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Pre-Service Teachers' Belief About the Efficacy of Their Mathematics Teaching: A Case Study

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Abstract:
This paper studies the pre-service teachers' mathematics teaching self-efficacy throughout the bachelor's degree in Primary Education. Our hypothesis is that the mathematical courses included in the bachelor's degree can influence their mathematics teaching self-efficacy. To carry out the study, pre-service teachers of each year of the Primary Education Degree answer the Mathematics Teaching Efficacy Belief Instrument (MTEBI) at the end of the 2016-17 academic year. The MTEBI is comprised of two sub-scales, namely, Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE). Obtained results evidence a statistically significant difference (in positive) between the pre-teachers of the first and the last year of the bachelor's degree in the PMTE subscale. Therefore, these results show that the three teaching and learning mathematics courses (TLM) included in the bachelor's degree do change the students' PMTE. Concretely, the second TLM course, which is connected to a student teaching practice period, really makes the difference. Scores obtained in the MTOE subscale, on the contrary, do not increase throughout the Degree. To sum up, this study shows that the Mathematical Curriculum of the bachelor's degree can influence on the PMTE of the pre-teachers. Therefore, teacher educators should be aware of the importance of the Mathematical Curriculum and design the teaching and learning mathematics courses in order to promote the PMTE of the pre-teachers.
Keywords: mathematics self-efficacy, pre-service teacher, primary education, personal teaching efficacy, teaching outcome expectancy

INTRODUCTION

Today, there is a widespread opinion of the importance of teacher training to achieve success in primary education. Some of the existing research is concerned about the low mathematical elementary content knowledge of pre-service teachers (e.g., Buchholtz & Kaiser, 2013; Gutiérrez, Gómez, & Rico, 2016; Mapolelo & Akinsola, 2015; Montes et al., 2015; Osana & Royea, 2011; Ryan & McCrae, 2006; Wu et al., 2018). According to Ball, Hill, and Bass (2005), and Ball, Thames, and Phelps (2008), the quality of mathematics teaching depends on teachers' knowledge of the content. They focused their work on determining what teachers need to know about mathematics to be successful with students in classrooms.

Other researches are worried about the lack of motivation and confidence of pre-service teachers when they teach and learn mathematics (e.g., Gil, Ahstoh, & Algina, 2004; Giles, Byrd, & Bendolph, 2016; Moses et al., 2017; Swars, Daane, & Gisen, 2006; Wilkins & Brand, 2004). The problem is that if they do not change their beliefs, they will show them when teaching mathematics at Primary school. Bursal (2010) points out that teachers are the most important single influence on students' attitudes toward

Mathematics and Science. The author suggests that, since most of tomorrow's teachers are today's pre-service teachers, the beliefs they hold should be of concern to teacher educators.

Related to students' attitude towards mathematics, teachers' efficacy is considered an important factor in high-quality mathematics, since it is related to a variety of desirable student outcomes instruction (e.g., Chang, 2015; Newton et al., 2012; Nurlu, 2015; Tunç et al., 2020).

The current paper aims at studying the primary pre-service teachers' mathematics teaching self-efficacy throughout the bachelor's degree in Primary Education. Our hypothesis is that the teaching and learning mathematics courses included in the bachelor's degree influence their mathematics teaching self-efficacy. Although this is a case study, this research may provide useful insights for teacher educators.

SELF-EFFICACY THEORY

Bandura developed the self-efficacy theory (Bandura, 1977, 1982, 1986). That theory is based on the principal assumption that psychological procedures serve as means of creating and strengthening expectations of personal efficacy. Within this analysis, efficacy expectations are distinguished from response-outcome expectancies. An outcome expectancy is defined as a person's estimate that a given behaviour will lead to certain outcomes. An efficacy expectation is the conviction that one can successfully execute the behaviour required to produce the outcomes.

According to Bandura, the strength of people's convictions in their own effectiveness is likely to affect whether they will even try to cope with given situations. People fear and tend to avoid threatening situations they believe exceed their coping skills, whereas they get involved in activities and behave assuredly when they judge themselves capable of handling situations that would otherwise be intimidating. Efficacy expectations determine how much effort people will expend and how long they will persist in facing obstacles and aversive experiences. The stronger the perceived self- efficacy, the more active the efforts.

