Lebanese Pre-service Teachers' Dispositions and Efficacy Beliefs in an Early Years Mathematics Methods Course

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With the growing emphasis on early mathematics education, it is imperative to explore the preparedness of early years mathematics pre-service teachers in relation to content knowledge, beliefs, and dispositions. Therefore, this mixed-methods study explored Lebanese pre-service teachers' mathematics dispositions and efficacy beliefs in the context of a mathematics methods course. The sample comprised of 11 pre-service teachers who completed a survey prior to and after completing the methods course. Additionally, they each participated in a semi-structured interview shortly after beginning the course. Results revealed pre-service teachers had the most positive beliefs with regards to how mathematics is learned, the nature and usefulness of mathematics, and personal teaching efficacy. Following the course, statistically significant differences were observed with regards to how mathematics is learned, personal teaching efficacy beliefs, and general teaching efficacy beliefs. Practical implications include the importance of subject-specific mathematics methods courses for teachers of younger children, as well as supporting the development of pre-service teachers' conceptual mathematical understanding prior to entering the profession.

Keywords• mathematics teacher education research•teacher beliefs•Lebanon•early years mathematics

Introduction

In recent years, there has been a growing emphasis on early mathematics education (e.g., Fuson et al., 2015). As a result, many educators are shifting their focus to establishing a strong mathematics base during students' earlier years of education (Ashbrook, 2019), providing a foundation on which future understanding can be built. An early foundation is especially important in mathematics as mathematics knowledge begins to form at an early age (Ashbrook, 2019; Rittle-Johnson et al., 2019).

Given the importance of early exposure to mathematics, a great responsibility falls to teachers of young children to ensure they develop a strong foundation of mathematics knowledge (National Council of Teachers of Mathematics [NCTM], 2013). The significance of teacher preparedness is heightened given results from prior research that reveal shortcomings in mathematics content knowledge among some pre-service teachers who graduated from teacher education programs that did not explicitly address these potential gaps (Norton, 2019). This further highlights the importance of appropriate university coursework, such as content-specific methods courses, for promoting teacher preparedness.

With the anxiety and low self-confidence that many teachers feel about teaching mathematics to young children (McClure et al., 2017; Pelkowski et al., 2019), it becomes important to not only equip pre-service teachers with the strategies and knowledge they need to teach mathematics, but also to ensure they have the appropriate dispositions and self-efficacy beliefs to do so effectively. This is especially critical given the relationship between teaching self-efficacy beliefs and a teacher's effort in the classroom, goals, and aspirations (Gresham & Burleigh, 2019; MacDonald, 2020; Tschannen-Moran & Hoy, 2001; Twohill et al., 2022).

In Lebanon, given differences in university coursework between pre-service teachers for elementary mathematics and secondary mathematics (Younes, 2013), pre-service teacher dispositions and efficacy beliefs may reasonably differ across age groups. The resulting dispositions and efficacy beliefs continue

to impact methods of teaching, with traditional teacher-centered instruction persisting as the norm in Lebanese mathematics classrooms (Hajal, 2019).

Currently, there is limited research on early years mathematics pre-service teacher preparation (Tippet & Milford, 2017), especially as related to pre-service teacher dispositions and efficacy beliefs for teaching mathematics in Lebanon. Therefore, to help fill this gap in the literature and provide additional guidance on how best to prepare early years mathematics teachers in Lebanon for the profession, the present study was guided by the following two research questions:

1. What are Lebanese pre-service teachers' dispositions and efficacy beliefs prior to completing a methods course for teaching mathematics?
2. To what extent do Lebanese pre-service teachers' dispositions and efficacy beliefs change after completing a methods course for teaching mathematics?

Review of Relevant Literature

In this paper, foundational years will be used to denote the early elementary years of education (i.e., grades one through three, students aged 6 to 8 years). Topics in the foundational years of mathematics are often divided into the following six domains: numbers and counting, calculations, spatial awareness, patterns, measurement, and shapes (Parlakian, 2018). The following sections present a survey of the literature on mathematics in the foundational years and the complexity of mathematics teacher preparation, particularly the need to foster pre-service teachers' dispositions and self-efficacy beliefs.

Mathematics in the Foundational Years

Some researchers have indicated that students have a readiness for learning mathematics from a young age (DeJarnette, 2018; Hachey, 2013; McClure et al., 2017). For young children, early exposure to mathematics is not only predictive of future success in mathematics (Hardy & Hemmeter, 2019; Pelkowski et al., 2019), but it has also been shown to positively impact their perceptions of and dispositions towards STEM (DeJarnette, 2018). Indeed, as early as pre-kindergarten (students aged 3 to 4 years), students have demonstrated engagement with STEM-based topics, including mathematics (Tippet & Milford, 2017).

