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Perception of Teachers' Attitudes and Training Competence of Teachers in the Field of Mathematics

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Abstract: This article presents the results of a study on the perception that future teachers have in relation to the attitudes their teachers showed towards mathematics during the Primary Education stage, their level of competence in mathematics, and the possible relationship between both variables. A questionnaire was administered to a sample of 488 future Primary School teachers, subjecting the obtained data to a descriptive, multivariate, and inferential analysis in order to know the perception of these attitudes, establish subject profiles, and know the incidence between this variable and mathematical competence. The future teachers show an ambivalent perception of their teachers' attitude towards mathematics. Three profiles of subjects with negative, neutral, and positive perception are set, with almost half of the sample included in the first two profiles. In the inferential study, values that reflect a significant incidence between both variables are obtained. It is important that teachers convey favourable attitudes towards mathematics to their students, since the more favourable they are, the better the levels of competence obtained. To minimise this deficit, content and activities aimed at improving mastery and encouraging the development of favourable attitudes towards this discipline through specific actions should be incorporated into training programs.

Keywords: attitude; mathematics; mathematical competence; teacher training; Primary Education

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1. Introduction

Despite the unquestionable functionality and usefulness of mathematics as an area of knowledge, its teaching—learning processes in the different educational stages are usually linked to learning difficulties, usual attitudes of rejection, and little affinity between students and the subject [1].

Teaching mathematics is a complex task, and for it to be successful, among other variables, it requires teachers' knowledge and competence to identify the variety of objects and meanings involved in solving school assignments [2].

Teachers' competence requires using, in an interrelated way, the knowledge of the mathematical content to be taught and the knowledge from which students start [3], through the pedagogical knowledge of the content [4,5]. In this sense, we cannot ignore the need to emphasize the initial training of future teachers in specific didactics to achieve successful learning [6] that promotes innovation and motivation when they start their professional careers.

Data from the latest reports available in TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment), which evaluate students in the fourth grade of Primary School and Secondary School, convey the need to delve into the causes underlying the low performance of Spanish students in these international evaluations in the field of mathematics.

In TIMSS 2019, our country reached an overall average score of 502 points, below the EU average (513) and the OECD average (527). This score is also lower in each of the

three content areas assessed: numbers, measurements, geometry, and data. Similarly, when classifying students according to their level of performance, the data are also negative, given that the Spanish percentage at the very low levels is higher than in the EU and the OECD. Likewise, the Spanish percentages at the high and advanced performance levels are lower than those in the EU and the OECD [7].

In PISA 2018, the data obtained indicate that Spanish students obtained an average score of 481 in mathematics, below the EU (494) and the OECD (489) average. This trend persists over the last four evaluation cycles. Furthermore, the distribution of students by performance levels shows that the percentage of Spanish students located at a low performance level is above the EU and the OECD percentage. In relation to the percentage of advanced performance students, our country is below the EU and the OECD ones [8].

The recent publication of the PISA 2022 results shows that Spanish students have worsened their level of proficiency in all evaluated areas, but especially in mathematics, where they have reached their worst historical average score (473). However, this result is, for the first time, above the OECD average (472) and slightly below the EU average (474). It should be noted that the results are partly conditioned by the COVID-19 pandemic, and there has been a generalised decline in student performance in a large number of countries participating in the assessment [9].

One of the variables that has an impact on low student performance is the role of the teacher in the teaching–learning processes [10], with attitudes towards mathematics playing a relevant role [11–17]. It is convenient to specify that the term attitude does not have a univocal conceptualisation, but presents various meanings, even when linked to the field of mathematics.

Attitudes, along with beliefs and emotions, are considered essential components of the mathematical affective domain [18,19]. Bailey [20] points out that these attitudes, when studied in teachers, reflect their impact on the cognitive and affective aspects of their students. Therefore, it is worrying that there are future Primary Education teachers who begin their university studies with an ingrained negative emotional charge towards mathematics, and who, after receiving didactic training in this subject, continue to reflect a stagnation in their mathematical affective domain [21]. This circumstance reflects the existing need in this group to link the affective domain to teaching practices in mathematical training [22].

Blanco [23] highlights that attitudes towards mathematics predominate an affective component that is reflected in positive aspects such as interest, satisfaction, or curiosity, or in negative aspects such as rejection, denial, frustration, or avoidance of mathematical activities. On the other hand, Rodríguez et al. [24] point out that the attitude towards mathematics refers to beliefs about the effectiveness and interest of students in performing mathematical tasks in academic and daily situations. Likewise, Fetterly [25] and Riling [26] offer conceptualisations of attitudes towards mathematics that focus on some cognitive processes associated with the mathematical context, such as creativity and cognitive flexibility.

The role of the teacher cannot be limited to being a transceiver of curricular contents if the purpose is to achieve in their students the competences established by current educational legislation. Treviño-Reyes [27] indicates that teachers of the 21st century must have a set of knowledge, skills, and attitudes that create suitable learning environments. This educational context is key for students to feel eager to learn and face their learning with confidence and motivation [28].

