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Attitudes towards Mathematics in Future Elementary School Teachers

María José Seckel[a]
José Hernán Parra[a]
Claudia Vásquez[b]
Francisca Bravo[c]

[a] Universidad Católica del Maule, Departamento de Formación Inicial Escolar, Avenida San Miguel 3605, Talca, Chile.
[b] Pontificia Universidad Católica de Chile, Departamento de Didáctica de la Matemática, O´Higgins 501, Villarrica, Chile.
[c]Universidad Católica del Maule, Departamento de Matemática, Física y Estadística, Avenida San Miguel 3605, Talca, Chile.

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ABSTRACT

This study has the purpose to describe the attitudes towards mathematics of 239 future elementary school teachers of a Chilean university, as well as the relation among such attitudes and gender, the math scores taken from the university selection test (PSU, according to its Spanish translation) and the intent to choose math as specialization. The present study used a quantitative approach and the data collection was conducted by using a Likert questionnaire, which was applied before starting the training courses. The results showed that a high percentage of participants declared to have a positive attitude towards mathematics, being the dimension "Utility of mathematics" the one with the higher percentage. Moreover, it could be observed that there is no relation between a negative attitude and the variables of gender, PSU and intent to choose math as specialization. The study suggests studying in depth the factors that affect the development of positive and negative attitudes towards mathematics as well as the course of actions that should be taken in order to strengthen them during the training program

Keywords: Attitude towards mathematics, admission profile, teacher training.

Atitudes em relação à matemática em futuros professores do ensino fundamental

RESUMO

Este estudo tem como objetivo descrever as atitudes em relação à matemática de 239 futuros professores do ensino fundamental de uma universidade chilena, bem como a relação entre essas atitudes e gênero, as notas de matemática obtidas no teste de seleção da universidade (PSU, de acordo com a tradução em espanhol) e a intenção de escolher matemática como especialização. O presente estudo utilizou uma abordagem quantitativa e a coleta de dados foi realizada por meio de um questionário Likert, que foi aplicado antes de iniciar os cursos de treinamento. Os resultados mostraram que um alto percentual de participantes declarou ter uma atitude positiva em relação

Corresponding author: Belén Giacomone. Email: belen.giacomone@gmail.com

à matemática, sendo a dimensão "Utilidade da Matemática" aquela com o maior percentual. Além disso, pode-se observar que não há relação entre uma atitude negativa e as variáveis de gênero, PSU e intenção de escolher matemática como especialização. O estudo sugere estudar em profundidade os fatores que afetam o desenvolvimento de atitudes positivas e negativas em relação à matemática, bem como o curso das ações que devem ser tomadas para fortalecê-las durante o programa de treinamento.

Palavras-chave: Atitudes em relação à matemática, perfil de admissão, formação de professores

INTRODUTION

To learn mathematics is usually measured by the students' academic success from the knowledge point of view, regardless the affective dimension (Gil, Blanco & Guerrero, 2005). Even though such dimension is a key factor for the students to achieve success in this discipline (Gómez-Chacón, 2009; Gamboa, 2014). This is so because the more positive the attitudes towards mathematics are: the higher will be the perception of its utility, self-awareness will be better, the students will be more confident when learning mathematics and a better behavior towards its approach will be reached (Palacios, Arias & Arias, 2014). All the aforesaid, becomes relevant when it is connected with the attitudes in the teaching training and related with a certain topic. Because, if a teacher does not value a topic or consider he or she is not prepared to teach it or even dislikes it, he or she will not accomplish an effective learning from his or her students (Estrada & Batanero, 2015). Therefore, it is important to give more value and reinforce the affective component in the teaching training.

In terms of attitudes, different authors agree on the fact that the attitude towards mathematics is a predisposition to answer positively or negatively to the assignments. Such response will be influenced by factors like: emotional disposition, personal qualities, self-perception and anxiety, among others (Casis, Rico & Castro, 2017). According to Ajzen and Fishbein (2005) the attitude towards mathematics is a multidimensional set of cognitive, emotional and conative elements (acting for or against an object.)

