





## **Pre-Service Teachers' Perceptions of and Preparation for the Math Proficiency Test**

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### **Abstract**

Pre-service teachers in Ontario, Canada are required to pass the Math Proficiency Test (MPT) to obtain teacher certification. The MPT has two separate sections that focus on content and general pedagogy. An online survey about the Math Proficiency Test was developed and distributed to pre-service teachers to investigate their perceptions of and preparation for the MPT. Results are reported in relation to four main survey factors: 1) support for the MPT, 2) math anxiety, 3) math teaching confidence, and 4) preparedness for the MPT. In general, pre-service teachers were not in favour of the Math Proficiency Test and reported high levels of anxiety about taking it, despite their low levels of math performance anxiety and high levels of math teaching confidence. Study implications are discussed in relation to the merits of pre-service teacher testing in mathematics.

Keywords: Teacher Tests, Mathematics Education, Math Anxiety, Math Teaching Confidence

### **Introduction**

In August 2019, the Government of Ontario in Canada passed a regulation that requires prospective teachers to pass a math proficiency test (MPT) to become certified to teach in the province. This regulation outlines information about the development, content, and administration of the test. The MPT is developed by the Education Quality and Accountability Office (EQAO) and contains two multiple-choice sections: one on math curriculum content (70% of the test) and one on pedagogy (30% of the test). To pass the test a candidate must obtain 70% or more on each section of the test. Administration of the

test occurs within a post-secondary institution or remotely and there is no limit to the number of times a person may take the test. Because the MPT regulation came into effect at the end of the summer of 2019, pre-service teachers who were already in, or had already been accepted into, B.Ed. programs received no forewarning about the math test they were legally required to pass to become a certified teacher. All pre-service teachers (Kindergarten to Grade 12) were required to pass the MPT to gain certification, regardless of whether they would be qualified to teach mathematics. While all elementary teachers (Kindergarten to Grade 6) are expected to teach mathematics, only teachers with a background in mathematics and successful completion of math curriculum courses are permitted to teach middle school and high school math.

The purpose of this study was to learn about pre-service teachers' perceptions of the MPT and how they prepared themselves to complete it. The research questions that guided this study were:

- What are pre-service teachers' perceptions of the MPT?
- How do pre-service teachers' past and present experiences with math influence their perceptions of the MPT?
- How are pre-service teachers preparing to take the MPT?

To this end, pre-service teachers were invited to participate in an online survey in which they were asked about their thoughts on the MPT, their attitudes and experiences with math, and how they were preparing for the MPT. Ultimately, this study provides initial insights from pre-service teachers about the Math Proficiency Test that can help inform public educational policy about it and similar tests.

### **Literature Review**

#### **The Role of Teachers' Professional Competence in Mathematics Education**

Teaching is a complex profession that requires educators to understand how students learn, implement effective instructional strategies, support positive attitudes to learning, and reflect on (and improve) their instructional practices. Theories about what makes a good teacher tend to emphasize singular factors such as student-teacher relationships (Jowett et al., 2023) or teacher self-efficacy (Thommen et al., 2022), but these theories neglect the reality of all that teaching encapsulates. Shulman (1987) outlined a triadic model of the types of knowledge that teachers should have: content, pedagogical, and curriculum. Extending Shulman's work to the field of mathematics education, Hill et al. (2008) developed a conceptual model about mathematics instruction, known as mathematics knowledge for teaching (MKT). The two main components of the initial MKT model were subject matter knowledge and pedagogical content knowledge, suggesting that these two areas should be the focus of training for mathematics teachers. While there

appears to be a relationship between elementary teacher content knowledge and student mathematics achievement (Hill et al., 2005; Kukla-Acevedo, 2009), it is not as strong as one might expect. Only a small effect size of 0.10 was found between the content knowledge of Grade 6 mathematics teachers and student achievement (Metzler & Woessmann, 2012). This suggests that improving student math learning requires more than simply increasing teachers' math content knowledge. Targeting teachers' pedagogical content knowledge may be more beneficial for enhancing students' mathematical achievement (Capraro et al. 2005; Tirosh et al. 2011). In fact, the updated mathematics knowledge for teaching (MKT) model appears to be only one factor, which is most likely pedagogical content knowledge (PCK; Charalambous et al., 2019). PCK is developed by having teachers revisit math content specifically within the context of how to teach it for deep understanding, allowing them to learn the what and how of teaching math simultaneously. This could be a positive shift in mathematics education because teachers with good conceptual knowledge and who connect mathematics to everyday situations have a greater impact on student learning than teachers whose knowledge is limited to math facts and formulas (Tchoshanov, 2011). Essentially, it is not enough for teachers to superficially know (and be tested on) mathematics content. They require opportunities to develop conceptual mathematical understanding by being introduced to high-quality instructional strategies that facilitate learning. For example, elementary teachers should learn the importance of unit fractions and how to teach them using mathematical representations (e.g., manipulatives, drawings, number lines), so that students develop a solid understanding of fractions as units and not two separate numbers (Douglas, 2020; NCTM, 2014).