Despite the importance of positive attitudes in mathematics teaching processes, research shows that a significant proportion of students who begin and pursue their university studies in the Undergraduate Degree in Primary Education show negative attitudes towards mathematics, with anxiety towards this subject being the most significant factor [29–38]. This fact is rather unusual given that, in the near future, they will be responsible for teaching mathematics to students between the ages of 6 and 12.

These studies and teachers in the area of Didactics of Mathematics coincide with the perception that a significant proportion of future teachers show negative attitudes towards

this discipline during their classes and even recognize that they have limitations in learning mathematics that originate in the Primary Education stage [39]. These negative attitudes may have been learned from their mathematics teachers, favouring the lack of affinity with the mathematical content they reveal. In this regard, Alsina and López [40] investigate the willingness of 141 future teachers to teach mathematics, concluding that only 23% of the sample chose mathematics as their preferred subject to teach as the first option. However, those who selected it as the last option represent 45% of the total sample.

It is an especially serious fact that future teachers show negative attitudes towards mathematics because these attitudes can be transferred to students due to the fact that they act as learning models [41–50]. During Primary School, teachers' attitudes when teaching mathematics are important for a favourable mathematical self-concept formation of students between the age of 6–12 years old, based on positive attitudes linked to affinity, motivation, and self-confidence towards the subject [35]. These attitudinal experiences will favour the formation of memories rooted in long-term memory that favour the creation of functional affective bonds towards mathematics.

Koch [51] points out that two key moments can be considered for the evolution and increase of negative attitudes such as anxiety towards mathematics. She places the first moment on the first years of Primary School and the second one when the transition from this stage to ESO (Compulsory Secondary Education) occurs.

This reality reflects the need to work on improving the didactic preparation of future Primary School teachers in the curricular area of mathematics and also on the system established for their selection. In fact, behind the acclaimed successful performance of Finnish students in international assessments, there is a selection and training of their teachers based on their previous good academic performance at the beginning of their university studies and on their attitudes towards teaching [52].

Therefore, we consider it important to carry out an analysis that allows us to know the perception that future teachers have of the attitudes towards mathematics that their teachers showed during their stage in Primary Education, understood as references of attitude. We understand that the answers given by the subjects are based on those teachers who have been referents in the shaping of this perception, through the attitudinal experiences linked to the teaching–learning processes of this subject and the intensity associated with them. This will allow us to determine if there is an impact between this perception and the initial mathematical competence level of future teachers when they enter their university studies.

Research objectives

- To know the perception of future Primary School teachers of the attitudes towards mathematics shown by their teachers at this educational stage when they were taught this subject.
- To establish subject profiles, according to the type of perception of teachers' attitudes towards mathematics, among future Primary School teachers.
- To determine the relationship between the perception of teachers' attitudes towards mathematics among future Primary School teachers and the level of mathematical competence before they entered university.

2. Materials and Methods

The entire research process proposed, the procedures, and the use of information collection instruments were submitted for the approval of the Research Commission of the Department of Didactics and School Organization, (University of Granada, Granada, Spain).

2.1. Participants

A non-probabilistic convenience sample was chosen, as the subjects who participated in the study were selected for their accessibility and suitability for it. In this research, the sample is made up of 488 first-year students of the Undergraduate Degree in Primary Education of the University of Granada, of which 61.9% are women and 38.1% are men.

With regard to age, 74.40% are between 18 and 20 years old, 23.6% are between 21 and 30 years old, and 2% are over 30 years old.

2.2. Instrument

The data collection instrument used was based on the "Scale of attitudes towards mathematics" by Fennema and Sherman [53], which was later validated by Broadbooks et al. [54]. This scale is composed of nine attitude subscales that are administered in an individualised way. For the present research, we selected the subscale referring to the perception of teachers' attitudes towards mathematics, which is linked to motivational aspects. With the aim of gathering more extensive information on attitudinal perception and adapting it to the objectives of our research, new items were selected relating to the perception of attitudes towards mathematics related to enjoyment, attention to learning difficulties, methodology, and assessment, belonging to a second instrument developed to ascertain the perception of attitudes towards mathematics in the school environment, previously designed and validated by Sánchez Mendías [35].

The set of items is constructed on the understanding that this variable has an impact on the level of commitment that a student is willing to put into mathematical learning and on their motivation to choose their university studies.

In the design of our questionnaire, an initial evaluation was made of the various sub-dimensions of attitude considered to be of interest for the study, considering the degree of appropriateness and relevance for our research. Once this assessment has been carried out, the distribution of the items in the questionnaire, based on the perception of the attitude to be assessed, follows the following scheme:

- Motivation towards learning (8 items).
- Satisfaction towards the subject (4 items).
- Attention to learning difficulties (4 items).
- Innovation in methodology (6 items).
- Evaluation systems and techniques (8 items).

The items were subjected to the judgement of experts in attitude measurement to assess their construct, wording, and presentation validity. According to Cabero and Llorente [55], the judgement of experts, used as an evaluation strategy, offers a set of advantages among which the possibility of obtaining extensive and rigorous information on the object of study and the quality of the information transferred by the judges stands out.

