is good in addition and subtraction, but I struggle with multiplication and division in most cases."

Similarly, Brea said she also did not like math, and it was not her favorite subject in K–12 as she did not have a good math teacher. She said,

> "My least favorite subjects in my K–12 were math and history because I didn't have the best teachers. The teachers I had were not very helpful or enthusiastic. They just made it difficult to learn. I had a literature teacher at high school who made the lesson fun. So, ELA [English language arts] is my favorite subject."

On the other hand, Kam shared a positive attitude toward mathematics and showed her enthusiasm for math; math was her favorite subject. Kam was good at math, and she loved it. She said that "Math was my favorite subject in my K–12. All my life, I have just realized that I've been naturally good at math. So, I genuinely enjoy doing it."

Mark also showed a strong positive attitude towards mathematics. He shared that he loved math, and he considered math as the most important subject for students. He said,

> "Mathematics is my favorite subject. I love math. I always have my math book with me, always put it in the car. It keeps me sharp. I love thinking math. These are numbers, and there's either a right way or a wrong way to do it. There is nothing in between."

These mixed attitudes reflect how impactful elementary experiences can be. Poor personal experiences learning math in school carried over into the student teachers' student-teaching. However, positive personal experiences helped the other two student teachers feel good about their ability to instruct.

Positive Attitude Toward Math Student-Teaching

At the first group interview with three participants (Sara, Brea, and Kam) and during the individual interview with Mark (he could not join the group, and interviewed later), the researcher asked them to talk about their attitude toward math student-teaching. They were also asked what their plan was for math during their student-teaching. Sara and Brea said that they had anxiety about teaching mathematics, but they wanted to learn how to teach mathematics during their student-teaching. On the contrary, Kam and Mark liked math, and math was their favorite subject. They were happy for the opportunity to sharpen their math skills during their student-teaching.

Sara shared her plan to gain math teaching skills from her phase II student-teaching. She explained,

> "I am not comfortable teaching math at all. I want to be more comfortable with it and other content-based subjects like social studies and science. So, my aim during the internship is to be more comfortable with teaching math; that's one I really need to focus on."

Brea echoed Sara and said she was not comfortable teaching math because she had math anxiety. She also planned to gain some math teaching skills from her phase II student-teaching. She said,

> "Math is giving me a little bit of anxiety. I am not sure if it is just for math as a whole. So, I want to be comfortable in teaching math. I want to make sure that I'm doing it accurately."

Kam shared her strong positive viewpoint toward math and talked about how she was helping others in her family in math. She shared her happiness about her phase II student-teaching because she was placed with a mentor who liked math and science:

> "I like math, and it's my favorite subject since elementary. Everyone in my family comes to me for math because they hate it. It's just amazing that now I am in math and science class with my current [phase II-mentor] teacher. I very much happy at this phase as opposed to my phase I [she only taught ELA in her phase I]."

Mark shared about his math teaching improvement from his math student-teaching his phase II class and mentor were the same as his phase I. He said that he was achieving more math skills that made him more comfortable in math. Mark stated,

> "I don't have anxiety teaching math by myself. I am getting more and more comfortable every day as I am teaching in the same class. Sometimes, she [mentor] does not show up while I teach. I do not look for her help during my teaching. I am becoming more and more comfortable in teaching math every day by myself."

The participants had a reasonable expectation of achieving math teaching skills from their phase II student-teaching: Sara and Brea, who had math anxiety, were eager to accomplish some math teaching skills; Kam was happy to have the opportunity to practice math in phase II as she did not have the chance in phase I; and Mark enjoyed his math teaching.

Unsatisfactory Solo Math Teaching

Brea, Kam, and Mark[1] was interviewed to explore their feelings, thoughts, and learning from their solo math teaching in their Phase II student-teaching.

[1] Sara was not interviewed about her solo math teaching because of a scheduling conflict.

