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Teaching practice: Contributions to Spanish prospective mathematics teachers

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Abstract

Prospective primary education (PE) teachers of mathematics are trained on university programs which include core subjects in the field of the didactics of mathematics. However, these subjects have no general practical component. Therefore, this research aims to analyze the contribution of practical courses to the development of good practice in mathematics education. For this purpose, an ethnographic study was carried out with the participation of 23 prospective teachers who completed a questionnaire with closed and open-ended questions. The closed responses were analyzed by frequency and percentage, and the open-ended responses were analyzed using the ATLAS.ti software (v. 22) (ATLAS.ti, 2022). The results show that most of the prospective teachers identified principles of good practice in mathematics classes, and most of them found a relationship between their initial training and what they experienced in these classrooms. In the light of the results, contributions are made to improve the initial training of mathematics teachers in PE.

Keywords: primary education, higher education, prospective teachers, mathematics, good practice

INTRODUCTION

The aim of the Council of Europe's (2018) recommendations on education and the last education law passed in Spain (LOMLOE, 2020) is for compulsory education to make citizens capable of addressing and solving problems in everyday situations. This aim will be more easily attained through good teaching performance in the classroom; that is, through the implementation of good educational practices, the development of which should be promoted by primary education (PE) teacher training programs.

Good practice in mathematical education is a controversial term given its complexity (Shonfeld & Magen-Nagar, 2020). Specifically, the National Council of Teachers of Mathematics (NCTM) (NCTM, 2000) suggests that it essentially consists in identifying what students know and what they need to learn, and then to challenge them to learn it well. In other words, the aim is to achieve students' competence in mathematics (Niss, 2003; OECD, 2004). It is thus a question of mathematics teachers knowing and understanding the mathematics they teach, as well as having the necessary pedagogical tools to teach it, showing the flexibility to adapt the content to the specific students in each individual case (Alsina, 2016). Our review of the literature suggests that principles of good practices include teachers carefully selecting the appropriate teaching material (Anthony & Walshaw, 2009; Planas & Alsina, 2014) and their making connections between mathematical content and other curricular areas. This latter aspect is, however, of the mathematical processes recognized by the NCTM (2000), the least widely used by in-service teachers (Fernández et al., 2020; León Mantero et al., 2020). As a principle of good practice, we would further add teachers showing positive attitudes towards the subject, as such attitudes impact the implementation of teaching (Coppola et al., 2012; Fernández-Cézar et al., 2018) and the performance of students (Stronge et al., 2011).

Training in mathematics didactics is acquired by students of PE degrees through basic or core subjects taught at faculties of education. However, the development and acquisition of good teaching practices in mathematics is also supported by the teaching

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Contribution to the literature

- Spanish prospective teachers, or pre-service teachers, of mathematics greatly identify good practices during their teaching practice periods in PE schools.
- Additionally, a majority see a relationship between their initial training in mathematics and what they observed in these classes.
- From this we can assume that, although there is room for improvement, the programs in Spain prepare mathematics future teachers for their job in a great extent.

practice courses in teacher training programs, known in Spain as the practicum. These courses have been analyzed from the perspective of teachers and student teachers (González-Garzón & Gutiérrez, 2012), and of university professors (Fernández & de Lurdes Carvalho, 2013). For some disciplines, there exist proposals for programs for these practical courses, such as that outlined by Cerezo (2003) for physical education. However, few studies have addressed the role of the practicum in mathematics in pre-service training. The literature includes a few studies of a propositional nature, such as that by Palarea Medina (2011), and a number of others based on the authors' reflection on their own practice, comparing it with the practices of other teachers such as their schoolteacher, an example being that by Catalán (2006). Despite the different nature of these works, all the studies we found coincide in that reflection is fundamental for future teachers, as it contributes to the construction of critical thinking (Tejada-Fernández et al., 2017), as well as to their initial and professional development as mathematics teachers (Alsina, 2010; Hernández et al., 2018).