Despite the importance of mathematics learning opportunities for young children, mathematics instruction should not rely on traditional methods of drilling and memorisation (Hachey, 2013). Instead, effective learning opportunities should involve active engagement, making connections among disciplines and to the real world, and encouraging the use of and exposure to appropriate mathematics vocabulary in authentic contexts (Fuson et al., 2015; McClure et al., 2017; NCTM, 2013; Parlakian, 2018; Pelkowski et al., 2019; Stites & Brown, 2019).

Mathematics Teacher Preparation

Researchers have noted the need for greater teacher preparation in order to effectively teach mathematics to young children (Hachey, 2013). Teachers themselves have sometimes noted their own need for more preparation to teach STEM domains, such as mathematics (Jamil et al., 2018). The task of preparing teachers—particularly pre-service teachers—for mathematics instruction is made more complex due to the need for teacher educators to cover all stages of teaching and learning, from translating curricula for the development of mathematics lessons (Earnest & Amador, 2019) to effectively assessing students' mathematics learning (Chen et al., 2014).

Additionally, because mathematics understanding is often separated into procedural knowledge and conceptual knowledge, pre-service teachers are responsible for knowing how to communicate both modes of knowledge, although conceptual knowledge has gained greater international emphasis in recent years (Herppich & Wittwer, 2018). In a previous study, pre-service teachers recognised the distinction between mathematics conceptual knowledge and procedural knowledge; for example, they knew not to automatically attribute conceptual knowledge to a student who solved a problem correctly (Herppich & Wittwer, 2018). However, for pre-service teachers who were not taught mathematics

conceptual knowledge when they were students, it may be more difficult to design and implement instruction in ways beyond how they themselves were taught mathematics (Fuson et al., 2015).

Mathematics Teacher Preparation in Lebanon

Pre-service teachers' preparation for and beliefs about teaching mathematics have been shown to vary depending on the country (e.g., Isiksal et al., 2009). In Lebanon, although teacher education programs reportedly employ some student-centered methods of instruction to prepare pre-service teachers, learning activities generally lack opportunities for experiencing practical instructional teaching methods, such as collaboration and hands-on learning activities (Osta, 2012). The impact of this lack of opportunities to learn by doing can be observed in how pre-service teachers later approach their own instruction when they make the transition to novice teachers. Specifically, in Lebanon, there exists an observable need to prepare pre-service teachers to depart from traditional methods of instruction and adopt more constructivist and student-centered approaches in the classroom (Hajal, 2019; Nasser, 2005; Younes, 2013). This transition becomes more critical in mathematics classrooms given the importance of such student-centered teaching methods for foundational years mathematics learning (Fuson et al., 2015).

With regards to mathematics content knowledge of pre-service teachers in Lebanon, it is likely to differ depending on the age group they are teaching. Given the structure of teacher education in Lebanon, the majority of elementary mathematics pre-service teachers do not pursue a mathematics degree, whereas secondary mathematics pre-service teachers do (Younes, 2013). Indeed, in a previous study, researchers found that among a sample of 467 secondary mathematics teachers throughout Lebanon, approximately 85% held either a bachelor's or master's degree in mathematics and 13% held a master's in education or in mathematics education (Anouti & Rouadi, 2018). As a result, secondary mathematics teachers in Lebanon may be viewed more as mathematics subject experts and elementary mathematics teachers are more likely to be viewed as education experts. As a consequence, their respective coursework differs accordingly. The lack of intensive mathematics coursework for elementary mathematics pre-service teachers can impact their mathematics instruction. In a study of elementary teachers in Lebanon, results revealed a greater tendency to teach with procedural problem-solving techniques than conceptual learning strategies (Chahine & King, 2011).

Mathematics Beliefs During Teacher Preparation

Effective teacher preparedness moves beyond the development of content and pedagogical knowledge to encompass fostering pre-service teachers' dispositions and self-efficacy beliefs. International interest in teachers' self-efficacy beliefs, whether general or subject specific, has been high on the research agenda with a rapidly growing body of work currently available (MacDonald, 2020; Twohill et al., 2022). Common among their findings is the importance of efficacy beliefs in guiding the application of teachers' professional knowledge in the context of classroom teaching and thereby likely to have a profound influence on students' learning and achievement (Gresham & Burleigh, 2019; Twohill et al., 2022). For the present study, dispositions are defined as subjective beliefs based an individual's values, attitudes, and experiences (Cruz et al., 2019). Efficacy beliefs are defined as the belief in an individual's ability to execute a desired behaviour (Bandura, 1977). More specifically, teaching efficacy beliefs are defined as the belief that an individual can effectively teach even the most unmotivated student (Aloe et al., 2014). According to Twohill et al (2022), the importance of efficacy beliefs lies in the outcomes they produce for teachers and learners. They define teacher efficacy as "a teacher's sense of ability to organize and execute teaching that promotes learning … and therefore, mathematics teaching efficacy is taken to be a teacher's perceptions about their own effectiveness to organize and execute teaching that promotes mathematics learning" (p. 3).

