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El dominio afectivo en el aprendizaje de las matemáticas según el género de los estudiantes

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El dominio afectivo en el aprendizaje de las matemáticas según los estudiantes' género

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Abstracto:
El rendimiento en matemáticas, la reducción de la ciencia como vocación en los estudios universitarios, así como la desmotivación y las actitudes desfavorables hacia las matemáticas generadas en la Educación Secundaria son motivo de preocupación. Esta investigación se centra en las implicaciones afectivas ligadas al aprendizaje de las matemáticas durante la Educación Secundaria, con una visión de variables explicativas como las actitudes, la motivación y las creencias y sus diferencias según el sexo. Los resultados obtenidos por las niñas muestran una peor motivación y autoconcepto matemático, así como una actitud menos favorable hacia las matemáticas que los niños. De las 42 creencias sobre matemáticas, 13 muestran una diferencia de género; 10 de los cuales pertenecen a la categoría creencias sobre la enseñanza de las matemáticas, y de estos, 5 tienen un tamaño de efecto medio.

Palabras clave:
Educación secundaria, actitudes, motivación, creencias, aprendizaje de matemáticas.

Resumen:
El rendimiento en matemáticas, la disminución de vocaciones en los estudios universitarios de ciencias, así como la desmotivación y las actitudes desfavorables hacia las Matemáticas que se generan en la Educación Secundaria son motivo de preocupación. Esta investigación se centra en las implicaciones afectivas vinculadas con el aprendizaje de las Matemáticas durante la Educación Secundaria y profundiza en variables explicativas tales como actitudes, motivación y creencias y sus diferencias en función del sexo. Los resultados obtenidos por las chicas muestran peor motivación y autoconcepto matemático, así como una actitud hacia las matemáticas más desfavorable que los chicos. Además, de un total de 42 creencias sobre las matemáticas, 10 de las 13 que muestran diferencias de género pertenecen a la categoría de creencias sobre la enseñanza de las matemáticas y de ellas cinco se consideran de efecto mediano.

Palabras clave:
Educación secundaria, actitudes, motivación, creencias, aprendizaje, matemáticas.

Currículum:
Les résultats en mathématiques, le déclin des vocations dans les études universitaires en sciences et la démotivation et les attitudes défavorables envers les mathématiques générées dans l'enseignement Secondaire

sont préoccupantes. Cette recherche porte sur les implications affectives liées à l'apprentissage des mathématiques pour l'enseignement Secondaire, et en approfondissant des variables explicatives telles que les attitudes, la motivation et les croyances et leurs différences par sexe. Les résultats obtenus par les filles montrent pire concept de soi motivation pour les mathématiques, et attitude envers les mathématiques, que les garçons. En outre, d'un total de 42 croyances sur les mathématiques, 10 des 13 qui présentant des différences entre les sexes, appartiennent à la catégorie des croyances sur l'enseignement des mathématiques et don't, cinq ont une taille d'effet moyenne.

Mots clés:
Enseignement secondaire, attitudes, motivation, croyances, apprentissage des mathématiques.

Resumen:
Matemática realização, em declínio vocações na ciência faculdade e desmotivação e atitudes desfavoráveis em relação matemática gerados no ensino secundário, são motivo de preocupação. Esta pesquisa enfoca as implicações emocionais associados com a aprendizagem da matemática para o ensino secundário, aprofundando variáveis explicativas, como atitudes, motivação e crenças e suas diferenças por sexo. Os resultados obtidos pelas meninas mostram pior auto-conceito motivação e matemática e atitude para o pior matemática do que os rapazes. Além disso, mmm total de 42 crenças sobre matemática, 10 das 13 diferenças de género mostrando pertencem à categoria de crenças sobre o ensino da matemática e de que 5 tem tamanho médio efeito.

Palavras-chave:
Ensino Secundário, atitudes, motivação, crenças, aprendizagem da matemática.

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1. Introducción

La educación matemática tiene una gran presencia en todos los sistemas educativos del mundo. Como consecuencia, tiene una posición significativa en los informes que contrastan el rendimiento académico entre diferentes países, como los informesPISA o IEA. En ambos informes, España obtuvo la puntuación más baja en matemáticas. Los países latinoamericanos analizados obtienen resultados claramente por debajo del promedio de laOCDE.

In the case of the most recent PISA report (2015), Spain is ranked 32 in the list with a score of 486 points, slightly below the OECD average (490) and well below Singapore, who led the ranking with a score of 564 points. All Latin American countries included in the report are ranked below the OECD average, Argentina being in the lead in 42nd position with 456 points.

The difficulties in performance seen in primary education, and especially in secondary education children, have turned mathematics education into a cause for concern. This concern increases when we deal with socially disadvantaged contexts, and in particular when we refer to women, who habitually suffer these consequences to a greater extent; in the 2015 evaluation (INEE, 2015) there is a 16-point difference in favour of boys; this was double the OECD average. For this reason this research seeks to delve deeper into this field, doubtlessly relevant not only to Spain but also to disadvantaged contexts in Latin American countries.

Attempts to explain the performing difficulties in mathematics, traditionally resort to cognitive aspects mainly, such as the person's knowledge and capacities. However, the topic's difficulty, the effort required and the cumulative nature of such difficulties with age, do not suffice to explain the poor performance, let alone the students' rejection of the topic, since some students adore it. The truth however is that rejection is resulting in academic failure, a cause for concern due to its educational and vocational repercussions. From an educational point of view, the explanation is associated to the methodology, but also to some social beliefs and emotional experiences in learning maths.

Hence, in this research we deal with the affective domain of learning maths, with the aim of analysing the possible gender differences related with the psychological constructs that configure such domain in secondary education students living in disadvantaged social contexts. This research topic may offer support in designing more effective teaching practices, committed to guaranteeing gender equality in maths education in adverse circumstances, which habitually affect women to a greater extent.