However, it is unclear whether the practicum achieves its educational aims (Latorre Medina & Blanco Encomienda, 2011), nor whether the reflection on the teaching practice undertaken is sufficiently profound to adequately contribute to undergraduates' teacher training (Barquín Ruiz, 2001). Thus, when students find a mismatch between what they have experienced in the PE classroom and what they have learned at university, the tendency is for them to consolidate the most conservative ideas (Barquín Ruiz, 2001; Caro et al., 2021), which, in some cases, occurs because they lack the skills to implement different approaches (Oliveira & Hannula, 2008). Their practical experiences, despite taking place in actual classrooms, may be far from the desired profile of a teacher that implements good practices (González Sanmamed & Fuentes Abeledo, 2011). It is thus advisable to provide them with spaces for shared reflection that allow them to connect theory and practice (González-Garzón & Gutiérrez, 2012; Hummes et al., 2019; Morales-López & Moll, 2017) and discuss what it means to be a good teacher, in addition to offering them models for developing good practice in the classroom (González-Garzón & Gutiérrez, 2012; Hummes et al., 2019; Morales-López & Moll, 2017).

In light of the above, the general aim of the present study is to analyses the contributions of these practical courses to the development of good practice in mathematics educations. To this end, our specific aims are:

1. To ascertain whether pre-service primary teachers identify good practices during teaching-learning in mathematics in school classrooms.
2. To determine whether pre-service primary teachers perceive a relationship between what they learn in their initial training and what they witness in school classrooms.

MATERIALS AND METHODS

The present research is an exploratory, descriptive study on the contributions of the practicum to good practice in pre-service teachers' training. It is an ethnographic study (Álvarez-Álvarez, 2008; Serra, 2004), but cannot be considered a pure one since it uses the non-participant naturalistic observation of the pre-service teachers. In relation to education, Acuña (2011; 2015) suggests that observation is a different type of research to ethnographic studies, in contrast to other authors (Álvarez-Álvarez, 2008; Serra, 2004) that consider it a way of collecting data that is a part of ethnography. A survey was used as our data collection method, being a questionnaire oriented towards the aims of the study.

Participants

The study sample comprised students enrolled in a PE degree course who were engaged in their practicum in state schools in a province in the center of Spain. All the 32 students assigned to the area of the didactics of mathematics in the academic years of 2021-2022 and 2022-2023 at this Faculty of Education agreed to participate. However, only 23 of them finally gave their informed consent, thus constituting the sample.

Location and Materials

Table 1 and **Table 2** show the questionnaire for reflection on classroom practices that participants observed. It was made up of closed and open-ended questions, related to principles of good practice, which were drawn from the scientific literature (Anthony & Walshaw, 2009; NCTM, 2000; Planas & Alsina, 2014).

Table 1. Survey questions 1 to 3 and the principle of good practice to which they are related

Question	Principle of good practice
Q1.1. Is structured manipulative material, such as Cuisenaire rods, geoboards, tangrams, or non-structured material, such as food containers, beans, plasticine balls, used to develop the mathematical concepts of shape, number, size, etc.?	Resources and representations
Q1.2. If used, give an example and say how it is used.	Resources and representations
Q1.3. Is a textbook used or paper and pencil worksheets, or both?	Resources and representations
Q1.4. Are they used every day, some days of the work or sporadically?	Resources and representations
Q1.5. Is the book, or the worksheets, combined with manipulative material, or is only printed material used?	Resources and representations
Q1.6. If they are combined, give an example to show how they are combined	Resources and representations
Q1.7. When such material is used, how is it distributed in the classroom?	Resources and representations; organization for learning
Q1.8. Is the type of material used to work on mathematical content selected specifically for each type of topic or is the choice random?	Resources and representations; organization for learning
Q2.1. With respect to your answers above, do they coincide with what you expected as regards the most widely used material to teach mathematics?	Theory-practice relationship
Q2.2. When a child fails to understand some of the content or a concept in the book, does teacher turn to other material or everyday situations to help child resolve any doubts?	Attitudes in mathematics class
Q2.3. Give an example of something you have experienced to illustrate this	Attitudes in mathematics class
Q2.4. Is the teacher's attitude towards their students positive or negative when they have difficulties in understanding a concept?	Attitudes in mathematics class
Q2.5. Describe a case to show the attitude you allude.	Attitudes in mathematics class
Q3.1. Is the mathematics content dealt with in isolation or have you seen it worked upon in conjunction with other areas of the curriculum?	Making connections
Q3.2. Give an example from you experience.	Making connections
Q3.3. What strategies does the teacher use to work jointly on different subjects?	Making connections