Brea's math teaching

Brea taught the whole class in a second-grade class. The topic was introducing the number line and practicing skip counting. Brea shared her feelings about her first solo math teaching experience. She said she was not happy with her performance, explaining, "I was so unhappy because I missed the reality of this lesson as math lesson is scripted for us." She expressed her concern for the scripted math lesson as the lesson contained too many pages. According to her experience, she could not deal with the number of pages online and got frustrated. She said, "I was just very confused with the number of pages I have to maneuver back and forth. It was difficult for me following so many pages." Brea said that that situation continued to worsen until the end of the lesson, and she "just kept messing up."

Brea shared her understanding and her personal feedback about the lesson she taught. She understood the reasons for her bumbling throughout the class. She shared her "one small misstep" in dealing with many online manipulatives, and the number of pages started creating missteps, and it continued. She said, "This [one] little, tiny thing affected my whole lesson." Brea felt that if she could contribute to creating the lesson and would have had physical manipulatives, she could do better in teaching that lesson. She said, "If I would have actual manipulatives, then the transition would be smooth." Though Brea was not satisfied with herself during her teaching, her mentor reacted positively. Brea said,

> "But my mentor teacher says I do a good job . . . She gave me suggestions on some of the areas she said to improve, mainly just pacing and asking questions that will engage the whole group versus the individual."

Kam's math teaching

Kam did not have the opportunity to teach math in her phase I student-teaching. In phase II, she was with a different mentor teacher in another school. In phase II, she taught math for a few small group sessions. She shared that her first math teaching experience was not a good class for her. She was nervous. She said, "Honestly, I didn't do a perfect job. I was nervous in my first official math lesson of the semester." Kam explained that her challenge was to engage the students. Kam said she added Halloween to her math lesson to make it attractive to engage her students, but it did not work. She shared that getting responses from the students was the biggest struggling point. She said, "My biggest challenge was getting their responses. I was calling them by name, and nobody answered."

Kam understood that the virtual setting was an issue for her teaching. The students turned off their cameras, and they were muted. Kam said, "Every time. I asked a question. I got a very awkward silence." Therefore, Kam was frustrated. To overcome the challenges, she changed her approach to teaching. She said, "Instead of lecturing and asking them questions, I turned it into a game, and then everything just changed." She then found her students were engaged, and they were happy. She said, "My students were so glad, and I asked to know how did they feel about the class. They replied that they liked the game." Kam shared her learning from that lesson and said she needed to add games to her math lessons to make them fun for the students. Her mentor gave her constructive feedback and suggestions. Kam said, "She [mentor] told me what I did wrong and where I did great."

Mark's math teaching

Mark liked math, and he was practicing math in both phases I and II of his student-teaching under the same mentor and in the same class. In the conversation with Mark about his solo math teaching, he shared a positive experience. He said, "I taught calendar math today, and I feel great about the lesson as I know they [they students] walked away with useful knowledge." He said he made the students happy, and he played a movie at the end of the class. It was a fun class for the students. He also shared that he faced some challenges in conducting the class. Engaging students in learning activities virtually was a major challenge for him. In the virtual setting, he had less control over the class, which created a challenge. He said, "It is tough to control students' behavior virtually and engage them in the lesson. I have to back and forth to the other screen for the large group."

Mark talked about what he learned from the class, saying that the teachers needed to keep the students engaged at all times. He felt that he needed some strategies to keep the students happy and engaged. He shared, "I have to make funny faces and [ask] funny questions. I have to make me the focus of the class for the entire eight hours online." Mark's mentor observed his class, but did not give him feedback right away after the class. He expected to get the mentor's feedback through email later. He said, "She [mentor] has two kids. So, I will probably have her feedback sometime in the evening. You know it's normally in the form of an email."

Overall, the participants did not have a good math student-teaching experience. They all faced some challenges conducting math virtually. Though Kam and Mark like math, they could not engage their students in online math class.

Mentors' Support in Math Student-Teaching

As the individual and group interviews progressed, the participants shared how they were improving in math teaching. Their mentors were supportive and provided regular feedback to them. Their mentors also guided them in achieving math teaching skills.