2. Theoretical framework

Since the 1980s, especially since McLeod's studies (1988,1992), we have witnessed a gradual increase of the value given to the affective dimension of knowledge acquisition, especially with regard to mathematics learning, at the expense of all that is rational and cognitive (Campos, 2003; Gómez Chacón, 1999, 2000; Hart, 1989; Hidalgo, Maroto & Palacios, 2000a, 2000b; Mandler, 1984; Mcleod, 1988, 1992, 1994).

Given the complexity of the affective domain, it should be noted that when we talk about this domain in this study, we are referring essentially to the beliefs, attitudes and motivation (Gómez Chacón, 1997; Mcleod, 1989, 1992).

2.1. Attitudes towards mathematics

An attitude is usually defined as an evaluative feeling (good-bad) of the person towards objects, problems, people or any other aspect identifiable in our context (Perlman & Cozby, 1985).

Regarding the components that conform attitudes, some authors (Cooper & Fishman, 1974; Fishbein & Azjen, 1980) outline the following: a) perceptive or cognitive component, related to ideas and beliefs; b) affective or sentimental component, related to emotions and feelings and, lastly, c) behavioural or conative

component, which is related to actions. Other authors supress the behavioural component and reduce attitudes to two-dimensional constructs (Bagozzi & Burnkrant, 1979; Zajonc & Markus, 1982). In any of these interpretations, beliefs are considered as a part of the attitudes.

Among the factors influencing the shaping of attitudes within the educational context, Munne (1980) includes the very educational contents, the direct experience with the discipline, attitudes that manifest within the context and the fulfilment of personal expectations, or lack thereof.

Within the concept of attitude towards mathematics education, two main concepts can be discerned (NCTM, 1991; Callejo, 1994): attitudes towards mathematics and mathematical attitudes. *Attitudes towards mathematics* are related to the value, appreciation and preference given to this discipline, placing more emphasis on the affective than the cognitive side, and is manifested in terms of interest, satisfaction, curiosity, appreciation, etc.. (Callejo, 1994; Gómez Chacón, 2000; Hidalgo, Maroto & Palacios, 2004). *Mathematical attitudes*, on the contrary, are more related to the use of general abilities that are relevant in the mathematical tasks (such as open-mindedness, flexibility in the solution-seeking of problems and reflective thinking), aspects more related to cognition than affection.

We will focus on attitudes towards mathematics whose relevance in the teaching-learning process and the mathematical performance of students is openly acknowledged today (Miñano & Castejón, 2011; Miranda, 2012; Sakiz, Pape & Hoy, 2012). It is necessary to make clear that no dependence relationship has been demonstrated to exist between the two (McLeod, 1992), although Mato & Muñoz (2010) obtained a predictive value of the performance in mathematics from the attitudes towards this topic, and Castañeda & Alvarez (2004) found a significant incidence of attitudes of rejection towards mathematics in the solving of problems, working with students in teacher-training at the *Universidad Autónoma del Estado de México*.

Regarding gender, Fennema and Sherman (1977) in their first studies found gender differences related with success in mathematics. These researchers also studied the relationship with affective and attitudinal variables, with findings clearly showing that men showed greater confidence than women, and stated that mathematics was more useful to them. Thomas (2000), Willis (1995) and Fullarton (1993) among other authors, stated that the negative attitude that women showed towards learning mathematics contributes to their lower level of engagement and lesser success in disciplines with a mathematical content. More recent studies confirm this idea among secondary school students: a more favourable attitude towards mathematics in boys, and less confidence in mathematical achievement and less perceived competence for learning mathematics among girls (Barbero, Holgado, Vila & Chacón, 2007; Devine, Fawcett, Szűcs, & Dowker, 2012; González-Pienda et al., 2012; Ursini, & Sánchez, 2008; Sax, Kanny, Riggers-Piehl, Whang, & Paulson, 2015).

2.2. Motivation for mathematics learning

The concept of motivation is a complex one and depends on the theoretical approach adopted. There seems to be a certain consensus when we refer to those cognitive and affective factors that have a direct influence in the choice, direction, persistence, reiteration and quality of an action (Pardo & Alonso Tapia, 1990). The idea of motivation has evolved from being considered as a dimension of the person that could be activated, to being understood as a concatenation of moments or states, or as a change in the person's priorities that generates new motives thanks to the interaction of a series of variables, most of them related to the context (Hernández, 1991).

Since there is consensus in attributing motivation a dispositional role in the process of teaching-learning, this can be explained in terms of reciprocal interactions between the class context, students' feelings and beliefs on their motivations and, on this basis, the corresponding behaviour. In this way, the class context conditions the feelings about motivation and the latter conditions the actions that take place in the classroom (Pintrich, 2006). As a consequence, research oriented to studying the motivation of students has emphasized both, the context and nature of implicit knowledge and the beliefs in the different ways of accessing knowledge that humans develop according to the culture we belong to.

From a contextualist approach, both cultural and individual aspects present in the teaching-learning process have been taken into account. Motivation is conceived as the process that accounts for all the driving forces involved in the way students are oriented and committed to the learning tasks, as well as the choice of targets with a certain emotional component (Díaz-Barriga, 2012). This entails the need to know the degree of interaction between students and teachers, the teacher's dynamics to foster students' motivation, and the most stimulating strategies used. In addition, a number of factors can be controlled by teachers through actions and messages that enhance students' motivation (Arends, 1994). These elements refer to the level of involvement of students in the classroom and their feelings of empathy with the other people. An affective classroom climate and the students' interest and commitment during the teaching-learning process are also related factors.

From the perspective of implicit knowledge and beliefs, these are considered as a set of experiences that take shape implicitly in general and act in a latent manner. From these beliefs, subjects infer, predict and plan actions to take in certain situations and, as a consequence, tend to construct motivational patterns of action to adapt to the different learning situations.