Table 2. Survey questions 4 to 6 and the principle of good practice to which they are related

Question	Principle of good practice
Q4.1. Do children feel capable, confident, afraid or anxious about maths? Justify your answer.	Attitudes in mathematics class
Q4.2. Have you noticed the girls generally feeling differently about maths compared to the boys? Justify your answer.	Attitudes in mathematics class
Q4.3. Have you perceived the children's progress in learning mathematics?	Theory-practice relationship
Q4.4. Describe how they act when they work on the subject in class.	Theory-practice relationship
Q5.1. Do you feel equipped to work with the children?	Theory-practice relationship
Q5.2. Where do you think that the training you receive at the university should be improved, in the mathematical content, in the strategies to address this content, in the content related to the interaction between teacher and pupils, or in other questions?	Theory-practice relationship
Q5.3. Does the training you have received in mathematics teaching during your degree studies fit with what you have encountered in the classroom at the school?	Theory-practice relationship
Q5.4. What matches and mismatches have you observed in your training?	Theory-practice relationship
Q6.1. How do you think teacher that mentored you at school felt when teaching mathematics?	Attitudes in mathematics class
Q6.2. Did you notice differences with what they felt when teaching other subjects?	Attitudes in mathematics class
Q6.3. Describe the difference or differences you observed.	Attitudes in mathematics class
Q6.4. How do you feel when you teach mathematics compared to when you teach other subjects? Justify your answer.	Attitudes in mathematics class
Q6.5. Describe the difference, if there is any.	Attitudes in mathematics class
Q6.6. What feelings do you have when preparing, organizing and putting your mathematics classes into practice?	Attitudes in mathematics class
Q6.7. How would you rate your level of satisfaction with the mathematics training you have received at university?	Theory-practice relationship

These principles were as follows: resources and representations, organization for learning, making connections, attitudes in the mathematics classroom and the relationship between theory and practice.

Procedure

The procedure was authorized by the social research ethics committee of the University of Castilla-La Mancha (Spain), under code CEIS-634122-B5K2. All the undergraduates assigned to the area of mathematics participated in the reflective seminar (González-Garzón & Gutierrez, 2012; Hummes et al., 2019; Morales-López & Moll, 2017) in which the theory underlying the educational research analyzed and classroom practice were revisited, although only those providing their informed consent were surveyed. The seminar focused on characterizing good practice in mathematics

Table 3. Responses to questions on the use of teaching resources

	Are the following used …?			
Q1.1.	Structured manipulative material	Non-structured manipulative material	Both	Neither
Frequency	5	3	7	8
Q1.3.	Textbook in paper or digital format	Paper and pencil worksheets	Both	Neither
Frequency	6	4	13	0
	They are used …			
Q1.4	Every day	Some days	Only sporadically	No response
Textbooks	16	0	0	7
Paper and pencil worksheets	8	3	5	
	They are combined		They are not combined	
Frequency	13		10	
	They are used …			
	To facilitate understanding of mathematical content	Randomly	They are never used	No response/other response
Frequency	13	0	2	8

education, drawing on Anthony and Walshaw (2009) and Planas and Alsina (2014), also incorporating reflection on participants' experiences of mathematics and their feelings or affect towards the subject across their different stages of education (Coppola et al., 2015). The participants observed the in-service teachers with whom they worked for 80% of the 240 hours of their practicum II, given that the seminar took place once their teaching practice had begun.

Data Analysis

The Microsoft Excel software package was used to analyze the closed questions, obtaining the frequencies and percentages of the responses, while the ATLAS.ti software (v. 22) (ATLAS.ti, 2022) was employed for the open-ended questions. To analyze the latter, we extracted codes for their interpretation using a deductive analysis agreed upon by three of the authors of this work (Taylor et al., 2015).

