

TURKISH PRE-SERVICE MATHEMATICS TEACHERS' BELIEFS IN MULTIPLICATION

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Abstract

Mathematics teachers' beliefs play an important role in the mathematics teaching practices. However, the instruments used to measure the mathematics on certain contents are still limited. Thus, this study was conducted to develop a Multiplication Beliefs Questionnaire (MBQ) to identify and examine the profile of Turkish pre-service mathematics teachers' beliefs. The samples of this study consisted of 414 four-year pre-service primary mathematics teachers from 18 different universities in Turkey collected using a convenience sampling technique. The validity of the questionnaire was analyzed using an exploratory factor analysis (EFA). We obtained four components of beliefs in multiplication covering, remote belief in multiplication (C1), multiplication operation belief in mathematics textbooks (C2), dynamic belief in multiplication learning (C3), and self-efficacy belief in multiplication problems (C4). The results showed that the pre-service mathematics teachers' beliefs in components C1, C3, and C4 were positive, while component C2 was neutral. This study had an essential contribution to the mathematics literature since developing a questionnaire on multiplication distributed to the pre-service teachers. The previous studies showed that belief was subjective yet objectively influenced knowledge. Thus, identifying the pre-service teachers' beliefs in teacher education may provide various benefits in reforming mathematics teaching.

Keywords: Beliefs, Beliefs in Multiplication, Pre-Service Mathematics Teachers, Questionnaire Development

Abstrak

Keyakinan guru matematika berperan penting dalam praktik mengajar matematika. Namun instrumen untuk mengukur keyakinan pada konten tertentu masih terbatas. Sehingga penelitian ini dilakukan untuk mengembangkan kuesioner keyakinan perkalian (KKP) untuk mengidentifikasi dan memeriksa profil keyakinan calon guru matematika di Turki tentang topik ini. Penelitian ini menggunakan *convenience sampling* yang terdiri dari 414 calon guru matematika pada tahun keempat dari 18 universitas berbeda di Turki. Validitas kuesioner dianalisis dengan menggunakan *exploratory factor analysis* (EFA). Kami memperoleh empat komponen keyakinan tentang perkalian: keyakinan terasing tentang perkalian (C1), keyakinan tentang operasi perkalian dalam buku teks matematika (C2), keyakinan dinamis tentang belajar perkalian (C3), dan keyakinan *self-efficacy* tentang masalah perkalian (C4). Hasil penelitian menunjukkan bahwa keyakinan calon guru matematika positif untuk komponen C1, C3 dan C4 dan netral untuk komponen C2. Studi ini memiliki kontribusi penting untuk literatur karena mengembangkan kuesioner tentang perkalian yang diberikan kepada calon guru matematika. Berdasarkan penelitian sebelumnya, keyakinan berpengaruh pada pengetahuan, meskipun keyakinan bersifat subjektif dan pengetahuan bersifat objektif. Sehingga mengidentifikasi keyakinan calon guru dalam pendidikan guru dapat bermanfaat dalam reformasi pengajaran matematika.

Kata kunci: Keyakinan, Keyakinan Tentang Perkalian, Calon Guru Matematika, Pengembangan Kuesioner

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Belief has become an interesting topic to study shown by many disciplines which have already concerned on belief, such as social psychology which studies the belief structure and content influencing a person's thinking (Bar-Tal, 1990, Wilson & Cooney, 2002). Education is also considered interesting in which belief highly influences the learning practices (Cormas, 2020; Liljedahl, Rösken, & Rolka, 2021; Sevgi et al., 2021). In addition to the teachers' knowledge, belief can also influence the students'

mathematical success (Ball, 1991; Hamukwaya & Haser, 2021). Muhtarom, Juniati, and Siswono (2019) found that pre-service teachers' beliefs on the nature of mathematics supported the beliefs in the teaching-learning process in the mathematics classrooms.