Motivation is thus tied to the student's personal history, but also a developing ability that can be educated (Escaño & Gil, 2001, 2008). Hence we say motivation is tied to the classroom's educational approach and does not seem to make sense unless inserted into the learning process, in relation with the remaining variables involved (Paris & Turner, 1994; Pintrich & Schunck, 2006). Thus, the dispositional character of motivation is not something inherent to the subject exclusively, but is part of the educational process, and even a consequence of it. From this perspective, motivation in education is related to the interaction of the

variables present within the educational situation and is related to the context (Pintrich, 1999; Zimmerman & Kintasas, 1997).

Motivation is still considered a fundamental variable to lead students towards proper, long-lasting knowledge acquisition (Pintrich & Schunk, 2006). It is therefore imperative to keep students committed to the study of a subject, and for students to have a better understanding of their learning process. This contributes to an enrichment and improvement of educational practices, and to students getting more personal, permanent learning.

Some studies reach similar conclusions regarding the role of motivation in learning mathematics in secondary education (Gavilán, 2002). Moreover, Cubillo & Ortega (2002) carried out research with students aged 15 to 17 years, and found a positive correlation between student's valuation of mathematics and the degree of motivation, through a pretest/posttest analysis.

With regard to motivation according to gender, several studies have demonstrated that boys present with a greater extrinsic motivational orientation (Anderman & Anderman, 1999; Midgley & Urdan, 1995; Roeser, Midgley & Urdan, 1996; Urdan et al., 1998), while girls present with a greater intrinsic motivation (Meece & Holt, 1993; Nolen, 1988).

In a study carried out with secondary school children, González-Torres & Torrano (2013) reached the conclusion that boys are more oriented towards performance goals than girls. Boys perceive themselves as more competent than girls; this was also found in the area of mathematics in other studies (Patrick et al., 1999; Pintrich & Zusho, 2002). Although they tend to undervalue their capacities more than boys, girls for their part, orientate their goals to deep and significant knowledge (learning goals).

2.3. Beliefs about mathematics

Beliefs about mathematics are considered as one of the components of individual's implicit subjective knowledge, based on experiences about mathematics and its teaching and learning (Gómez Chacón, 2000).

The student's beliefs are categorized in terms of the object of belief: beliefs about mathematics; about oneself; about teaching mathematics; and beliefs about the context within which mathematical education takes place (Mcleod, 1992).

From the perspective of Mathematical Education, beliefs have been analysed with two different orientations, one related to the acquisition of new concepts based on previous knowledge and beliefs (Azcárate, 1997; Pecharromán, 2009; Socas, 2007) and the other based on the so-called mathematical emotional profile (Hidalgo, Maroto, Ortega & Palacios, 2013). The idea of this emotional profile assumes the existence of a bidirectional relation between emotions, attitudes and beliefs on the one hand, and performance on the other; in the sense that the experience of learning mathematics provokes reactions and influences beliefs, and conversely, the latter influence in the capacity of learning (Gómez Chacón, 2000; Guerrero, Blanco & Vicente, 2002). Hidalgo, Maroto & Palacios (2004, 2005) obtained relations between beliefs and the rejection of students towards mathematics, when attempting to identify their mathematical emotional profiles.

Since the end of the last century, research has been carried out on students' beliefs about mathematics and their influence on their views on the subject and on learning it. The different studies carried out to assess the students' evolution in Primary and Secondary Education have seldom yielded any details about the evolution of beliefs on mathematics in Secondary Education, although such beliefs last into old age. More recently some studies have attempted to detect what beliefs can have a negative repercussion on such learning, while analysing whether these differences varied at all according to sex and age (Alomar, 2007; Hidalgo et al., 2013; House, 2007; Poulou, 2007). Other studies have sought to relate mathematical beliefs with the type of methodology used Warfield, Wood & Lehman (2005) or with performance (Alomar, 2007; Chen & Zimmerman, 2007; Simpkins, Davis-Kean & Eccles, 2006).

There is research about the incidence of gender in learning mathematics where there seems to be no significant difference until the age of 12 or 13 years (Fennema & Sherman, 1977). In addition, when these differences take place, they could be attributed to the changes associated with puberty and adolescence, except they continue with age. However, other previous studies indicate the tendency of girls to be less confident about their mathematical abilities and to have an inferior mathematical self-concept than boys (Devine, Fawcett, Szűcs, & Dowker, 2012; Sax, Kanny, Riggers-Piehl, Whang, & Paulson, 2015). It has also been reported that girls' performance happens to be worse, as they perceive that seeking help in the classroom becomes more difficult (Kessels, & Steinmayr, 2013); this could be related to some belief within the group 'Beliefs related to the teaching of mathematics'.

Ultimately, the results obtained in previous research show the relevant role of the student's affective dimension in learning mathematics and justify the need for further in-depth investigation. There seems to be a mutual influence between attitudes, beliefs, motivation and performance and there seem to be differences according to gender and the passing of time (Hidalgo et al., 2013). These results reinforce the need to foster the students' motivation to weaken negative beliefs and encourage positive attitudes, as well as the need to delve deeper into the significant differences in the affective domain of adolescents according to their gender, with the aim of obtaining conclusions about their educational implications. These conclusions can therefore support the design of more affective educational practices engaged with guaranteeing the gender equality in mathematics education in adverse circumstances that habitually affect women more.

In accordance with the previous theoretical background, this study aims to look into the possible gender differences on the affective domain related to mathematics learning of a sample of secondary school students characterised by belonging to dysfunctional families and with important performance difficulties, sharing the same educational context. Crucially, the specific objectives of the study are posed as follows:

1. To examine the motivation and the attitudes towards learning mathematics expressed by a sample of secondary students based in the same disadvantaged educational centre with a view to analysing whether any differences between girls and boys concerning these variables might be identified.
2. To study possible gender differences that the secondary school students in the sample display regarding the following three sets of beliefs linked to the process of learning mathematics: beliefs over the activity of learning mathematics, beliefs over the relationship with teachers and, finally, beliefs connected to the influence of personal learning paths in mathematics.