A more comprehensive view of teacher effectiveness is described by the term "professional competence", which includes knowledge, beliefs, motivation, and self-regulation (Kunter et al., 2013). An investigation of the influence that secondary teacher's instructional quality had on student math achievement found that aspects of teachers' professional competence (pedagogical content knowledge, enthusiasm for teaching, and self-regulation) were positively associated with student outcomes (Kunter et al., 2013). Moreover, teachers' self-efficacy in math instruction is positively associated with student achievement (Perera & John, 2020) and greater student self-confidence in math (Stipek et al., 2001). Thus, it appears that to support student learning, mathematics educators need to have well-developed math pedagogical content knowledge and high math teaching self-confidence.

### **Pre-Service Teachers and Math Anxiety**

Math anxiety is described as feelings of apprehension and psychological distress when encountering math (Luttenberger et al., 2018). One popular and well-established

measure of math anxiety, the Mathematics Anxiety Rating Scale (MARS) was first developed almost 50 years ago (Richardson & Suinn, 1972), and was later followed by an abbreviated version called the MARS-Revised (Alexander & Martray, 1989). Studies using the MARS-Revised instrument with elementary pre-service teachers revealed higher levels of math anxiety in education students than in other undergraduate students (Bursal & Paznokas, 2006; Harper & Daane, 1998). Many pre-service elementary teachers have math anxiety because of negative teaching behaviour and instructional approaches they experienced themselves as young students (Bekdemir, 2010). Pre-service teachers with high levels of math anxiety indicated that the following practices contributed to their anxiety: focusing on right answers, fear of making mistakes, low confidence levels, and timed tests (Harper & Daane, 1998). Math anxiety is negatively correlated with math performance (Zhang et al., 2019). For example, pre-service teachers with higher levels of anxiety scored more poorly on both procedural and conceptual fraction tests (Rayner et al., 2009). Moreover, teachers with math anxiety tend to have students with lower levels of math achievement than teachers without math anxiety (Ramirez et al., 2018; Schaeffer et al., 2021). Ways to help pre-service teachers reduce their levels of math anxiety include math education courses that develop math content knowledge (Reid et al., 2018), promotion of a growth mindset towards math (Boyd et al., 2014), building self-confidence in math (Finlayson, 2014), using microteaching (Peker, 2009), and focusing on conceptual knowledge before procedural knowledge (Gresham, 2007).

### **Assessing Math Teaching Effectiveness through Testing**

According to the Ontario Ministry of Education, the Math Proficiency Test “builds confidence that teachers are well prepared for teaching the mathematics curriculum, regardless of the grade assigned” (Ontario College of Teachers, 2021). Despite this assertion, there is no clear evidence that teacher testing increases teacher effectiveness (Ayers & Qualls, 1978; Selke et al., 2004). In fact, teacher testing may reduce the number of new teachers in certain minority groups (Angrist & Guryan, 2008; Petchauer, 2014), exclude teachers that would positively contribute to student learning and achievement (Goldhaber, 2007), and result in teacher shortages (Berliner, 2005). It may be that teacher tests do not assess teacher effectiveness because teaching is a complex multi-dimensional construct based on underlying competencies (Berliner, 2005). Teacher tests appear to focus mainly on assessing subject area knowledge, a very limited indicator of teacher effectiveness. It is important to note that math anxiety correlates negatively with performance on math tests, especially when the test is high stakes (Ashcroft & Moore, 2009; Ho et al., 2000; Miller & Bichsel, 2004), like the MPT that controls teacher certification. Moreover, it is known that females generally have higher levels of math anxiety than males (Dowker et al., 2016), and this trend is true in adults (Hart & Ganley,

2019) and post-secondary students (Baloğlu & Koçak, 2006), including pre-service teachers (Malinsky et al., 2006). There is also evidence that older post-secondary students tend to demonstrate higher levels of math anxiety than their younger peers (Baloğlu & Koçak, 2006), which is concerning because post baccalaureate B.Ed. programs have a mix of ages within their student population. High levels of math anxiety may prevent pre-service teachers from demonstrating their actual math content knowledge. This brings into question whether high stakes tests such as the Math Proficiency Test, can provide a valid measure of teacher's knowledge of mathematics or pedagogy and if unintended biases are reflected in the results, limiting the ability for some groups (e.g., women, older pre-service teachers) to gain entry into the teaching profession.