Taking all the abovementioned into account and considering the unanimity in the field to define attitude (Philipp, 2007), we base the present study in McLeod's (1992) perspective, for whom the affective domain is understood as a "wide range of believes, feelings and moods, which usually are considered to be something more than the cognition's pure domain" (p. 576). Accordingly, we refer to term "affections" in a broad sense and we consider the emotions, beliefs and attitudes as their main descriptors. We understand 'attitude' as a "mental construct, not directly observable but rather inferred from an attitude scale of value or from the observation of the individuals' behavior" (Batanero, 2009, p. 6).

From this perspective, the attitudes towards mathematics are a factor that can determine the mathematics performance, at school as well as at university. At school

level, it can be observed that traditionally, during the first years the students' attitude towards mathematics is a positive one, turning into a less favorable one throughout the years (Pantziara & Philippou, 2015; Dowker, Cheriton, Horton & Mark, 2019), when a rejection towards the learning of such discipline is observed. So, taking into account the gender variable, some authors consider that once women achieve adulthood they show a lower attitude than men towards mathematics (Charles, 2017), thus determining the university career selection.

On the other hand, it can be observed a relation between the teacher-training attitude and the math learning level reached by the students. That is to say, that the teacher-training attitude has an impact on the math teaching practices and therefore affecting the attitudes and learning of his or her students (Jong & Hodges, 2015; Hobri, Dafik & Hossain, 2018), specially during the transition from elementary to secondary level (Deieso & Fraser, 2018). Thus, different studies have focused on studying the attitudes of teachers already teaching or during their initial training,exploring the attitudes towards mathematics in a broad sense (Beilock, Gunderson, Ramírez & Levine, 2009; Tsao, 2014), or in specific mathematical topics, as well. For example, studies considering attitudes towards statistics and probability (Vásquez, Alvarado & Ruz, in press).

Tsao (2014) points out the importance of doing a follow up on the attitudes towards mathematics during the entire initial teaching training process for the elementary school, in order to determine the actions that should be followed in the succeeding years of the career and even at the moment the teachers graduate. In this sense, it is considered to be most necessary to continue exploring how the attitudes manifest during the early years of training of the future elementary school teachers. Particularly, in the light of the background information, the investigation presented agrees with the first step of a broader project, which purpose is to describe the attitudes towards mathematics manifested by the students who enter the careerin General and Basic Teaching Education with specialization (hereon: future elementary school teachers). Such purpose allows to know the admission profiles of the career. In this sense, taking into account the results it is intended to develop solving actions during the initial training process, because the lower attitudes can be reverted from one semester to the other under appropriate training circumstances (Evans, 2000; González, 2017). The latter implies to expand the quantitative data presented in this research through qualitative techniques, allowing the exploration in deep the previous school experiences of the participants (Estrada & Díez-Palomar, 2011; Pérez-Tyteca, Monje & Castro, 2013).

In particular, the expectation is to respond the following questions: What attitudes towards mathematics do the future elementary school teachers have when they start the career? What is the connection among the attitude towards mathematics and the score reached at the university selection test in mathematics, gender and the declaration of intent of the specialization these future elementary school teachers plan to follow?

THEORETICAL FRAMEWORK

There are two types of theories within the mathematic education field that explains theoretically the research conducted: the attitudes towards mathematics and the previous researches about the attitudes towards mathematics in future elementary school teachers.

Attitudes towards mathematics

As from the second half of the twentieth century several new philosophical theories arise in relation to the nature of mathematics; introducing a naturalist trend of such discipline by which a critical vision is included on how the social aspects have an impact on the knowledge acquisition (Socas & Camacho, 2003). In such context, the development of researches that consider the affective educational domain of the teaching and learning processes of mathematics becomes stronger (i.e. Seckel & Font, 2020), researches that understand the need of contemplating such domain (i.e. Hummes, Font & Breda, 2019), actually comprehending that not only the disciplinary knowledge is the element that determines a good academic performance, but also that there are other elements such as the notions (beliefs), emotions and attitudes (among others) which can also explain the affective educational domain (McLeod, 1992; Gamboa, 2014).