Taking into account the theory proposed by Bandura (1977), most studies consider the self-efficacy for teaching as a two-dimensional concept (e.g., Enochs, Smith, & Huinker, 2000). The first dimension, personal teaching efficacy, represents a teacher's belief in his or her skills and abilities to be an effective teacher. The second dimension, teaching outcome expectancy, is a teacher's belief that effective teaching can bring about student learning regardless of external factors such as home environment, family background, and parental influences (Swars et al., 2007).

The Mathematics Teaching Efficacy Belief Instrument (MTEBI) for pre-service teachers resulted from the modification of the Science Teaching Efficacy Belief Instrument (STEBI-B) (Enochs & Riggs, 1990). It was validated in (Enochs, Smith, & Huinker, 2000) by considering a sample of elementary pre-service teachers and it is used to measure mathematics teaching self-efficacy (e.g., Giles, Byrd, & Bendolph, 2016; Moody & DuCloux, 2015; Newton et al., 2012; Swars et al., 2007).

RELATED WORK

This section presents existing research that studies the self-efficacy for teaching mathematics.

In Swars et al. (2007), the authors present a longitudinal study of elementary pre- service teachers' mathematics beliefs and content knowledge. Two instruments, the Mathematics Beliefs Instrument (MBI) and the Mathematics Teaching EfficacyBeliefs Instrument (MTEBI), were administered to the participants four times during the teacher preparation program. They conclude that the teacher preparation programs can have an impact on the beliefs of pre-service teachers about mathematics teaching and learning, that is on their self-efficacy. At the end, they point out that their research give them information about how to construct their program, which may provide more opportunities to enforce the pre-service beliefs about their efficacy.

Bursal (2010) investigates Turkish pre-service elementary teachers' self-efficacy beliefs regarding mathematics and science teaching. Particularly, that work is focused on the teaching self-efficacy beliefs of participants in elementary mathematics and science (PMTE and PSTE). The outcome expectancy is not studied, since according to Bursal, it is usually viewed to be inconsistent among pre-service teachers. The reported results manifest those participants with mathematics/science high school majors have significantly higher PMTE and PSTE scores than those with other high school majors.

Newton et al. (2012) examines the relationship between mathematics content knowledge and teacher efficacy during an elementary mathematics methods course. They found a positive moderate relationship between content knowledge and personal teaching efficacy. However, they did not find any relationship between content knowledge and outcome expectancy.

In Moody and DuCloux (2015), the authors study the mathematics teaching efficacy of traditional and non-traditional elementary pre-service teachers enrolled in a three-course, three-semester mathematics sequence. They show that non-traditional elementary pre-service teachers improve their self-efficacy beliefs with regard to both personal teaching efficacy and outcome expectancy. However, traditional pre-service teachers' beliefs concerning outcome expectancy do not change significantly.

In a more recent approach, Giles, Byrd, and Bendolph (2016) analyse the elementary pre-service teachers' self-efficacy for teaching mathematics. They show that the pre-service teachers had positive levels of efficacy regarding their mathematics teaching abilities as well as positive levels of outcome expectancy for their students in mathematics.

Nurlu (2015) investigates primary school teachers' characteristics by comparing their mathematics teaching self-efficacy beliefs. Their results show that teachers with a higher self-efficacy belief show a higher level of effort and persistence with students. Besides, those teachers believe in students' achievements and take responsibilities for students' success.

Chang (2015) examines relationships among elementary mathematics teachers' efficacy and their students' mathematics self-efficacy and achievement. The reported results reveal that the mathematics teachers' efficacy beliefs significantly influenced both their students' mathematics self-efficacy and achievement.

Hadley and Dorward (2011) study the relationship among elementary teachers' mathematics anxiety, mathematics instructional practices, and student mathematics achievement. They mention how low-level self-efficacy beliefs for teaching mathematics can cause mathematics anxiety, which, at the same time, can influence negatively on students' achievement. The authors found a positive relationship between anxiety about mathematics and anxiety about teaching mathematics. Moreover, increased student mathematics achievement was related to lower levels of anxiety about teaching mathematics but was not related to general anxiety about mathematics.

Brinkmann (2019) studies the self-efficacy in mathematics and examining specific strategies for increasing self-efficacy in teaching mathematics. The author points out how teacher preparation programs can be more informed and bolster self-efficacy of pre-service teachers.