### **Method**

An online survey was developed and distributed to examine pre-service teachers' perspectives of and preparation for the Math Proficiency Test (MPT). In addition, pre-service teachers were asked about their past and present experiences with mathematics as these would likely influence their perceptions about the MPT. Survey items asked pre-service teachers (TCs) to share their thoughts on the MPT, their attitudes and experiences with math, and how they were preparing for the MPT. The survey was first distributed to pre-service teachers at one Ontario university near the beginning of 2020. The initial group of respondents welcomed the opportunity to voice their opinions and suggested the survey be made available to their peers across the province. Consequently, arrangements were made to share the survey more widely with pre-service teachers from other Ontario faculties of education in the spring and summer of 2020. Data collection occurred during a six-month period, from February to July of 2020.

### **Survey Instrument**

The Math Proficiency Test survey had 86 closed-response items. Ten of these items were demographic items, 11 came from the Anxiety in Teaching Mathematics scale (McAnallen, 2010), 15 items were adapted from the Abbreviated Mathematics Anxiety Rating Scale (Hopko et al., 2003), and the remaining 50 items were developed by the authors and specific to the context of the Ontario Math Proficiency Test. All closed-response items were scored using a 5-point Likert scale. At the end of the survey, pre-service teachers were provided with the opportunity to complete one open-response question that asked, "Are there any additional comments you would like to share about the MPT?" Approval to distribute the online survey to pre-service teachers was granted by appropriate university General Research Ethics Boards.

### **Sample**

Participants were recruited by education student organization email listservs and social media. There was a total of 444 survey responses from pre-service teachers enrolled in Bachelor of Education programs in 13 different Ontario universities. Females accounted for 82% of the sample and males accounted for 15%, while 3% of respondents did not disclose their sex. The mean age of the sample was 25.6 years old. Twenty percent of respondents were aged 21 or 22, 41% were 23 or 24 years old, 27% were aged 25 to 29, and the remaining 12% were 30 or over. Almost three quarters of respondents (73%) were in consecutive (post-baccalaureate) teacher education programs, with the remaining 27% in concurrent education programs. Elementary pre-service teachers comprised 66% of the sample, with the remaining 34% preparing to be secondary teachers. Most of our respondents (83%) had registered for the MPT field test, suggesting that the Ministry's incentive of counting a pass on the field test as a test pass was effective. Respondents were asked to identify their reason for not registering for the field test. Among respondents who did not sign up for the field test ( $n=76$ ), 68% indicated that there were logistical problems with registering (e.g., testing sites full, no accommodations at preferred site, location is problematic).

With regards to prior mathematics education, 40% of the sample indicated they had taken mathematics courses at the post-secondary level (college or university), 32% indicated they had completed Grade 12 mathematics, and 24% had Grade 11 as their highest mathematics course. Surprisingly, 5% of the respondents reported their highest mathematics course was Grade 9 or 10.

### **Data Analysis**

Exploratory factor analysis (EFA) using SPSS Version 26 was conducted to find patterns of response in the survey and see which items formed a defensible subscale. Bartlett's test of sphericity was not significant and the KMO measure of sampling adequacy was  $KMO = 0.945$ , indicating that factor analysis was likely to yield interpretable results. A maximum likelihood algorithm was used to extract the factors, with an oblimin rotation. Fabrigar and Wegener (2012) advise using a variety of tests, alongside a theoretical framework, to determine the number of factors. In our case, different techniques for determining the number of factors yielded different results. Using the Kaiser criterion yielded 10 factors, while a scree plot indicated six factors. Parallel analysis also indicated six factors. Constraining the factor analysis to six factors showed at least one item loading strongly onto each of the first five factors, but no item loaded more strongly than 0.266 on the sixth factor, making the sixth factor impossible to interpret. Thus, we opted to keep five factors. The strongest loading items on each factor were used to make a judgement about what that factor represented. The correlations between the five factors are shown in Table

2. The moderate value of the correlations indicates the five factors are distinct.

Table 2: Correlations between factors

Factor	1	2	3	4	5
1	1.00				
2	-.38	1.00			
3	.30	-.34	1.00		
4	.30	-.41	.21	1.00	
5	.26	-.10	.10	.35	1.00

These five factors were used to form subscales for the survey items. Each subscale is composed of items that loaded at 0.60 or stronger onto the factor to keep each subscale compact, while ensuring high internal consistency. The five factors related to the survey subscale items were: support for the MPT, math anxiety (performance), math test-taking anxiety, math teaching confidence, and preparedness for the MPT. We noted that the two anxiety scales represented two different but related constructs. Math anxiety (performance) items relate to respondents' confidence (or anxiety) in *performing* mathematics, whereas math test-taking anxiety was related to being *assessed* on their mathematical skills and knowledge. A granular analysis of our data found multiple examples of respondents who had low math anxiety (performance) but high math test-taking anxiety, indicating that confidence in one's ability to perform mathematical calculations is not a guarantee of confidence in one's ability to do well on a mathematics test.