Sara was comfortable in teaching ELA and did not like to teach math. However, her mentor was supportive and motivated her to practice math along with other elementary subjects. Sara explained, "I told her [mentor] I am comfortable doing ELA. But she told me to learn how to do them all. She pushes me to do math like actually doing the math lesson." Her mentor teachers also showed her how to make the scripted math lesson suitable for the students: "She [mentor] told me to add questions in the slide, like showing how many different ways to get into this math problem." Sara's mentor guided her regularly from the beginning when she needed help. She related that "My first math class was like pulling teeth with them [students]. She [mentor] told me I was

nervous and gave me tips." At the end of the student-teaching, Sara was confident in math teaching. She said, "My math teaching definitely got better, and I got improvement my math teaching only for my mentor."

Similarly, Brea also had math anxiety and preferred to teach ELA, but her mentor teacher was supportive and helpful, helping her in shaping the scripted lesson plan and guiding her on how to conduct math classes. Brea said, "My mentor teacher was very supportive. She offered her help always like what I should do, how I can do better in math." Brea's mentor also gave her constructive feedback both formally and informally. She said, "Whenever I taught, she gave me feedback on just how it went and how I could do it better." Brea was happy with her mentor as she got tremendous support. She explained, "It's amazing that I have a good relationship with my mentor, but had I not, I would be completely lost. I wouldn't have anybody to lean on." At last, Brea gained confidence in teaching math. She said, "I could definitely see a lot of growth in math teaching from our first conversation when you first interviewed me. Now I can teach math."

Mark had a different kind of positive student-teaching experience with math. He liked math, and math was his favorite subject. But his mentor did not like math, and she allowed Mark to conduct more math classes. Mark said, "My mentor does not like math, and she wants me to teach it." Therefore, Mark got the opportunity to practice teaching more math classes. The mentor suggested that he edit the pre-prepared math lesson plan to make it appropriate for the class. Mark's mentor also guided him to learn all teaching-related activities. Mark said, "My mentor is like a guide showing me through the process of teaching." Mark was very impressed with his mentor's help and said, "She has become more than a mentor." Mark utilized these opportunities and achieved more math teaching knowledge. At last, he said, "It was really a great experience practicing more and more math classes this fall. I got more comfortable with teaching math."

Kam, who also loves math like Mark, went into student-teaching with the hope to practice math teaching. She said, "Math was never a challenging subject for me. So, I just wanted to practice something that I like, and definitely, it was teaching math." But she did not have the opportunity to practice math in her Phase I as her mentor did not allow her to teach subjects other than ELA. In Phase II, she was with a different mentor in a different school. She was happy that her new mentor was a STEM person. She said, "I got ELA classes in my Phase I. In Phase II, I am in math class, and I am also in science class." Kam was happy with her new mentor, and she had an excellent relationship with her mentor. Kam said, "The only person I have a relationship with within my new school is my mentor teacher. I literally have a very strong relationship with my mentor." Yet her relationship did not give her the experience she was looking for. Kam taught only a few small group instructions for math. In the last focus group interview, she expressed her frustration that her mentor did not give her a chance to teach math. She said, "It makes me upset that I didn't really get to do with math teaching, just observing it being taught. She [mentor] told me, 'okay, you have to teach science classes.'"

These responses show that mentors clearly affect student teachers' experiences. Sara and Brea had math anxiety and were nervous about teaching mathematics. However, their mentors motivated them to learn math teaching. They followed their mentors, and they said that they were feeling confident in teaching math. Similarly, Mark, who liked math, had the opportunity to practice more math classes than any other subject. He was highly confident about teaching math. However, Kam did not have a chance to practice teaching math as her mentors did not allow her.

Changed Attitude Toward Math

In the last week of the participants' phase II student-teaching, a group interview was conducted. In that focus group, they shared that they had learned and practiced mathematics throughout the semester, which changed their attitude toward the subject.

Sara, who had math anxiety, said that her student-teaching and her mentor helped her achieve some math teaching skills. She shared that her student-teaching had a positive effect on her attitude toward math. She said, "My attitude did change overall. Now I definitely feel comfortable in some points, especially multiplication and division. I definitely feel better from my past position." Similarly, Brea, who also had math anxiety, shared a changed attitude toward math. She was also positive, like Sara. Brea said, "I definitely got learning in teaching math. I gained a lot more math understanding to go over my fear in teaching math. I was really nervous. Now, I definitely see a change from my first conversation to now."