Results obtained in the above presented studies evidence the importance of improving the primary pre-service teachers' self-efficacy for teaching mathematics. As mentioned earlier, this paper aims at studying the personal mathematics teaching efficacy (PMTE) and the mathematics teaching outcome expectancy (MTOE) of pre-service teachers along the bachelor's degree in Primary Education. Our hypothesis is that the teaching and learning mathematics courses included in the bachelor's degree can influence the pre-service teachers' self-efficacy for teaching mathematics.

Table 1. Distribution of the Teaching and Learning Mathematics courses (TLM) and the student teaching periods at the Primary Education Bachelor Degree, and MTEBI administration (semester is denoted by S)

	1st		2nd		3rd		4th	
	S1	S2	S3	S4	S5	S6	S7	S8
TLM				TLM1	TLM2	Student teaching 1	Student teaching 2	TLM3
Duration in weeks (and hours)				17 (60h)	17 (60h)	13 (360h)	13 (360h)	17 (50h)
MTEBI		test		test		test		test
N (%)	133 (97.8%)		107 (69.4%)		95 (66%)		84 (72.4%)	

METHODOLOGY

This section exposes the methodology adopted in this research. Pre-service teachers of each year of the Primary Education Degree answer the aforementioned Mathematics Teaching Efficacy Belief Instrument (Personal Mathematics Teaching Efficacy and Mathematics Teaching Outcome Expectancy) at the end of the 2016-17 academic year.

Participants and Context

This study was held on the 2016-17 academic year at the Rovira and Virgili University, Spain. Participants were enrolled at the 4-year bachelor's degree in Primary Education in the Faculty of Science Education and Psychology, located in a small city, Tarragona. Students of all the years of the Bachelor were invited to answer the MTEBI. That is, the participation was optional for the students that assisted at the session when the test was applied. Specifically, the number of participants of each year of the Bachelor was 133, 107, 95 and 84, respectively. Hence, the test was administrated to 419 pre-service teachers, which represents the 76% of the enrolled students that academic year. Notice that the four studied groups correspond to individuals at different moments of the bachelor's degree, rather than the same individuals over time. It should be remarked that the participation was completely anonymous.

The Primary Education Degree consists of a four-year program, composed by eight semesters. The first year of the program contains only introductory pedagogical courses. The Bachelor includes three mandatory courses of Teaching and Learning Mathematics (TLM). **Table 1** shows the distribution of the three TLM courses along the bachelor's degree. It also shows the semester when the MTEBI was administrated (it was at the end of the academic year).

The TLM1 course (2nd year) presents the mathematical content pre-service teachers need to know to teach in Primary school. The students have to review mathematical content and processes, and to solve problems. In the TLM2 course (3rd year), the pre- service teachers learn how to use manipulatives and interactive applications to teach Numeracy at Primary school. Finally, in the TLM3 course (4th year), the teacher presents them materials to teach Geometry at Primary school. The sessions of TLM3 consist of Geometry workshops, in which the students have to work in teams. The idea of these workshops is to promote a student-centered learning.

In addition to the TLM courses, the students have two 3-month teaching periods along the Bachelor (see **Table 1**). During these student teaching periods, the pre-service teachers stay at a school under a supervised teaching practice. Particularly, they have to observe and analyse everything they see at school. Furthermore, they have to teach some lessons, in a supervised way. In the first period of student teaching, they have to analyse the mathematics teaching at the particular school and use manipulatives they studied in TLM2. After the student teaching period, they must prepare a report to conclude the TLM2 course. Therefore, the TLM2 course is linked to the first student teaching period.

Instrument

As mentioned above, the Mathematics Teaching Efficacy Belief Instrument (MTEBI) for pre-service teachers (Enochs, Smith, & Huinker, 2000) is used in the current research. It was designed for pre-service teachers. The original MTEBI version consists of 21 items in a five-point Likert scale measuring one (strongly disagree) to five (strongly agree). However, as in (Liu, Jack, & Chiu, 2007), the third Likert scale item, uncertain was deleted to encouraging pre-service teachers to indicate a level of certainty. Therefore, the MTEBI used in this work consists in a four-point Likert scale.

