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Spanish adaptation of the Math and Me Survey in primary education: Measuring second and fourth graders' attitudes toward mathematics

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Abstract: The English version of the "Math and Me Survey" was developed to measure mathematical attitudes of elementary students. This study was used to translate, validate and examine the attitudes of Spanish students in the second and fourth grades of primary school. The translation-back translation procedure was adopted. A total of 81 students (42 boys and 39 girls), with a mean age of 8.19 years completed the Spanish survey. The psychometric properties of the adapted survey were examined by internal consistency, reliability and factorial structure. The exploratory factor analysis of the 18-item adapted questionnaire provided a two-factor structure, similar to the original questionnaire: mathematical self-concept and enjoyment of mathematics. For each factor, the Spanish survey had high internal consistency, respectively ω = .89 and ω =.91. However, the confirmatory factor analysis did not show overall good fit. The adapted survey should be interpreted with caution, suggesting a need for further investigation to be used as an effective tool for evaluating math self-concept and enjoyment in a Spanish-speaking context. In addition, the results of its application indicated that (1) second-graders had a better mathematics self-concept and enjoy mathematics more than fourth-graders, and (2) boys had a greater mathematics self-concept than girls, but girls enjoyed this subject more in second grade.

Subjects: Mathematics Education; Psychometrics/ Testing & Measurement Theory; Test Development, Validity & Scaling Methods

Keywords: mathematics attitudes; elementary students; self-concept; enjoyment

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1. Introduction

The study of students' mathematical attitudes has aroused interest in educational research due to its relevance in the teaching-learning process (Adelson & McCoach, 2010). For several decades, the importance of beliefs about and attitudes towards the learning of mathematics has deepened since they may affect students' behavior and educational outcomes (A. Dowker et al., 2019; Adelson & McCoach, 2010; Cvencek et al., 2020; Hannula et al., 2016). Different studies (M. F. Del Río et al., 2019) have shown that it is possible to study students' attitudes toward different subjects such as mathematics and therefore the behavior they manifest in relation to them. Notably, these attitudes can be conditioned by students' budgets and personal experiences regarding the subjects and can affect their performance and learning (Areepattamannil, 2012; M. Del Río et al., 2016). As Bandura (2006) posited learning is affected by the students' beliefs in their abilities to perform a specific task (self-efficacy), and these determine their behavior and cognition (Bandura, 1997). In fact, children demonstrate different levels of emotional, social and cognitive engagement in school (Bong & Skaalvik, 2003), and they are in need of successful experiences to develop academic positive perceptions (self-concept). While self-efficacy represents children's expectations of what they can successfully accomplish, self-concept represents children's knowledge and perceptions of the self (Bong & Skaalvik, 2003; Holenstein et al., 2021). Academic self-concept is influenced by the result of social comparison and is related to how children feel about themselves toward a given domain (for an overview, see Bong & Skaalvik, 2003). Students who have a positive self-perception are more likely to perform better (Vasalampi et al., 2020), thus the importance of providing early positive experiences in areas such as mathematics.

In the first years of school, boys and girls can form an idea about different subjects and know if they like them or not. For this reason, it is foreseeable that as students progress through a course, they will adopt an attitude toward it, creating a self-concept and displaying their pleasure or enjoyment in relation to the subject (Eccles et al., 1993). They also begin to create their own perceptions, ideas and beliefs about mathematics, which can influence and even predict their academic performance (Mazana et al., 2019; Williams & Williams, 2010). Although students' attitudes about mathematics develop over time (Ma & Kishor, 1997), some studies document the importance of the role of children's early experiences such as parents' attitudes towards mathematics (Aunola et al., 2013; Mohr-Schroeder et al., 2017) and how these may even improve students' attitudes toward mathematics (Rowan-Kenyon et al., 2012; Sheldon & Epstein, 2005) which can increase student's interest (Aunola et al., 2013) and achievement in mathematics (Lipnevich et al., 2016; Mohr-Schroeder et al., 2017). Therefore, parents can also become a positive influence on their children's attitude, which is regarded as a key contributor to the performance in mathematics (Mazana et al., 2019).