Changing the teachers' beliefs could be started from the education programs. Developing beliefs in mathematics and its teaching is one objective in the teacher preparation programs (Cross 2009; Zuljan, Valenčič, & Pejić, 2021). Thus, belief reformation in teacher education programs is greatly required (Szydlik, Szydlik, & Benson, 2003; Geisler & Rolka, 2021). The pre-service teachers participating in the programs have different initial beliefs in teaching and learning mathematics influenced by their previous experiences when studying at schools (Richardson, 1996). The study conducted by Liljedahl et al. (2021) revealed that the pre-service teachers' beliefs might change the course methods in teacher education. However, reforming the pre-service teachers' beliefs is not an easy nor simple process (Grootenboer, 2008).

Dealing with education in Turkey, Dede (2012) revealed that mathematics teachers at both primary and secondary schools have implemented a constructivism approach since 2004. Meanwhile, its implementation in higher education, especially in the faculty of education, has been started in 1997. In the constructivism approach, students independently constructed and developed their knowledge based on their levels of competency. Constructivism theories claimed that humans have their own understanding and knowledge related to the world through their first experiences and reflections (Reigeluth, 1999). The study conducted by Zuljan et al. (2021) showed that constructivism as a scientific way of teaching can improve the teachers' competencies and professional developments.

Constructivism approach applied in education is expected forming the desired mathematical beliefs. Many previous studies on beliefs have been conducted, including those on beliefs in mathematics nature and structure (Szydlik et al., 2003), beliefs in mathematics nature and teaching (Dede & Uysal, 2012), relationship between teachers' beliefs and teaching practices (Polly et al., 2013; Ren & Smith, 2018; Yang et al., 2020). Most conducted studies have discussed beliefs in mathematics nature, teaching, and learning, yet rarely referred to certain mathematical domains, processes, or topics (Zhang & Morselli, 2016). Therefore, this research then developed instruments meeting the requirements to measure the pre-service teachers' beliefs by focusing on certain mathematical contents, such as multiplication.

This study specialized in a multiplication content, that is, belief in multiplication as each mathematics term and object or procedure may become a belief object (Törner, 2002). The belief object on multiplication is greatly interesting to review since no research on how pre-service teachers view this content has been previously conducted. This content was chosen to review the pre-service teachers' beliefs as multiplication as one of difficult concepts at schools (Kennedy & Tipps, 1997) and there are various concepts and strategies possibly applied in multiplication (Simon, Kara, Norton, & Placa, 2018).

Belief plays an important role to the pre-service teachers. Consequently, various studies in this field have discussed various topics related to the influence of beliefs on knowledge and factors

influencing the development of beliefs. The topics on beliefs are recently popular to discuss including beliefs in mathematics, learning mathematics, and teaching mathematics depending on the pre-service teachers' belief types. Studies on pre-service teachers' mathematical beliefs generally identify the belief types. Although many studies have been conducted in the mathematical beliefs, only few have developed instruments to assess beliefs in certain countries. This study aimed to identify the measured belief variables on multiplication using EFA equipped with SPSS software to construct each component in developing the questionnaire and examining the profile of Turkish pre-service mathematics teachers' beliefs in multiplication.

METHOD

Samples

Since 2000s, mathematics curriculum in Turkish elementary, junior high, and senior high schools (including the university's primary and secondary mathematics education programs) have been partly improved based on the constructivism philosophy. Thus, the research participants were also educated using this philosophy. In Turkey, the elementary and Junior high Mathematics Teaching Programs were conducted in 4 years. After the completion, the students then took some national examinations (for example, Professional Teaching Knowledge Test in Turkey: ÖABT). Those passing this exam then became the mathematic teachers for the junior high schools (for 5-8 grade levels) and senior high schools (for 9-12 grade levels). The research samples consisted of 414 fourth-year pre-service primary mathematics teachers (117 males and 297 females) from 18 different universities from several provinces in Turkey collected using a convenience sampling technique. The data showed that the female pre-service teachers participated more in this study, due to the increasing interest of Turkish female students in mathematics teaching programs when compared to the male students. Convenience sampling technique was employed in this research since the subjects were selected based on the researchers' interest in the related participants (Gravetter & Forzano, 2009). The research samples were conducted on the four-year pre-service primary mathematics teachers generally taking the mathematics courses on mathematical education and educational sciences. Some courses included Introduction to Algebra, Real Analysis, Geometry, Measurement and Evaluation, Mathematical Teaching Methods, Instructional Technology and Material Design, Introduction to Educational Sciences and Psychology Development.