Mark's experience was also positive in his math student-teaching. Mark was good at math, and math was his favorite subject. He shared that he enjoyed teaching math in his student-teaching. He was learning every day by teaching math during Phase II. He said, "As time progressed, I felt more comfortable and confident teaching math."

However, Kam, who liked math, hoped to sharpen her math teaching skills from her student-teaching, but she did not have the opportunity to teach math. She said, "I did not teach math at all. That upset me severely because I am literally good at math." Kam's unsatisfactory math student-teaching experience did not improve her math teaching capability.

In sum, Sara and Brea had math anxiety, and they did not like math at all when they began their student-teaching. In the first group interview, they shared that they were not comfortable teaching math. However, in the last group interview, they expressed their achievement in math teaching skills. They were happy and confident in math. Student-teaching also made Mark happy as he practiced enough math classes. However, Kam did not have the chance to improve her math teaching skills.

DISCUSSION

This study intended to explore how math student-teaching experiences impacted elementary student teachers' math anxiety. There were four elementary student teachers in this study as participants. Among them, Sara had math anxiety. She did not like math. Even during her student-teaching, she was not interested in math. She was placed in fourth grade for her student-teaching, and she did not know how to teach multiplication and division. She knew that she had to teach multi-step word problems in fourth

grade, where she needed multiplication and division. She realized her lack of content knowledge could not satisfy her students' needs. According to Reid and Reid (2017), teachers need solid math content knowledge to support students to learn math. Sara understood her lack of math content knowledge and confessed her stress about teaching math. She said, "My first math class was like pulling teeth with them [students]." She did not have enough math content knowledge, and it created stress for her.

Sara's mentor knew that she needed to teach all elementary subjects in the classroom. The mentor motivated Sara to practice math. Sara said, "She [mentor] pushes me to do the math." Her mentor also helped her to achieve some math teaching skills. The mentor guided her on how to prepare a math lesson plan. Her mentor gave her a good experience of learning throughout the semester, engaging Sara in learning math content and pedagogy. The mentor regularly gave her informal feedback. Sara always had a conversation with her mentor before school started to talk about her planning. Then again, after the school hour, she and her mentor had another discussion, which the mentor used to show her strength and weaknesses and gave her suggestions. Those conversations helped her in reflecting and thinking for preparation for the next math teaching. Wexler (2020) said that mentor teachers had a positive role in developing student teachers' teaching skills. Similarly, Sara's mentor engaged her in practicing math teaching, and it brought a positive result. At the last focus group, Sara said, "I definitely feel comfortable in some points, especially multiplication and division." Thus, from her student-teaching experience, she learned math content and pedagogical knowledge, which gave her confidence in math teaching. She said that her math teaching was better than her first teaching.

Similarly, Brea also had math anxiety, and she was placed in second grade in her student-teaching. Her math anxiety started during her elementary school experience. She said she did not have a math teacher who could motivate her to learn math in K–12. Therefore, she did have not enough of a foundation in math to teach. Rafiepour et al. (2019) found that math teachers' content and pedagogical knowledge are closely connected. The authors also said that without enough math content knowledge, teachers could not apply appropriate math pedagogy in the classroom. Brea's first solo math teaching was not positive. She was unorganized and confused. This happened because of her lack of math content knowledge. Therefore, lack of and fear of math content knowledge created a fear while teaching math, and she said, "I just kept messing up."

Additionally, scripted math lesson plans were also an issue for Brea while teaching. She could not cope with the scripted lesson plan. However, Brea's mentor was supportive of her. The mentor guided her to follow the lesson plan and engaged her in hand-on experience in shaping the lesson plans. Kang and Battey (2017) said that when mentors provide constructive feedback and allow student teachers to practice teaching, it helps the student teachers achieve necessary teaching skills. Brea also had a similar opportunity from her mentor. The mentor always gave her constructive feedback. Brea said that her mentor guided her, like "What I should do, how I can do better in math." The mentor's support and guidance helped Brea to achieve math teaching skills and made her confident. In the last interview, she said, "I definitely got learning in teaching math. Now I see a change from my first conversation to now."