On the whole, studies suggest that children's mathematics beliefs have an impact on performance on cognitive and affective levels and the development of positive perceptions are related to successful learning (Marsh & O'Mara, 2008; OECD, 2013) as they are associated with academic performance (Geddes et al., 2010). Moreover, children's emotions influence both the learning process and academic performance in which the importance of affective-emotional aspects and an interest in mathematics is evident (Hidalgo et al., 2012; Sorvo et al., 2022). In addition, the relevance of the effect of emotions in the teaching-learning process should be taken into account (Hidalgo et al., 2012) since they have the ability to determine the success and/or failure of the student as well as their academic performance in this subject (D. Dowker et al., 2012).

Research on the attitudes of boys and girls toward mathematics is considerable (A. Dowker et al., 2019; Adelson & McCoach, 2011; Asika, 2021; Cvencek et al., 2015, 2020; D. Dowker et al., 2012; Hidalgo et al., 2012; Paz-Albo et al., 2017; Viljaranta et al., 2014) and allows us to identify the elements that condition these attitudes and thus to explore the ways in which they can be modified to improve academic performance (for intervention development that boost children's beliefs about math, see Cvencek et al., 2015). Mathematics attitudes are far more malleable than

cognitive ability characteristics (Lipnevich et al., 2016), and therefore, for the educational field, the possibility of modifying students' attitudes in the early years toward subjects is of great interest. Authors such as Hidalgo et al. (2012) state that there is a real rejection by some students of mathematics and suggest that it is due to the influence of cognitive and emotional variables since students who understand and handle mathematics with some ease affirm that it is easy and fun (2012).

In line with the above, studies have shown that the development of positive emotions and beliefs in students promotes attitudes of approaching mathematics, and these perceptions of their mathematical abilities (mathematics self-concept) play an important role in academic performance (M. Del Río et al., 2016). Likewise, other international measures, such as the Program for International Student Assessment (PISA), assess the level of self-concept as a key factor in the results of standardized tests; that is, the better a student's self-concept is, the better their performance in mathematics is (Sáenz, 2007 Servicio de Ordenación Académica y Evaluación Educativa [SOAEE], 2019). Although the results by Sáenz (2007) do not show a significant relationship between motivation and performance in mathematics, other studies (SOAEE, 2019) affirm that greater motivation correlates with better results on skills tests.

Different studies have focused on mathematics not only due to its compulsory nature in primary and secondary education but also because it is usually the subject that poses the most difficulties for students, although it is among the subjects that contribute the most important skills and knowledge, both for the study of other subjects and for success in life (Martínez-Artero & Nortes, 2013). Moreover, mathematics has an instrumental character since it is the basis for acquiring new knowledge in other subjects and its practice develops in the child an interest in research, creativity or even the ability to apply mathematical reasoning in everyday situations.

On the other hand, a key aspect of changing an attitude is to first know the assessment that the subject makes of the dimensions that compose it. In this case, it is necessary to know primary school students' evaluation at both the cognitive level (mathematics self-concept) and the emotional level (the enjoyment of mathematics) with the aim of being able to modify this evaluation, as long as it is necessary, and thus influencing students' behavior. Most studies have focused on mathematics anxiety, but as A. Dowker et al. (2019) suggest other attitudes such as self-confidence and enjoyment are also important to study since they are usually positively related to performance. However, if there are instruments to assess these mathematics attitudes in secondary school children (see Adelson & McCoach, 2011 for a detailed description), instruments to assess primary school children's attitudes to mathematics in a Spanish-speaking context are scarce since there is a lack of suitable scales (see Guzmán et al., 2021 for a review of scales for young children in the English-speaking context). Adelson and McCoach (2011) validated the "Math and Me Survey" instrument, designed for third- to sixth-grade students, identifying two dimensions: the enjoyment of mathematics and mathematical self-perceptions. This 5-point Likert-type scale has reported a good level of reliability (see Adelson & McCoach, 2011) and uses a vocabulary that is understandable by second-grade children, making the scale more accessible to younger children. Therefore, the "Math and Me Survey" questionnaire originally developed by Adelson (2006) was adapted to Spanish to assess primary school children's beliefs about their abilities to perform well in mathematics (self-perceptions) and the extent to which they enjoy doing and learning mathematics (enjoyment).