RESULTS

The results were organized following the principles of good practice indicated in **Table 1** and **Table 2**.

Identifying Good Practices

Resources, representations, and organization for learning

Eight questions were included, of which six referred to teaching resources (Q1.1, Q1.2, Q1.3, Q1.4, Q1.5, and Q1.6), and two to classroom organization (Q1.7 and Q1.8). The response frequencies for the questions on the use of teaching resources are shown in **Table 3**.

Two of the participants that reported the teachers with whom they were undertaking their teaching practice used no manipulative material in the classroom gave the following answers to Q1.1.:

> "… Using manipulative materials, except in probability and measurement, or cards to do fun things, in higher grades, is complicated. It is more useful to exemplify with funny examples using web pages or applications, Kahoot, which, being included on the Carmenta platform [a regional classroom digitalization project], they can use it, is more useful as I see it."

Another participant states

> "… I haven't seen any. I don't know if it's because of the grade, sixth. The teacher follows the book and sets the exercises. They understand the things well and they haven't needed any other material."

Q1.2 asked about examples of the material used and how it is used. The participants specified these in some cases: one participant reported that they used boxes and containers for geometric figures, another that logic blocks were used for flat shapes, and another that models of prisms were used to calculate area and volume. Another two alluded to the use of geoboards and tangrams for the same purpose. The use of sheets of paper or plasticine for the study of fractions was reported by three, while three others referred to working with multilink cubes or Cuisenaire's rods. Another participant stated that non-structured material was used for work on quantity and basic operations. Two students reported the use of material for magnitudes, with measuring instruments such as rulers being used, three used scales, one used measuring jugs and two a digital clock. However, three of the participants reflected that they could give few examples because manipulatives were barely used in the classrooms where they were

doing their teaching practice. Only one participant alluded to the use of experiential learning for certain topics such as topological notions.

With relation to Q1.3 and Q1.4 on the use of printed material, textbook or pencil and paper worksheets, more than half use both textbook and worksheets, with more than 75% using a textbook on a daily basis. More than half also use textbook or worksheets combined with (Q1.5). For this question, however, two of the students report the following:

> "… The textbook is used for explaining, The manipulatives are only used for free play."

and,

> "Practice is not interrelated with mathematics, since 80% use the book and worksheets, 20% use material such as the abacus, puzzles, trees to be decorated with plasticine, with no relation to the content ... a real pity."

Regarding the combination of manipulative materials with books or worksheets, Q1.6, only one participant stated these were typically combined. In other classrooms, the manipulatives were used to explain the worksheets or the content the book, with the students subsequently being allowed to use them. Four participants reported the sporadic use of a combination of the methods. On the other hand, four participants stated that worksheets were never combined with manipulatives, and two only sporadically. Also, in case of one participant, teacher never used manipulatives.

A total of 11 participants gave an answer to Q1.7, the question on the organization of teaching resources in the classroom. The participant that reported the manipulatives were appropriately combined with books and worksheets also stated that they were distributed to each child by the teacher, while another participant, who said they were used only for some mathematical topics, reported that the teacher distributed them once the pupils had been divided into groups of four or five. Meanwhile, four participants stated that manipulative material was not distributed as it was not used. Two report that manipulatives were available but were stored in drawer units, while two others said they were accessible in the construction/manipulation corner.

Question 1.8, on the choice of teaching materials for mathematical content, was answered by 17 participants. More than half of them said it was chosen in relation to the content in order to facilitate learning and understanding. Of the 8 participants that did not give a specific answer to the question, it is worth noting those whose reflections suggest a mismatch between what they study in their courses on theory and what they find in the classroom:

One said,

> "It was a bit disappointing to see that the vast majority of mathematical content in primary is dealt with using the textbook or worksheets, since they could be combined with material that are motivating for them, or at least for the students to have various ways of learning maths, and to avoid the monotony or unawareness causing them to reject maths, as so often happens."