Research Design

The design of this research consisted of two phases: 1) developing and validating the questionnaire items; and 2) implementing EFA on the questionnaire items. Due to the long procedures, we first developed a framework to compile the teachers' beliefs on multiplication. We compiled the questionnaire items referring to Ernest's (1989), McLeod's (1992), and Beswick's (2012) theories on beliefs summarized in Table 1.

Table 1. Questionnaire development framework on beliefs in multiplication

	Instrumentalist	Platonist	Problem-solving
Beliefs on multiplication	Believing that multiplication is related to rules and procedures; the implementation of multiplication can solve the problems found in real-life.	Believing that multiplication is a rule and strategy existing for a long time; representing the existing multiplication number.	Believing that multiplication ideas can be developed following individual knowledge; representation of the created multiplication number
Self-efficacy beliefs	Posing or solving multiplication problems using strategies remembered	Posing or solving multiplication problems using the existing strategies	Posing or solving the multiplication problems using various strategies
Beliefs about teaching multiplication	Mastering multiplication by memorizing	Mastering multiplication by understanding	Mastering multiplication by developing ideas on multiplication
Beliefs about social context	Following and remembering multiplication strategies in textbooks	Understanding multiplication strategies in textbooks and problems of multiplication numbers which has a solution in the textbooks	Multiplication strategies are not only in textbooks but can also be created independently

After developing the framework above, we then arranged the questionnaire items through the following phases:

Phase 1: Developing and Validating the Questionnaire Items

This study aimed to develop a questionnaire on multiplication beliefs, including its construction and validation for Turkish pre-service mathematics teachers on multiplication. The construction of questionnaire was measured by selecting and developing the appropriate items reflecting the respondents' literature, context, and language. Several items were constructed and translated. The validity of items was assessed by experts and revised based on their inputs. A trial version was then tested and resulted to construct the experimental version of Multiplication Beliefs Questionnaire (MBQ) for this study.

54 Likert-scale items were constructed based on the available sources/theories to assess the belief statements, ranging from "strongly disagree" to "strongly agree". The instruments consisted of 30 positive statement items and 24 negative statement items implying the characteristics of 3 belief types consisting of Instrumentalist; Platonist; and Problem Solving. The belief items in multiplication were structured based on the beliefs in multiplication; self-beliefs in multiplication; multiplication teaching beliefs; and multiplication beliefs in social context. Each MBQ item gave five points, indicating the agreement levels on the related statements, in which positive statements were scored ranging from 1 to 5, while negative statements were ranging from 5 to 1, and high score indicated that the respondent had

a very strong positive belief. The following multiplication beliefs (MB) items were presented as examples:

- MB1 : Multiplication operation is only dealing with calculation (Instrumentalist)
- MB10 : Strategies in multiplication operation is fixed (Platonist)
- MB13 : Every individual may have different multiplication definitions (Problem solving).

The instruments' psychometrics and language verifications were involved in investigating the items' definition and understanding. The questionnaire items were developed from English and then translated into Turkish to ensure that the questionnaire appropriately measured the pre-service teachers' multiplication beliefs. The questionnaire draft content validity was evaluated by three university experts experienced in Mathematics Education and Educational Evaluation to assess the conformity of items to the indicators formulated in accordance with the theory. In terms of language validity, this research applied the translation guideline stages developed by Beaton et al. (2000) to the questionnaire. The first stage was Adaptation. The questionnaire was given to two Turkish experts with different educational backgrounds (Mathematics education specialist and education specialist) to independently translate from English to Turkish. The second stage was synthesizing and then retranslating the questionnaire into English by those mastering English to examine the validity and consistency. The English translation results were then reviewed by the authors/writers as the questionnaire developers. In retranslation or third stage, synonymous terms were found and the authors mastering Turkish then chose the appropriate terms. Finally, in the fourth stage, some items written in Turkish got a minor revision. Based on the experts' opinion, no item was removed, but item number 22 was divided into 2 items (MBN) consisting of:

- MB22 : Using a standard multiplication is better than using a risky uncommon strategy,
This item was divided into:
- MBN22 : The best way in multiplication process is using standard formula.
- MBN23 : Alternative strategy is best in multiplication process.

