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FACTORES PERSONALES DEL ALUMNADO QUE PREDICEN EL RENDIMIENTO EN MATEMÁTICAS EN EDUCACIÓN PRIMARIA EN ESTADOS UNIDOS

Students´ factors that predict mathematical performance in primary education in USA

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Resumen:

El objetivo de este artículo es predecir la influencia de los factores personales del alumnado sobre el rendimiento en matemáticas en educación primaria. Se trata de un estudio ex-post-facto que utiliza la base de datos del estudio TIMSS 2019 en Estados Unidos. La muestra está formada por 8601 estudiantes estadounidenses de 4º de Educación Primaria (50,45% niños; 49,54% niñas). Se realizaron un Análisis Factorial Exploratorio (AFE) y un Análisis Factorial Confirmatorio (AFC) de los 24 ítems del cuestionario del alumnado sobre el proceso de enseñanza y aprendizaje de las matemáticas (KMO= .952). Se identificaron cuatro factores: actitud, ansiedad, autoeficacia del alumnado y actitud del profesorado. Se utilizó un análisis de regresión múltiple para predecir la influencia de los factores de los estudiantes en el rendimiento matemático. Los resultados muestran que la autoeficacia es el factor que más contribuye al rendimiento y en el que se encuentran más diferencias de género, seguido de la ansiedad matemática, a favor de los chicos, que explica la brecha de género en Estados Unidos. La actitud del profesor, el segundo factor que más contribuye al rendimiento, refuerza tanto la actitud del alumnado como su autoeficacia. El número de libros en casa tiene un gran efecto sobre el rendimiento del alumnado. Los resultados sugieren la necesidad de plantear la enseñanza de las matemáticas desde un enfoque más práctico y dotar de más recursos a las escuelas en contextos desfavorecidos.

Palabras clave: ***Rendimiento académico, ansiedad matemática, autoeficacia, educación primaria, actitud del alumnado, actitud del profesorado.***

Abstract:

This paper aims to predict the influence of personal factors of students on mathematical performance in primary education. This is an ex-post-facto study using the database from the TIMSS 2019 study in USA. The sample comprises 8601 American students of 4th grade (50.45% boys; 49.54% girls). An Exploratory Factor Analysis (EFA) and a Confirmatory Factor Analysis (CFA) were carried out on the 24 items from the student questionnaire on the mathematics teaching and learning process (KMO= .952). Four factors were identified: students´ attitude, anxiety, self-efficacy and teachers´ attitude. A multiple regression analysis was used to predict the influence of students' factors on mathematical performance. Results show that self-efficacy is the factor that most contributes to performance and in which more gender differences are found, followed by math anxiety, in favor of boys, which explains the gender gap in the United States. Teacher´s attitude, which is the second factor that most contributes to performance, reinforces both students´ attitude and their self-efficacy. Number of books in the home has a great effect on students´ performance. Findings suggest the need to propose the teaching of mathematics from a more practical approach and provide more resources to schools in disadvantaged contexts.

Key Words: ***Academic achievement, mathematical anxiety, self-efficacy, primary education, students´ attitude, teachers´ attitude.***

1. Introduction

A number of studies have discussed the personal factors of students that explain the gender gap and the difference between boys and girls in mathematics performance: the student's attitude (Stoet & Geary, 2018), mathematics anxiety (Dowker et al., 2016), the teacher's attitude (Tourón et al., 2019) and self-efficacy (Cheryan et al., 2017; Prast et al., 2018). These factors have an impact on performance, a broader construct or concept understood as the learning that the student achieves at school, which is reflected in school grades. Progress must be made in understanding the effect of school factors in primary education, when concerning signs in performance are noted that could lead to educational failure in secondary school (Breda & Napp, 2019).

Research has shown that boys have a more positive attitude toward mathematics than girls (Else-Quest et al., 2013; Guo et al., 2015; Ganley & Lubienski, 2016). This intrinsic motivation, which foretells academic performance, is affected by anxiety (Ramírez, 2017). Gender differences in the attitude toward mathematics start in primary school and intensify as students go from one grade to the next (Ayuso et al., 2021; Contini et al., 2016).