The features that set the affective domain have been the center of interest in different researches. In some of those investigations, the features have been analyzed separately or establishing relations, underlining that the attitudes towards mathematics act as bridges between beliefs and emotions (Di Martino & Zan, 2011). Moreover, the importance of measuring the attitudes towards mathematics at both school and university level is also a key feature. This being so, since it was observed that there is a relation between the low attitudes and the performance in mathematics (Cargnelutti, Tomasetto & Passolunghi, 2017). Therefore, an early detection is crucial to elaborate plans that focus on reverse the low results (González, 2017). The review of the literature on the matter reveals that the attitudes towards mathematics can be explored from the measurement of positive categories (liking mathematics, self-confidence on mathematics, among others); or negative categories (anxiety towards mathematics, failure expectations, etc.) (Dowker, Cheriton, Horton & Mark, 2019). Such reviews have triggered the design of multiple instruments, which intend to measure the attitudes at different educational levels (Ganley & McGraw, 2016; Palacios, Arias & Arias, 2014). Particularly, the measurement of the attitudes towards mathematics among teachers (in active positions or during their training level) has been studied due to its importance throughout the training processes (mathematics competence development when teaching) and the impact those attitudes have on the students (Wilkins, 2010; Dewi y Fah 2018).

It is important to mention that the evaluation of the attitudes towards mathematics has been developed widely through quantitative techniques (questionnaires or the Likert scale test). However, several authors agree on the importance to carry out complementary

studies, such as qualitative ones that will collect useful information about the elements or training experiences that will have a positive or negative impact on the teaching process. All of the above will allow orientating the intervention plans (Estrada y Díez-Palomar, 2011; Pérez-Tyteca, Monje y Castro, 2013).

Preliminary researches on the attitudes towards mathematics in future elementary school teachers

The attitudes towards mathematics in future elementary school teachers have been studied more than the attitudes in teachers in active positions because it is considered that in the early process of teaching training it is possible to develop efficient learning methods that allow afterwards revert the negative attitudes and encourage the positive ones (Gresham, 2007; Ren & Smith, 2017).

In addition, it has been noticed that the researches made on future elementary school teachers have been conducted considering several focus of interest. In some of the works, the attitudes towards mathematics are described (Casis, Rico & Castro, 2017), while in others such attitudes are linked with other variables such as: academic performance, considerations over teaching practices, willingness to study mathematics more thoroughly, gender, among others (Maza, 2002; Beilock, Gunderson, Ramírez & Levine, 2009; Tsao, 2014; Ren & Smith, 2017; Nortes & Nortes, 2017).

In general, researches have shown that the number of women in the training process of becoming elementary school teachers is greater than men. This fact has caught the attention for studying the relation between the attitudes towards mathematics and gender. Moreover, some researches point out that a woman, once an adult, tends to show higher levels of anxiety towards mathematics, having a negative impact in the girls' academic performance (Beilock, Gunderson, Ramírez & Levine, 2009). Also, there has been an established relation between the previous training received by the future mathematics elementary school teachers and the attitude showed towards the discipline. However, the results are inconsistent, in some cases the relation is observed (Maza, 2002) and in others it isn't (Nortes & Nortes, 2017). Finally, the study made by Hackett & Betz (1989) is significant, they point out that the variables of mathematics self-confidence and the liking mathematics could be good indicators of the expectations the students have when choosing math courses. This fact has lead to consider the relation between the attitudes towards mathematics and the intentions to choose the mathematics' specialization.