This process resulted in 55 MBQ items consisting of 31 positive statement items and 24 negative statement items. In the last stage, the MBQ was then given for a piloting study. The piloting study was conducted after some corrections based on the experts' suggestions. The Turkish version of MBQ was given to 25 pre-service teachers to answer and show that there was no non-understandable statement. The piloting study found some difficult-to-understand statements, such as:

- M15 : The definition of multiplication concept may differ.

Phase 2: Exploratory Factor Analysis (EFA)

A factor analysis was conducted to explore a strong correlation between variables inside a group, yet variables outside a group poorly correlated. Meanwhile, EFA was then employed by using the

Principal Axis Factoring (PAF) method. According to Howard (2016), PAF method can present more accurate factor analysis results based on EFA. This study used 414 data of respondents considered adequate (Thompson, 2004) with a rule of thumb with a loading factor of at least 0.32 for a sample size of 414 (Tabachnick & Fidell, 2013). The first response to those 55 items were analyzed using the Kaiser-Mayer-Olkin Approach (KMO) and Barlett's Sphericity Test (BTS), resulting in KMO (0.842) and BTS (6687.397; 1485, $p < 0.001$), which were considered sufficient to justify the obtained four components. According to Kaiser (1974), the minimum acceptance of KMO was 0.5. Meanwhile, Cronbach's Alpha was calculated to determine the questionnaire's internal consistency.

RESULTS AND DISCUSSION

Exploratory Factor Analysis

Based on the method used in factor analysis, 55 items with the loading factors of less than 0.32 were removed. From 414 respondents of pre-service teachers, 14 MBQ items with Cronbach's alpha (α) of 0.771 were obtained. Referring to Hair, Anderson, Tatham, and Black (1998), scores between 0.60 and 0.70 were considered as the minimum acceptance limit for the internal consistent reliability coefficient. Those 14 items consisted of 6 negative statement items and 8 positive statement items. The maximum standard deviation score for MBQ items was approximately 1, indicating that the data distribution tended closing to the average value.

To obtain the framework of MBQ components, the responses given to the MBQ items were analyzed using both PAF and Varimax rotation method. The Varimax method developed by Kaiser (1958) was recognized as a good and widely used method. The communality items showed the variation ranging from 0.402 to 0.710 was considered having a high communality (Tabachnick & Fidell, 2013). The procedures to identify factors in MBQ items used the eigen value of greater than 1. The number of the obtained factors was four as MBQ components seen in Table 2. The KMO value calculated in the final MBQ was 0.782, while the BTS was 1487.397; 91; $p < 0.001$. With the KMO value of > 0.50 , the BTS factor analysis could be then proceeded (Kaiser, 1974).

All MBQ components were calculated at 51.293% of the variance and Merenda (1997) stated that "for the number of 'real' factors and components, the proportion [of variance accounted for] should be at least 0.50" (p. 158). The first, second, third, fourth component was respectively calculated at 17.747%, 11.708%, 11.453%, and 10.385%.

As presented in Table 2, 14 MBQ items were distributed into four components consisting of MBQ item 19, 20, 27, 28, 43 and then loaded with the highest in component 1 (C1), interpreted as remote beliefs in multiplication (RBM). C1 might be classified as a negative belief statement as mathematics was separated from the real life. Only mathematicians know that multiplication representation and multiplication problems can only be settled through the already-known strategies. The questions in C1 were different from those in the instrumentalist belief viewing that mathematics is useful in real life (Ernest, 1989), Grootenboer and Marshman (2016) called it as a utilitarian belief. It

is previously explained that negative statements were scored from 5 to 1. Figure 1 showed that the mean score of C1 was close to 4, Turkish pre-service teachers commonly did not agree with this remote belief view.