For the open-response question that allowed pre-service teachers to share comments about the Math Proficiency Test, qualitative thematic analysis was conducted. Emergent themes were: not being in support of the MPT, having anxiety about writing the MPT, believing the MPT was not a good measure of math teaching ability, and suggestions for improving the MPT. Pre-service teachers' specific explanations for each of the major themes were grouped into subthemes. Two hundred and twenty-two pre-service teachers from the sample provided comments about the MPT.

## Results

Results of the Math Proficiency Test survey are presented in relation to the five factors identified in it. Each factor will be discussed as a topic, with math anxiety performance and math test-taking anxiety being combined into the topic of math anxiety. The four topics are as follows: support of the MPT, math anxiety, math teaching confidence, and preparedness for the MPT. For each topic, quantitative results of pre-service teachers' subscale ratings will be presented first to provide information about their agreement levels, followed by qualitative responses that provide insights into pre-service teachers' ratings. When a theme (or sub-theme) is identified in qualitative responses, the

number of teacher candidate responses associated with it will be specified. Lastly, T-tests revealing gender differences and teaching division differences on the five subscales are reported.

### Support of the MPT

In the “Support of the MPT” subscale, pre-service teachers were asked to rate their level of agreement with the items using a 5-point Likert scale, ranging from strongly agree (5) to strongly disagree (1). Items were related to respondents’ belief about the MPT’s ability to ensure Ontario teachers are well prepared to teach mathematics, the Ontario Ministry of Education’s communication about the MPT to pre-service teachers, and the provision of time and resources to prepare for the MPT (see Table 3). This subscale had the lowest internal consistency ( $\alpha = 0.86$ ), but it was still high. As can be seen in Table 3, the mean values for the items on this subscale were low, indicating that respondents were largely opposed to the implementation of the MPT. The lowest ranking item on the scale was the provision of sufficient online resources to prepare for the MPT (1.56).

Table 3: Support of the MPT subscale items

Item	Mean (sd) (max = 5)	Loading
The MPT will ensure that Ontario teachers are well prepared for teaching the mathematics curriculum.	1.75 (1.02)	0.70
The Ontario Ministry of Education has effectively communicated what types of questions will be on the MPT.	2.22 (1.20)	0.61
The Ontario Ministry of Education has given sufficient time to prepare for the MPT.	1.64 (1.06)	0.73
The Ontario Ministry of Education has sufficient online materials to prepare for the MPT.	1.56 (0.90)	0.73
The Ontario Ministry of Education has effectively communicated when and where the MPT will take place.	1.79 (1.11)	0.64
I am in favour of the MPT.	1.59 (1.03)	0.75

Cronbach’s alpha ( $\alpha = 0.86$ )

One hundred and nineteen respondents included comments indicating their opposition to the MPT in the qualitative survey item. The main reasons pre-service teachers had for being against the MPT were because it was unfair (93), a waste of time and resources (20), and inequitable (6). While some pre-service teachers commented on how the MPT was unfair in a general manner, others identified how the MPT was unfair with explanations (see Table 4). The most frequently reported comments about why the MPT was unfair were that pre-service teachers were tested on math content that they would not be required to teach (39; this was particularly relevant for secondary teachers who do not



have a teachable in math), the quick implementation of the MPT did not give pre-service teachers adequate time to prepare for it (33), and the pedagogy questions were too specific and covered the entire K-12 system, even though pre-service teachers are certified to teach in specific divisions (19).

Table 4: How the MPT is unfair with pre-service teachers' comments

How the MPT is Unfair	Sample Comments
Math content questions (39) - it is unfair to be tested on math content that pre-service teachers wouldn't be required to teach.	<p>"There is a reason secondary teachers are limited to their teachable subjects, they specialize and are qualified in certain subjects. It is insulting for a highly educated English, art, or technology (etc.) teacher to have their career ride on a math test."</p> <p>"This test is unfair in the range of math. I will be certified to teach up to grade 6 and am being tested on grade 9."</p>
Timing (33) – the quick implementation of the MPT left pre-service teachers with little time to prepare.	<p>"It was sprung on us during the school year (at the end of our program/graduating year) while were in placement (do you think we actually have time to prepare when we're in placement?)"</p> <p>"I strongly believe that the MPT should be considered for cohorts that are aware of its existence and SHOULD NOT be a requirement for cohorts that HAD ALREADY STARTED prior to its implementation."</p>
Pedagogy questions (19) – the questions were too specific, especially when TCs were expected to know answers to questions across all grade divisions, instead of the division they would be certified to teach in.	<p>"A very large portion of my pedagogy questions were about the Ontario Secondary School Credit Recovery Program. I am in P/J French as a Second Language."</p> <p>"I was very worried about the pedagogy, and all of the questions I got wrong were from the Grades 1-8 Curriculum documents, which I will never teach."</p>