Taking into account all the above, the specific objectives of this study were (a) to examine the properties of the adapted Spanish version of the "Math and Me Survey" questionnaire (Adelson, 2006) for use with Spanish children; (b) to describe and analyze mathematics self-concept and the enjoyment of mathematics in a sample of Spanish second- and fourth-grade children; and (c) to explore the role of gender and age in the relationship between self-concept and enjoyment. Moreover, based on previous research on the psychometric properties of the "Math and Me Survey", it is hypothesized that the Spanish version will also have a two-factor solution as well

as the measured variables influenced by the same factor proposed by Adelson and McCoach (2011). We also hypothesize that there will be significant differences in mathematics self-concept and enjoyment of mathematics between boys and girls. We expect the boys to identify with math more strongly (A. Dowker et al., 2019; Cvencek et al., 2011, 2015; D. Dowker et al., 2012; M. F. Del Río et al., 2019) and younger children to enjoy learning math more.

2. Method

The adaptation process was based on the method of translation and back translation by professionals and a pilot study. In addition, an exploratory and descriptive quantitative methodology is used to deepen understanding of the attitudes of primary school students toward mathematics.

2.1. Participants

This study included 81 students from a primary school aged between seven and ten years, (M = 8.19; SD = 1.07) and was conducted during the second semester of the 2018–2019 school year. Of the 81 participants, 36 were in second grade (44.4%), and 45 were in fourth grade (55.6%). The sample is summarized in Table 1.

The sample design was nonprobabilistic and accidental (Otzen & Manterola, 2017). To access the sample, first, a co-ed educational center was invited to collaborate in this study to obtain a balanced sample, nearly equally-sized subgroups. The parents of all participants provided written informed consent.

2.2. Instrument

As a measurement instrument for this research, an adaptation of the "Math and Me Survey" designed by Adelson (2006) was developed to measure the attitudes toward mathematics of primary school students. The translated questionnaire "*Las Mates y Yo*" (Math and Me) consists of 18 items that measure mathematics self-concept (8 items) and enjoyment of mathematics (10 items) on a five-point Likert scale, in which 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree and 5 = strongly agree. This scale was chosen because the reliability of a questionnaire is greater than when using a four-point scale, and the scale is suitable for primary school students (Adelson & McCoach, 2010).

The original version was translated and culturally adapted to ensure the semantic and conceptual equivalence of the new questionnaire (Carvajal et al., 2011). This process included a method that is considered to be of the highest quality, namely, translation-back translation with bilingual speakers (Carvajal et al., 2011) in a pilot study. In addition, the questionnaire was evaluated by an interdisciplinary team of experts in translation, bilingual education, psychology and linguistics. The final version in Spanish was adapted during the administration of the pilot study, and the modifications were implemented in agreement with the members of the evaluation team.

2.3. Procedure

After obtaining approval for the research from the Research Ethics Committee of the Rey Juan Carlos University (internal registration number 2808201810018), the participating school was

Table 1. Sample data by class and course

Class and course	*Boys*	*Girls*	*Total*
	***n* = 42**	***n* = 39**	***N* = 81**
Class I: 2nd grade	6	8	14
Class II: 2nd grade	9	13	22
Class III: 4th grade	14	5	19
Class IV: 4th grade	13	13	26

informed about the protocol they had to follow when administering the instrument. Written informed consent was obtained from the parents or guardians on behalf of the participant children and teachers administered the questionnaire in their classrooms to ensure that they followed the same protocol and that the variables of interest were controlled as much as possible.