Another reported that

> "… using the book and worksheets, and giving schoolmasterly explanations, so they hardly ever use other types of material, which is not all what I expected …"

And in the words of a third,

> "Once, to explain liter, half-liter and quarter-liter, the teacher brought a jug and a big bottle. Just that ..."

Making connections

We included three questions on making connections with other areas, Q3.1, Q3.2, and Q3.3. With regard to Q3.1, most of the participants reported that mathematics is worked upon in isolation, while only a minority say that connections were made with other areas. When asked about the areas on which work was typically conducted in connection with mathematics, Q3.2, two participants said mathematics work was connected with natural and social sciences (e.g., for scales on maps or measurements of plants in the garden), one alluded to art (e.g., in the construction of stained glass windows), two mentioned physical education and, as examples, referred to working on probability with basketball shots, topological notions, when running and counting steps, measurements of time and other magnitudes, such as length. In one case, it was said connections were mainly made with Spanish language, and, in two cases, it was used in conjunction with all subjects. Meanwhile, two participants alluded to its sporadic use in connection with English as a second language, in the form of the names of numbers and geometric figures.

Of the responses to Q3.3 on the strategies used by the teacher, it is worth noting that one participant responded negatively on the connections made between mathematics and other areas, yet said that the teacher

> "… connected art, poetry, and whatever came up in science, for example, for chemical reactions, they did a drawing or a project, but not with maths."

Another two participants said that work was done based on experiences from the students' daily lives, bringing them into classroom, such as a birthday party.

Table 4. Frequencies for teachers' attitudes in the case of difficulties encountered by primary students

Q2.2	Other material	Situations from everyday life	Both	Does not change material
Frequency	5	10	4	3

Table 5. Teachers' feelings in the mathematics class

P6.1	Comfortable	Confident	Good	Others
Frequency	8	3	7	2

Table 6. Primary school students' feelings in the mathematics class

Q4.1	Capable	Confident	Afraid	Anxious or nervous	Insecure	Some capable others afraid
Frequency	6	5	3	5	3	4

Table 7. Pre-service teachers' feelings in the mathematics class

P6.4	Comfortable	Confident	Good	Nervous	Mixed feelings
Frequency	8	6	2	3	4

Attitudes in the mathematics class

This section includes 9 questions, which are divided into attitudes of the teacher (**Table 4** and **Table 5**), of the primary schoolchildren (**Table 6**), and of the pre-service teacher (**Table 7**).

In this case, one participant reported that the teacher used other material, but never in the case of mathematics, and it was thus not counted as a response to this question, leaving N = 22. Meanwhile, another participant said the teacher used other examples from the book or the Internet, suggesting that they used other didactic material, but not manipulatives. A total of 16 participants answered Q2.3 explicitly, reaffirming their response to the previous question, but failing to give examples in 8 of them. The examples given by the remaining two were the use of everyday shopping situations to work on money, the decimal representation of monetary quantities and percentages, and another two reported the use of manipulative material to practice volume and mass. Additionally, the use of board games with dice and cards for probability was alluded to by another two participants, as well as the use of rulers for notion of number and operations. The last one showed that logic blocks were used to work on plane figures.

With regard to the attitude the teachers showed towards the doubts or needs of their pupils in the mathematics class, Q2.4, 20 reported this as positive, while 2 said it was negative. In Q2.5, the participants generally responded by describing the attitude once more.

Table 5 shows the responses to Q6.1 on how the teachers feel when they are in the mathematics class

This question was not answered by 3 participants, with responses such as the following appearing in the others column:

> "… had told them that she had always been bad at it, she didn't like it and didn't feel comfortable with it, that she was quite nervous, but she showed the children a positive and helpful attitude so that what happened to her wouldn't happen to them,"

and

> "... if she can she avoids them (mathematics classes)."

As to Q6.2 on whether there were differences with other areas, 12 participants answered affirmatively, while 8 answered negatively. Of the answers on differences (Q6.3), only a few were more specific. In these responses, it is worth highlighting those given by four participants who said that the subject the teacher liked most was mathematics, and that they taught it with great enthusiasm. In contrast, one participant said

> "… all they did (in mathematics class) was to follow a script, nothing more);"

while two others stated

> "... You could really see that language and social sciences were what they liked most, it was really noticeable,"

and

> "... I think they liked other subjects like language or social sciences more ..."