First, the items were analysed by seven judges from a psychological and educational perspective, considering their recommendations and suggestions. Once the suggested changes had been made, the items were subjected to a second assessment by seven experts in general didactics and mathematics, and the recommendations and suggestions made were also taken into account, leaving the items of the questionnaire in their final form. To determine the reliability of the expert judgement, Kendall's Coefficient of Concordance (Kendall's W) was used, whose values range between 0, as the minimum value, and 1, as the maximum value. In our case, an average of 0.92 was obtained, indicating a high concordance and adjustment to the measurement objectives.

Based on the contributions made, the precise adjustments were made to configure the final questionnaire "Scale of Perception of Primary School Teachers' Attitudes towards Mathematics by future teachers". (See Appendix A), obtaining the following structure:

- Subscale: Motivation towards learning (Items 1–8).
- Subscale: Satisfaction towards the subject (Items 9–12).
- Subscale: Attention to learning difficulties (Items 13–16).
- Subscale: Methodology innovation (Items 17–22).
- Subscale: Evaluation systems (Items 23–30).

After that, a pilot study was carried out, with a sample of 47 first-year students of the Undergraduate Degree in Primary Education of the Faculty of Education Sciences of the University of Granada in order to carry out a preliminary assessment of the reliability and validity of the questionnaire. In this preliminary assessment, the result achieved on the

Cronbach's alpha coefficient, used to measure reliability, was $\alpha = 0.87$, which denotes a meritorious internal consistency of the instrument [56] and, therefore, adequate reliability. On the other hand, each item was also correlated by scale with the total of the scale minus the correlated item; this is known as corrected total-item correlation, with Pearson correlation coefficients above 0.40–0.45, which gives them sufficient criterion validity, as indicated by Abad et al. [57].

In the quality parameters of the definitive measuring instrument given to the sample, the reliability of the instrument is recalculated as internal consistency, again using Cronbach's alpha coefficient as an index, implemented in the SPSS Statistics software package version 25 from the average inter-element correlation, obtaining a value of $\alpha = 0.927$.

Finally, two questions related to their experience with the subject of mathematics when it was attended in Compulsory Secondary Education were also incorporated into the questionnaire. Both items include whether they failed this subject and their average grade in the exams taken, respectively. Thus, we aimed to know their antecedents in mathematical competence before entering the university degree.

2.3. Procedure

The questionnaire was given in the first semester to first-year students of the Degree in Primary Education at the University of Granada, with the collaboration of teachers who teach in the eight existing groups. Previously, they were asked for objectivity and honesty in their answers, since they were anonymous, granting them a maximum time of twenty-five minutes for their completion.

2.4. Data Analysis

Data relating to two variables have been collected from each participant: the perception they have about the attitudes their teachers showed them towards mathematics when they were studying this Primary Education stage and their level of mathematical competence before they entered university studies, consolidated during the Compulsory Secondary Education stage. For the calculation of descriptive statistics (means, standard deviations, maximum and minimum values, and frequencies), multivariate analysis in the determination of clusters, and inferential analysis of ANOVA variance to determine the influence of the variables studied, SPSS package version 25 was used.

3. Results

3.1. Perception of Teachers' Attitudes towards Mathematics in Future Teachers-PTAM

The descriptive statistics were obtained from the sum of the average values obtained in the items that compose the questionnaire. Let us remember that this scale is composed of 30 Likert-type items, so a minimum value of 30 and a maximum of 150 will be obtained. These data are shown in Table 1, as well as an adaptation thereof on a scale ranging from 1 to 5, which facilitates the interpretation of the results. In order to identify the typology of the perception of the attitude towards mathematics, based on the average score obtained by the participants on the scale, five levels of attitude used by [29,30,37] were established, adapting the score to the following gradation:

- Average value 1: very negative perception.
- Average value 2: negative perception.
- Average value 3: neutral perception.
- Average value 4: positive perception.
- Average value 5: very positive perception.

Table 1. Descriptive statistics of the PTAM scale and their respective subscales.

	N	Minimum	Maximum	Average	S.D.
Perception of teachers' attitudes towards mathematics (items 1 to 30)	488	39.00	149.00	111.86	19.09
(PTAMmo)	488	1.00	5.00	3.81	0.80

Table 1. *Cont.*

	N	Minimum	Maximum	Average	S.D.
Perception of teacher attitudes: satisfaction (Items 9–12)	488	4.00	20.00	14.14	3.28
(PTAMsa)	488	1.00	5.00	3.54	0.82
Perception of teacher attitudes: support (Items 13–16)	488	4.00	20.00	16.79	3.27
(PTAMsu)	488	1.00	5.00	4.19	0.82
Perception of teacher attitudes: methodology (Items 17–22)	488	6.00	29.00	20.15	3.88
(PTAMme)	488	1.00	5.00	3.36	0.65
Perception of teacher attitudes: evaluation (Items 23 to 30)	488	8.00	40.00	30.27	6.22
(PTAMev)	488	1.00	5.00	3.78	0.78

We observed that the average value obtained in the PTAM (3.73), out of a maximum of 5, indicates that the subjects have a neutral perception with a positive tendency of their teachers' attitudes towards this subject when they were teaching it. The standard deviation (0.64) indicates that there is dispersion in the data.