Mathematics anxiety refers to the negative emotions, feelings of apprehension and fear that mathematics prompt in students as they perform a task (Vukovic, et al., 2013), offering an explanation about mathematics learning difficulties based on gender (Mammarella et al., 2019). Anxiety has a negative effect on self-efficacy (Du et al., 2021; Pitsia et al., 2018) and on attitude (Li et al., 2021), which means that the less anxiety a student has, the more the student will believe he/she can perform well in mathematics (Paechter et al., 2017).

Studies have shown that girls experience more anxiety in relation to mathematics as a result of a weak belief in their capabilities in STEM subjects (Bieg et al., 2015; Goetz et al., 2013). Furthermore, students who experience anxiety toward mathematics display a more negative attitude and pay less attention, which influences academic performance (Geary et al., 2021; Sutter-Brandenberger et al., 2018). The study by Else-Quest et al. (2010) shows that boys have lower levels of anxiety, more self-efficacy and a more positive attitude toward mathematics than girls because girls have a more negative perception of their mathematical skills than boys due to parents' high expectations of their children's performance based on gender (Mejía-Rodríguez et al., 2021).

The study by Ren & Smith (2017) indicates that math teachers' knowledge affects their attitude toward teaching, encompassing professional knowledge about the subject as well as the way in which it is taught, the didactic strategies used and the teacher's enthusiasm for teaching (Baier et al., 2019). The teacher's attitude about teaching mathematics has an impact on the student's self-efficacy to complete the tasks (Blazar & Kraft, 2017). Moreover, this is a predictive factor in academic performance (Blömeke & Vegar, 2019; Yu & Singh, 2018). Research has shown the negative correlation between the teacher's attitude in class and the student's anxiety about mathematics (Lazarides & Buchholz, 2019), as well as the positive correlation between the mathematics teacher's attitude and a more positive attitude toward the subject (Toropova et al., 2019; Vidic & Duranovic, 2020).

Self-efficacy refers to the beliefs in one's own capacity to organize and carry out the required actions in a specific situation and to achieve the desired result (Bandura, 1997). This is one of the most significant predictive factors in mathematics performance (Jiang et al., 2014; Rodríguez et al., 2020). Research has shown that both self-efficacy and attitude predict performance in mathematics, and they are higher for boys than for girls (Recber et al., 2018; Reilly et al., 2019). This difference arises from stereotypes related to gender and to the fact that higher scores in self-efficacy among boys lead to higher scores in performance. A number of studies (Grigg et al., 2018; Lee et al., 2014) show that students with higher self-efficacy feel more secure and more predisposed to accomplish learning goals and strive to achieve good academic performance.

The socio-economic level of the student is one of the predictive factors for academic performance (Cleary & Kitsantas, 2017; Coleman et al., 1996; Dietrichson et al., 2017), which is reflected in the number of books at home (Chmieleweski, 2019; Engzell, 2021).

These factors have an impact on performance, a broader construct or concept understood as the learning that the student achieves at school, which is reflected in school grades. Progress must be made in understanding the effect of these factors in primary education, given that concerning signs in performance may be noted at this stage which, if left unaddressed, could lead to educational failure in secondary school.

To this end, the data released in the findings of the TIMSS study 2019 in the United States, which assesses the performance of 4th-grade students in mathematics, is useful. This study establishes four levels of performance (p. 32): low, from 400 to less than 475 points, intermediate, from 475 to less than 550, high, from 550 to less than 625, and advanced, from 625 points and up. The findings of TIMSS 2019 show a score of 535 points for American students' performance in mathematics, 91 points less than Singapore. This difference is even greater when they reach 8th grade, when American students' performance is 515 points, 101 points less than Singapore (TIMSS 2019 U.S. Highlights Web Report, 2022). In the United States, 4th-grade boys scored 11 points more, on average, than girls in mathematics (540 vs 529 points, respectively).