Table 6 shows the 23 participants' responses to Q4.1 and Q4.2 on primary children's attitudes.

One pre-service teacher that said the children are afraid also stated that

> "… they don't really like maths much."

For Q4.2 on differences in feelings between boys and girls in the mathematics class, 15 participants answered that they have observed no differences, and of those that answered affirmatively, two said that the girls are brighter, one said that the girls need more help, while

Table 8. Theory-practice relationship in teaching materials

P2.1	Not at all	Partially	Totally
Frequency	9	4	8

another reported that the girls tend to be more insecure in the mathematics class.

Information on the pre-service teachers' attitudes towards teaching maths was collected in Q6.4, Q6.5 and Q 6.6. **Table 7** presents the responses to QP6.4.

The participants that reported mixed feelings said that they felt nervous or a little insecure at the beginning, but, by the end, they felt good.

A total of participants answered Q6.5 on the differences in their feelings in mathematics compared to other classes. Of these, three said that mathematics motivated them more than other subject areas, and two that it motivated them less. Two other participants answered extensively, stating that

> "… I've never liked maths and I've always found it hard. In baccalaureate, things changed a bit, but my teachers didn't help me to feel good about the subject…"

or

> "… I feel under pressure, for example, I feel I have to prepare it more than the other class … Then ,when I was teaching, I felt quite at ease, but I didn't prepare it the same, I anticipated the doubts, so I'd be able to respond to them."

As to how they felt preparing their mathematics class, 14 replied that they felt very satisfied, three others said they felt satisfied, and one that they felt pressure when starting to prepare, but then felt good. The rest of the participants did not answer this question.

Relationship Between their Initial Training and the School Classrooms

We included six questions on the relationship between theory and practice in the pre-service teachers' training. **Table 8** shows answers to Q2.1 on coincidence between use of teaching materials and theory.

Two participants did not respond. The way the participants framed their responses shows that they had built their expectations on the basis of their training at their faculty of education. On the one hand of the eight that agreed, seven state that at university they had been taught to teach mathematics using a lot of manipulatives, and some of them thought this would be the reality in the classroom. However, one of these participants said they already knew the school and, thus, although there were no manipulative materials, this met their expectations, as they did not expect them either. This shows this participant had a different expectation based on the teaching theory courses and their previous experience as a student at the school. On the other hand, nine of the participants found practically no manipulatives in the primary classrooms. In addition, four reported partial agreement, as they had found materials for certain topics, but not for all of them.

Two questions, Q4.3, Q4.4, referred to the pre-service teachers' perceptions of the learning process, being answered by 21 and 17 participants, respectively. A total of 19 participants reported perceiving learning in the primary school students, and two reported perceiving it sometimes. None said they had perceived no learning.

Those answering *sometimes* gave evidence for their reply, while the others did not. They said:

> "… But with those who are bad at maths, it's like they don't improve no matter how much you go forward with them. For example, there are two girls who are really good at everything, and in maths they work, and we work with them, they have private tutoring and everything, yet they only just pass ... I don't know why that would be".

or

> "… There are some students who, yes, you can notice some progress, as they do the maths on their own, looking for solutions to do it, either using their fingers, with rulers, asking the teacher and they end up getting it right on their own."

Questions 5.1 to 5.4, and Q6.7 inquire about the appropriateness of the participants' training and its usefulness in their teaching, as well as their satisfaction with the training received.

Q5.1 on whether they were equipped to teach was answered by 20 participants. Of these, 19 said they were, despite still having a lot to learn a lot to learn, and one did not see themselves as ready. The latter acknowledged that their university education and teaching practice had provided them with a great deal of training. They felt, however, that the litmus test would be when they were on their own in the classroom and felt they would lack the tools to perform adequately.

Table 9 shows the responses on what the participants felt needed improving in their university teacher training.