For the PTAMmo subscale, the average achieved (3.81) shows that the subjects consider that the teachers' attitudes towards motivation to learn mathematics were neutral with a positive trend. The value of the standard deviation (0.80) indicates that there is dispersion in the answers.

In the PTAMsa subscale, the average value obtained (3.54) indicates that the sample perceives the teachers' attitudes of satisfaction towards the subject as neutral with a slightly positive trend. The standard deviation results (0.82) show dispersion in the answers.

Regarding the PTAMsu subscale, the average obtained (4.19) in the subjects of the sample positively perceived the supportive attitudes when they had learning difficulties in mathematics. The value of the standard deviation (0.82) indicates a dispersion of answers similar to that of the previous subscales.

Likewise, in the PTAMme subscale, the average value (3.36) indicates that the sample perceives the attitude towards the methodology in a neutral way. The results of the standard deviation (0.65) show a higher level of consensus than in the rest of the subscales studied.

Finally, the average obtained (3.78 out of a maximum of 5) on the PTAMev subscale indicates that the subjects in the sample perceive, in a neutral way with a positive trend, the teachers' attitudes when performing evaluation tasks in mathematics. The value of the standard deviation (0.78) indicates that there is dispersion in the answers.

In general terms, the data obtained on the scale of perception of teachers' attitudes towards mathematics in future teachers and their respective subscales show a neutral perception of the attitudes towards mathematics shown by their Primary School teachers when they taught them mathematics, with a positive tendency, but not as such, except in supportive attitudes, where the values show a positive perception.

3.2. Cluster Analysis of the Perception of Teachers' Attitudes towards Mathematics in Future Teachers

With the aim of going deeper into the data obtained previously, a cluster analysis was carried out, taking into account the scores of the items included in the attitude perception scale, giving rise to three clusters or groups of subjects that present common characteristics that differentiate them from the rest.

The cluster analyses carried out belong to the so-called hierarchical cluster analysis using Ward's method, and have been taken as a measure of dissimilarity in all cases with quadratic Euclidean distances.

The mean scores, obtained by a random selection of subjects from each of the groups that emerged, were also analysed in order to find out the characteristics that define each of the groups in terms of the levels of manifestation of the perception of attitudes towards mathematics.

Table 2 shows the results obtained with this analysis, and it can be seen how profile 1 is formed by 33.80% of the subjects and is characterised by a negative perception of the attitudes towards mathematics shown by their teachers—something that would not benefit

the development of positive attitudes of their students in relation to this subject. This group obtains an average score of 2.98 on the scale of 1–5, and a standard deviation of 0.64.

Table 2. Cluster analysis of the PTAM.

Perception of Attitude	Frequency	Percentage	Valid Percentage	Accumulated Percentage
Profile 1—Negative	165	33.80	33.80	33.80
Profile 2—Neutral	61	12.50	12.50	46.30
Profile 3—Positive	262	53.70	53.70	100.00
Total	488	100.00	100.00	100.00

On the other hand, profile 2 is composed of 12.50% of the subjects. These future teachers present a neutral perception of the attitudes towards mathematics that their teachers showed them. This shows that they have not observed a positive or negative attitude in their teachers in their relationship with mathematics. This profile has an average score of 3.67 and a standard deviation of 0.63.

Ultimately, profile 3, which is the most representative, includes 53.70%. It includes subjects who did perceive positive attitudes towards mathematics in their teachers in the teaching–learning process. This perception would contribute to the development of a positive attitude towards the discipline and towards the mathematical contents they have worked on during their academic career [37]. In this third group, an average score of 4.12 and a standard deviation of 0.64 are achieved.

According to these data, 46.30% of these future teachers do not have favourable perceptions of attitude towards mathematics from those who were their teachers during Primary School. In this context, where unfavourable attitude trends prevail, it is difficult to establish a basis for educational practice to develop with a favourable predisposition towards the study of mathematics, to promote the development of positive attitudes, and optimise the level of competence of students.

3.3. Analysis at the Inferential Level of the Perception of Teachers' Attitudes towards Mathematics and the Level of Mathematical Competence of Future Teachers

For the study of the incidence of the perception of the attitudes of future teachers towards mathematics in mathematical competence, two factors have been taken into account as a way of measuring this performance; the first being to know if they ever failed this subject during Compulsory Secondary Education, and the second one to know their usual grade in the mathematics exams at this stage. The establishment of these criteria as a measure of the level of mathematical competence has been used in previous studies [37,39].

3.3.1. Failed Mathematics during Secondary School

The descriptive statistics obtained in this first factor are represented in Table 3, highlighting that 36.89% of the subjects are reported to have failed mathematics. In this sense, we appreciate a remarkable percentage of future teachers who recognize having a low level of previous mathematical competence.

Table 3. Percentages and frequencies of future teachers who failed mathematics in Secondary School.