2.4. Data analysis

To analyze the data, in addition to a descriptive analysis, factor analysis was used to identify latent factors. The exploratory factor analysis (EFA) was used to test the dimensionality and contrast the structure of the translated scale with that of the original instrument using IBM SPSS Statistics for Macintosh (Version 28.0.). Confirmatory analysis (CFA) was computed using AMOS to test the measurement model. McDonald's omega was calculated to ensure the internal consistency of the instrument. An analysis of variance (ANOVA) was performed to make comparisons among the classroom groups, and the Students' t-test was used to compare the means of the second- and fourth-grade children groups and to determine whether gender differences existed by grade level.

3. Results

3.1. Factor analysis

The factor analysis was performed to test the dimensionality of the instrument using the maximum likelihood method (ML) since it allows a wide range of fit indices (Goretzko et al., 2021). Inspection of the strength of the relationship among the questionnaire items in the correlation matrix revealed the presence of many coefficients of .3 and above (as recommended by Tabachnick & Fidell, 2011), and the factorability of the data was assessed using Bartlett's test of sphericity, and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. Bartlett's test of sphericity reached statistical significance ($\chi^2 = 976.133$; $gl = 153$; $p < .001$), and the KMO value was .851, exceeding the recommended value of .6, supporting the factorability of the correlation matrix (Pallant, 2016; Tabachnick & Fidell, 2011).

To determine the numbers of factors to extract, we considered the Kaiser-Guttman rule, the interpretation of the elbow of the Scree plot and the results from the parallel analysis (PA). Using Kaiser's criterion, the first four factors recorded eigenvalues above 1 (8.023, 2.515, 1.216, 1.048), explaining 44.57%, 13.97%, 6.76% and 5.82% of the variance respectively. An inspection of the Scree plot revealed a clear break after the second factor so, as suggested by Pallant (2016), only the first two factors were retained since they also capture much more of the variance accounted for. Additionally, we also conducted a PA, using the online tool by Patil et al. (2017), since it is among the most accurate methods in determining the number of factors to retain (Fabrigar & Wegener, 2011; Finch, 2020; Hayton et al., 2004). Considering the results of the PA, which agreed with the interpretation of the Scree plot, and the variance explained by the Kaiser-Guttman rule, we decided to extract two factors. The two-factor model explained a total of 58.54% of the variance, with Factor 1 contributing 44.57% and Factor 2 contributing 13.97%.

The pattern matrix of the ML solution with oblimin rotation, the structure matrix, and the extraction communalities for the 18 items of the "Las Mates y Yo" questionnaire are in Table 2. Initial communalities for all the items are above .30 (Table 2) and the rotated structure sorted the measured variables into the same factors of the original "Math and Me Survey" instrument proposed by Adelson and McCoach (2011). Both factors show a number of strong loadings with 10 items loading above .3 on Factor 1, which seems to index "enjoyment of mathematics" and 8 items loading above .4 on Factor 2, which seems to index "mathematics self-concept", and have a moderate correlation (.447).

As the EFA suggested a two-factor solution, as described above, a two-factor CFA was performed using maximum likelihood estimation to test the model with procedures of computing goodness-of-fit coefficients: the standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA), comparative fit index (CFI) and the Tucker-Lewis Index (TLI).