Below, we present some of the participants' reflections, which, despite being somewhat contradictory, illustrate the pre-service teachers' beliefs. For example, on strategies, one participant says:

> "… I would like there to be more on the strategies needed to explain certain content, and not just

Table 9. Elements for improvement in pre-service teacher training proposed by the participants (N = 17)

P5.2	Content	Strategies	Teacher-student interaction	Practice	Everything	Nothing
Frequency	1	6	3	17	3	1

Table 10. Pre-service teachers' levels of satisfaction with their initial training and their frequencies (N = 21)

P6.7	Very satisfied	Satisfied	Neutral	Dissatisfied	Very dissatisfied
Frequency	3	12	1	2	0

> general strategies ... for example 'measurement' I would like to have known 'tricks' or techniques to make it easier for children to learn."

On teacher-student interaction, there are contrasting ideas. For example, one participant said:

> "… the greatest weakness I see in the teaching at the university is with respect to classroom management, that is to say, in the little training we receive in this area, I mean, there is no work at all on teacher-student interaction …"

While a third participant reported:

> "… I think we talked about interaction in the psychology classes, but I don't think it's necessary. I did what I thought I had to do, and it worked for me."

Regarding the demand for more teaching practice, almost all the participants suggested it should start earlier than it currently does. They believed, for example, that it would be good to engage in placements in different schools in order to gather different perspectives, or that case studies could help them learn to deal with specific learning difficulties and to acquire different teaching techniques.

As regards Q5.3 on the match between their training at the faculty in the didactics of mathematics and what they witnessed in the classroom, the answer was affirmative for six of the participants, negative for three of them, with 11 partially agreeing. One of the participants did not answer. The justifications given in the answers to Q5.4 vary. On the one hand, a majority of participants considered the need for teaching practice from the first year so as to have contact with children in combination with the material, and not to explore the material without pupils; on the other hand, some of the pre-service teachers (six) recognized that what they are taught at the faculty of education suggests a more modern approach, with a greater variety of materials, but when they arrive in the classroom, they see that the actual teaching is not the same. Consequently, they question the initial training they received, but not the practice they observed in schools. In particular, two of those who said this consider that the more modern approach might be useful for the earlier years, but not for the higher ones, 5th or 6th grade, where they were doing their practicum. They thus do not question the absence of the methods about which they learnt in their training. Only one of these five students saw the mismatch and is unsure whether it is the faculty or the school that should change. Finally, one of the students said that

> "… the media have changed at school, with digital whiteboards, tablets, but all the rest is still the same."

The pre-service teachers' overall satisfaction with the initial training received is the subject of Q6.7. **Table 10** shows the responses.

Of the responses given, 15 participants were satisfied, and, of the two that were dissatisfied, one expressly stated that their university training was not very useful. The comments on satisfaction focused once more on the elements they would change, which were already covered in the answers to Q5.2.

DISCUSSION

The overall aim of this research was to analyze the contributions of the practicum to the development of good practice in mathematics education, with two specific aims: ascertaining whether pre-service teachers identified good practice, and to collect their view of the relationship between theory and practice during their training received.

With regard to the identification of good practices, the majority of participants responded that found teachers made appropriate use of teaching materials and that the organization of these materials in the classroom is adequate. However, some of the participants were unable to give examples and there were even some participants that deemed it appropriate that manipulative materials were not used in 5th and 6th grade. These statements are evidence that their previous experiences in education bore more weight with these pre-service teachers than their theoretical training in the faculty, which is consistent with the findings of Latorre Medina and Blanco Encomienda (2011).

Nevertheless, the participants recognize that there is often excessive use of the type of material that is not supported by research in mathematics education, such as printed worksheets or textbooks (Alsina, 2010). This suggests that the theoretical and practical classes given in the courses on the didactics of mathematics at the faculty have helped them to assimilate the use and

appropriate presence of material. However, what they observe is not always what they have learnt leads them to expect. Thus, when the pre-service teachers allude to mismatches with what they expected, the expectations of the majority are based on the theory they were taught during their degree. This runs counter to the findings of Latorre Medina and Blanco Encomienda (2011) who attribute greater weight to previous experience. However, the learning undertaken in the faculty classrooms does not have the same effect on all students, as there are still a minority for whom their previous experience as school students prevail.