3. Method

3.1. Context characteristics

The school our sample belongs to is located in a town of about 30.000 inhabitants in the Greater Bilbao area (Spain). It is located in an area that underwent a strong process of industrialization during the 20th Century; and subsequently, as a consequence of the corresponding deindustrialization, it is undergoing a serious deterioration in living conditions. This town has an unemployment rate of 21.67%; half of the population have had only primary education or no formal education, and the immigrant population rate is 6.5% (EUSTAT, 2017). We can say that the school belongs to a socially disadvantaged context, with a significant proportion of dysfunctional families, school performance difficulties and a significant number of foreign students.

3.2 Sample

The sample under analysis comprises 202 secondary school students, 86 girls and 116 boys. All the participants in the study attended the same public school. Table I accounts for the distribution of the participants in the study in accordance with their academic year at the time of the study:

Table I
The distribution of participants in the study, broken down by their educational level (N=202)

Academic year	%	Age of the students	Repeaters within academic year
First year	32.2	12-15	5
Second year	27.3	13-15	7
Third year	12.9	14-16	3
Fourth year	27.8	15-18	8

3.3. Measuring tools

The participants in this study answered two scales to assess, respectively, students' attitudes and motivation towards learning mathematics and, also, a scale to weigh up their beliefs towards learning mathematics.

Attitudes were measured in more detail by means of the questionnaire proposed by Palacios, Arias & Arias (2014). This is a five-point Likert scale with 32 items developed on the basis of four psychological constructs: enthusiasm towards learning mathematics, sense of usefulness of mathematics, sense of lack of self-competence to learn mathematics, and mathematics self-concept. Apart from these four subscales, the questionnaire also provides a total score that enables the assessment of students' global attitude toward the learning of mathematics as a whole. Internal reliability and consistency were demonstrated via average variance extracted, construct reliability and the McDonald's Omega coefficients estimates corresponding to the four-correlated-factor model. The coefficients obtained in all four factors (Mathematical self-concept M=.630, Enjoyment of Mathematics M=.753, Self -perception of Mathematical incompetence M=.734 and Perception of usefulness M=.681) indicate that the scale shows sufficient evidence of reliability.

Furthermore, the study of the participants' motivation was measured by means of the questionnaire designed by Rey, Hidalgo & Espinosa (1989). This is a five-point Likert scale consisting of 26 items related to key aspects of the motivation; such as interest and enthusiasm for academic activity, one's aspirations, a perception of independence and needs and the usefulness of the subject and performance, amongst others. The questionnaire offers a measurement of the participants' general motivation. The reliability test gave a value $\alpha = .91$.

Finally, the students' beliefs towards learning mathematics were measured in accordance with the methodological approach proposed by Hidalgo *et al.* (2013). This consists of a battery of 41 statements about the process of learning mathematics in the classroom, about which participants have to express their agreement or disagreement by means of a five-point Likert scale. A Cronbach's alpha value of a=0,9 has been obtained; therefore, we can be assured that the scale is validated and reliable. As for the statements appearing in the questionnaire, Table II describes the types of categories involved in this questionnaire, along with a summary of the topic of each category and some examples of the beliefs comprising the test.

Table II
Description of the categories of statements included in the questionnaire to study students' beliefs about mathematics

Categories	Theme of the category	Examples of beliefs
Social beliefs about mathematics	Common social suppositions about leaning mathematics	· People who are keen on mathematics are a little strange. · Learning mathematics is, generally speaking, boring. · Mathematics are abstract and far from reality.
Beliefs related to teaching mathematics	Presumptions on the influence that mathematics teacher's teaching style has on one's own learning process	· Good marks in mathematics are related to the support that students receive. · The teaching methods of mathematics teachers are usually more boring than those of other subjects. · Students' efforts are taken into consideration by mathematics teachers more often than by teachers of other subjects.
Beliefs related to learning mathematics	Ideas on the connection that personal features, habits and family factors have with learning mathematics	· Bad grades in mathematics are linked to bad luck. · One's own capacities lead to success in mathematics. · Learning mathematics demands daily study

The abovementioned questionnaires were filled out anonymously by the participants in the study and except for academic level and gender, no personal information was gathered during the data collection. The members of the research team handed out the questionnaires in two separate sessions in the students' own classroom during school hours in March 2016. The research procedure was agreed upon and approved by the Academic Board of the school involved in the study.

Concerning the statistical procedures, the study of gender differences was carried out using the Mann-Whitney test (Siegel & Castellan, 1988) and Pearson's correlation coefficient (r) was chosen to account for the *effect size* (Tomczak & Tomczak, 2013). The reason why we used contrast statistics corresponding to non-parametric tests is that when analysing the distribution through the Kolmogorov-Smirnov test, some attitude subscales, especially mathematical self-concept, were observed to not adjust to a normal distribution.

4. Results

The results of this study are presented below (Table III). First, the figures related to the whole of the sample are introduced and subsequently, the results in connection with the study of the gender differences regarding motivation and attitudes towards learning mathematics. The final part of the section covers the analysis of the differences that girls and boys display in relation to their beliefs on learning mathematics.

Regarding the first point, Table III spells out the statistical descriptors of the scores that the participants in the study, regardless of gender, achieve in connection with their motivation and attitudes towards the process of learning mathematics. Along with this, the data resulting from the subscales that comprise the questionnaire of their attitudes is also broken down.