Conceptual Framework for Mathematics Teachers' Beliefs

For the present study, we adopted the conceptual framework posited by Cruz et al. (2019), in which mathematics teachers' beliefs are noted to include two important factors: mathematics dispositions, and efficacy for teaching mathematics. The first factor can be further broken into the following three constructs: (1) Nature and Usefulness of Mathematics, or one's beliefs about the general nature of mathematics and how useful it is, (2) Learning of Mathematics, or beliefs about how individuals best learn mathematics, and (3) Perseverance in Mathematics, or beliefs about one's own ability to persevere in mathematics and potential to solve even challenging mathematics problems. The second factor, efficacy beliefs, can be separated into the following two constructs: (1) Personal Teaching Efficacy, or beliefs about one's own efficacy for teaching mathematics, and (2) General Teaching Efficacy, or beliefs about teachers' general efficacy for teaching mathematics. Both of these factors—dispositions and efficacy beliefs—play a significant role in how teachers fulfill their responsibilities and, consequently, students' achievement outcomes (Cruz et al., 2019; Gresham & Burleigh, 2019; Peker & Erol, 2018; Twohill et al., 2022). As such, it is important to investigate how these factors are represented in novice teachers (Cruz et al., 2019), as well as how they are shaped in pre-service teachers as they work toward completing their teacher education program.

Significance of Mathematics Teachers' Beliefs.

Research has demonstrated the important predictive nature of both dispositions and teaching efficacy beliefs on various desired teaching practices and outcomes (Cruz et al., 2019; Jamil et al., 2018; Ma & Cavanagh, 2018). Dispositions and beliefs toward mathematics have been shown to play a significant role for teachers "in the creation, development, and progression of attitudes, practices and even knowledge" (Cruz et al., 2019, p. 401). Similarly, more positive teaching efficacy beliefs have been linked to improved student achievement, increased activity and effort, and greater persistence in overcoming obstacles (Peker & Erol, 2018). In valuing the performance of teacher education students, taking dispositions into consideration further reveals their propensity towards mastering conceptual skills and mathematical procedures (Ibañez & Pentang, 2021).

Despite the importance of mathematics teacher beliefs, researchers have noted that both pre-service and in-service teachers sometimes lack the self-efficacy to incorporate components of elementary-level STEM into the classroom (DeJarnette, 2012). Although some studies have found some aspects of pre-service teachers' beliefs, such as mathematics teaching self-efficacy, to be low (McClure et al., 2017; Pelkowski et al., 2019), others have found it to be relatively high (e.g., Peker & Erol, 2018; Taşdemir, 2019). It is possible that such beliefs are affected by context. For instance, both the study by Taşdemir (2019) and by Peker and Erol (2018) were conducted in Turkey. Some studies in the US have also found relatively high mathematics efficacy beliefs among pre-service teachers (e.g., Chen et al., 2014; Gresham & Burleigh, 2019), but reported results may differ across regions or in other countries (e.g., MacDonald, 2020).

Furthermore, differences in pre-service teachers' mathematics beliefs may depend on the age group they are preparing to teach. In previous research, pre-service teachers for secondary students reflected more positive mathematics dispositions than those preparing to teach elementary students (Cruz et al., 2019). This difference in mathematics dispositions could be attributed to a lack of sufficient mathematics content preparation. Specifically, secondary mathematics teachers are often required to complete more intensive mathematics courses than their elementary counterparts, and research has shown how pre-service teachers with high prior mathematics achievement have higher self-efficacy beliefs than pre-service teachers with lower prior mathematics achievement (Taşdemir, 2019). Similarly, elementary pre-service teachers who expressed greater personal teaching efficacy for mathematics tended to have taken significantly more mathematics courses in high school than did their counterparts who expressed lower efficacy beliefs (Jeffrey et al., 2018). Therefore, the number of mathematics courses taken, along with the degree of achievement attained, appears to be linked to later mathematics teaching efficacy beliefs. The importance of content-specific training is emphasised in another study, in which teachers' self-efficacy beliefs about teaching mathematics increased following professional development, in-class

support, and the long-term implementation of STEM-based lesson plans (DeJarnette, 2018). It is possible, therefore, that sufficient content-specific practice and training can help increase teachers' mathematics dispositions and efficacy beliefs, particularly for elementary mathematics pre-service teachers.