Fails Mathematics	Frequency	Percentage	Valid Percentage	Accumulated Percentage
Yes	180	36.89	36.89	36.89
No	308	63.11	63.11	100.00
Total	488	100.00	100.00	100.00

The linkage of this mathematical performance with the "Perception of Teachers' Attitudes towards Mathematics" is shown in Table 4. In this table, it can be observed how the subjects who had failed the subject of mathematics during Secondary School obtained a lower average score (105.75) and a less favourable perception of these attitudes than those who did not fail (115.42).

Table 4. Descriptive statistics of the PTAM scale and *t*-test on the failures in mathematics in Secondary School.

	Failed Mathematics	N	Average	*t*-Test for Equality of Means *t*	*t*-Test for Equality of Means Sig. (Bilateral)
Perception of Teachers' Attitudes towards mathematics.-PTAM	Yes	180	105.75	−5.56	0.00
	No	308	115.42	−5.56	
Perception of Teachers' Attitudes: motivation. PTAMmo	Yes	180	28.25	−6.09	0.00
	No	308	31.79	−5.94	
Perception of teacher attitudes: satisfaction. PTAMsa	Yes	180	13.32	−4.31	0.00
	No	308	14.62	−4.26	
Perception of teacher attitudes: support. PTAMsu	Yes	180	16.16	−3.29	0.00
	No	308	17.16	−3.26	
Perception of teacher attitudes: methodology. PTAMme.	Yes	180	18.93	−5.44	0.00
	No	308	20.86	−5.45	
Perception of teacher attitudes: evaluation. PTAMev	Yes	180	29.08	−3.26	0.00
	No	308	30.97	−3.26	

On the other hand, in the "motivation" subscale, the average score of subjects who report having failed mathematics during this stage (28.25) is lower and represents a less favourable perception than that of subjects who passed this subject during all courses of this educational stage (31.79).

Regarding the "satisfaction" subscale, the group of subjects who failed this subject had a lower average value (13.32), while those who did not fail it obtained a higher average score (14.62), resulting in a more positive assessment of these attitudes.

Subjects who acknowledged not having failed the subject of mathematics during Secondary School achieved, in the "support" subscale, a higher average value (17.16) and a more positive perception of these attitudes than those who failed in this discipline during this educational stage (16.16).

The results obtained in the "methodology" subscale indicate that subjects who had failed mathematics obtained a lower average score (18.93), presenting a more negative assessment of these attitudes of their teachers than those who did not (20.86).

In the "evaluation" subscale, the least favourable perception of these attitudes is held by subjects who report having failed mathematics during this period, with an average score of 29.03, which is lower than that obtained by subjects who passed this subject in all courses of this educational stage (30.97).

In order to analyse whether the differences observed between the average scores obtained on the PTAM scale and the fact of failing mathematics during this educational stage may be significant, the *t*-test for equality of means with *t*-values, with or without equality of variances, was performed.

The results in Table 4 showed that failing mathematics during Secondary School had an impact on the scores obtained, both on the PTAM scale and on its five subscales. This means that the differences in the means obtained by each group are statistically significant, so the perception of attitudes towards mathematics shown by Primary School teachers is related to the level of mathematical competence of the subjects.

3.3.2. Usual Marks in Mathematics Exams at Secondary School

The aim is to relate the perception that subjects have of the attitudes that their teachers showed towards mathematics with the grades they usually obtain when they take mathematics evaluation tests. In this sense, five score intervals have been established to classify the subjects, corresponding to those established in the regulatory framework enforced in our country, to determine their level of competence: insufficient (0–4.99), sufficient (5–5.99), good (6–6.99), remarkable (7–8.49), and outstanding (8.50–10). With respect to this last interval, it should be noted that the outstanding grade (from 8.50 onwards) is a practice that teachers tend to use in evaluations during Secondary School, especially in complex subjects as in the case of mathematics, where there are few students with high levels of proficiency, as Sánchez Mendías et al. [37] pointed out.

The frequencies and percentages of each group are gathered in Table 5. It should be noted that only 5.33% of future teachers are at a high level of mathematical competence (grades from 8.50 to 10). This implies that there is a small number of subjects who have previously excelled in their mathematical performance and have chosen to study this university degree. On the other hand, we observed that the medium-high level of competence (scores 7–8.49) is the most representative of the established categories, with 40.57% of the sample.

Table 5. Percentages and frequencies of the usual grades in mathematics exams.

Usual Grade	Frequency	Percentage	Valid Percentage	Accumulated Percentage
0–4.99	61	12.50	12.50	12.50
5–5.99	81	16.60	16.60	29.09
6–6.99	122	25.00	25.00	54.09
7–8.49	198	40.57	40.57	94.63
8.50–10	26	5.33	5.33	100.00
Total	488	100.00	100.00	100.00

To the contrary, future teachers who are starting their teacher training exhibit a medium-low level of mathematical competence (0–6.99), which represents more than half of the sample (54.10%), previously showing improved performance.

The relationship between mathematical competence with the PTAM is shown in Table 6. In this table, we can observe that the group of subjects with the highest average value and a better perception of these attitudes usually obtains scores between 8.50 and 10 points (117.50) in mathematics exams. On the other hand, the group of subjects with the lowest average value and the least favourable perception usually obtains scores between 0 and 4.99 (103.45).