Table III
Statistical descriptors of the results achieved by the students in the sample regarding the scales of motivation and attitudes towards learning mathematics. Total sample

	N	*Median* (Mean)	*Cronbach's α*
Motivation (total)	176	85.03 (86.0)	0.9
Attitude (total)	161	77.01 (77.0)	0.96
Subscale: enthusiasm towards learning mathematics	181	23.09 (22.0)	0.94
Subscale: sense of usefulness of mathematics	179	12.18 (13.0)	0.66
Subscale: lack of self-competence to learn mathematics	171	15.43 (14.0)	0.94
Subscale: mathematics self-concept	181	9.17 (9.0)	0.8

Moving onto the study of gender differences, the girls in the sample display worse motivation towards learning mathematics (*Mdn=83*) than their male counterparts (*Mdn=87*), *U=3141*, *p=.045*, *r=.15*. Moreover, the overall attitude expressed by the girls (*Mdn=74*) is also significantly lower than that of the boys (*Mdn=80*), *U=2546*, *p=.035*, *r=.166*.

Regarding the examination of the gender differences linked to the four subscales comprising the attitude scale, significant differences have been found in connection with the *mathematics self-concept* subscale between girls (*Mdn=8*) and boys (*Mdn=10*) *U=2880*, *p=.001*, *r=.247*.

Finally, and with regard to the examination of possible gender differences linked to students' beliefs on the issue of teaching and learning mathematics, thirteen of the forty-two beliefs comprising the questionnaire showed significant differences between boys and girls. Table IV details the statistical descriptors of the beliefs that display significant differences presented in descending order of *effect size* (r) within each of the categories of beliefs.

Table IV
Statistical descriptors of the beliefs displaying gender differences in descending order of effect size (r) within each type of belief

Beliefs related to	*Item*	*Median* (Mean)		*r*	*U*	*p*
		Male	*Female*			
teaching mathematics	*When I get bad grades in mathematics, it is mainly due to the lack of help from teachers.*	1.0 *(0.91)*	1.0 *(1.6)*	.285	2613	.000
	Mathematics teachers are always ready to clarify doubts and help in the resolution of difficulties in class.	3.0*(2.91)*	3.0 *(2.28)*	.262	2801	.000
	The difficulties that I have in mathematics, or that I could have in the future, are due to the lack of help.	1.0 *(1.1)*	1.0 *(1.57)*	.233	2890	.002
	Mathematics teachers are often less accessible than teachers in other subjects.	1.0 *(1.13)*	1.0 *(1.5)*	.232	2994	.002
	My belief is that there is a certain relationship between my dislike towards mathematics and mathematics teachers.	1 *(0.91)*	1 *(1.6)*	.230	3032.5	.002
	When I get bad grades in mathematics, it is mainly due to the lack of help from those around me.	0.0 *(0.71)*	1.0 *(1.06)*	.174	3132,5	.020
	I think that some mathematics teachers do					

5. Conclusions

The data presented in this study indicate that, as far as the sample examined is concerned, girls and boys feel differently about the school experience of learning mathematics.

On the one hand, and in relation to objective 1, the overall attitude and motivation towards mathematics is worse in girls than in boys. However, the low *effect size* found (*.166* and *.15* respectively) suggests that the significant differences pinned down by the Mann-Whitney test should be considered with caution. More interestingly, the gender differences liaised with the construct *mathematics self-concept*, one of the four belonging to the attitude scale, displays a substantially higher *effect size* (*.247*). This fact indicates that the beliefs expressed by the girls in the sample when it comes to leaning mathematics are not only significantly worse than those of their male counterparts, but also that the strength of connexion between the variables (that is to say, between gender and their *mathematics self-concept*,) is fairly close to a medium threshold. These results obtained in a disadvantaged context are along the same lines as part of a previous research that also stresses the tendency of girls to express worse confidence in their mathematics skills and lower mathematics self-concept than boys (Devine, Fawcett, Szűcs, & Dowker, 2012; Sax, Kanny, Riggers-Piehl, Whang, & Paulson, 2015). The results could also be linked to a hypothetical difference in environmental pressure that students might suffer according to their gender, a subject worth examining in future research.

Regarding objective 2, the results related to the study of gender differences linked to the students' beliefs about mathematics reveal that the boys and girls in the sample respond differently in 13 out of the 44 beliefs considered. It is also worth noting that almost all the beliefs showing gender differences (10 out of 13) belong to the category *beliefs on teaching mathematics*.

More interestingly, when considering the *size effect* in tandem with the gender differences, 5 out of 13 beliefs displaying gender differences, exceed the *.02* threshold, which may be considered as a level coming close to a medium association between the variables. These 5 beliefs approaching a medium *size effect*, belong to the category of teaching mathematics and they all refer to the student's conviction that the support received during their learning process and the quality of the relationship between teacher and learners affect their marks in mathematics. In other words, in contrast to their male classmates, the girls in the sample are significantly more prone to believing that the lack of support (within and outside the classroom) and also poor teacher-learner relationships are connected to their bad grades in maths.

These results seem to reveal a different way of experiencing educational support in general and in mathematics in particular, according to gender, and very likely according to the educational differences within the family context. This observation is in line with the findings provided by previous research (Ursini, & Sánchez, 2008) and highlights the need for teachers to take into account these possible differences in interpretation of educational support within the context of mathematics, as girls associate in a different, and apparently more intense manner, the affective dimension with the type of support given by teachers.

These ideas connect with previous research in a variety of ways. Thus, it has been reported that girls' school performance happens to be worse as they perceive seeking help in the classroom as more difficult (Kessels, & Steinmayr, 2013). Besides that, it is described that male adolescents may be more reluctant to

look for academic support (Ryan, Gheen, & Midgley,1998; Ryan, Shim, Lampkins-uThando, Kiefer, & Thompson, 2009) and also more inclined to assess more favourably interpersonal relationships with their teachers (Kim, Fisher, & Fraser, 2000).