METHODOLOGY

With the intent to explore the attitudes towards mathematics in the future elementary school teachers and the relation with variables such as: gender, the math scores taken from the university selection test, and the intent to choose mathematics as specialization, it was decided to follow a quantitative methodology approach (Hernández, Fernández,

& Baptista, 2014). The design of this investigation is descriptive, because it is intended to do precise and very careful descriptions of the investigated educational phenomenon (Bisquerra, 2012).

Participants

The study was conducted with a sample of 239 future elementary school teachers at a university located in the central-southern region of Chile, among the classes of entering students 2017 and 2018, who were admitted to the career through a University Selection Test (PSU according to its Spanish translation.)

The 85% (203) of the participants are women, against the 15% (36) who are men. Regarding to their ages, the age average is 20 years old, since the 71% of the participants are between 18-20 years old. It is important to point out that, also at the time the study was conducted, the participants were initiating their first academic semester, and they didn't start taking their specialization courses yet. Lastly, also mentioning that the type of sample used was unplanned because the participants involved were all the students who had attended class the day the administration of the instrument was set, and they were not aware of this fact. On table 1 it can be observed the participants' characteristics.

Table 1
Participants' Characteristics

Mathematics PSU	f	%	Gender		Intent to choose Math as specialization	
			Woman (f)	Man (f)	Yes (f)	No (f)
293-386	1	0.4	1	0	0	1
387-480	22	9.2	20	2	3	19
481-574	163	68.2	139	24	68	95
575-668	51	21.3	39	12	37	14
669-762	1	0.4	1	0	1	0
763-856	1	0.4	1	0	0	1
Total	239		201	38	109	130

Instrument

The data collection was conducted through the survey technique following the design of Likert scale (Torrado, 2016). Specifically, the Scale of Attitudes towards Mathematics (EAM according to the Spanish translation of *Escala de Actitudes hacia las Matemáticas*) designed and supported by Palacios, Arias and Arias (2014). This instrument considers 32

items that consist of a statement and a Likert scale of five points: (1: strongly disagree; 2: disagree; 3: neither agree nor disagree; 4: agree; and 5: strongly agree.)

Following the proposal of Palacios, Arias and Arias (2014), the instrument applied is focused on the dimensions showed in Table 2.

Table 2
Dimensions items

Dimensions	Scale items
Perception of mathematics incompetence (inability perception, clumsiness, confusion, difficulty and failure expectations)	1-2-3-4-5-6-7-8-9-10-11-12
Liking mathematics (positive emotions during the mathematics' learning process)	13-14-15-16-17-18-19-20-21-22-23-24
Utility perception (mathematics' utility and needing)	25-26-27-28
Mathematics self-confidence (self awareness regarding skill and ability to learn mathematics)	29-30-31-32

From the total of items that represent the instrument, 14 are stated in a positive way (items: 13, 14, 15, 16, 17, 19, 21, 24, 26, 27, 29, 30, 31 and 32) and 18 in a negative way (items: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 18, 20, 22, 23, 25 and 28). The aforesaid, in order to avoid the acquiescence of the subjects consulted (Morales, 1988) at the time of recording the results, the punctuation was inverted (1: strongly agree; 2: agree; 3: neither agree nor disagree; 4: disagree; and 5: strongly disagree) therefore, it was possible to interpret them correctly and also all the items had the same direction. The latter, allowed to have an homogenous comparative scale of all the items, in which the average measure of a more (or less) higher response will always indicate a more (or less) positive attitude, regardless of the way the item was written, that is in a positive or negative way.

Research Procedure

This study's authors conducted the administration of the instrument. They informed the participants the importance of their sincere answers, since such responses would be anonymous and would have no influence on their pending courses. Prior to conducting the sample, the free and informed consent was obtained from the students. The time limit offered to answer the sample for 45 minutes.

Data Analysis

The statistics package SPSS was used for the treatment of the data statistics, which allowed establishing the participants' percentage that have a positive or negative attitude

towards mathematics in each of the dimensions. Moreover, the relations (through the Pearson's Chi-squared Test) between the attitude manifested and the following variables: 1) gender; 2) academic performance (mathematics PSU); and 3) intent to choose the mathematics specialization (which is chosen by the end of the 4th semester of the career) were also established.