The MTEBI is comprised of two subscales, Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE). The PMTE subscale consists of 13 items (2, 3, 5, 6, 8, 11, 15, 16, 17, 18, 19, 20, and 21). Eight of these items are reverse scored. That is, they are stated in negative manner (3, 6, 8, 15, 17, 18, 19 and 21). Notice that the responses corresponding to these items have to be inverted before being added into the total PMTE score (4 = 1, 3 = 2, 2 = 3, 1 = 4). The MTOE subscale consists of 8 items (1, 4, 7, 9, 10, 12, 13, and 14). Thus, PMTE scores range from 13 to 52 while MTOE scores range from 8 to 32.

RESULTS

This section reports the results obtained in the current research. Recall that the pre-service teachers' self-efficacy was measured at the end of the academic year, considering each of the four years of the bachelor. The Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE) subscales were studied separately.

Analysis of the Results

The mean and standard deviation of the scores that each group of students give to the PMTE and MTOE subscale items will be computed and compared. In order to determine the reliability of the obtained results, the Cronbach's alpha (α-Cronbach) is calculated. Specifically, the obtained Cronbach's alpha is 0.77 and 0.74 for the PMTE and MTOE subscale, respectively.

An ANOVA test will be performed to see if the difference among means obtained in each year are statistically significant. Additionally, a Tukey's HSD (honestly significant difference) test will be applied to study the relation between each pair of groups.

Personal Mathematics Teaching Efficacy (PMTE)

This section studies the scores given by the students to the PMTE subscale items.

First, **Table 2** shows the mean and standard deviation of the scores that each group of students give to the PMTE subscale items. In order to emphasize the evolution of the scores along the years of the Primary Education Degree, and also for the lack of space in the table, only the scores corresponding to pre-teachers of the 1st and 4th years are shown. The rank of the students' responses based on the mean score is also included in the table. In the reverse questions, the inverted scores are shown.

Notice that the PMTE scores given by students of the 1st year are in general lower than the ones given by students of the 4th year. In the 1st year responses, there are 6 questions with a score above 3.20 (questions 20, 2, 8, 19 and 6). In the case of the 4th year, there are 9 questions with a score above 3.20 (questions 20, 15, 2, 19, 8, 21, 6, 3 and 16).

The highest score in the 1st and the 4th years is obtained in the question 20 (When teaching mathematics, I will usually welcome student questions), with a mean score of 3.77 and 3.79, respectively. The two-lowest scores, on the contrary, are obtained in both years in the questions 17 and 5. Specifically, in the 1st year, the lowest score was obtained in the question 17 (I wonder if I will have the necessary skills to teach mathematics), with a mean score of 2.41. In the 4th year case, the lowest score was obtained in the

Table 2. Mean and standard deviation of the scores that participants give to the PMTE sub-scale items and rank of the student responses based on the mean score (MTEBI administered to students of the first and fourth years of the bachelor)

No	Question	first			fourth		
		M	SD	rank	M	SD	rank
2	I will continually find better ways to teach mathematics.	3.52	0.62	2	3.69	0.47	3
3 (R)	Even if I try very hard, I will not teach mathematics as well as I will most subjects.	3.17	0.99	6	3.27	0.91	8
5	I know how to teach mathematics concepts effectively.	2.47	0.81	12	2.83	0.69	13
6 (R)	I will not be very effective in monitoring mathematics activities.	3.21	0.87	5	3.35	0.80	7
8 (R)	I will generally teach mathematics ineffectively.	3.46	0.83	3	3.49	0.87	5
11	I understand mathematics concepts well enough to be effective in teaching elementary mathematics.	2.95	0.85	10	3.19	0.74	10
15 (R)	I will find it difficult to use manipulatives to explain to students why mathematics works.	3.16	0.80	7	3.71	0.63	2
16	I will typically be able to answer students' questions.	3.06	0.69	9	3.20	0.65	9
17 (R)	I wonder if I will have the necessary skills to teach mathematics.	2.41	0.90	13	2.85	0.94	12
18 (R)	Given a choice, I will not invite the principal to evaluate my mathematics teaching.	2.86	0.95	11	3.05	1.07	11
19 (R)	When a student has difficulty understanding a mathematics concept, I will usually be at a loss as to how to help the student understand it better.	3.39	0.81	4	3.58	0.68	4
20	When teaching mathematics, I will usually welcome student questions.	3.77	0.53	1	3.79	0.44	1
21 (R)	I do not know what to do to turn students on to mathematics.	3.11	0.75	8	3.36	0.85	6