Methods

In the following sections, the research design is presented, including the procedures followed to obtain ethical approval and ensure student anonymity. Next, the context of the study is described. Following this section, the mixed methods methodology adopted in this study is explained, including the research design, participants, and data collection and analysis procedures. While similar studies on pre-services teachers' dispositions and efficacy beliefs have adopted qualitative (Gresham & Burleigh, 2019) or quantitative methods (MacDonald, 2020; Twohill et al., 2022), we postulated that a mixed-methods design would be suited for the purpose of this study as it included a limited number of pre-service teachers taking the same mathematics course.

Research Design

In the present study, a concurrent mixed-methods design was used. According to Creswell (2014), mixed methods research is useful as it provides the means for both quantitative measurements and qualitative data to inform one another, ultimately capturing a more comprehensive understanding of the phenomenon under investigation. The present study was a theory-driven analysis with constructs established a priori; the purpose behind the mixed-methods design was, therefore, to find meaning for the quantitative results.

Ethical approval was attained in accordance with the university's protocol to protect the privacy of the participating pre-service teachers. Students were informed of the study's purpose and aims and were required to sign a consent form in accordance with ethical considerations. Although the first author was the lecturer of the course under investigation, the students were assured that their participation in this study would not affect their grades. They were also assured that the analysis of the data would not begin until only after their grades were issued. Furthermore, the second author, who was not involved in the delivery of the course, collected the students' surveys. The student names initially written on the survey to ensure comparing pre- and post-survey results at the end of the course was possible. Each student name was replaced with a code to ensure participant privacy and anonymity was maintained.

Interviews were conducted by either the first or second author. In conducting the interviews, students were reassured that their responses to the interview questions would have no bearing or influence on their experience in the course in any way. The emergence of the same themes across participants reassured us of the limited impact on students' honesty despite some being interviewed by the course instructor. Their confidentiality was further maintained through the use of pseudonyms when reporting the findings in this article.

Context of the Study

The course, which took place over a period of three months, was designed to teach methods of mathematics instruction for the following topics typically covered in Cycle 1 (Grades 1–3) in Lebanese schools: numbers and counting, place value, addition, subtraction, multiplication, division, number patterns, and measuring. The course was student-centered, with frequent opportunities for students to apply and reflect on the strategies they were learning. As part of the course requirements, all students designed a mathematics lesson plan based on a topic and strategy of their choice, and then delivered the lesson through microteaching in front of their peers. They also engaged in one-hour weekly classroom observations of an in-service elementary mathematics teacher for the second half of the course.

Participants and Sampling Procedure

Participants were pre-service teachers enrolled in a methods course, Teaching of Mathematics at the Elementary School. The participants were selected using non-random purposive sampling (Patton, 2002), as pre-service teachers who were enrolled in the mathematics course were recruited for participation in this study, in alignment with our study's aim. All students enrolled in the course—the only one of its kind offered at the university, which was chosen through convenience sampling (Patton, 2002), being the course taught by the first author—were invited and agreed to participate in the study. All 11 pre-service teachers who were enrolled in the mathematics course agreed to participate in the study. They were all female and ranged in age from 20 to 23 years old.

Research Instrument

The quantitative data were collected through the administration of the Mathematical Dispositions and Self-Efficacy for Teaching Mathematics (MDSETM) survey designed by Cruz et al. (2019). The MDSETM survey consists of 10 five-point Likert-style items for each of the following five constructs: Nature and Usefulness of Mathematics, Learning of Mathematics, Perseverance in Mathematics, Personal Teaching Efficacy, and General Teaching Efficacy. Sample items for each construct, respectively, include such statements as "Mathematics is an unrelated collection of facts, rules, & skills," "Memorizing and mastering algorithms is how people learn math," "By trying hard, I can become smarter in mathematics," "I will continually find better ways to teach mathematics," and "When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort" (Cruz et al., 2019, p. 419–420). For each item, participants determined the extent to which they agreed or disagreed with statements supporting each of the five Likert-type constructs. Furthermore, in each section, half of the items were negatively worded to deter acquiescence bias.