Table 2. "Las Mates y Yo" questionnaire items, their standardized factor pattern and structure coefficients, and their communalities

Item	Pattern coefficients		Structure coefficients		C
	Enjoyment	*Self-concept*	*Enjoyment*	*Self-concept*	
10. Las mates son divertidas. [Math is fun.]	**.837**	.141	.900	.515	.850
6. Disfruto haciendo puzles de mates. [I enjoy doing math puzzles.]	**.808**	−.340	.656	.022	.660
16. Disfruto estudiando mates. [I enjoy studying math.]	**.798**	.097	.842	.454	.785
14. Disfruto jugando con juegos de mates. [I enjoy plaing math games.]	**.751**	−.103	.705	.233	.735
11. Tengo muchas ganas de aprender mates nuevas. [I look forward to learning new math.]	**.698**	.134	.758	.446	.690
18. Resolver problemas de mates es divertido. [Solving math problems is fun.]	**.692**	.213	.787	.522	.787
4. Las mates son aburridas.* [Math is boring.]	**.623**	.194	.710	.472	.706
2. Me encantan las mates. [I love math.]	**.594**	.369	.759	.635	.725
13. Odio las mates.* [I hate math.]	**.553**	.167	.628	.415	.456
8. Hago problemas de mates por mi cuenta "solo por diversión." [I do math problems on my own "just for fun."]	**.307**	.154	.376	.292	.340
12. Las mates me resultan fáciles. [Math comes easily to me.]	−.117	**.911**	.290	.859	.783

(*Continued*)

Item	Pattern coefficients		Structure coefficients		C
	Enjoyment	***Self-concept***	***Enjoyment***	***Self-concept***	
17. Hacer mates es fácil para mí. [Doing math is easy for me.]	−.030	**.895**	.371	.882	.811
7. Las mates son muy difíciles para mí. * [Math is very hard for me.]	−.058	**.735**	.271	.709	.665
1. Soy realmente bueno/a en mates. [I am really good at math.]	.188	**.664**	.485	.748	.677
3. Entiendo las mates. [I understand math.]	.037	**.640**	.324	.657	.498
5. Puedo resolver problemas difíciles de mates. [I can solve difficult math problems.]	.116	**.566**	.369	.618	.558
15. Sé si mis respuestas en mates tienen sentido. [I can tell if my answers in math make sense.]	.135	**.509**	.363	.570	.504
9. Las mates son liosas para mí.* [Math is confusing to me.]	.086	**.494**	.307	.532	.521

Note. Recoding of negative items* of the questionnaire (the opposite values were assigned to the response categories). Pattern coefficients given in boldface signify items loading primarily with that factor.

C = Communalities of the measured variables.

The two latent variables represent the same two factors of the originally "Math and Me Survey" proposed by Adelson and McCoach (2011). After estimating the model fit, goodness-of-fit statistics showed that the two-factor model, which had a χ^2 of 287.48 and *df* of 134 ($p < .001$), did not exhibit good fit. With this model, the χ2/df ratio (2.145) was greater than 2.0. Both the CFI (.832) and TLI (.808) did not meet the ideal cutoff value of being above .95 (Hu & Bentler, 1999; Marsh et al., 2004). Finally, the SRMR (.088) was above the cutoff value of .08 (Hu & Bentler, 1999), typically used as an indicator of good model fit, and the RMSEA (.120) was noticeably greater than the ideal cutoff value of <.06 suggested by Hu and Bentler (1999).

Table 3. Means and standard deviations of students' attitudes by course

Dimension	Second (n = 36)		Fourth (n = 45)		Overall (N = 81)	
	M	***SD***	***M***	***SD***	***M***	***SD***
Self-concept	3.63	0.90	3.41	0.81	3.51	0.85
Enjoyment	4.27	0.74	3.43	0.99	3.86	0.94
Total	4.06	0.55	3.42	0.85	3.70	0.79

3.2. Reliability

To estimate the reliability of the scores for each of the two factors of the "Las Mates y Yo" instrument, internal consistency was calculated using McDonald's omega since it is a more suitable measure for applied research, as suggested in the current methodological literature (Hayes & Coutts, 2020). We reverse scored Items 4, 7, 9, and 13 and used the recoded items in the reliability analysis. The resulting McDonald's omega values can be interpreted as a good internal reliability since estimates were>0.8 for the globality of the questionnaire (ω = .917), and its both dimensions: enjoyment of mathematics (ω = .912) with 10 items, and mathematics self-concept (ω =.886) with 8 items. These coefficients assume that the items measure the same construct and resemble the results obtained by Hilton (2018) and Adelson and McCoach (2011). Likewise, it was evident that there would be no significant improvements if any items were eliminated.