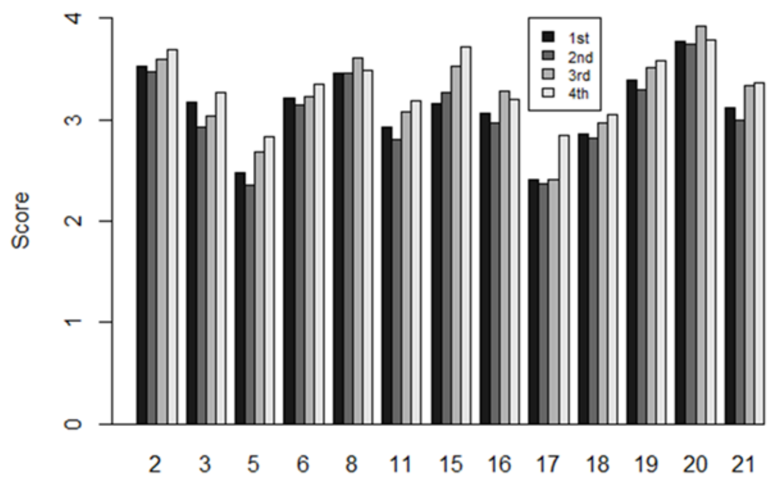

Figure 1. Mean of the scores corresponding to the PMTE subscale items through all the years of the degree

question 5 (I know how to teach mathematics concepts effectively), with a mean score of 2.83. However, recall that even these worst results correspond to a mean score of 60% and 70%, respectively.

Figure 1 shows the mean score obtained in each of the PMTE questions through all the years of the Primary Education Degree. Again, in the reverse items, the inverted scores are provided.

It can be seen that the rank of the questions is the same or very similar in all years of the degree. It is noteworthy to see the evolution of some of the questions along the Degree. Notice, for instance, the positive evolution of question 17: in the fourth year, students are more positive with the fact of having the necessary skills to teach mathematics. In the case of question 15, the students clearly improved their confidence on using manipulatives to teach mathematics. Another example of positive evolution is question 21, which corresponds to students' belief about their capacity to turn students on to

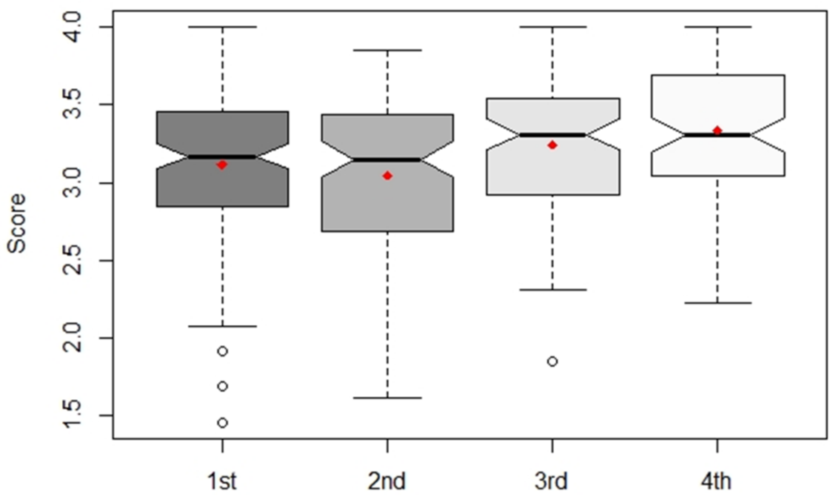

Figure 2. Individual pre-teacher average scores given to the PMTE subscale items

Table 3. PMTE (Mean and standard deviation)

	1st	2nd	3rd	4th
Mean (%)	3.12 (77.96%)	3.046 (76.15%)	3.24 (81.09%)	3.33 (83.37%)
SD (%)	0.49 (12.28%)	0.495 (12.38%)	0.40 (9.95%)	0.43 (10.89%)

mathematics. However, it should be remarked that the PMTE scores given by students in the 2nd year of the Degree are in most cases lower than the ones given by students in the 1st year of the bachelor.

Additionally, **Figure 2** shows the individual students average scores corresponding to the PMTE items (that is, the PMTE scores averaged by the number of PMTE items scored by the student), for every year of the Primary Education Degree. In particular, the polygonal figures enclose data in between lower and upper quartiles (medians are represented by horizontal lines in thinner regions and means are denoted with points). This representation permits to study the distribution of the scores given by all the students.