Data Gathering Procedures

The survey was administered twice: the first administration occurred two weeks after the start of the methods course in which the participants were enrolled so that participants would have sufficient time to become aware of their own mathematics dispositions and efficacy beliefs. The second administration of the survey occurred three months following the end of the course, or approximately six months since the first administration of the survey. We chose to lengthen the time before the second administration to determine if potential shifts in dispositions were long-lasting or temporary as an immediate result of taking the course.

Qualitative data were collected through semi-structured individual interviews, which prompted participants to share their perceptions according to a defined set of questions, yet also allowed participants to share their thoughts freely and without restrictions (Creswell, 2014). Interview questions were designed around the five constructs in the MDSETM survey (Cruz et al., 2019) but were open-ended to allow participants an opportunity to delve into further detail regarding their dispositions and self-efficacy beliefs for teaching mathematics, and to learn more about how the participants approached planning their own mathematics lesson. Sample interview questions included "How do you believe mathematics should be taught?" and "What role does the teacher play in helping a child be successful in mathematics?" Interviews were conducted approximately two months following the first administration of the MDSETM survey.

Data Analysis

Quantitative and qualitative data were analysed concurrently. In the reporting of the results, there was slightly more weight given to the qualitative results as the small sample size limited the applicability of statistical analyses. We began data analysis following recommendations by Saldaña (2013), whereby we created a table for the five constructs on the survey and then transcribed each participant's interview data under the appropriate construct.

Then, using the quantitative data, we first calculated Cronbach's alpha reliability estimate for the scale during pre-course administration and found it to be, α = 0.91, which indicated strong overall reliability. Scores were then calculated for each construct by first reverse-coding the negatively-worded items (Chyung et al., 2018) and then finding the mean of the ten relevant items that applied to each construct. Then, descriptive statistics were calculated to compare results across the five constructs. Finally, we conducted *t*-tests to compare the pre-course and post-course results on each construct, as well as item-by-item comparisons. For each construct, we then looked at item means and used themes and quotes that emerged from the qualitative data to help clarify and elaborate on the results.

Results

To answer the first research question regarding pre-service teachers' mathematics dispositions and efficacy beliefs prior to completing the methods course, we calculated descriptive statistics using the pre-course survey data. Results are detailed in Table 1.

Table 1
Means, Standard Deviations, and t-test Results for Pre/Post Survey

	Nature and Usefulness of Mathematics		Learning of Mathematics		Perseverance in Mathematics		Personal Efficacy Beliefs		General Efficacy Beliefs	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pre-course	3.79	.49	3.10	.35	3.99	.52	3.75	.57	3.46	.34
Post-course	3.84	.33	3.59	.51	4.17	.49	4.15	.47	3.76	.39
t	-.29	--	-6.03**	--	-1.28	--	-2.31*	--	-2.20*	--

Note. *M* = Mean. *SD* = Standard Deviation. * $p < .05$ ** $p < .01$

For interpretation purposes, we speculated that higher scores on the construct "Nature and Usefulness of Mathematics" would indicate a belief in the more open-ended and dynamic nature of mathematics, as well as the highly useful nature of it. Further, we posited that higher scores on "Learning of Mathematics" would equate to a belief in students' more active and exploratory role in learning mathematics, as well as a belief that everyone possesses the ability to learn mathematics. For "Perseverance in Mathematics," we hypothesised that higher scores indicated a greater growth mindset with regards to mathematics learning (i.e., by putting in more effort, participants believe they can improve their mathematics performance). Higher scores on the final two constructs were also considered as potentially equating to higher self-efficacy beliefs in participant's own ability to teach mathematics effectively and to greater responsibility attributed to teachers in general for students' mathematics learning, respectively.

Based on the pre-course quantitative results, we noted pre-service teachers had the most positive dispositions regarding their own perseverance in learning mathematics: they consistently felt they could do better in mathematics if they exerted more effort (*M* = 3.99). They were also more likely to feel mathematics was useful and open-ended than to feel it was unnecessary and fixed (*M* = 3.79), and they felt relatively capable of teaching mathematics effectively (*M* = 3.75). Regarding general efficacy beliefs (*M* = 3.46), while they felt teachers bore significant responsibility for students' learning of mathematics, they were also likely to attribute some of this responsibility to parents, with the relevant item mean asking about importance of parents for mathematics achievement being 4.27. The lowest construct mean was related to how students learn mathematics (*M* = 3.10): the pre-service teachers felt strongly about being active in the learning process (*M* = 4.18) and about there being many ways to learn

mathematics (M = 4.82). However, within this construct, their responses to the item regarding everyone's ability to learn mathematics were notably lower (M = 3.27).