3.3. Attitudes toward mathematics

The analysis of the data collected shows that second- and fourth-grade students had a positive attitude toward mathematics in two dimensions: self-concept and enjoyment. Notably, as shown in Table 3, the attitudes of second-grade students toward mathematics are higher in both dimensions. However, comparing the differences between the two courses shows that they are only statistically significant in the enjoyment dimension [t (66.720) = 5.77, p < .001; d = 0.808] and in the total calculation of the questionnaire [t (75.706) = 4.09, p < .001; d = 0.730]. This difference found in the total score is most likely due to the difference observed in the enjoyment scale. The effect sizes for these analyses were found to exceed Cohen's convention for medium (d = 0.5) and large effects (d = 0.8).

When segmenting the data by gender (Table 4), there were no significant differences between boys and girls in second grade in any of the dimensions. It might be inferred, therefore, that there is no statistically significant difference between boys and girls in the enjoyment dimension [t (34) = 1.56, p = .127], the self-concept dimension [t (34) = 1.94, p = .061] and total computation [t (34) = 0.60, p = .552]. However, there were only a statistically significant difference in the mean self-concept dimension between boys and girls in fourth grade [t (43) = 2.67, p = .011; d = 0.812].

As shown in Table 4, boys have a higher self-concept than girls, but this result is lower in fourth grade. On the other hand, second-grade girls enjoy mathematics more than fourth-grade girls, which indicates a statistically significant difference in scores [t (37) = 4.765, p < .001; d = 1.531], which was also observed in the overall calculation of the questionnaire [t (37) = 3.695, p = .001; d = 1.187].

4. Discussion and conclusion

This study sought first to determine whether the factorial structure of the Spanish adaptation of the "Math and Me Survey" by Adelson (2006) was similar to that obtained in previous studies. Second, this study aimed to determine the mathematics attitudes related to self-concept and enjoyment in primary school students. Finally, it sought to assess possible differences in attitudes related to age and gender.

Regarding our first objective, the analysis showed that the exploratory factorial structure of the Spanish adaptation was similar to that of the questionnaire by Adelson and McCoach (2011). The EFA seemed to mainly favor a two-factor solution, which was shown to explain over 58% of the

Table 4. Means and standard deviations of students' attitudes by grade level and gender

Dimension	Second grade ($n = 36$)				Fourth grade ($n = 45$)			
	Boys		Girls		Boys		Girls	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Self-concept	3.96	0.95	3.39	0.80	3.66	0.78	3.04	0.73
Enjoyment	4.25	0.62	4.51	0.34	3.52	0.92	3.28	1.11
Total	4.12	0.65	4.01	0.46	3.58	0.79	3.18	0.90

variance and the items are grouped into the same two factors or dimensional constructs, namely, mathematics self-concept and enjoyment of mathematics, as shown in Table 2. The interpretation of the two factors was consistent with the mathematics structure originally proposed by Adelson and McCoach (2011), and these two dimensions are aligned with the original instrument and are related to each other. In addition, the EFA results affirmed that the first objective was achieved since the 18 measured variables are influenced by the same two factors, supporting the original structure of the "Math and Me Survey".