Mark formed a math identity in his student-teaching through his continuous math teaching experience. His mentor did not like to teach math and opened an opportunity for him to teach it. As a result, Mark conducted math classes every school day during his Phase I and Phase II student-teaching. Peterson and Leatham (2018) said that when student teachers focused on mathematics and had more practice with math, they improved their math skills. This happened to Mark. More and more math teaching experience throughout the school year made him confident in math teaching. The mentor did not interfere with Mark. As a mentee, Mark explored various math pedagogies in his math teaching and led his own learning. Mark reflected and thought about his own teaching experience and tried to do better in his next class. His own-paced math teaching experience made him more confident in teaching mathematics. His math teaching performances also impressed the school administration, and he was hired in that school before his graduation.

However, Kam, who liked math, could not practice math in her phase I or phase II student-teaching. In phase I, her mentor forced her to teach only ELA, and in phase II, her other mentor asked her to teach only science. Kam led only a few small group math instructions, and that is the only math student-teaching experience she had. Soslau et al. (2019) found that student teachers do not recognize themselves as learning agents, but they rely on their mentors. Similarly, Kam's student-teaching relied on her mentors. The mentors did not involve her in practicing math teaching. As an elementary student teacher, she was supposed to practice all elementary subjects, but Kam did not have that opportunity. Her student-teaching did not improve her math skills. Instead, she lost her motivation to teach. She said, "It is not like the experience that works."

Kam's mentors did not give her a satisfactory math student-teaching experience, and there was no conversation between Kam and her mentors regarding her math teaching. Additionally, no university supervisors visited her class during her phase I and phase II student-teaching. As she said, "I have yet to be observed by any supervisor. I've never seen anybody in my class from my department. I've taught numerous times, and no one has ever come." Her mentors gave her a good experience in other subjects, but not in math, which she liked. She did not have hands-on experience teaching mathematics, and it negatively affected her learning how to teach math. That inadequate math teaching experience did not help her to reflect and think about teaching mathematics. Kolb's (1984) four cycle of experiential learning did not happen in her student-teaching, specifically for teaching mathematics.

In sum, this study found that math student-teaching for elementary student teachers profoundly impacted removing student teachers' math anxiety and developing their math teaching skills. Kang and Battey (2017) said that the mentor teacher's role was vital for the elementary student teacher to form a math identity. The mentor's constructive, specific, and timely feedback are essential. Kang and Battey (2017) added that mentor teachers need to create the opportunity for elementary student teachers to practice math teaching. Sara and Brea, who had math anxiety, had mentors who gave them the opportunity to practice math. The mentors guided them, and they had regular constructive conversations with their mentors about their math teaching. Thus, the student teachers reflected and thought about their experiences and practiced. Thus, they achieved math skills, and it removed their math anxiety. Similarly, Mark also led his own learning, reflecting, and thinking about his experiences as the mentor gave

him freedom in his teaching. Then Mark became more confident in teaching math. On the other hand, Kam's math student-teaching experience was substandard as she did not have the opportunity to go through Kolb's (1984) four cycles of experiential learning in math. Kam's lack of experiential learning gave her a negative impact in math teaching and toward the teaching profession overall.

CONCLUSION

The findings of this study show that three out of four participants were not prepared enough to teach mathematics in the elementary classroom. As in-service teachers, they cannot avoid math as they need to teach all subjects in their elementary classroom. In the school district where my participants did their internship, elementary teachers are grade-level teachers; in other words, one teacher teaches all elementary subjects in their class. So, an elementary teacher must have the necessary content and pedagogy skills in four basic elementary subjects (i.e., math, ELA, science, and social studies). Their lack of math content and pedagogical knowledge negatively impacts their students' math learning. Even in-service elementary teachers have math anxiety. As a result, elementary students in the United States do not gain sufficient math knowledge. These students also suffer in math in their next level of education and international math competitions.

Elementary teachers' math anxiety negatively affects their students' math learning. As a result, the students of the United States are not doing well in math and science compared to other developed countries. The trend in international mathematics and science studies (TIMSS) is an international math and science competition for the fourth and eighth grade students of developed countries held every four years. Their results show that United States' students are never top ranked among the participating countries (Mullis et al., 2012; International Association for the Evaluation of Educational Achievement [IEA], 2015, 2019). United States students' weaknesses in math negatively impact the STEM field. Thus, the U.S. hires thousands of information technology experts, engineers, and medical doctors from abroad every year. U.S. domestic schools cannot produce enough skilled individuals in STEM because of students' lack of math skills.