The specific objectives of this research are:

-To analyze the influence of student attitude on self-efficacy, the influence of student anxiety on attitude and self-efficacy, and the mathematics teacher's attitude on the student's self-efficacy, anxiety and attitude (Figure 1).

-To analyze the gender differences linked to students' personal factors.

-To predict the influence of factors on mathematics performance.

Based on these objectives, the following hypotheses have been formed:

H1. The student's attitude toward mathematics influences his/her self-efficacy.

H2. The student's anxiety about mathematics influences his/her attitude.

H3. The student's anxiety influences his/her self-efficacy.

H4. The mathematics teacher's attitude influences the student's attitude.

H5. The teacher's attitude influences the student's anxiety.

H6. The teacher's attitude influences the student's self-efficacy.

H7. The student's attitude toward mathematics predicts his/her performance.

H8. Anxiety about mathematics predicts the student's performance.

H9. The teacher's attitude predicts the student's performance.

H10. Self-efficacy in mathematics predicts performance.

H11. The student's gender influences his/her performance.

H12. The number of books at home influences performance.

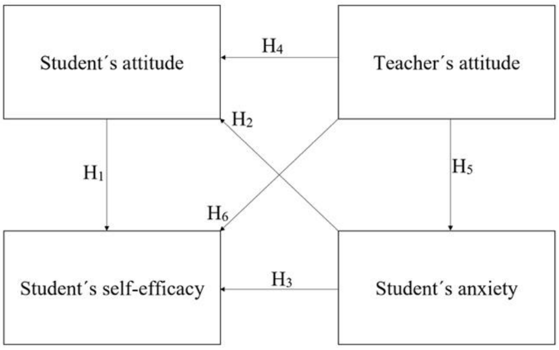

Figure 1. Explanatory model on performance in Mathematics

2. Methods

This study can be categorized as non-experimental research because the participants cannot be randomly assigned, and the independent variables cannot be manipulated. This is an ex post fact study, in which the phenomenon is analyzed after it has occurred.

2.1. Sample

The sample consists of 8601 students from 294 schools in the United States (50.45% boys, 49.54% girls) at 4th grade (primary school) level with an average age of 10.2 years, who participated in the TIMSS 2019.

2.2. Instrument

The instrument used is the student questionnaire, consisting of 24 items about mathematics teaching and learning, arranged on a Likert scale into 4 levels, in which 1 is "Strongly disagree" and 4 is "Strongly agree" (Table 1). The study by Ivanova & Michaelides (2022) showed and adequate fit of correlated factors for self-concept, enjoyment and usefulness of learning mathematics in USA in the TIMSS 2015, which it allows to deepen the knowledge of this instrument.

2.3. Variables and analysis procedures

He analysis procedure comprises four phases.

In the first, diagnostic tests of the normality of the distribution of independent estimates and items were conducted for the five plausible values, available in the TIMSS database, and the average risk values were calculated to measure mathematics performance (dependent variable).

In the second, an Exploratory Factor Analysis (EFA) and a Confirmatory Factor Analysis (CFA) of the 24 were carried out, based on the matrix of polychoric correlations in order to assess the adequacy of the data for their factorization. Four factors were defined with a minimum of five variables and saturations greater than .557.

In the third, a T-test of independent samples was done in order to discern the gender differences linked to the factors.

In the fourth phase, a multiple regression analysis was carried out to predict mathematics performance based on the student factors, gender and the number of books at home.

IBM SPSS Statistics 28 software and R 4.3. were used to perform the analyses.