RESULTS

The results obtained are presented in the first place, from a global analysis of the four dimensions used. Then, the items forming each dimension will be analyzed thoroughly. In order to do so, it will be shown the percentage of participant who manifest a positive or negative attitude in each of the dimensions studied and its items respectively. Afterwards, it will be shown the relations observed between the studied dimensions and the gender, the score reached at the university selection test, and the intent to choose the mathematics specialization.

Results' Global Analysis

One general look of the data, allows us to determine the percentage of the participants who manifest a positive or negative attitude in the dimensions used in the instrument. Furthermore, it can be observed the percentage of participants who *neither agree nor disagree* with the statements related to each dimension (see Figure 1).

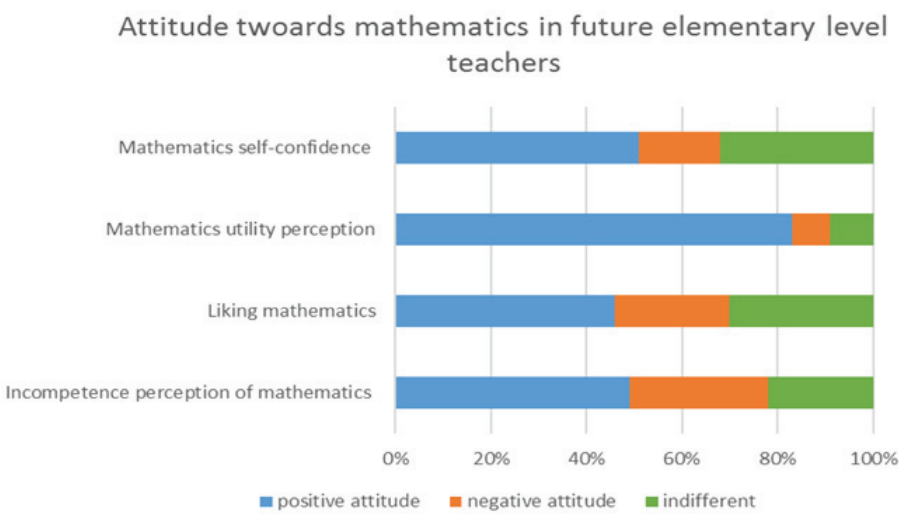

Figure 1. Attitude towards mathematics in future elementary school teachers.

The data included in Figure 1 realize that in at least two of the dimensions measured there is more than a 50% who manifest a positive attitude towards mathematics. Therefore there is a 198 of the cases that perceive the mathematics' utility and 122 cases that have a good mathematic self-confidence. On the "Liking mathematics" and "Perception of mathematics incompetence" dimensions, there are less than a 50% of the participants who have shown a positive attitude, recording 57 cases with a lower mathematics liking and 69 cases that consider themselves mathematic incompetents.

Item results analysis

In the following table, the results obtained in the associated items for each of the dimensions explored are presented.

Table 3
Percentage of the responses obtained for each of the items in every dimension on the attitudes towards mathematics

Dimension	Items	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Perception of mathematics incompetence	1. During mathematics I find it hard to decide what I have to do	13	27	33	20	7
	2. I usually feel that I am unable to solve mathematical problems	9	25	20	31	15
	3. I usually have difficulties with mathematics	18	31	20	23	8
	4. I feel more clumsy in mathematics than most of my fellow classmates	11	21	21	29	18
	5. Mathematics confuses me	11	32	21	26	10
	6. I had always have trouble with mathematics	15	20	17	33	15
	7. Whatever I do, I always get low scores in mathematics	7	14	21	39	19
	8. Frequently, during math lessons I go blank in my mind	6	14	22	41	17
	9. I don't know how to study mathematics	8	17	28	28	19
	10. Except for a very few cases, I cannot seem to understand math no matter how much effort I put on	3	18	23	41	15
	11. It will always be difficult for me to learn mathematics	3	10	21	38	28
	12. I am one of those people who just wasn't born to learn math	6	12	18	30	34