Table 2. Rotated structure matrix of PAF method

MBQ Items	Component				α
	1	2	3	4	
M20 Decimal numbers of multiplication operation cannot be implemented in daily life.	0.748				0.818
M28 Only mathematicians can find multiplication operation representation.	0.689				
M27 The fact that fraction multiplication has different representation is not found in some sources and shows that there is no different representation of multiplication.	0.666				
M19 Integer multiplication operation cannot be implemented in daily life.	0.655				
M43 Only known strategies can be used to solve the multiplication problems.	0.495				
M48 Solution for all multiplication problems can be found in the mathematics textbooks.		0.701			0.712
M47 Multiplication problems forms can be easily found in mathematics textbooks.		0.700			
M29 All strategies of multiplication operation can be found in school mathematics textbooks.		0.578			
M31 Some strategies in multiplication operation can be explored.			0.812		0.715
M12 Multiplication operation procedure can be re-found by the students.			0.550		
M35 New strategies can be generated from previous multiplication strategies in mathematical sources.			0.549		
M55 I can pose multiplication problems in many ways.				0.735	0.697
M54 I know how to pose difficult multiplication problems.				0.676	
M53 I can solve difficult school multiplication problems.				0.520	

*Note: Only the loading scores greater than 0.32 was presented

The second component (C2) was interpreted as the pre-service teachers' view related to the beliefs in multiplication operation on mathematics textbooks (BOMT). With a mean closing to 3, which was considered neutral, the pre-service teachers commonly had a neutral view on all problems related to the multiplication operations found in the mathematics textbooks. Ernest (1994) supported that

mathematics materials should be enriched by adding the mathematical problems and activities into textbooks.

In addition to the previous two components, three items (M12, M31, and M35) were loaded into component 3 (C3) with a general characteristic of dynamic beliefs in multiplication learning (DBLM). C3 was classified as a component showing that in mathematics learning, pre-service teachers had a dynamic belief. Ernest (1989) viewed that learning dynamics was the problem-solving type of belief learning, in which the students might explore the strategies to independently find a solution to the multiplication problems. Figure 1 showed that the mean score was approaching to 4, explaining that the pre-service teachers commonly agreed with the multiplication learning through exploration, or commonly called as a dynamic belief.

The fourth component (C4) included three items consisting of 53, 54, and 55. The three components tended to be self-beliefs or by Bandura (1986) called self-efficacy. McLeod (1992) designed the belief categories, one of which, self-belief, for example, a belief that ‘I can solve problems’. Op 'T Eynde, De Corte, & Verschaffelg (2002) exemplified self-efficacy belief as ‘‘I am confident, I can understand the most difficult material presented in the readings of this mathematical course’’. In this C4, the pre-service teachers believed in their ability to settle the mathematical problems. C4 could be then called as self-efficacy beliefs in multiplication problems (SEMP). C4 showed the mean score was approaching to 4, considering that the pre-service teachers agreed with their self-efficacy belief in multiplication problems. Finally, those 14 MBQ items containing 4 components in multiplication obtained in this study were used to explore the Turkish pre-service teachers’ multiplication beliefs.

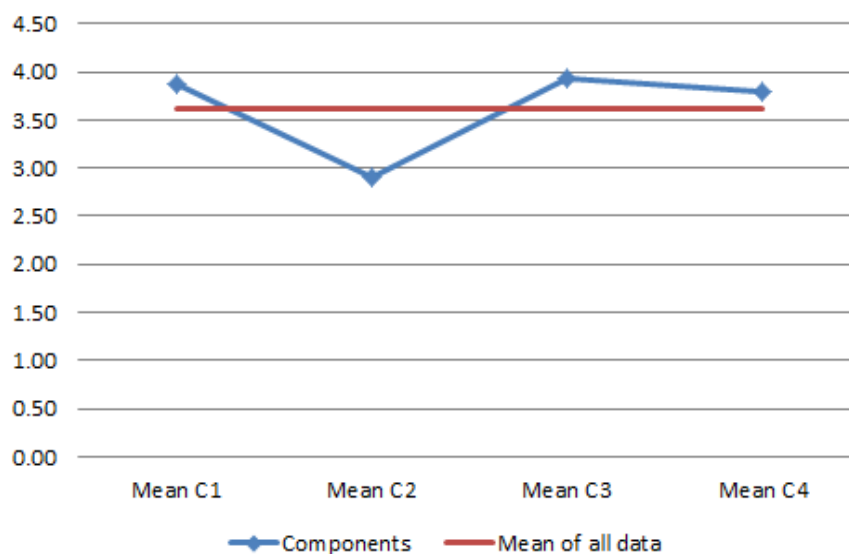


Figure 1. Mean score of each component

Summary of Questionnaire Responses

The summary of four component pre-service teachers’ responses is shown in the following tables.