It is noteworthy to remark results obtained in the 2nd year of the bachelor's degree: the obtained mean, median and minimum values are smaller than the ones obtained in the 1st year. In the 3rd year, on the contrary, the improvement is clear. Finally, it is interesting to highlight the good results obtained in the 4th year: recall that the distribution of the scores is nearly symmetric (mean is similar to median, but a little higher). The minimum obtained score is 2.23 (55.77%), which is quite high, compared to the minimum values obtained the other years. The other three years, the mean is under the median and the range of values is larger due to some obtained small scores.

In order to compare the global performance of the students of each year of the degree, **Table 3** shows the mean and standard deviation of the scores given by each group of students to the PMTE items. Additionally, an ANOVA test was performed to see if the difference among means obtained in each year are statistically significant.

The ANOVA gives the following values: $F = 7.243$ and $p = 9.55\times10{-}5 < 0.001$. Hence, the difference among means is statistically significant. Then, a Tukey's HSD (honestly significant difference) test is applied to study the relation between each pair of groups. Specifically, the difference between the obtained means is statistically significant between 2nd and 3rd years ($p = 0.01379$) and between 1st and 4th years ($p = 0.00731$).

Mathematics Teaching Outcome Expectancy (MTOE)

This section studies the scores given by the students to the MTOE subscale items.

Table 4. Mean and standard deviation of the scores given for the participants to the questions corresponding to the MTOE subscale and rank of the student responses based on the mean score (MTEBI administered at the first and fourth years of the bachelor)

No	Question	first			fourth		
		M	SD	rank	M	SD	rank
1	When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.	2.44	0.83	8	2.42	0.66	8
4	When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	3.33	0.65	2	3.05	0.58	2
7	If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	2.84	0.76	5	2.74	0.89	6
9	The inadequacy of a student's mathematics background can be overcome by good teaching.	3.36	0.62	1	3.44	0.57	1
10	When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	2.81	0.77	7	2.93	0.65	4
12	The teacher is generally responsible for the achievement of students in mathematics.	2.94	0.70	3	2.98	0.66	3
13	Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	2.89	0.69	4	2.86	0.64	5
14	If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.	2.83	0.75	6	2.59	0.70	7

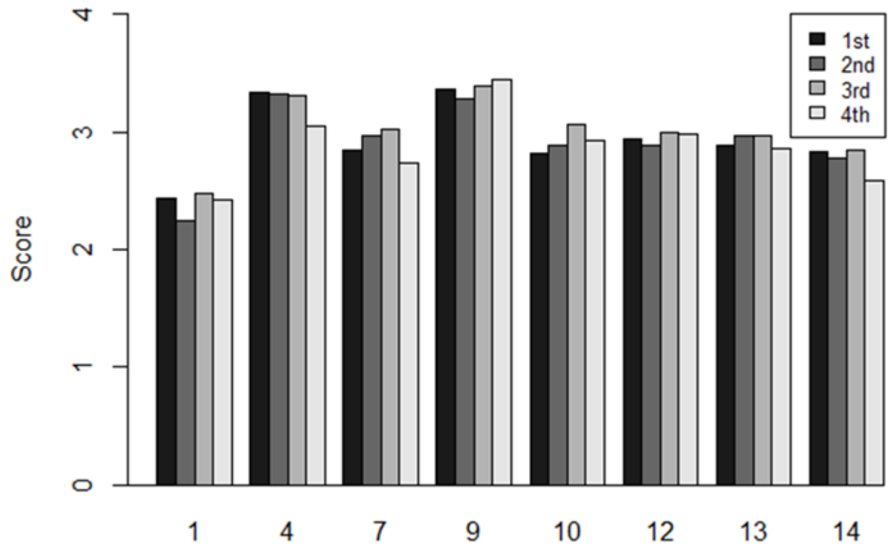

Figure 3. Mean of the scores corresponding to the MTOE subscale items through all the years of the degree

First, **Table 4** shows the mean and standard deviation of the scores given by the participants of the 1st and 4th years of the bachelor to the MTOE subscale items.

In this subscale, the highest mean score obtained in the 1st and the 4th years of the bachelor corresponds to question 9 (The inadequacy of a student's mathematics background can be overcome by good teaching), with a mean score of 3.36 and 3.44, respectively. The lowest mean score was obtained in question 1 (When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort), with a mean score of 2.42 and 2.42 in the 1st and 4th years, respectively.