In sum, the data presented reveals two phenomena concurring synchronically in the sample under study, which might arouse the interest of those in charge of mathematics classroom management. On the one hand, the girls in the sample express significant lower general motivation and worse attitudes towards mathematics and, even more salient, they perceive themselves as less capable for learning mathematics than their male counterparts. On the other hand, the girls in the sample also stand out because they link more intensively their performance in the mathematics classroom with their perception of the support received from their teachers and the confidence these show in the learners.

The abovementioned ideas lead us to consider, in line with previous research, that the teaching activity might not be perceived equally by all students in the classroom (Den Brok, Fisher, Rickards, & Bull, 2006) and that different interventions for girls and boys might be required when the classroom environment is perceived differently by these two groups (Fraser, 2012).

Given that girls and boys might not perceive teaching activity in the same way, the study of the factors linked to both teacher's characteristics and teaching strategies that improve learning mathematics for the two groups of students, seems to be a significant objective for further research.

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References

Alomar, B. O. (2007). Personal and family factors as predictors of pupils' mathematics achievement. *Psychological Reports, 101*, 259-269.

Alonso, J. (1991). *Motivación y aprendizaje en el aula. Cómo enseñar a pensar*. Madrid: Santillana.

Anderman, L.H. y Anderman, E.M. (1999). Social predictors of changes in students' achievement goal orientations. *Contemporary Educational Psychology, 25*, 21-37.

Arends, R. (1994). *Aprender a enseñar*. Nueva York: McGraw-Hill.

Azcárate, C. (1997). Si el eje de ordenadas es vertical, ¿qué podemos decir de las alturas de un triángulo?. *SUMA, 25*, 23-30.

Bagozzi, R.P., & Burnkrant, R.E. (1979). Attitude organization and the attitude-behavior relationship. *Journal of Personality and Social Psychology, 37*, 913-929.

Barbero, M.I., Holgado, F.P., Vila, E. & Chacón, S. (2007). Actitudes, hábitos de estudio y rendimiento en Matemáticas: Diferencias por género. *Psicothema, 19*(3), 413-421.

Callejo, M.L. (1994). *Un club matemático para la diversidad*. Madrid: Narcea.

Campos, J. (2003). *Alfabetización emocional: un entrenamiento en las actitudes básicas*. Madrid: San Pablo.

Castañeda, A. & Álvarez, M.J. (2004). La reprobación en matemáticas. Dos experiencias. *Tiempo de educar, 5* (9), 141-172.

Chen, P., & Zimmerman, B. (2007). A cross-national comparison study on the accuracy of self-efficacy beliefs of middle-school mathematics students. *Journal of Experimental Education, 75* (3), 221-244.

Cooper, R. & Fishman, J. (1974). The study of language attitudes. *International Journal of the Sociology of Language, 3*, 5-19.

Cubillo, C. & Ortega, T. (2002). Influencia de un modelo didáctico en la opinión/actitud de los estudiantes hacia las matemáticas, *Uno, 31*, 57-72.

Den Brok, P., Fisher, D., Rickards, T., & Bull, E. (2006). Californian science students' perceptions of their classroom learning environments. *Educational Research and Evaluation, 12* (1), 3-25.

Devine, A., Fawcett, K., Szűcs, D., & Dowker, A. (2012). Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety. *Behavioral and brain functions, 8* (1), 33. doi: 10.1186/1744-9081-8-33

Díaz Barriga, F. (2012). Reformas curriculares y cambio sistémico: Una articulación ausente pero necesaria para dar cabida a la innovación. *Revista Iberoamericana de Educación Superior, 3* (7), 24-40.

Escaño, J., & Gil, M. (2001). Motivar a los alumnos y enseñarles a motivarse. *Aula de innovación educativa, 101*, 6-12.

Escaño, J., & Gil, M. (2008). *Cinco hilos para tirar de la motivación y el esfuerzo*. Barcelona: ICE-UB-Horsori.

Fennema, E., & Sherman, J.A. (1977). Sex related Differences in Mathematics Achievement, Spatial, Visual and Affective factors. *American Educational Research Journal, 12*, 52-71.

Fraser, B. J. (2012). Classroom learning environments: Retrospect, context and prospect. In B. J. Fraser, K. Tobin & C. J. McRobbie (Eds.), *Second international handbook of science education* (pp.1191-1239). Dordrecht: Springer Netherlands. doi:10.1007/978-1-4020-9041-7_79

Fullarton, S. (1993). *Confidence in mathematics: The effects of gender*. Geelong, Australia: Deakin Unversity Press.

Gairín, J. (1987). *Las actitudes en educación. Un estudio sobre matemáticas*. Barcelona. PPU.

Gavilan, P. (2002). Comparación de modelos de resolución de problemas en una clase tradicional y una clase cooperativa. *Uno, 31*, 34-43.

Guerrero, E., & Blanco, L.J. (2004): Diseño de un programa psicopedagógico para la intervención en los trastornos emocionales en la enseñanza y aprendizaje de las matemáticas. *Revista Iberoamericana de Educación Matemática, 33*, 256-269.

Guerrero, E., Blanco, L., & Vicente, F. (2002). Trastornos emocionales ante la educación matemática. En J.N. García (coord.). *Aplicaciones a la Intervención Psicopedagógica* (pp. 229-237). Madrid: Pirámide.

Gómez Chacón, I. M. (1997). La alfabetización emocional en educación matemática. *Revista Uno, 13*, 13-15.

Gómez Chacón, I. M (1999): *Procesos de aprendizaje en matemáticas con poblaciones de fracaso escolar en contextos de exclusión social. Las influencias afectivas en el Conocimiento de las matemáticas*. Madrid: Ministerio de Educación y Cultura-CIDE.

Gómez Chacón, I. M. (2000). *Matemática emocional: los afectos en el aprendizaje matemático*. Madrid: Narcea.

González-Pienda, J.A., Fernández-Cueli, M., García, T., Suárez, N., Fernández, E., Tuero-Herrero, E. & Helena da Silva, E. (2012). Diferencias de género en actitudes hacia las matemáticas en la enseñanza obligatoria. *Revista Iberoamericana de Psicología y Salud, 3* (1), 55-73.