Table 6. Descriptive statistics of the PTAM and the usual grades in mathematics exams.

	Usual Grade in Mathematics Exams	N	Average	S.D.
Perception of Teachers' Attitudes towards mathematics PTAM	0–4.99	61	103.45	18.84
	5–5.99	81	105.48	17.29
	6–6.99	122	111.18	17.98
	7–8.49	198	116.73	18.21
	8.50–10	26	117.50	24.18
	Total	488	111.86	19.09
Perception of Attitudes: motivation. PTAMmo	0–4.99	61	27.45	6.43
	5–5.99	81	27.82	6.03
	6–6.99	122	29.72	5.89
	7–8.49	198	32.63	5.86
	8.50–10	26	33.07	7.58
	Total	488	30.48	6.42
Perception of Attitudes: satisfaction PTAMsa	0–4.99	61	12.62	3.39
	5–5.99	81	13.37	3.34
	6–6.99	122	13.81	3.41
	7–8.49	198	14.90	2.83
	8.50–10	26	15.96	3.30
	Total	488	14.14	3.28
Perception of Attitudes: support PTAMsu	0–4.99	61	16.29	3.31
	5–5.99	81	16.33	3.17
	6–6.99	122	16.86	3.14
	7–8.49	198	17.13	3.14
	8.50–10	26	16.57	4,76
	Total	488	16.79	3.27

Table 6. *Cont.*

	Usual Grade in Mathematics Exams	N	Average	S.D.
Perception of Attitudes: methodology PTAMme	0–4.99	61	18.54	3.74
	5–5.99	81	18.92	3.67
	6–6.99	122	20.29	3.66
	7–8.49	198	20.99	382
	8.50–10	26	20.65	4.48
	Total	488	20.15	3.88
Perception of Attitudes: evaluation PTAMev	0–4.99	61	28.54	6.45
	5–5.99	81	29.02	6.06
	6–6.99	122	30.47	5.92
	7–8.49	198	31.07	6.06
	8.50–10	26	31.23	7.75
	Total	488	30.27	6.22

On the other hand, on the PTAMmo subscale, the group with the least favourable perception and the lowest average score is that of subjects who report having achieved grades between 0 and 4.99 (27.45). To the contrary, the group with the most positive perception, with the highest average value, is found in subjects who usually achieve grades between 8.50 and 10 (33.07).

The results from the PTAMsa subscale indicate that the group that has a less favourable perception of these attitudes, with a lower average score (12.62), is that of subjects with grades between 0 and 4.99, while subjects with grades between 8.50 and 10 are the group with a higher average value (15.96) and a more positive perception.

The results obtained from the PTAMsu subscale indicate that the group of subjects with the highest average value and the most positive perception of these attitudes obtains grades between 7 and 8.49 points (17.13) on exams. On the other hand, the group of subjects with the lowest average value and the least favourable perception usually obtains grades between 0 and 4.99 (16.29).

In the PTAMme subscale, the group with the lowest average score and the least favourable perception is that of subjects who usually obtain grades between 0 and 4.99 (20.95). At the opposite end, the group with the highest average value and, therefore, the most favourable perception of these attitudes, comprises subjects who usually achieve grades between 7 and 8.49 (18.54).

The results from the PTAMev subscale indicate that the group that has a lower average score and, consequently, a less favourable perception of these attitudes, is that of subjects with grades between 0 and 4.99 (28.54), while subjects with grades between 8.50 and 10 are the group that shows a more positive perception of these attitudes, with a higher average value (31.23).

To assess whether these differences between the means were significant, an ANOVA (analysis of variance) was carried out on this factor. The results obtained are shown in Table 7:

Table 7. PTAM ANOVA and usual grades on mathematics exams.

		Sum of Squares	df	Root mean Square	F	Sig.
Perception of teachers' attitudes towards mathematics. PTAM	Inter-groups	13,194.27	4	3298.57	9.69	0.00
	Intra-groups	164,408.24	483	340.39		
	Total	177,602.52	487			
Perception of Attitudes: motivation PTAMmo	Inter-groups	2291.46	4	572.86	15.52	0.00
	Intra-groups	17,826.46	483	36.90		
	Total	20,117.92	487			
Perception of Attitudes: satisfaction PTAMsa	Inter-groups	403.35	4	100.84	10.01	0.00
	Intra-groups	4862.01	483	10.06		
	Total	5265.37	487			
Perception of Attitudes: support PTAMsu	Inter-groups	56.79	4	14.19	1.32	0.26
	Intra-groups	5179.52	483	10,72		
	Total	5236.32	487			

Table 7. *Cont.*

		Sum of Squares	df	Root mean Square	F	Sig.
Perception of Attitudes: methodology PTAMme	Inter-groups	429.81	4	107.45	7.48	0.00
	Intra-groups	6932.96	483	14.35		
	Total	7362.77	487			
Perception of Attitudes: evaluation PTAMev	Inter-groups	464.05	4	116.01	3.04	0.01
	Intra-groups	18,431.15	483	38.16		
	Total	18,895.20	487			

As can be seen, the data obtained in the significance (p) values, both for the scale studied and for four of its subscales, are less than 0.05, which shows that the differences in the average scores achieved by each of the configured groups can be considered statistically significant. This means that the perception that the subjects have of the attitudes towards mathematics that their teachers showed during Primary School is an influential factor in the subject's usual grade in the mathematics evaluation tests.