Those tables show the percentage of responses which were based on the categories of strongly agree, agree, neutral, disagree, and strongly disagree.

Table 3. The percentages of Turkish pre-service teachers' responses on RDM items

RDM Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Decimal numbers multiplication operation cannot be implemented in daily life.	2.7%	6.5%	14.7%	17.6%	58.3%
Only mathematicians can find multiplication operation representation.	3.9%	9.4%	14.5%	36.1%	35.9%
The fact that fraction multiplication has different representation is not found in some sources and shows that there is no different representation of multiplication.	5.8%	11.1%	15.9%	26.1%	41.1%
Integer of multiplication operation cannot be implemented in daily life.	3.4%	5.8%	11.6%	15.9%	63.3%
Only known strategies can be used to solve the multiplication problems.	5.3%	18.1%	22.7%	33.8%	20.0%

Table 3 shows that most pre-service teachers did not agree with the given negative statements. Pre-service strongly disagreed with the statement that integer, fractions, and decimal multiplications were separated from the real life. In addition, they also strongly disagreed with the statement that only mathematicians could find multiplication operation representation. Meanwhile, they disagreed with the statement in which only the known strategies could be used to solve the multiplication problems. Therefore, it revealed that most Turkish pre-service teachers' responses strongly disagreed with the items related to the remote beliefs in multiplication.

Table 4. The percentages of Turkish pre-service teachers' responses on BOMT items

BOMT Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Solution for all multiplication problems can be found in mathematics textbooks.	10.4%	25.4%	38.9%	21.7%	3.6%
Multiplication problems form can be easily found in mathematics textbooks.	10.6%	29%	39.1%	16.7%	4.6%
All strategies of multiplication	8.9%	19.6%	32.9%	26.8%	11.8%

operation can be found in the school mathematics textbooks.

The highest percentage of pre-service teachers' responses was on the 'Neutral' BOMT positive statement (Table 4). Most pre-service teachers gave neutral responses on the use of textbooks in the multiplication operation learning. The neutral view on solution for all multiplication problems were found in the mathematics textbooks.

Table 5. The percentages of Turkish pre-service teachers' responses on DBLM items

DBLM Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Some strategies in multiplication operation can be explored.	1.7%	2.7%	16.7%	49.8%	29.2%
Multiplication operation procedure can be re-found by the students.	1.4%	1.7%	13.8%	46.1%	37.0%
New strategies can be generated from previous multiplication strategies in mathematical sources.	1.7%	5.1%	24.6%	46.1%	22.5%

Table 5 shows that most pre-service teachers agreed with the positive statement of DBLM items. They agreed that the multiplication operation could be explored and re-founded by the students. In addition, they also agreed that the new strategy could be generated from the previous multiplication strategy. Therefore, most Turkish pre-service teachers supported the dynamic multiplication operations.

Table 6. The percentages of Turkish pre-service teachers' responses on SEMP items

SEMP Items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I can pose multiplication problems in many ways.	7%	4.3%	27.1%	45.9%	22.0%
I know how to pose difficult multiplication problems.	2.2%	8.7%	35.3%	37.7%	16.2%
I can solve difficult school multiplication problems.	1.0%	4.6%	19.8%	38.2%	36.5%

Table 6 shows that most pre-service teachers' responses agreed with the positive SEMP statement items showing positive self-efficacy belief to pose with the mathematical problems in many ways and knew how to pose with the difficult mathematical problems. They also believed that they could solve the difficult school-grade multiplication problems. Thus, most Turkish pre-service teachers in this study had positive self-efficacy beliefs in the multiplication problems.