Liking mathematics	13. I find learning mathematics to be fun	15	24	30	24	7
	14. Whenever I have to study mathematics I do the homework with certain joy	11	18	38	26	7
	15. I could spend hours studying mathematics and doing exercises	7	17	33	31	12
	16. If I had the chance, I would apply to optional courses	9	33	31	22	5
	17. The subject taught during mathematics class is very interesting	17	45	30	6	2
	18. Mathematics is one of the most boring subjects	4	5	26	34	31
	19. I like mathematics	23	23	27	19	8
	20. I dislike mathematics	3	11	32	31	23
	21. I feel comfortable solving mathematical problems	15	26	27	25	7
	22. Mathematics is up next, how dreadful!	4	7	26	30	33
	23. I can't stand studying mathematics, even the easy parts	1	7	17	37	38
	24. Mathematics is easy	4	11	40	27	18
Utility perception of mathematics	25. Mathematics is useless	1	1	5	24	69
	26. Mathematics is useful and necessary in every aspect of life	58	28	9	3	2
	27. Mathematics should be included only in scientific careers	3	5	13	35	44
	28. Learning mathematics is something for only a few people	2	7	18	36	37
Mathematics self-confidence	29. I can become a good mathematics' student	36	36	18	7	3
	30. If I wanted to, I think I could dominate mathematics well	42	39	12	5	2
	31. To me it is easy to calculate mentally	10	20	39	22	9
	32. According to my mathematics teachers and professors I am a good student	6	14	58	18	4

The results shown in Table 3 recognize the dimension of "Perception of mathematics incompetence", the items: 7 (Whatever I do, I always get low scores in mathematics), 8 (Frequently, during mathematics' lessons I go blank in my mind), 10 (Except for a very few cases, I cannot seem to understand mathematics no matter how much effort I put on), 11 (It will always be difficult for me to learn mathematics) and 12 (I am one of those people who just wasn't born to learn mathematics) were the most selected ones, with an answer percentage of 58%, 57%, 56%, 66% and 64% respectively. Therefore, even though in general terms it is observed that a percentage lower than 50% of the participants declared themselves competent in mathematics, the majority expressed a positive attitude towards their own mathematics' performance expectation.

In reference to the dimension of "Liking mathematics", it is observed that items 17 (The subject taught during mathematics class is very interesting), 18 (Mathematics is one of the most boring subjects), 20 (I dislike mathematics), 22 (Mathematics is up next, how dreadful!) and 23 (I can't stand studying mathematics, even the easy parts) are those in which the majority of participants expressed a positive attitude with a percentage response of 62%, 66%, 54%, 63% and 74% respectively. Thus, even though in general terms it is observed that a percentage lower than 50% expressed a positive attitude in this dimension, it is observed that the majority of the participants stated that the contents studied in the discipline are interesting and expressed a positive attitude towards studying them.

As for the dimension of "Utility perception of mathematics", it is observed that all of the items (25, 26, 27 and 28) presented a high percentage of responses that shown

a positive attitude, with a 93%, 86%, 79% and 73% respectively. That is to say, those participants considered useful and necessary to study mathematics.

Finally, in the dimension of "Self-confidence", it is observed that the items 29 (I can become a good mathematics' student) and 30 (If I wanted to, I think I could dominate mathematics well) are the ones with the highest ratings, with a percentage of response of 72% and 81% respectively. That said, regardless the fact that in general terms the participants expressed a positive attitude in this dimension, a high percentage of the participants (58%) stated that they Neither agree nor disagree in item 32 (According to my mathematics teachers and professors I am a good student) and only a 20% stated that they strongly agree or agree with the same statement.