The "support" subscale (0.26) is the one in which the difference between the means is not statistically significant, given that the significance value is higher than 0.05.

4. Discussion and Conclusions

The analysis carried out indicates that the subjects have a neutral, although slightly favourable, perception of the attitudes that their teachers showed towards mathematics when they taught them mathematics during Primary School. In other words, they did not perceive in them a clearly favourable attitude towards this subject, something desirable to have conveyed a positive affective response to these future teachers. This is important since, as Koch [51] points out, negative attitudes such as anxiety towards mathematics can be developed during this stage.

In carrying out a differentiated study of the perception of these attitudes, it has been observed that the only one that is positively valued is the one related to motivation for learning. Among the neutrals with a positive tendency, we find support for learning difficulties and evaluation. All these attitudes are related to the more generic functions of the teacher, i.e., with unavoidable actions of the profession, motivating pupils, attending to their demands for attention of difficulties, and carrying out a correct evaluation to check the degree of achievement of the proposed objectives. These seem to be developed in a more positive attitudinal environment, as they are more generic competences and less linked to a specific subject.

In contrast, perceptions of the attitudes towards mathematics that receive less recognition and are linked to a higher attitudinal load are those that refer, on the one hand, to the way in which the subjects perceived their satisfaction for the discipline and, on the other hand, to the methodological innovation applied by their teachers. In these cases, both attitudes are closely linked to the relationship the teacher has with the discipline and to more specific skills. It is not an easy task for a teacher to show satisfaction for content with which they feel uncomfortable or to use a good teaching methodology if they do not have a good knowledge basis of the discipline.

In this sense, Gresham [44] emphasizes that poor teaching techniques can favour the appearance of negative attitudes among students of the Degree in Primary Education. We should keep in mind that the unfavourable assessment of teachers' attitudes towards mathematics has already been considered in other studies a factor of incidence in the development of negative attitudes among students [46,58,59], which reduces the level of competence in the field of mathematics [10].

Regarding the data obtained in the Cluster analysis, it is significant that, of the three attitude perception profiles obtained (negative, neutral, and positive), two majority groups have been formed with polarised positions. Although the highest percentage of subjects belong to the positive perception group, at the opposite end, a high percentage also holds a negative perception. Consequently, the group of subjects who did not take a position on this perception is very small, indicating that almost 9 out of 10 future teachers observed

still remember positive or negative attitudes of their teachers during the origin of their mathematics training, favouring the development of their own attitudes. Regarding the number of profiles formed regarding the perception of attitudes towards mathematics, the data differ from the study carried out by Maroto [60], where four clusters were structured. They coincide with the works of Ávila-Toscano et al. [61] and Martín [62], because they obtained three profiles in both studies. However, the distribution of percentages of subjects in the three clusters is smaller at the extremes of positive and negative perception of attitudes, with a majority in the intermediate attitude defined as ambivalent or neutral. This difference with respect to our results may have its origin in the fact that the latter research works directly on the attitudes of the future teachers themselves and not on the perception of these attitudes by other subjects.

Regarding the level of mathematical competence, we can highlight that there is a significant percentage of future teachers who begin their university studies with a certain deficit in knowledge of mathematical content, having failed this subject during Secondary School. This coincides with the representation of the group of subjects with a negative perception of attitudes of their teachers in the Cluster analysis.

These data reproduce the pattern that our students followed in the international assessments of TIMMS in Primary Education and PISA in Secondary Education, since part of these students arrive at university with a low affinity for the field of mathematics [63,64]. This reality should lead us to look for references in other countries with traditionally effective educational systems. Uusiautti and Maatta [65] highlight that, in Finland, future teachers with a social and cognitive vision of teaching are selected and have a strong commitment and motivation in their university education in order to work as a teacher with homogeneous involvement across curricular areas. Currently, Estonia has become a new benchmark thanks to its good results in PISA, betting on a teacher training system that provides a solid basis for greater freedom in working with content and methodologies and a high commitment to educational innovation.

With regard to the possible relationship between the perception of teachers' attitudes towards mathematics during Primary School and the mathematical competence of future teachers, measured by the number of failures in this subject during their Secondary School period, we can indicate that there is a statistically significant relationship between both variables in such a way, that the better the perception of attitudes, the lower the probability of the subject having a low performance.

Likewise, the analysis of the differences marked by the subjects in their perception of the attitudes their teachers showed towards mathematics and their usual grade in this subject indicates that there is a more favourable view of these attitudes as their level of performance increases, both on the global scale and in the subscales of motivation, satisfaction, and evaluation. The same progress is followed in specific attitudes of support and methodology; however, the group with the maximum performance does not achieve the most favourable attitude assessment. These differences are significant both in the scale studied and in almost all specific attitudes, excluding support attitudes.