As regards making connections across curricular areas, most participants perceive that such links are scarce in the mathematics class, which coincides with the findings of León Mantero et al. (2020) on in-service teachers.

Meanwhile, the in-service teachers exhibit a positive attitude towards their pupils' difficulties, and the participants report that the teachers provide examples that help the children overcome their difficulties, even using different types of material.

In the question on how the in-service teachers felt in the mathematics class, 90% describe this positively, with the remaining participants reporting it negatively, such as … "*she had been bad at maths herself,*" that is, the teacher herself spoke about her experiences with mathematics when at school. This statement underscores the suggestions of Coppola et al. (2015) on the creation of attitudes based on previous experiences of success or failure, and how these prevail over time (Latorre Medina & Blanco Encomienda, 2011). However, when delving into whether they felt the same or different in other curricular areas, 40% of the participants stated that there was a difference with other subjects, with half saying it was because they liked mathematics more than other areas, and the rest the contrary. All the statements, both those showing a positive and negative attitude, are consistent with previous studies relating teaching practices with attitudes towards mathematics (Coppola et al., 2015; Prada Núñez & Hernández Suárez, 2021), demonstrating that the participants find that the teacher's attitude is reflected in their classroom practice and in the attitudes of their students (Mensah et al., 2013).

Furthermore, there is a piece of evidence that is striking. This was the reporting of an in-service teacher who moved on to something new despite the fact there still being students with doubts, because they had already spent too much time explaining the content. For the pre-service teacher who witnessed this, it was useful to relate this attitude to what was taught in the psychology course in their training. Therefore, the question in the survey helped them link theory to practice.

In the case of the primary students, it is worth noting that our participants mostly perceived no differences between girls and boys. Those that did differed as to who appeared better at mathematics, with two saying the boys and two the girls. The words most often alluded to as positive feelings in the pupils were *capable* and *confident*, while the most frequent negative feelings were *anxious* or *nervous,* followed by *afraid* or *insecure*. In the case of the pre-service teachers, they mostly report feeling *comfortable* and *confident*, although some refer to feeling *nervous* and *mixed feelings* (33%), which we understand to be both positive and negative. Reflection on these questions helped the in-service teachers become aware of their feelings towards mathematics and mathematics classes, and to channel them positively, in line with the findings of Coppola et al. (2015). We can thus say that reflection helps them manage their emotions and leverage the knowledge acquired in their initial training.

Finally, the questions about their level of agreement with the appropriateness of their teacher training for what they believe will be their profession, most agree with the need for more practical training, as well as sharing the wish for it to start earlier. Most of them agree, however, with the current training plan and the practical and theoretical subjects involved in it. In the case of the courses on the didactics of mathematics, they mention a lack of appropriate material and approaches to work with actual primary students, since, although this is done in theory, the theoretical content fails to be contextualized.

CONCLUSIONS

The analysis of the pre-service teachers' responses leads us to conclude that the majority identified principles of good practice in school classrooms during the teaching of mathematics. Additionally, a majority see a relationship between their initial training in mathematics and what they observed in these classes. From this we can assume that, although there is room for improvement, the combination of theory and practice in the programs in Spain prepare mathematics future teachers for their job in a great extent.

As a future proposal, we would like to expand the sample size, since the participants in the present research were all enrolled at the same faculty of education. We would thus be able to verify whether the results obtained can be generalized.

Furthermore, as a proposal, the university students' responses suggest various modifications that could be made to teacher training programs. On the one hand, practical courses should be taught across all four years of the degree courses in PE, as this is a particularly relevant and exciting area for students studying to become teachers (Caro et al., 2021). On the other hand, we suggest reducing the ratio of students per lecturer in

class, in order to be able to provide more individualized educational attention on good educational practices in the area of mathematics. Finally, it would be interesting to have a bank of schools or in-service teachers that implement good practice in mathematics classes, in order to guarantee that practical training is made up of experiences that university students can take as a reference for their subsequent teaching career.

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