González-Torres, M. C. y Torrano, F. (2013). Perfiles de motivación y rendimiento académico en matemáticas en estudiantes de educación secundaria: Utilidad del Patterns of Adaptive Learning Scales (PALS). En V. Mellado, L. J. Blanco, A. B. Borrachero y J. A. Cárdenas (Eds.). *Las Emociones en la Enseñanza y el Aprendizaje de las Ciencias Experimentales y las Matemáticas* (pp. 177-215). Badajoz: DEPROFE.

Hart, L. (1989). Describing the Affective Domain: Saying what we mean. In A. McLeod & V.M. Adams (Eds.). *Affect and Mathematical Problem Solving*, (pp. 37-45). New York: Springer Verlag.

Hernández, P. (1991). *Psicología de la instrucción*. México: Trillas.

Hidalgo, S., Maroto, A., & Palacios, A. (2000a). *Mathematical profile of Spanish school children moving on from preschool to Primary Education. 10 th Conference on Quality early childhood Education*. University of London, London.

Hidalgo, S., Maroto, A., & Palacios, A. (2000b). Simpatía hacia las matemáticas, las aptitudes y el rendimiento de los alumnos: un complicado triángulo. *Actas del IV Simposio de Formación Inicial del Profesorado*. Oviedo: Universidad de Oviedo pp. 213-217.

Hidalgo, S., Maroto, A., & Palacios, A. (2004). ¿Por qué se rechazan las matemáticas? Análisis evolutivo y multivariante de actitudes relevantes hacia las matemáticas. *Revista de Educación, 334*, 75-99.

Hidalgo, S., Maroto, A., & Palacios, A. (2005). El perfil emocional matemático como predictor del rechazo escolar: relación con las destrezas y los conocimientos desde una perspectiva evolutiva. *Revista Educación Matemática. 17* (2), 89-116.

Hidalgo, S., Maroto, A., Ortega, T., & Palacios, A. (2013). Atribuciones de afectividad hacia las Matemáticas. *UNIÓN*. *Revista Iberoamericana de Educación Matemática, 35*, 93-113.

House, J. D. (2007). Mathematics beliefs and instructional strategies in achievement of elementary-school students in Japan: Results from the tiMss 2003 assessment. *Psychological Reports, 100* (2), 476-482.

ICECE (Instituto Canario de Evaluación y Calidad Educativa) (2002). *Estudio longitudinal de la ESO: avance de resultados*. Gran Canaria: ICECE.

INEE (Instituto Nacional de Evaluación Educativa) (2015). *Programa para la evaluación internacional de alumnos 2015: Factores asociados al rendimiento de los alumnos en PISA*. Madrid: Ministerio de Educación, Cultura y Deporte.

Kessels, U., & Steinmayr, R. (2013). Macho-man in school: Toward the role of gender role self-concepts and help seeking in school performance. *Learning and Individual Differences, 23*, 234-240.

Kim, H. B., Fisher, D. L., & Fraser, B. J. (2000). Classroom environment and teacher interpersonal behavior in secondary science classes in Korea. *Evaluation & Research in Education, 14* (1), 3-22.

Mandler, G. (1984). *Mind and body: Psychology of emotion and stress*. New York: Norron.

Mandler, G. (1989). Affect and Learning Causes and Consequences of Emotion Interactios. In D. B. McLeod and V. Adams (Eds.). *Affect in Mathematics Problems Solving: A New Perspective*. New York: Springer Verlag.

Mato, M.D., & Muñoz, J.M. (2010). Efectos generales de la variable actitud y ansiedad sobre el rendimiento en matemáticas en alumnos de Educación Secundaria Obligatoria. Implicaciones para la práctica educativa. *Ciencias psicológicas, 4* (1), 27-40. Recuperado el 7-5-17 de http://www.scielo.edu.uy/pdf/cp/v4n1/v4n1a04.pdf

McLeod, D. B.(1988). Affective issues in mathematical problem solving: Some theoretical considerations. *Journal for Research in Mathematics Education, 19*, 134-141.

McLeod, D.B. (1989). *Beliefs, attitudes, and emotions: new view of affect in mathematics education*. New York: Springer-Verlag.

McLeod, D. B. (1992). Research on affect in mathematics education: a reconceptualization. In D. Grows (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York: McMillan Publishing Company.

McLeod, D.B. (1994). Research on affect and mathematics learning in the JRME: 1970 to the present. *Journal for Research in Mathematics Education, 25* (6), 637-647.

Meece, J.L. y Holt, K. (1993). A pattern analysis of students' achievement goals. *Journal of Educational Psychology, 85*, 582-590.

Midgley, C. y Urdan, T. (1995). Predictors of middle school students' use of selfhandicapping strategies. *Journal of Early Adolescence, 15*, 389-411.

Miñano, P., & Castejón, J. L. (2011). Variables cognitivas y motivacionales en el rendimiento académico en Lengua y Matemáticas: un modelo estructural. *Revista de Psicodidáctica, 16* (2), 203-230. DOI: https://dx.doi.org/10.1387/RevPsicodidact. 930.

Miranda, A. (2012). Funcionamiento ejecutivo y motivación en tareas del cálculo y solución de problemas de niños con TDAH. *Revista de Psicodidáctica, 17* (1), 51-72.

Munne, F. (1980). *Psicosociología del tiempo libre. Un enfoque crítico*. México.

NCTM (1991). *Estándares Curriculares y de Evaluación para la Educación Matemática*. Publicado en castellano por Sociedad Andaluza para la Educación Matemática "THALES".

Nolen, S.B. (1988). Reasons for studying: Motivational orientations and study strategies. *Cognition and Instruction, 5*, 269-287.