3. Results

Table 1 shows the items of the Mathematics questionnaire

Table 1
Questions about Mathematics in School

M1. I enjoy learning mathematics
M2. I wish I did not have to study mathematics
M3. Mathematics is boring
M4. I learn many interesting things in mathematics
M5. I like mathematics
M6. I like any schoolwork that involves numbers
M7. I like to solve mathematics problems
M8. I look forward to mathematics lessons
M9. Mathematics is one of my favorite subjects
M10. I know what my teacher expects me to do
M11. My teacher is easy to understand
M12. My teacher has clear answers to my questions
M13. My teacher is good at explaining mathematics
M14. My teacher does a variety of things to help us learn
M15. My teacher explains a topic again when we don’t understand
M16. I usually do well in mathematics
M17. Mathematics is harder for me than for many of my classmates
M18. I am just not good at mathematics
M19. I learn things quickly in mathematics
M20. Mathematics make me nervous
M21. I am good a t working out difficult mathematics problems
M22. My teacher tells me I am good at mathematics
M23. Mathematics is harder for me than any other subject

M24. Mathematics makes me confused

Source: TIMSS 2019

3.1. Matrix of polychoric correlations

Tables 2 and 3 show the results of the polychoric correlations between the variables that influence mathematics performance.

Table 2
Matrix I

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
M1	1.000									
M2	-.477	1.000								
M3	-.668	.637	1.000							
M4	.686	-.416	-.561	1.000						
M5	.827	-.518	-.742	.688	1.000					
M6	.657	-.396	-.513	.597	.683	1.000				
M7	.693	-.422	-.572	.582	.74	.639	1.000			
M8	.769	-.454	-.647	.646	.822	.684	.722	1.000		
M9	.760	-.460	-.692	.611	.871	.623	.695	.817	1.000	
M10	.237	-.082	-.126	.223	.201	.241	.217	.230	.176	1.000
M11	.376	-.201	-.281	.412	.349	.324	.336	.314	.297	.300
M12	.352	-.232	-.276	.411	.310	.292	.301	.281	.261	.266
M13	.415	-.275	-.357	.502	.403	.346	.350	.344	.340	.242
M14	.331	-.184	-.260	.416	.310	.280	.272	.296	.273	.268
M15	.301	-.189	.508	-.287	-.389	-.301	-.161	-.347	-.250	-.222
M16	.505	.411	.511	-.292	-.373	-.280	-.153	-.331	-.207	-.191
M17	-.270	-.264	-.401	.551	.633	.585	.286	.610	.477	.428
M18	-.318	-.177	-.258	.390	.468	.453	.223	.470	.341	.314
M19	.494	.426	.536	-.330	-.451	-.351	-.185	-.422	-.257	-.213
M20	-.349	.342	.441	-.234	-.412	-.243	-.337	-.331	-.411	-.0303
M21	.430	-.214	-.336	.308	.496	.375	.590	.467	.522	.1840
M22	.381	-.201	-.284	.270	.421	.318	.376	.406	.443	.2386
M23	-.371	.362	.475	-.256	-.483	-.247	-.346	-.351	-.497	-.051
M24	-.384	.377	.482	-.264	-.478	-.274	-.394	-.365	-.474	-.032

Table 3
Matrix II

	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20
M11	1.000									
M12	.691	1.000								
M13	.681	.683	1.000							
M14	.347	.275	.258	1.000						
M15	-.237	-.177	-.182	-.427	1.000					
M16	-.211	-.131	-.165	-.451	.634	1.000				
M17	.471	.361	.335	.647	-.375	-.347	1.000			
M18	.324	.292	.282	.582	-.273	-.254	.557	1.000		
M19	-.255	-.186	-.189	-.434	.688	.625	-.398	-.260	1.000	
M20	-.303	-.211	-.202	-.474	.649	.637	-.448	-.291	.716	1.000

	M21	M22	M23	M24
M21	1.000			
M22	.518	1.000		
M23	-.344	-.278	1.000	
M24	-.418	-.319	.711	1.000

Results from Tables 2 and 3 confirm the existence of latent variables of a continuous nature on which the observable variables are built. In this sense, the latent variables that correlate highly and positively, forming a direct relationship, belong to the same factor. For example, item M1 (I enjoy learning mathematics) and item M5 (I like mathematics) belong to factor 1.