Figure 3 shows the mean of the scores corresponding to each of the MTOE subscale items through all the years of the Degree.

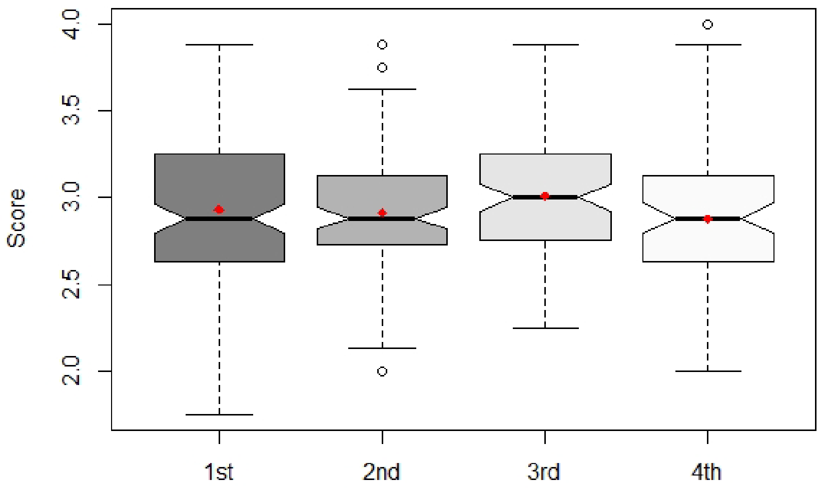

Figure 4. Individual pre-teacher average scores given to the MTOE subscale items

Table 5. MTOE (mean and standard deviation)

	1st	2nd	3rd	4th
Mean (%)	2.93 (73.23%)	2.91 (72.84%)	3.01 (75.22%)	2.87 (71.91%)
SD (%)	0.42 (10.53%)	0.37 (9.22%)	0.37 (9.32%)	0.41 (10.19%)

As in the PMTE subscale, the rank of the questions is the same or very similar in every group of students. However, the positive difference between first and last grades is not as notable as in the PMTE subscale. Indeed, the evolution of the scores is different in each item of the MTOE subscale.

Additionally, **Figure 4** shows the mean of the values that each pre-service teacher gives to the MTOE subscale items.

It can be seen that the lowest values of MTOE are obtained in the 1st year of the degree. The minimum value is very small: 1.75 (43.75%). Besides, there is a clear improvement on the 3rd year values. Notice that the minimum value in the 3rd year is 2.25 (56.25%) and the distribution is nearly symmetric (the mean and median are nearly equal). It should be noticed that the mean and median decrease in the 4th year with respect to the 3rd year.

Finally, **Table 5** shows the mean and standard deviation of the scores given by each group of students to the MTOE items. In this subscale, the ANOVA gives the following values: $F = 1.828$ and $p = 0.14 > 0.05$. Therefore, there is no significant difference among groups.

DISCUSSION

Obtained results evidence that the pre-service teachers' PMTE increases along the Bachelor's degree. It should be remarked the statistically significant difference obtained between the PMTE values at 1st and 4th years ($p = 0.00731$). Therefore, the current Primary Education Degree program does have an impact on the pre-service teachers' PMTE. These results are in accord with the ones presented in (Swars et al, 2007), where the authors show that pre-teacher training programmes can have an impact on pre-teachers beliefs about mathematics teaching and learning.

The reported study also shows the positive and statistically significant evolution between 2nd and 3rd years of the current bachelor's degree in primary education ($p = 0.0138$). It is noteworthy to remark that, as mentioned above, the students take the TLM2 course connected to a student teaching period during the 3rd year. Concretely, students have to analyse the relation between the content of the TLM2 course and the reality observed at school. Besides, they apply some methodologies presented during the TLM2 at school, they see how they teach at a real classroom and they observe how children learn. Therefore, the design of this 3rd year of the bachelor's degree definitely helps to improve the PMTE of students.