Therefore, to enhance elementary teachers' math teaching skills, teacher education department needs to look for ways to do so as the department develops pre-service teachers into licensed teachers. Teacher education departments need to find ways to build up their pre-service teachers' math content and pedagogy skills. Mathematics methods professors should have up-to-date knowledge of the elementary math curriculum and in-service teachers' teaching methodologies. My participants shared the gap between the learning in the math methods courses and their mentors' approaches. They found little connection between the pedagogy they learned in the math methods courses and pedagogy their mentors applied in the classroom. Thus, math methods professors need to form a connection between the pedagogy taught in the college classroom and their hands-on application in the elementary classroom. For example, methods professors may invite the mentors as guest speakers in their classes. The methods professors also could visit the student-teaching and have the practical experience of an elementary math classroom. This communication and cooperation between the mentors and methods professors may positively impact pre-service teachers' math content and pedagogical learning.

Research says low confidence is a barrier to math learning (Soysal et al., 2022). So, the methods professors should find ways how to develop student teachers' confidence in math in their math methods courses through more hands-on activities. The math methods professor may consider problem-solving approaches in the math methods courses than heavily focusing on math content to enhance prospective teachers' efficacy (Ersozlu et al., 2022a). The problem-solving practices may also enhance their pedagogical skills. Individual preservice teachers might have different types of math anxiety (Ersozlu et al., 2022b) So, the methods professors need to discover the reason and could intervene with appropriate remedies with one-to-one coaching or group activities.

Faculty supervisors may connect the mentor teachers and methods professors. The faculty supervisors may visit more math classes and can share with the methods professors. If the faculty supervisors do not have math skills, the department may manage math experts as faculty supervisors. The teacher education department may recruit doctoral students as graduate assistants from their university's mathematics education doctoral program and engage them as field supervisors for the elementary pre-service teachers' internship. The graduate assistant can observe mentors' math teaching, support teacher candidates in their internship, and work with the math methods professors in the college classroom. These activities will help the intern have a better math student-teaching experience and boost the doctoral candidates' practical math learning.

School districts should also work collaboratively with the teacher education department as the school district have to provide effective teachers to their students. The school district may connect their mentor teachers with the methods professors to work collaboratively to develop pre-service teachers. The school district may cooperate with the methods professors by providing up-to-date math curricula and other necessary information that will be helpful for the math methods professors to prepare their pre-service teachers to meet the school district's demands. The school district may cooperate in arranging the methods professors' and pre-service teachers' visits to the elementary classrooms. The school district and the teacher education department may organize professional development programs for the mentors and the methods professors. The collaboration between the school district and the teacher education department will eventually benefit the elementary students, which is so desperately needed.

Significance

The findings of this study would be practical for the elementary teacher education programs to redesign their prospective teacher candidates' student teaching arrangement. The findings could be a wake-up call for the teacher education department to communicate better with the host schools and the mentors with departmental expectations of the student teaching. The math

methods professors could find this study useful to connect mentor teachers with math methods classes that could positively impact mentors' math content and pedagogy. The host schools and school districts could also find this study beneficial to provide the student teachers with the necessary support to have successful student teaching as these teachers might feel the school vacancies.

Limitations

This study had a few limitations. First, the data is from only one source and one perspective: the pre-service teachers. Second, the participants' classes were not observed due to COVID restrictions. Also, the mentor's voice was absent in this study. Finally, mentors' written feedback was also not reviewed.

Scope for Future Study

This study raises some questions that can be investigated in the future. First, a study could be conducted to examine elementary student teachers' math anxiety levels their connection more closely with their K–12 education. Second, a future study can be conducted to explore how the mentor's feedback and guidance can help the student teacher in achieving adaptive competency for math teaching. A further study can be conducted to explore how the college classroom in the teacher education program can remove pre-service teachers' math anxiety.

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