Table 4
Exploratory Factor Analysis on the questionnaire items

Item	Factor 1	Factor 2	Factor 3	Factor 4	Communalities
M1	.879	-.417	.292	.524	.776
M8	.878	-.362	.310	.513	.783
M7	.870	-.416	.303	.557	.771
M9	.843	-.476	.232	.550	.734
M5	.821	-.340	.267	.428	.825
M6	.772	-.276	.298	.450	.617
M3	.756	-.276	.298	.450	.644
M4	.708	-.196	.381	.365	.543
M2	.668	.513	-.211	-.215	.552
M23	-.462	.837	-.101	-.448	.809
M24	-.431	.810	-.116	-.405	.834
M17	-.339	.804	-.084	-.448	.767

M18	-.420	.803	-.142	-.444	.853
M20	-.273	.738	-.104	-.209	.788
M13	.343	-.147	.780	.267	.719
M12	.289	-.138	.759	.277	.688
M14	.251	-.057	.735	.157	.741
M11	.311	-.191	.734	.361	.663
M15	.180	-.049	.627	.136	.690
M10	.210	-.085	.557	.342	.552
M21	.485	-.450	.211	.809	.831
M19	.500	-.471	.249	.809	.778
M16	.519	-.519	.236	.783	.751
M22	.323	-.157	.343	.622	.725

Source: Compiled by the author.

The first factor is defined by variables M1, M2, M3, M4, M5, M6, M7, M8 and M9, which are related to the student's attitude. The items saturated by this factor include items related to the benefits entailed in learning mathematics and the consideration of mathematics as a favourite subject.

The second factor refers to the student's anxiety about mathematics. It is defined on the basis of variables M17, M18, M20, M23 and M24, which are linked to the difficulty posed by mathematics for the student.

The third factor is related to the mathematics teacher's attitude. It is defined by variables M10, M11, M12, M13, M14 and M15, which are related to the student's opinion about how the teacher teaches.

The fourth factor is defined on the basis of variables Ml16, M19, M21 and M22, linked to the student's self-efficacy. The variables saturated by this factor are related to the student's personal consideration for learning the concepts and progressing in mathematics.

The factorial weights of the items on the factor have satisfactory values, as well as the set of communalities, which demonstrate that the items are satisfactorily represented in the factorial model.

3.2. Exploratory and Confirmatory Factor Analysis

Factor reduction was sought by applying an oblique method rotation, which affords the most plausible factor solution based on the nature of the data and makes it possible to correlate the factors (student attitude, anxiety and self-efficacy, teacher attitude). In accordance with the excellent value of the Kaiser-Meyer-Olkin (KMO) measure .952 and the degree of significance attained in Bartlett's test of sphericity (=.000), it was confirmed that the factor analysis is applicable, pertinent and suitable, thus providing assurance to continue the process.

Table 5 shows the results of the oblique factor analysis on the variables that affect mathematical performance.

Table 5
Variance explained by each factor

	Initial eigenvalues			Extraction sums of squared loadings
	Total	% of variance	Cumulative %	Total
1	9,098	37,907	37,907	9,098
2	2,967	11,239	49,146	2,697
3	1,982	8,26	57,406	1,982
4	1,204	5,018	62,425	1,204
5	.792	3,301	65,726	
6	.739	3,08	68,806	
7	.695	2,898	71,703	
8	.621	2,587	74,291	
9	.601	2,503	76,793	
10	.530	2,208	79,001	
11	.501	2,087	81,088	
12	.481	2,003	83,092	
13	.465	1,939	85,031	
14	.453	1,889	86,92	
15	.442	1,84	88,759	
16	.410	1,708	90,467	
17	.379	1,58	92,047	
18	.365	1,519	93,566	
19	.336	1,398	94,964	
20	.313	1,304	96,268	
21	.264	1,101	97,369	
22	.250	1,044	98,413	
23	.224	.933	99,345	
24	.157	.655	100	

Source: Compiled by the author.