The absence of significant differences in the perception of supportive attitudes may be due to the fact that students with good performance in the Degree in Primary Education do not need support from teachers, while those with low performance may feel that they have not received the support they need to experience adequate attention to their needs.

Given this educational reality, we consider it necessary for Primary School teachers to transmit positive attitudes towards mathematics to their students, since the more favourable they are, the higher the levels of competence that will be achieved. Therefore, content and activities aimed at improving the mastery of mathematical content and promoting the development of favourable attitudes towards this discipline should be incorporated into training programs for future teachers.

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Institutional Review Board Statement: Our research has, at all times, taken into consideration the ethical and deontological aspects of educational research. Ethical review and approval was not required for this study because no personal data were collected from the subjects and no interviews were conducted. This is a survey study in which no personal data were requested from the participants. The responses collected are completely anonymous and collect information about the subjects' educational experiences. However, two basic principles have been considered: (1) to guarantee the protection of the persons who have participated, in terms of dignity and integrity; (2) informing the participants and obtaining their consent to participate in the research after having been informed in detail. The questionnaire applied has a preamble that includes an informed consent, in which the objectives of the research, the benefits of the work, the absence of harm and the options of participating, not participating or leaving the survey at any time are indicated. Finally, the researchers thank you for your attention and, if you have so decided, for your participation. We would like to point out that this informed consent has been understood as an instrument that allows the researchers to synthesise and inform relevant aspects of the study to be carried out and, for their part, to safeguard the safety and well-being of the people who agree or do not agree to take part in it.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

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Appendix A

Perception of Teachers' Attitudes towards mathematics in future teachers.

QUESTIONNAIRE

Instructions

Below are a series of statements about yourself in relation to mathematics. Answer by circling the value that represents your degree of identification with the content of the statement. To do this, you have a scale of values ranging from 1, which represents a total disagreement with the statement, to 5, which represents a total agreement with it.

Table A1. Scale of Perception of Primary School Teachers' Attitudes towards Mathematics by future teachers.

1	Primary School teachers used to tell me I could be good at mathematics.	1	2	3	4	5
2	My Primary School teachers have motivated me to study more mathematics.	1	2	3	4	5
3	My Primary School teachers thought I was the kind of person who could do well in mathematics.	1	2	3	4	5
4	My Primary School teachers have made me feel that I have the ability to be good at mathematics.	1	2	3	4	5
5	At school, teachers told me that I did not have any talent for mathematics.	1	2	3	4	5
6	When I have had low grades in mathematics at school, I have felt ignored by my teachers.	1	2	3	4	5
7	I have had difficulties having my teachers trust my ability to learn mathematics during Primary School.	1	2	3	4	5
8	My Primary School teachers thought studying mathematics was a waste of time for me.	1	2	3	4	5
9	Primary School teachers have made me like mathematics.	1	2	3	4	5
10	My Primary School teachers enjoyed teaching mathematics.	1	2	3	4	5
11	The teachers who taught me in school are responsible for me not liking mathematics.	1	2	3	4	5
12	At school, I have had teachers who did not like to teach mathematics.	1	2	3	4	5
13	When I did not understand a mathematic exercise or problem, my Primary School teacher would help me solve it.	1	2	3	4	5

Table A1. *Cont.*

14	Primary School teachers cared about helping me when I did not understand some of their explanations about mathematics.	1	2	3	4	5
15	At school, my teachers did not make an effort to help me when I had difficulties solving a mathematic exercise or problem.	1	2	3	4	5
16	Primary School teachers ridiculed me if I had trouble understanding their explanations about mathematics, instead of helping me.	1	2	3	4	5
17	At school, teachers made their mathematics lessons fun.	1	2	3	4	5
18	I liked the way my Primary School teachers taught mathematics.	1	2	3	4	5
19	Usually, my Primary School teachers were concerned with explaining mathematics well.	1	2	3	4	5
20	Primary School teachers taught mathematics in a very boring way.	1	2	3	4	5
21	I did not like the method my teachers used to teach mathematics in school.	1	2	3	4	5
22	My Primary School teachers were not interested in teaching mathematics well.	1	2	3	4	5
23	Primary School teachers have always been concerned about me passing mathematics.	1	2	3	4	5
24	My Primary School teachers have always valued the effort I made to pass mathematics.	1	2	3	4	5
25	When Primary School teachers evaluated me, it was shown the time I spent studying mathematics.	1	2	3	4	5
26	Usually, Primary School teachers did a good job in evaluating their students in the subject of mathematics.	1	2	3	4	5
27	Primary School teachers did not care that I failed mathematics.	1	2	3	4	5
28	My Primary School teachers did not know how to value the effort I made to pass mathematics.	1	2	3	4	5
29	Primary School teachers used to give me lower grades than I deserved in mathematics.	1	2	3	4	5
30	At school, teachers did not evaluate mathematics well because they did not care about failing many students.	1	2	3	4	5

Other matters

(Circle)

1. Have you ever failed mathematics during Compulsory Secondary Education?
   a. Yes b. No
2. What is your usual grade on mathematics evaluation tests?
   0 1 2 3 4 5 6 7 8 9 10

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