Confirmatory factor analysis was then performed using a two-factor model although none of the goodness-of-fit statistics showed overall good fit for the adapted instrument. As Marsh et al. (2011, 2014) and Morin et al. (2013) suggest the assumptions of CFA could be overly restrictive for many multidimensional instruments and therefore, the CFA measurement model neither fits with empirical data nor represent substantive theory realistically. Furthermore, based on Marsh et al. (2014) research almost no multidimensional scales provide a good fit and they usually fail to meet standards of good measurement. This indicates a need for looking into the underlying factors impacting the structure because fit indices such as RMSEA might also be elevated due to relatively small sample sizes (Finch, 2020; Taasoobshirazi & Wang, 2016), typical of models tested in math and science education (Taasoobshirazi & Wang, 2016). However, some of the studies carried out by Adelson and McCoach (2011) found that a two-factor structure of the original "Math and Me Survey" was a better fit for their data, but this used a larger sample size ($N = 302$), and the goodness-of-fit indices performed particularly well (see Adelson & McCoach, 2010 for their model fit indicators).

This study also showed the specific characteristics of attitudes toward mathematics in the population analyzed with respect to these two dimensions. Significant differences were observed in relation to the age of the students, and the scores on the self-concept and enjoyment dimensions are inversely proportional, that is, the younger the age is, the higher the scores are. This statistically significant correlation in the enjoyment dimension shows that the working hypothesis was in the correct direction. The results support previous studies with primary school children in suggesting that students' interest and motivation in relation to mathematics declines with age as they find it uninteresting and unentertaining. In addition, the study done by the Spanish Association for Digitalization (Asociación Española para la Digitalización, 2019) corroborates that enjoyment of mathematics is related to a good perception of mathematics in primary education. However, these assessments change in secondary education and may be of interest to researchers in education and school counseling since it appears that mathematics interest, motivation, and enjoyment decreases with age (Adelson & McCoach, 2011; Gottfried et al., 2007; Hettinger et al., 2022).

In terms of the gender of the participants, the data obtained show that the means of the two dimensions are high but decrease over time in both groups. Although the scores indicate that both boys and girls have a high self-concept, there are differences between students participating in the same course. Boys seem to have a higher mathematics self-concept than girls, which becomes a statistically significant difference in fourth grade. Previous research has confirmed this gender differences in terms of self-concept in primary education (see Mejía-Rodríguez et al., 2021; Rodríguez et al., 2020; Vasalampi et al., 2020) and suggest that girls may be losing their motivation during this educational stage. D. Dowker et al. (2012) also found that primary school boys rated themselves higher than girls. Similarly, other studies (Cvencek et al., 2020; Paz-Albo et al., 2017) also point to these gender differences, echoing the results of this study. However, these differences in mathematics self-concept may be the result of differences in how the instrument functions across boys and girls since this study did not examine latent differences between genders.

The self-perception of boys and girls varies as students move through grade levels, although these differences become more visible in secondary education, where the positive self-perception of girls toward mathematics decreases more compared to that of boys (Organization for Economic Cooperation and Development [OECD, 2015). As M. Del Río et al. (2016) show, this math-gender stereotype belief can produce differences in student treatment that increase learning gaps and

different learning opportunities for boys and girls (M. Del Río et al., 2016). Moreover, as research suggest male students have usually higher self-concept values in math domains (Rodríguez et al., 2020; Saß & Kampa, 2019), and it may influence students' math-related beliefs, academic performance, school course selection and career interntions (Asika, 2021; Han, 2019; Passolunghi et al., 2014; Saß & Kampa, 2019). Although research is inconclusive on the role of self-concept in learning mathematics (see Holenstein et al., 2021), it seems to have a crucial impact on future development and career awareness of primary school students. This may be also particularly useful for school counselors and primary school educators since they can administer the survey to identify bilingual Spanish students with low mathematics self-concept and strengthen their math-related self-concepts that could result in student's increased interest and academic achievement over time.