To answer the second research question regarding the extent to which Lebanese pre-service teachers' dispositions and efficacy beliefs changed after completing the course, we referred to the post-course survey results, comparing means to the pre-course survey results using *t*-tests (detailed in Table 1). Referring to the post-course results, while the relative order of the construct means was similar to the pre-course survey results, there were statistically significant changes on the following constructs: Learning of Mathematics (p < .01), Personal Efficacy Beliefs (p < .05), and General Efficacy Beliefs (p < .05).

Finally, to further expand on the quantitative results, we analysed the qualitative data for patterns in pre-service teachers' responses related to the three constructs that experienced a statistically significant shift. Within each of these three constructs, we also looked at specific items that experienced a statistically significant change (refer to Table 2) to further delve into student beliefs and offer more clarity for survey responses. The results of this analysis for each of the three constructs are presented in the sections below; pseudonyms are used to protect participants' confidentiality.

Table 2
Pre/Post Means for Items with Statistically Significant Differences

Construct	Item	Pre-Course Mean	Post-Course Mean
Learning of Mathematics	Memorizing and mastering algorithms is how people learn mathematics**	3.73	2.64
	All students can learn mathematics*	3.27	4.27
	Many students are just not able to learn mathematics**	3.72	2.45
	My learning of mathematics depends solely on the teacher**	4.45	2.91
	There are many ways to learn mathematics*	4.82	4.45
	As a student of mathematics, I passively receive knowledge from the teacher*	2.82	3.82
Personal Efficacy Beliefs	Even if I try very hard, I will not teach mathematics as well as I will most subjects*	2.45	1.55
General Efficacy Beliefs	There is a limited amount that teachers can do to raise the performance of students who begin school with low abilities*	2.91	1.91

* p < .05 ** p < .01

Learning of Mathematics

We found that with regards to Learning of Mathematics, pre-service teachers were less likely after taking the methods course to believe memorising algorithms was how people learned mathematics (M_1 = 3.73; M_2 = 2.64) and they were more likely to believe all students were capable of learning mathematics (M_1 = 3.27; M_2 = 4.27). Both of these shifts were expressed in the interview data by numerous participants. For instance, Sara noted that during her time as a student, teachers often taught mathematics by simply teaching the rule and having students memorise and apply it. However, she believed learning mathematics should be more inductive. This view was supported in by the majority of her classmates, who stated mathematics is best learned through active learning opportunities. Many of the pre-service teachers also believed students learned mathematics better when it was connected to

the real world. As Farah indicated, "Students learn mathematics better when we connect their own lives and the real world to the lesson. They'll know it is useful." Nawwar echoed this sentiment:

> The best way to teach mathematics is to make connections to real life. We can also use strategies like taking them outside on field trips so they can see other places that use mathematics or experience mathematics lessons more authentically or kinesthetically. Anything that is learned without practice will be forgotten.

Following the methods course, pre-service teachers' perspectives also showed a greater belief that anyone could learn mathematics. However, interview data revealed pre-service teachers' beliefs about the necessary conditions for this potential to be realised. For example, Dana stated that while she believed anyone could learn mathematics, "a struggling student won't be able to reach the highest level like the strongest students. Changing ability also depends on [the teacher] doing activities that engage the students." While other pre-service teachers did not necessarily make an explicit distinction between struggling students and their peers, most did agree in the importance of the teacher in helping everyone learn mathematics. One pre-service teacher, Nawwar, described her journey as a struggling mathematics student whose performance turned around under the guidance of a mathematics teacher who encouraged and supported her. Supporting this more broadly, Maha stated:

> No one is dumb, but some students have a weakness in mathematics. However, they can fix this if the teacher follows up with them and if she is kind to them. […] Mathematics ability can change over time. Different experiences and different teachers influence a student's ability to change.

In addition to the importance of the teacher, Hamida also believed in the importance of family:

> Everyone can learn mathematics and this ability can change with time, depending on the teacher and the child's family. If a child isn't very good in mathematics, the parents should still encourage him and not put him down. With the teachers' help, they can know how to support their child best.

This belief was echoed by Nawwar, who claimed, "If a child's parents are educated, it makes it easier for the child to learn mathematics because they are more likely to support their child at home." Therefore, while pre-service teachers reflected a firm belief in everyone's ability to learn mathematics, they tended to attribute this potential to external variables, such as the effectiveness and compassion of a student's teacher and the involvement of parents.