Twenty pre-service teachers indicated that they were opposed to the MPT because it was a waste of time and resources. One teacher candidate communicated, "It is a colossal waste of time and money - standardized tests are not the way to tell if someone is a good teacher." Six pre-service teachers were against the Math Proficiency Test because they believed it was inequitable and discriminatory. According to one teacher candidate, the MPT is a barrier to potential teachers who may have had life challenges or who struggled with math: "This test is also a barrier for folks who would be incredible teachers, perhaps with specialized backgrounds or who have lived complicated lives and may not have

excelled in math.” Similarly, another teacher candidate indicated that the MPT reinforced the harmful cultural myth that math is a hard subject that only certain people are good at: “It is completely ridiculous to have an MPT. Math research shows that math should not be treated like it is harder than other subjects or superior.”

### Math Anxiety

There were two subscales related to math anxiety: 1) math anxiety (performance) and 2) math test-taking anxiety. The math anxiety (performance) subscale contained four items, all related to performing mathematical calculations. Factor loadings were high (see Table 5) and consequently so was the internal reliability ( $\alpha = 0.93$ ). The high internal reliability is perhaps not surprising as all four items on the subscale are quite similar. Pre-service teachers were asked to indicate their level of anxiety with survey items using a 5-point Likert scale (i.e., 1 = not at all, 2 = little, 3 = a fair amount, 4 = much, and 5 = very much). Mean scores for the items on this subscale were quite low, indicating that respondents did not experience anxiety (or little anxiety) when performing the mathematical calculations mentioned in the items.

Table 5: Math anxiety (performance) subscale items

Item	Mean (sd)	Loading
Being given a set of numerical problems involving addition to solve on paper	1.52 (1.00)	0.89
Being given a set of subtraction problems to solve	1.44 (0.94)	0.93
Being given a set of multiplication problems to solve	1.68 (1.04)	0.89
Being given a set of division problems to solve	1.93 (1.15)	0.84

Cronbach’s alpha = 0.93

The math test-taking anxiety subscale comprised of seven items in which pre-service teachers were asked to indicate their level of anxiety about math tests, particularly the Math Proficiency Test (see Table 6). Pre-service teachers used a 5-point Likert scale to rate their level of anxiety with survey items (i.e., 1 = not at all, 2 = little, 3 = a fair amount, 4 = much, and 5 = very much). Items that loaded strongly onto the scale related to thinking about the Math Proficiency Test or math tests in general. This subscale had very high reliability ( $\alpha = 0.95$ ). The item means were above 3.0, indicating that in general, respondents had moderate to high anxiety relating to mathematics testing and the MPT in particular.

Table 6: Math test-taking anxiety (abstract) subscale items

Item	Mean (sd)	Loading
Studying for the Math Proficiency Test	3.43 (1.47)	0.88
Thinking about the upcoming Math Proficiency Test	3.64 (1.42)	0.85
Hearing my peers discuss the Math Proficiency Test	3.52 (1.42)	0.76
Getting ready to study for the Math Proficiency Test	3.38 (1.47)	0.87
Thinking about whether I will pass the Math Proficiency Test	3.71 (1.49)	0.83
Writing a Math test or exam	3.63 (1.40)	0.82
I have math anxiety	3.10 (1.42)	0.76

Cronbach's alpha = 0.95

On the qualitative item, twenty-nine pre-service teachers reported feeling anxious and stressed about the Math Proficiency Test. The three main causes of anxiety and stress about the MPT were a lack of resources to prepare for the test (11), a lack of clear communication about the test (9), and the fact that the test is high stakes (8). A teacher candidate articulated just how high stakes the MPT is: "It is the most stressful situation I have ever experienced considering our entire teaching career is on the line." Similarly, another teacher candidate indicated "It's the most stressful test I have ever experienced".

### Math Teaching Confidence

The seven items on the "Math Teaching Confidence" subscale items related to mathematics teaching (see Table 7). Pre-service teachers were asked to rate their level of agreement with each item using a 5-point Likert scale, ranging from strongly agree (5) to strongly disagree (1). Most items were positively worded, so that high scores indicate high mathematics teaching confidence. Two items on the subscale were negatively worded and were reverse coded to calculate scale scores and Cronbach's alpha. Mean scores ranged, but generally showed respondents were confident in their ability to teach mathematics. The one exception was the "I have a lot of self-confidence when it comes to mathematics" item. The mean score for this item (2.90) was slightly below the scale midpoint of 3.0. The factor loadings were not as high for this subscale as some of the other subscales, but seven items loaded at 0.65 or above, so the overall reliability of the subscale is high ( $\alpha = 0.89$ ).