This study used EFA to analyze the developed questionnaire. Of 55 items, the analysis resulted in 14 items. We developed the questionnaire based on the belief theory in multiplication. Furthermore, the reason analysis using strict criteria excluded some items not meeting the requirements. In this EFA process, the researchers decided to issue several MBQ items with low-loading, cross-loading, or free-standing. However, in eliminating the MBQ items, the researchers also used the conceptual significance of the items. According to Beavers et al. (2013), before removing an item with a loading factor of less than 0.32, the researchers should analyze whether the items had too much conceptual vitality in the result part. It was eventually excluded that 41 items were in low-loading, cross-loading, or free-standing. In addition, the researchers assumed that those 14 items represented all developed items with a minimum of 3 items for 4 MBQ components. According to Costello and Osborne (2005), a component having a minimum of 3 to 5 items with a loading factor meeting the requirements could be considered qualified as a stable and solid component.

One of the examples is statement M10: The strategy in the multiplication operation is in the finished product. statement M10 is in contradiction with statement M31. Statement M31: Strategies in multiplication operations can be explored. Statement M31 expresses a problem-solving belief type which has a dynamic nature (Ernest, 1989). Meanwhile, M10 represents the instrumentalist belief type viewing that mathematics is considered collecting rules and procedures. According to Callejo and Vila (2009), problem-solving beliefs viewed closer to a positive view. The instrumentalist viewed beliefs as the opposite of problem-solving beliefs. So, the value of M10 is in contradiction with that of M31. If M31 answers “strongly agree” then DBLM tends to be positive and “strongly disagree” and has a negative DBLM tendency. The researchers also did the same thing, by removing several other items with low-loading, cross-loading, or free-standing. The selected items consisting of only 14 items had already represented all items.

The first component was related to the pre-service teachers' view that multiplication did not have its implementation in real life; the mastery of multiplication was limited, as a value, only to mathematicians; and that only familiar strategies could be used in multiplication. These three arising problems were identified as remote belief in multiplication. In fact, this remote belief saw mathematics in a small and rigid scope. Different from the opinion delivered by Ernest (1989), mathematics was considered unable to be implemented in real life as instrumentalist type. This research found that most Turkish pre-service teachers did not have remote belief in multiplication.

As mentioned above, Turkish mathematics curriculum had been updated since 2004 based on the constructivism philosophy. The participants in this study were in facts educated based on this philosophy and possibly resulted in the present outcomes. This was supported by the research conducted by Grootenboer and Marshman (2016), showing high results of survey on secondary school students' beliefs and stating that mathematics was useful, important, and could be implemented in daily life. These results were different from the findings of research conducted by Gómezescobar and Fernández (2018), mentioning that pre-service teachers viewed that mathematics was useless since they had low

confidence on their abilities or low self-efficacy beliefs. In this study, the Turkish pre-service teachers had a positive view on their self-efficacy beliefs in multiplication. It meant that they had a negative view on RDM.

Furthermore, the Turkish pre-service teachers in this research tended to have neutral view, believing that strategies and solutions of mathematics problems were available in mathematics textbooks. In line with the theory of McLeod (1992), social context affected the students' beliefs, the constructivism learning was possibly implemented in the Turkish curriculum and led the pre-service teachers have neutral view on the mathematics textbooks that multiplication learning sources could be obtained from everywhere. Referring to Cobb (1986), the social context, in this case the learning interaction, might be in the form of cognitive activity with meaningful activities constructing new knowledge or only passively received from the teachers and other learning sources, such as textbooks (Ernest, 1994). Dede (2006) found that Turkish mathematics textbooks in the elementary schools were isolated from the real world and written in abstract style. These results were in line with the findings of research conducted by Nicol and Crespo (2006) showing that the pre-service teachers viewed textbooks as useful for guidance at the beginning of teaching. In addition, textbooks were also flexible to adapt and change to meet the students' diverse needs in the classroom. However, the findings of research conducted Kılıç (2011) were different from those resulted in this study. The research showed that the Turkish pre-service teachers had a view that using textbooks encouraged the students to meet the expected learning objectives. There were different views related to the findings on the use of textbooks according to the pre-service teachers. The development of technology has shifted due to the use of printed textbooks. The shift in the use of textbooks had caused the pre-service teachers taking a neutral view. According to Robb (2019), students abandoned the use of printed textbooks due to the easy digital access.