Personal Efficacy Beliefs

Pre-service teachers' change in Personal Efficacy Beliefs revealed a greater confidence in their own ability to teach mathematics as well as other subjects. Only one item in this construct experienced a statistically significant change (reverse-coded item; M_1 = 2.45; M_2 = 1.55), demonstrating pre-service teachers' increase in mathematics teaching self-efficacy beliefs. The interview data supported this shift in self-efficacy, with most pre-service teachers connecting it back to either their increased comfort and conceptual understanding of the mathematics concepts, or to their experience with microteaching in the methods course. For instance, Sara and Hiba both indicated the importance of understanding the concept in order to feel comfortable teaching it, a belief emphasised by Rawan: "I feel capable that I can help students in mathematics if I understand the concept perfectly. If there's a concept I don't get, I would review it first before teaching it." For some of the pre-service teachers, the methods course represented their first opportunity to attempt a conceptual instead of a procedural understanding of foundational mathematics topics such as equality or basic mathematics operations. For instance, Nahla stated:

> I feel I understand the concepts enough now to be able to teach them, and this was all as a result from this course. Before, I don't believe I knew anything about these topics. […] Now, I understand what different symbols actually mean, not just memorising facts like when we were students.

Similarly, Dana said, "My current confidence in mathematics concepts is better after this course. I used to believe it was about teaching [students] rules to memorise, but I realise now that different topics are related."

In addition to gaining more conceptual understanding, experience with microteaching was also beneficial for many of the pre-service teachers. For instance, Nawwar said:

> After taking the course, I feel more confident in teaching mathematics and very comfortable with it. I felt microteaching really helped me too because it encouraged me to research more online for resources. Before this course, I didn't know what strategies to use or how to teach it.

For most pre-service teachers, their change in self-efficacy was related to the opportunities to gain better understanding and to then practice teaching. Echoing the beliefs of many of her classmates, Nourhan noted, "If I practice a lot, I feel I have the ability to teach mathematics well."

General Efficacy Beliefs

Finally, the pre-service teachers' change in General Efficacy Beliefs revealed a greater belief in teachers' general ability to impact struggling students' mathematics achievement. Specifically, they felt more strongly that teachers are capable of raising the performance of students who started school with lower abilities (reverse-coded item; $M_1 = 2.91$; $M_2 = 1.91$). Interview responses generally revealed an emphasis was placed on the role of the teacher in helping students learn mathematics by using visuals and manipulatives, by checking on students individually, and by paying extra attention to struggling students. For most of the pre-service teachers, supporting struggling students equated to working with them individually and giving them more practice. According to Rawan, "Some students can only understand mathematics well if the teacher guides them directly. […] She can also give them more practice, encourage them, give more real-life examples, all of which helps make mathematics simpler." Zeinab's response also highlighted the importance of attempting different approaches, further emphasising the critical role and responsibility the teacher has in helping struggling students learn mathematics:

> If a student is struggling in mathematics, the teacher might give additional remediation hours, re-explain the concept to him in the same way she did earlier, and then if that doesn't work, explain it in a different way until he understands it. She can then give him an activity to help him learn with concrete materials or she can help by drawing similarities to something that is familiar to him.

In addition to offering instructional support, pre-service teachers also indicated the importance of offering motivational support. For instance, according to Farah:

> If a student is struggling in mathematics, the teacher can call the student up to the board during instruction to encourage him. When he solves problems, she can help him and show him how mistakes can be corrected, motivating him to continue trying. If she feels he needs extra time, she can put in extra effort with him because when the child feels the teacher cares about him, he starts wanting to do better and work harder.

Therefore, interview results showed that pre-service teachers, while taking a methods course to learn more about how to teach mathematics, felt aware of the important role teachers play in helping students learn mathematics effectively by supporting them both instructionally and motivationally. While this does not eliminate the importance of the students' own role in learning, according to Rawan, "For younger grades, the teachers' role is more important than the student's because the students won't know their role at that age. But in grades 5 or 6, students can depend on themselves more, so their roles are more equivalent." Therefore, as many of the pre-service teachers indicated, the teacher's role and general efficacy in teaching mathematics is not to be overlooked.

Discussion

The purpose of the present mixed-methods study was to determine Lebanese pre-service teachers' dispositions and efficacy beliefs before and after completing a methods course for teaching mathematics. Results indicated pre-service teachers had the most positive dispositions with respect to how mathematics is learned and the nature and usefulness of mathematics, and high personal teaching efficacy beliefs. These remained the three constructs with the highest means post-course, although

statistically significant increases were noted on dispositions towards how mathematics is learned, personal teaching efficacy beliefs, and general teaching efficacy beliefs. Analysis of the qualitative data provided further insight into how their beliefs changed after the methods course. For learning mathematics, they felt memorising algorithms was less important than connecting mathematics to the real world. They were also more likely to believe anyone could learn mathematics, although this depended greatly on external factors like teacher and parent support. Regarding efficacy beliefs, they felt more confident that they could teach mathematics as effectively as other subjects and that teachers in general could make a difference with even the most struggling students' mathematics achievement.