Table 7: Math teaching confidence subscale items

Item	Mean (sd)	Loading
I feel confident in my ability to teach mathematics to students in the grades I will be certified to teach in.	3.92 (1.20)	0.72
I am confident that I can learn advanced math concepts.	3.64 (1.20)	0.75
I am able to use alternative methods for teaching a mathematical concept.	3.88 (1.04)	0.68
I have a lot of self-confidence when it comes to mathematics.	2.90 (1.30)	0.70
I have strong aptitude when it comes to math.	3.20 (1.18)	0.76
I find it difficult to teach mathematical concepts to students.*	2.38 (1.06)	-0.67
On the average, other teachers are probably much more capable of teaching math than I am.*	2.71 (1.21)	-0.65

\* These items were reverse coded

Cronbach's alpha ( $\alpha = 0.89$ )

The main theme that emerged from the qualitative data in relation to math teaching confidence was that the Math Proficiency Test was not a valid measure of math teaching ability (36). One teacher candidate explained, "The MPT is a multiple-choice assessment done on a computer and does not assess a teacher's ability to teach math." Similarly, another respondent asserted, "The MPT does not measure or properly assess how educators would actually go about TEACHING a mathematical concept or skill to a student." Pre-service teachers also indicated that the Math Proficiency Test would not make them better teachers (7). According to one teacher candidate, "A test does not teach you how to teach math to others." It was suggested by five pre-service teachers that a better method for improving their math teaching confidence and ability would be to replace the MPT with pre-service training and professional development.

### Preparedness for the MPT

The "Preparedness for the MPT" subscale contains three items that focus on the three types of math content questions on the MPT: number sense, relationships and proportional reasoning, and measurement (see Table 8). Pre-service teachers rated their level of agreement about their preparedness using a 5-point Likert scale, ranging from strongly agree (5) to strongly disagree (1). There was high reliability of the scale ( $\alpha = 0.93$ ) even with only three items. A close examination of the responses revealed differences in response patterns across the three "preparedness" items, even though they had similar means. For example, there was a bimodal distribution for the "I am prepared for the Relationships and Proportional Reasoning questions on the MPT", meaning that some pre-

service teachers felt well prepared, but others did not, with relatively few respondents in the middle. This may be because this section of the math content knowledge test tends to be the most challenging. In contrast, the “I am prepared for the Measurement questions on the MPT had similar numbers of respondents at all levels of agreement except for a large spike at the “agree” level.

Table 8: “Preparedness for the MPT” subscale items

Item	Mean (sd)	Loading
I am prepared for the Number Sense questions on the MPT.	3.55 (1.16)	0.82
I am prepared for the Relationships and Proportional Reasoning questions on the MPT.	3.27 (1.23)	0.80
I am prepared for the Measurement questions on the MPT.	3.42 (1.24)	0.81

Cronbach’s alpha ( $\alpha = 0.93$ )

Ninety percent of respondents took concrete action to find out about the MPT by accessing the Math Proficiency Test website developed by the Ontario Ministry of Education. To prepare for the MPT, 88% of pre-service teachers used MPT sample questions and 63% used worksheets or workbooks (see Table 9). Other MPT preparation strategies that pre-service teachers engaged in were peer study sessions (44%) and peer tutoring sessions (35%).

Table 9: Preparation strategies used by pre-service teachers

Item	Yes	No
Have you used the MPT sample questions to help you prepare for the test?	335 (88%)	47 (12%)
Have you attended peer tutoring sessions to help you prepare for the test?	134 (35%)	246 (65%)
Have you participated in informal peer study sessions to prepare for the MPT?	167 (44%)	212 (56%)
Have you been completing math worksheets or workbooks to help you prepare for the MPT?	239 (63%)	139 (37%)

In the open-response survey item, ten pre-service teachers identified ways to improve the Math Proficiency Test. Their suggestions were the following:

- Tailor MPT questions to teaching divisions (4)
- Include more questions and different types of questions in the MPT sample questions (3)

- Make it so that you only have to re-write the section you failed, instead of the entire test (1)
- Make the MPT an entrance exam (1)
- Have more resources and help available to prepare for the MPT (1)

Seven pre-service teachers recommended removing the MPT as a requirement for certification altogether. The MPT was described as dehumanizing by one teacher candidate: “This needs to be removed once and for all. It is so dehumanizing to forcefully implement an exam...to qualify whether or not somebody would make a good teacher.” Another teacher candidate suggested eliminating the MPT and replacing it with a math course: “I don’t believe that the MPT should decide a certification for teaching. I always had test anxieties and feel that this test should be removed and instead there should be a math course offered to new pre-service teachers.”