Palacios, A., Arias, V., & Arias, B. (2014). Las actitudes hacia las matemáticas: construcción y validación de un instrumento para su medida. *Revista de Psicodidáctica, 19* (1), 67-91. DOI: https://dx.doi.org/10.1387/RevPsicodidact.8961.68

Pardo, A., & Alonso Tapia, J. (1990). *Motivar en el aula.* Madrid: Universidad Autónoma de Madrid.

Paris, S.G., & Turner, G.C. (1994). *Situated motivation*. Hillsdale, NJ: Erlbaum.

Patrick, H., Ryar, A.M. y Pintrich, P.R. (1999). The differential impact of extrinsic and mastery goal orientation on males´ and females´ self-regulated learning. *Learning and Individual differences, 11*, 153-171

Pecharromán, C. (2009). *Aprendizaje de las propiedades de las funciones a través de las gráficas*. Tesis doctoral. Universidad de Valladolid, España.

Perlman, D., & Cozby, P.C. (1985). *Psicología social*. México: Interamericana.

Pintrich, P. (1999). Motivational beliefs as resources for and constraints on conceptual change. En Schnotz, W., Vosniadou, S., & Carretero, M. *New perspectives on Change Conceptual*. (pp 33-50). Amsterdam: Pergamon.

Pintrich, P. (2006).Las creencias motivacionales como recursos y restricciones para el cambio conceptual. En W. Shnotz, S. Voniadu, & M. Carretero (comps.) *Cambio conceptual y educación* (pp. 145-152). Buenos Aires: Aique.

Pintrich, P., & Schunk, D. (2006). *Motivación en contextos educativos: Teoría, investigación y aplicaciones.* Madrid: Pearson.

Pintrich, P., & Zusho, A. (2002). The Development of Academic Self-Regulation: The Role of Cognitive and Motivational Factors. En A. Wigfield y J.S. Eccles (Eds.), *Development of Achievement Motivation* (pp.249-284). San Diego, CA: Academic Press.

Poulou, M. (2007). Personal teaching efficacy and its sources: Student teachers' perceptions. *Educational Psychology, 27* (2), 191-218.

Rey, J. M., Hidalgo, E., & Espinosa, C. (1989). *La motivación en la escuela: cuestionarios para su análisis*. Málaga: Ágora.

Roeser, R.W, Midgley, C. & Urdan, T.C. (1996). Perceptions of the school psychological environment and early adolescents' psychological and behavioral functioning in school: The mediating role of goals and belonging. *Journal of Educational Psychology, 88*, 408-422.

Ryan, A. M., Gheen, M. H., & Midgley, C. (1998). Why do some students avoid asking for help? An examination of the interplay among students' academic efficacy, teachers' social–emotional role, and the classroom goal structure. *Journal of educational psychology, 90* (3), 528.

Ryan, A. M., Shim, S. S., Lampkins-uThando, S. A., Kiefer, S. M., & Thompson, G. N. (2009). Do gender differences in help avoidance vary by ethnicity? An examination of African American and European American students during early adolescence. *Developmental psychology, 45* (4), 1152.

Sakiz, G., Pape, S.J., & Hoy, A.W. (2012). Does perceived teacher affective support matter for middle school students in mathematics classrooms? *Journal of School Psychology, 50*, 235-255. doi: 10.1016/j.jsp.2011.10.005

Sax, L. J., Kanny, M. A., Riggers-Piehl, T. A., Whang, H., & Paulson, L. N. (2015). "But I'm Not Good at Math": The Changing Salience of Mathematical Self-Concept in Shaping Women's and Men's STEM Aspirations. *Research in Higher Education, 56* (8), 813-842.

Schoenfeld, A. H. (1992). Learning to think mathematically: problem solving, metacognition, and sense-making in mathematics. En D. A. Grows (Ed.), *Handbook 01 Research on Mathematics teaching and learning*. (pp. 334-370). New York: Macmillan.

Simpkins, S.D., Davis-Kean, P.E., & Eccles, J.S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42* (1), 70-83.

Socas, M. (2007). Dificultades y errores en el aprendizaje de las matemáticas. Análisis desde el Enfoque Lógico Semiótico. *Investigación en Educación Matemática, XI*, 19-52.

Thomas, J. P. (2000). Influences on mathematics learning and attitudes among African American high school students. *The Journal of Negro Education, 69*, 165-183.

Tomczak, M., & Tomczak, E. (2014). The need to report effect size estimates revisited. An overview of some recommended measures of effect size. *Trends in Sport Sciences, 21* (1), 19-25.

Urdan, T., Midgley, C. y Anderman, E.M. (1998). The role of classroom goal structure in students' use of self-handicapping strategies. *American Educational Research Journal, 35*, 101-122.

Ursini, S., & Sánchez, G. (2008). Gender, technology and attitude towards mathematics: a comparative longitudinal study with Mexican students. *ZDM, 40* (4), 559-577.

Valdez, E. (1998). *Rendimiento escolar y actitudes hacia las Matemáticas: una experiencia en la escuela secundaria*. México D.F.: Centro de Investigación y Estudios Avanzados.

Warfield, J., Wood, T. & Lehman, J. D. (2005). Autonomy, beliefs and the learning of elementary mathematics teachers. *Teaching and Teacher Education, 21* (4), 439-456.

Willis, S. (1995). Gender justice and the mathematics curriculum: Four perspectives. En L. Parker, L. Rennie, y B. Fraser (Eds.), *Gender, science and mathematics: Shortening the shadow* (pp. 41-51). Dordecht: Kluwer.

Zajonc, R.B., & Marcus, H. (1982). Affective and cognitive factors in preferences. *Journal of consumer Research, 9*, 123-131.

Zimmerman, B.J., & Kintasas, A. (1997). Developmental phases in self-regulation: Shifting from process goals to outcomes goals. *Journal of Educational Psychology, 89*, 29-36.