One of the most important findings in the present study is the importance of subject-specific methods courses that allow pre-service teachers to have sufficient opportunities to engage with methods of teaching mathematics prior to entering the classroom. As noted in the pre-service teachers' responses to the interview questions, much of their own perceived growth in confidence was attributed to the opportunities to practice embedded within the methods course. Such courses allow future teachers to engage in the same hands-on mathematics activities as their students, which can help alleviate their anxiety about teaching mathematics (McClure et al., 2017). Therefore, teacher education programs should be sure to note the importance and value of subject-specific methods courses. As researchers have noted, training for pre-service teachers should include exposure to both content knowledge of the subject to be taught in addition to opportunities to practice pedagogical skills (Earnest & Amador, 2019; McClure et al., 2017). In addition to providing these opportunities, subject-specific methods coursework can also prepare teachers to incorporate mathematics into students' daily experiences and ask students the right questions to prompt higher-level thinking, both important components for effective mathematics instruction (Chen et al., 2014; Pelkowski et al., 2019).

For some of the pre-service teachers in the present study, their increased self-efficacy beliefs for teaching mathematics stemmed from gaining a better conceptual understanding of foundational mathematics concepts, such as equality and operations. For example, Nahla noted how she began to understand what the different symbols meant, without having to memorise facts. Additionally, several pre-service teachers attributed part of their increased comfort with teaching mathematics following the methods course to their greater knowledge and familiarity with the appropriate vocabulary to use during mathematics instruction. The importance of communicating mathematics concepts accurately is highlighted in previous research (e.g., NCTM, 2013; Stites & Brown, 2019). This highlights the function of pre-service teachers' mathematics content knowledge as a prerequisite to mathematics instruction, a link that has led to the advocation for an increased emphasis on mathematics content knowledge in teacher education coursework (Norton, 2019).

Additionally, it is important to note that for several of the pre-service teachers, they struggled to move beyond how they were taught mathematics as children. For instance, in the present study, Maha felt she could not teach mathematics conceptually because that was not how she herself was taught in school. As Fuson et al. (2015) noted, for the many individuals who may not have been taught mathematics in a way to promote conceptual understanding, it can be difficult to move beyond rote teaching in their own instruction. Indeed, novice teachers' potential to resort to traditional methods of instruction despite teacher preparation has been observed in previous research in the absence of sufficient pre-service training (ElDeen & El-Sawy, 2018). Therefore, teacher education programs should ensure sufficient modelling of concept-based instruction and opportunities for pre-service teachers to practice so they can envision an approach to teaching that differs from their own experience.

Conclusion

Despite the limitations of a small sample size, the present study points to several important findings regarding the significance of methods coursework and the need for opportunities to practice in mathematics teacher education programs. The study's implications include the need to consider the importance of mathematics methods courses not only for secondary mathematics teachers, but also for early years mathematics teachers. This is of particular importance in light of the consideration that early years mathematics teachers are responsible for establishing the foundation of mathematics

understanding on which all consequent mathematics courses naturally build. Added to this, then, is the importance of ensuring that early years mathematics teachers are not only equipped with appropriate teaching methods knowledge but are also teaching from a place of mathematically sound conceptual understanding. The absence of such conceptual understanding on the part of the teachers may contribute in part to the tendency for early years mathematics teachers to teach from a place of procedural as opposed to conceptual knowledge (Chahine & King, 2011). In considering how to continually develop and improve the quality of mathematics teacher education, both of these implications are recommended to be taken on board.

Additionally, several directions for further research emerged. Future studies on mathematics education would benefit from focusing on pre-service teachers' confidence in assessing mathematics learning, which has been shown to be weaker in previous research (Chen et al., 2014). Additionally, future studies might consider investigating male pre-service teachers' dispositions and efficacy beliefs of mathematics pre-service teachers, as this study was limited to the participating female pre-service teachers. Finally, a study of teacher education coursework in Lebanon is warranted to compare pre-service teacher beliefs in light of the coursework undertaken to determine what coursework best prepares them to enter the profession with positive dispositions and efficacy beliefs. Such research, combined with the present study, could help reveal how to best prepare Lebanese pre-service teachers for the task of effective mathematics instruction, thereby promoting greater conceptual understanding in their students and increasing all students' academic success.

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