### **Gender and Teaching Division Differences on Subscales**

T-tests conducted on the subscales found gender differences for all five subscales. Females had higher math performance anxiety ( $t(66) = 5.02, p < .01$ ) and higher math test anxiety ( $t(228) = 2.23, p = .03$ ) than males. Conversely, males had more teaching confidence ( $t(34) = 4.38, p < .01$ ) and felt better prepared for the MPT ( $t(228) = 2.36, p = .02$ ) than females. In addition, males were more in favour of the MPT than females ( $t(24) = 2.25, p = 0.02$ ). All effect sizes were moderate ranging from  $d = 0.49$  to  $d = 0.70$ .

With respect to teaching division differences, t-tests conducted on subscales found divisional differences between elementary and high school pre-service teachers on four of the five subscales. Elementary pre-service teachers had higher levels of math test-taking anxiety ( $t(249) = 3.72, p < .001$ ) than high school pre-service teachers, and the effect size was medium ( $d = 0.41$ ). Elementary pre-services teachers also had higher levels of math anxiety performance than high school pre-service teachers ( $t(422) = 2.14, p = .03$ ), but the effect size was small ( $d = 0.22$ ). Elementary pre-service teachers had higher levels of math teaching confidence than high school pre-service teachers ( $t(137) = 2.71, p = .01$ ), and the effect size was moderate ( $d = 0.38$ ). Elementary pre-services teachers felt less prepared for the MPT than high school pre-service teachers ( $t(263) = 2.31, p = .01$ ), and the effect size was moderate ( $d = 0.30$ ). There were no statistically significant teaching division differences in support for the MPT ( $t(433) = 1.67, p = .1$ ).

### **Discussion**

The Math Proficiency Test survey provided pre-service teachers with the opportunity to share their thoughts about the MPT. It gathered a lot of interest because many pre-service teachers wanted to voice their opposition to the MPT. Our results indicate

there may be a valid concern that the MPT may not be measuring pre-service teachers' actual math content knowledge because of high levels of math test anxiety experienced by pre-service teachers. This anxiety exists despite the pre-service teachers in our sample feeling confident in their ability to perform mathematical calculations and in their math teaching abilities. Study findings are discussed in relation to survey item factors.

### **Support of the MPT**

The majority of pre-service teachers did not support the MPT. Numerous reasons were given for this. For example, they did not believe that the Math Proficiency Test would help ensure that teachers are well prepared for teaching mathematics. This may be the case because pre-service teachers have firsthand knowledge of how complex teaching is, which goes beyond knowledge of content and pedagogy to the notion of professional competence marked by knowledge, beliefs, motivation, and self-regulation (Kunter et al., 2013). It is also possible that pre-service teachers do not support the Math Proficiency Test because they have higher levels of math anxiety than most undergraduate students (Bursal & Paznokas, 2006; Harper & Daane, 1998). Moreover, pre-service teachers were blindsided by the MPT as it came into effect after many of them had already started their Bachelor of Education programs or were just about to begin their programs. With this in mind, it is not surprising that one of the most reported comments about the MPT was that it was unfair because of its quick implementation. Consequently, pre-service teachers did not believe that they had sufficient time, resources, or communication from the Ministry of Education for the MPT.

Many pre-service teachers also felt the Math Proficiency Test was unfair because of the nature of the test questions. Secondary teachers who had no intention of ever teaching math questioned why they needed to take the MPT to gain teacher certification. Elementary pre-service teachers wondered why they were required to answer math content questions up to a Grade 9 level when they were only certified to teach up to Grade 6. As researchers, we must admit to being puzzled as to why prospective teachers in certain subject areas are being tested on material that will never be relevant to their future career. While primary/junior pre-service teachers may have a slight chance of being required to teach intermediate math (up to Grade 8), it is unlikely that they would teach high school math. Some pre-service teachers indicated that they were opposed to the MPT because it was a waste of time and money and inequitable. There is support for this objection in the literature as prior studies have shown that standardized teacher tests are not good predictors of teacher effectiveness (Goldhaber, 2007) and can result in inequitable outcomes for particular minority groups (Angrist & Guryan, 2008; Petchauer, 2014).