Regarding the dimension of pleasure or enjoyment that the student experiences, the results indicate that girls in second grade enjoy mathematics the most but that there are significant differences in this dimension between girls in second and fourth grade. In addition, it seems that fourth-grade girls begin to enjoy mathematics less, and moreover, it is precisely in this course that boys begin to display enjoyment and greater confidence in their aptitudes. Similarly, previous studies (Mata et al., 2012) have shown this decline in attitudes for girls as they progress in school, although as Jacobs et al. (2002) point out gender differences in children beliefs with age, particularly for math, including their enjoyment of mathematics. These results can also help school counselors and educators understand how this dimension can also influence students' academic performance throughout primary education as well as their performance and choice of mathematics (Adelson & McCoach, 2011) in secondary education or other subjects related to STEM (science, technology, engineering and mathematics). Therefore, it is essential to consider not only children's school-related experiences but also the influences of parents, teachers and peers who influence children's beliefs and values (Mejía-Rodríguez et al., 2021) in addition to looking into how mathematics teaching and learning are negotiated in the classroom since the mathematics curriculum also becomes more demanding and it may provoke a fall in school children's math-related attitudes and interest (Mata et al., 2012).

These results show that self-concept and enjoyment are relevant to engage in subjects such as mathematics; however, their lack can cause girls to lose interest in these disciplines (Rodríguez et al., 2020; Valero-Matas & Coca, 2021). In addition, the results indicate how self-beliefs and mathematical enjoyment can be determinants of not only behavior and motivation but also academic performance (Asika, 2021; Rodríguez et al., 2020). In fact, research (Pekrun et al., 2017) has shown that students who enjoy mathematics have better long-term math achievement.

In general, the results obtained in this study show that both age and gender are important variables for understanding differences in self-concept in relation to STEM disciplines, such as mathematics, as girls tend to have a lower self-concept than boys (Mejía-Rodríguez et al., 2021; Rodríguez et al., 2020; Vasalampi et al., 2020). This result underscores the importance of enjoying learning, mainly in girls, to engage in these subjects that present more challenges to students (Asociación Española para la Digitalización, 2019) and thus encourage interest in STEM subjects from an early age. These data demonstrate the same pattern of results presented in the report *The ABC of Gender Equality* by the OECD (2015), although in countries with economies that have better performance on PISA, girls outnumber boys in subjects such as mathematics (OECD, 2015). In countries such as Spain, results from PISA (OECD, 2019) also seems to indicate that this gap is decreasing as girls' performance in mathematics improves, although the results remain below the EU average.

Analysis of the data reveals a correlation between age and the dimensions of mathematics self-concept and enjoyment of mathematics, and these two dimensions are key determinants of academic performance. In addition, as suggested by Asika (2021), self-concept is one of the predictors of academic performance and an essential pillar in the improvement of learning (OECD, 2015), so it may be desirable to focus in the early years on preserving and boosting students' confidence in their ability in mathematics (A. Dowker et al., 2019).

In conclusion, the results suggest that the adapted Spanish version of the "Math and Me Survey" by Adelson (2006) is equivalent to the original and can be used in Spanish-speaking contexts. Likewise, the results shed light on the existing relationship between the subject, in this case the student, and the attitudinal object, mathematics, as a key skill of the primary education curriculum. In addition, the results may contribute to understanding how mathematics self-concept and enjoyment of mathematics vary with gender and age, although causal relationships cannot be established due to the transversality of the study. Finally, longitudinal studies that reinforce the results are still pending so researchers can gain a better understanding of how these two dimensions might influence later STEM achievement and choice.

5. Limitations of the study and implications for further research

The reported work has several strengths but is not without limitations. First, we acknowledge that some caution is needed in drawing conclusions based on the analysis, as the sample size was relatively small and future studies should include a larger sample from a wider variety of schools as well. However, under some circumstances a sample of 100 -or even 50- cases are sufficient since it can also yield good quality results (de Winter et al., 2009), but more is better. Some authors also suggest that there should be a ratio of at least five cases for each item (see Pallant, 2016; Tabachnick & Fidell, 2011). Second, it would also be of interest further research should examine latent differences between genders (i.e., measurement invariance) and explore the extent to which the factor structure is represented in the same way for girls and boys. Additionally, the different results and its interpretation awaits clarification by more research.

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