Notice that the values of PMTE decrease between 1st and 2nd years. Specifically, the PMTE values obtained at the end of the 2nd year are clearly the smallest obtained during the bachelor. This is due to the content of the TLM course they attend during that year, mainly consisting of mathematical content. There is a high percentage of pre- service teachers that have not been receiving mathematics formation for 2 or 3 years when they arrive at the Bachelor. Sometimes, they do not remember mathematical concepts and they do not perform well when solving problems. The difficulties they have and the bad results obtained in most cases produce low levels of PMTE.

Obtained results do not show a positive evolution of the pre-teachers' MTOE during the bachelor's degree. These results are in accord with the ones presented in Moody and DuCloux (2015), where it is shown that traditional pre-service teachers' MTOE does not change significantly, while the PMTE does. Similarly, in Lian and Richarson (2009) and Mulholland, Dorman, and Odgers (2004), they show a positive effect of their approaches on personal science self-efficacy (PSTE) and a lack of positive change in the science teaching outcome expectancy beliefs (STOE). Also, Tunç et al. (2020) demonstrated that the instruction had positive contributions on the pre-service teachers' self-efficacy beliefs.

Results evidence that the smallest MTOE values are obtained in the 1st year. In the 2nd year, the obtained values are similar. Recall that the PMTE clearly decreases the 2nd year, which surely affects the MTOE values.

Besides, it is noteworthy the MTOE improvement obtained in the 3rd year. We are in accord with Utley et al. (2005), where they pointed out that as the pre-service teachers progress in their college coursework, the student's optimism and enthusiasm tend to increase and then become blemished when confronted with the reality of the classroom. As exposed in the PMTE case, the students attend the TLM2 course linked to a 3-month student teaching period. The clear relation between the theory taught at the University and the reality of the class reinforces the MTOE of the students.

However, the MTOE scores decrease the 4th year of the Bachelor, when students have assisted to the second student teaching period. We attribute to several points that decreasing. First, the TLM3 course they have just finished promotes a student-centered learning approach. Hence, it should be expected that the students did not have high levels of MTOE. Second, they assisted to the second student teaching period before taking the TLM3 course. Therefore, they do not have any mathematical task assigned during the second student teaching period. Finally, they are finishing the Bachelor and they know they will not receive more formation. Hence, they may feel uncertainty about being in a class and producing effect in the students learning.

CONCLUSIONS

This paper aimed at analysing the pre-service teachers' self-efficacy for teaching mathematics and its evolution throughout the bachelor's degree in Primary Education. To carry out the study, the pre-teachers of each year of the bachelor's degree in Primary Education were invited to answer the MTEBI at the end of the 2016-17 academic course. The MTEBI is comprised of two subscales, namely, PMTE and MTOE.

The obtained results evidence the clear influence of the bachelor's degree curriculum in the pre-service teachers' PMTE. Specifically, the difference between the mean PMTE value in the 1st and the 4th years was statistically significant. In the case of the MTOE, the obtained values did not differ significantly among the different years of the Bachelor.

This research provides interesting insights for teacher educators. Results obtained from the particular context and the bachelor's degree studied in this paper can be adapted and extended to other contexts and other bachelor's degrees in Primary Education. The TLM courses included in the current Degree can provide ideas to re-design TLM courses in other Universities in order to reinforce the primary pre-teachers' belief about the efficacy of their mathematics teaching.

Implications in Teacher Education

Taking into account the PMTE values obtained at the end of the 2nd year of the bachelor's degree studied in the current paper, a clear implication of this research would be to re-design the TLM1 course by providing experiences to the students that allow them to improve their self-efficacy. One idea could be to include some mathematical didactic content and to apply it to school in a short-term teaching practice period.

Regarding the obtained MTOE values, it is difficult to improve them, when the bachelor's degree program promotes a student-centered learning approach. However, one possibility to try to change it could be to redesign the 4th-year of the bachelor. Particularly, pre-service teachers could take the courses that conform the 4th year of the bachelor (including TLM3) during the first semester and assist to the student teaching period during the second semester. Hence, they could use the workshops presented in TLM3 to teach Geometry at school. This kind of real intervention at school might support the pre-service teachers to improve their outcome expectancy beliefs.

Future lines of research include, first of all, to collect data considering the same students along the Bachelor Primary Degree in order to study their evolution along the different academic courses. Further, it would be desirable to analyse the relation between mathematics pre-service teachers' background and mathematics self-efficacy. Finally, we would also like to analyse the relation among the pre-service teachers' self- efficacy and their achievements in the TLM courses of the Primary Education Bachelor.

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