### **Math Anxiety**

Pre-service teachers were asked to rate their level of math anxiety in relation to two factors: performance of math calculations and math test-taking anxiety, specifically the MPT. While pre-service teachers indicated that they had low levels of math anxiety when performing math calculations, they had high levels of anxiety about taking the Math Proficiency Test. Essentially, pre-service teachers felt comfortable performing math calculations, but were anxious about completing a test requiring them to demonstrate their math content knowledge. This is concerning given that math test-taking anxiety is negatively associated with test scores (Ashcroft & Moore, 2009; Ho et al., 2000; Miller & Bichsel, 2004). It may be that some pre-service teachers are unsuccessful on the MPT because of high levels of test-taking anxiety, not low math content knowledge. Interestingly, the math test-taking anxiety subscale item with the highest mean (3.71) was “Thinking about whether I will pass the Math Proficiency Test”. The high mean score on this item indicates that the gate-keeping role of the MPT is likely contributing to high levels of test-taking anxiety that undermine pre-service teachers’ ability to perform well on the test. In keeping with prior research that females tend to have higher math anxiety than males (Baloğlu & Koçak, 2006; Dowker et al., 2016; Hart & Ganley, 2019), the female pre-service teachers in our sample had higher math test-taking and math performance anxiety levels than their male counterparts. In addition, elementary pre-service teachers had higher math anxiety (test-taking and performance) than secondary school pre-service teachers in our sample.

In the open-response question, pre-service teachers indicated that three main factors that induced stress were a lack of resources to prepare for the test, inadequate communication from the Ontario Ministry of Education, and that it was high stakes. The Ontario Ministry of Education could help reduce anxiety around the Math Proficiency Test by providing more robust preparation resources and providing increased communication about the MPT. However, it is possible that some pre-service teachers may have such high math test-taking anxiety that they will never be able to pass the Math Proficiency Test, even with unlimited attempts to do so. It is our feeling the Ontario Ministry of Education should re-consider whether the MPT is a warranted gatekeeper, especially for secondary pre-service teachers who are not seeking certification to teach mathematics in a high school setting.

### **Math Teaching Confidence**

A promising finding from the Math Proficiency Test survey is that pre-service teachers had a high level of math teaching confidence. One possible explanation for this high level of confidence is that Faculties of Education are equipping pre-service teachers with the knowledge, skills, and attitudes they need to be confident mathematics educators.



Many pre-service teacher programs do this through math education courses that develop math content knowledge (Reid et al., 2018), promote a growth mindset towards math (Boyd et al., 2014), utilize microteaching (Peker, 2009), build self-confidence in math (Finlayson, 2014), and focus on conceptual knowledge before procedural knowledge (Gresham, 2007). A high level of pre-service teacher math teaching confidence is encouraging given that self-efficacy for teaching mathematics is positively associated with student achievement (Perera & John, 2020) and greater student self-confidence in math (Stipek et al., 2001). Further research about effective practices for building math teaching confidence in pre-service and in-service teachers could lead to greater student achievement and competence in math.

### **Preparedness for the MPT**

There was variability around how well-prepared pre-service teachers felt they were for the Math Proficiency Test. Ninety percent of pre-service teachers accessed the Math Proficiency Test website, indicating that this is a popular resource that the Ontario Ministry of Education can use to help pre-service teachers prepare for the MPT. During the first year the MPT was implemented, the website had a limited number of sample questions available for pre-service teachers to complete. During the second year of implementation, the Ontario Ministry of Education replaced the sample questions with an actual sample test. Pre-service teachers would likely benefit from having more sample tests available. We received anecdotal reports from some pre-service teachers that the questions on the sample test they completed online were very different from the questions they were randomly assigned on the Math Proficiency Test.

Over half of pre-service teachers (63%) reported using worksheets and workbooks to prepare for the Math Proficiency Test. The Ontario Ministry of Education could offer greater support to pre-service teachers by developing Math Proficiency worksheets and workbooks that enable pre-service teachers to practice important mathematical concepts addressed on the test. These resources could be organized by the types of questions (i.e., Number Sense, Relationships and Proportional Reasoning, and Measurement), with extra resources being dedicated to Relationships and Proportional Reasoning questions, which tend to be the most challenging. Worksheets and workbooks for the Math Proficiency Test would provide targeted practice for pre-service teachers to work on individually, in peer tutoring sessions, in study groups, or with a professional tutor.

### **Conclusion**

The Math Proficiency Test (MPT) survey provided pre-service teachers with an opportunity to voice their thoughts about the MPT. Ultimately, pre-service teachers were not in favour of the test and reported high levels of math test-taking anxiety, despite having

low levels of math anxiety (performance) and high levels of math teaching confidence. Because math test-taking anxiety impedes performance, the Math Proficiency Test may not be a reliable measure of pre-service teachers' math and pedagogy content knowledge. Moreover, teacher tests are not associated with greater student achievement and may prevent people who would be successful teachers from entering the profession, so the MPT may not be an effective use of time and resources. Instead of testing pre-service teachers, governments may be better served by equipping them to be effective math educators through high quality professional development (PD) opportunities; specifically, PD that focuses on strengthening math pedagogical content knowledge and math teaching self-confidence as these two factors are associated with student achievement. Research on increasing math teaching self-confidence is a particularly promising area of math education that warrants further investigation.

### Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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