Analysis of the relations among variables

According to the analysis of the results obtained through the use of Pearson's chi-squared test, in Table 4 it can be observed that in all of the dimensions that measured the attitudes towards mathematics, the instrument showed results –p greater than the level of significance α=0,05 whenever the dimensions were related with the different variables measured (the university selection test, gender and intent of specialization), except for the relation between "liking mathematics" and "gender" where the result obtained was p= 0.002, observing that women expressed a greater like towards mathematics.

Table 4
Results of the relation between the attitude towards mathematics (through dimensions) and interest variables (Mathematics' PSU, gender and intent of specialization)

	Chi-squared Test		
Dimension attitudes towards mathematics	**Mathematics' PSU**	**Gender**	**Intent of specialization**
Perception of mathematics incompetence	0,902	0,622	0,714
Liking mathematics	0,841	0,002	0,381
Utility perception of mathematics	0,265	0,334	0,775
Mathematics self-confidence	0,788	0,166	0,273

To sum up, we can indicate that there is no relation between the attitudes towards mathematics and the previous knowledge of the discipline (measured through the university selection test). Likewise, there are no relations between the attitudes and the intent to choose mathematics as specialization. Also, the same happens with the gender variable and the following dimensions: "Mathematic Incompetence", "Utility perception of mathematics" and "Mathematics self-confidence".

FINAL CONSIDERATIONS

Unlike other studies, (Tsao, 2014; Casis, Rico & Casto, 2017; Nortes & Nortes, 2017), this research focus its attention on the entering profiles of the future elementary teachers throughout their years of training . Since this type of study allows to know the attitudes towards mathematics through the transition process from the school education to the university level without having started the university level courses (Palacios, Arias & Arias, 2014). Therefore, the results' analysis reveals that a greater percentage of the participants declare a positive attitude in each of the dimensions, being the one with the better valuation (83%) "Utility of mathematics". Moreover, it is observed that a 51% affirms a positive attitude in the dimension "Mathematics self-confidence", assuming that it would be possible through an optimal remedial plan to potentiate the results obtained in the rest of the dimensions (Evans, 2000). However, it cannot be confirmed what Hackett & Betz (1989) argue, because there was no relation between the good mathematics self-confidence and the future intent to choose mathematics as specialization.

In turn, when relating the attitude towards mathematics (of each dimension) with the gender variable, the results of the present research disagree with the argument of Beilock, Gunderson, Ramírez and Levine (2009) and Charles (2017), because there is no significant difference between the attitude towards mathematics that men and women have, except for the liking mathematics dimension, where the women included in this research show a better attitude. Thus, it can be concluded that the attitudes of the women included in this research will not have a negative impact in their future students.

As far as the relation between attitudes towards mathematics and the previous mathematic knowledge (measured by the university selection mathematics test) this research agrees with the results reported by Nortes and Nortes (2017) because there is no significant relation shown between the previous mathematic knowledge and the dimensions studied of the attitudes towards mathematics.

Considering the data reported in this research and the need to address the entering profiles of the future elementary teachers throughout their years of training, we emphasize on the importance of expand the quantitative data of this study with other qualitative types (Estrada & Díez-Palomar, 2011). In this manner, through interviews (Pérez-Tyteca, Monje y Castro, 2013), it will be possible to know in deep about the experiences at school of the participants and how those experiences have an impact on the development of a positive or negative attitude in each of the dimensions studied. Such information will be useful for designing an intervention plan, suitable for the needs of the present study. What is more, those actions will derive towards the analysis of the changes on the attitudes during the intermediate training processes as well as in the period near the end of the career. Tsao (2014) points out that the latter is very relevant because if the attitudes towards mathematics are still at a lower level when finishing the career, it is recommended that during the first years of the professional practice, those teachers should be accompanied by a mentor.

AUTHORS' CONTRIBUTION

M.J.S, H.P, C.V and F.B participated in the results analysis and the drafting of the present research article. In particular, M.J.S and H.P collected the data and C.V. collaborated in the results interpretation.

DATA AVAILABILITY STATEMENT

The authors agree to make the data that support the results of this study available through reasonable request, at the authors' discretion.

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