Another finding showed that environment highly affected the development of pre-service teachers' beliefs. The second component respondents believed that rules, procedures, and strategies varied and could be obtained through invention and exploration. This result was supported by the research conducted by Liljedahl, Rolka, and Rösken (2007) stating that the pre-service mathematics teachers' beliefs might change when involved in the constructivism environments and in mathematics discovery. Grootenboer and Marshman (2016) also confirmed that the students could enjoy mathematics when their learning environment gave them opportunities to cooperate in solving the mathematical problems and engaged them in investigations. The research conducted by Şahin (2009) stated that in Turkey, curriculum with constructivism approach affected the teachers in teaching not by using the transmission model, but they emphasized more on implementing the student-centered model supported by Uysal and Dede (2016) who identified that the Turkish pre-service teachers had child-centeredness and problem solving-beliefs. The effect was that the teachers with constructivism beliefs could help the students improve their performance for the advanced mathematics assignments (Staub & Stern, 2002). Based on the research conducted by Yang (2020), it found that the dynamic belief had

a positive effect on the pre-service teachers' mastery on mathematics.

This constructivism-based teaching experience urged the Turkish pre-service teachers to get used to finding something new in their teaching activities. The result obtained from such process was something new. In this research, the belief was identified as a dynamic belief in multiplication learning. The term dynamic referred to Ernest (1989), stating that mathematics was a dynamic perspective on the problem solving-belief, in which the conducted constructivism learning was considered to establish the connection of procedure/rule/strategy. The research conducted by Geisler and Rolka (2021), showed that dynamic beliefs could change from school to university. In the first year at university, the dynamic belief of students tended to decrease. However, if the university uses the constructivism-based learning, it is possible for the students to have positive dynamic beliefs. The curriculum in Turkey was based on constructivism and supported the development of positive DBM as found in this study.

This research identified self-efficacy belief in multiplication as the fourth component. The pre-service teachers in this research had positive self-efficacy belief in multiplication that they could design and solve the difficult multiplication problems in various ways. According to Hailikari, Nevgi, and Komulainen (2008), self-belief influenced the students' ways in accessing and using their prior understanding on the new learning situations and their learning outcomes. This finding supported that reported by Sevgi et al. (2021), mentioning that Turkish mathematics teachers had high self-efficacy on strategies to support the students' learning activities. Thus, both in-service teachers and pre-service teachers may have their beliefs on new ideas and methods in mathematics. This was also supported by the findings of research conducted by Yılmaz and Turan (2020), mentioning that the Turkish pre-service teachers had high self-efficacy in teaching mathematics and the results of study conducted by Aydın, Sevimli, and Abed (2019) also showing that self-efficacy level indicated the pre-service teachers' knowledge level. The Turkish pre-service teachers' self-efficacy beliefs in this research showed that they had positive beliefs to use the constructivism-based learning strategies in multiplication. They greatly believed in using the problem-solving learning in multiplication.

CONCLUSION

This study aimed to formulate the MBQ instruments and then describe the profile of Turkish pre-service teachers based on the resulted instruments. The process started from the EFA iteration, items with low-loading, cross-loading, or free-standing, and conceptual similarity with higher loading factor to the analysis excluding the items. At the end of EFA, 14 MBQ items were obtained and represented four components of Turkish pre-service mathematics teachers' beliefs. This study found that the Turkish pre-service teachers had a positive DBLM in learning multiplication which required exploration activities to find the procedures or strategies independently performed by the students. This belief had a negative impact on RBM. It meant that the pre-service teachers did not believe that multiplication was useless in everyday life. The positive belief was also obtained in SEMP, which then explained that Turkish pre-service teachers had a belief to be able to solve the multiplication problems. Last but not

least, the Turkish pre-service teachers had a neutral view on BOMT, which mentioned that textbooks could improve multiplication activities.

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