In Table 5, four factors that explain more than 62% of the performance variance can be identified. Student attitude explains the greatest percentage of total variance (approximately 38%), followed by anxiety, which explains 11%, teacher attitude, which explains 8%, and self-efficacy, which explains over 5% of the variance.

After attaining the findings of the oblique factor analysis, a Confirmatory Factor Analysis (CFA) must be conducted in order to verify the suitability of the four-factor model.

The formula of Satorra-Bentler scaled chi-squared test for model goodness is S-Bx2/df**. The Chi-square value divided by the degrees of freedom should be smaller than 5 for a reasonable model fit (Kline, 2016). In this model,**

results show a Chi-square of 97 and 20 degrees of freedom, so the index is 4.85, which indicates a good model fit.

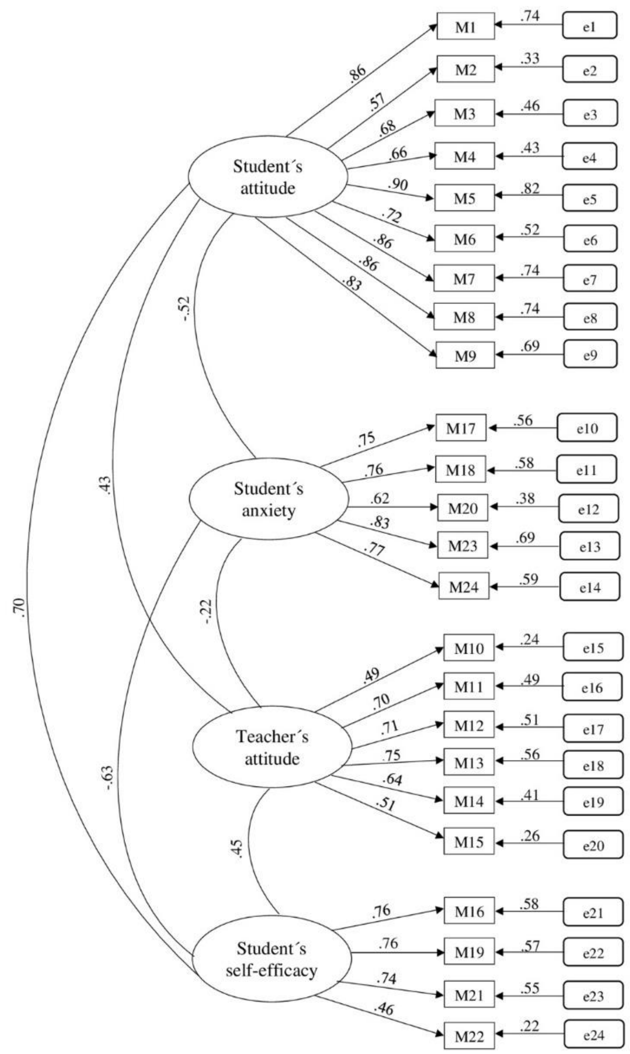

Figure 2. Confirmatory Factor Analysis (CFA)

Figure 2 shows how student attitude determines self-efficacy (ß=.70), and therefore, students that score higher in attitude toward mathematical are also expected to achieve higher scores in self-efficacy. Student anxiety determines self-efficacy (ß=-.63) and attitude (ß=-.52), meaning that students that score higher in anxiety also achieve lower scores in self-efficacy and attitude. Teacher attitude determines student attitude (ß=.43), self-efficacy (ß=.45) and anxiety (ß = -.22), so that higher teacher attitude scores will give rise to improved student attitude and self-efficacy and lower anxiety.

According to the reference values of Hu & Bentler (1999), the goodness of fit of the model is acceptable, the Tucker-Lewis index (TLI) = .93 (this must be closer to

.95 for an acceptable fit), the Comparative Fit Index (CFI) = .94 (this must be larger than .90 for an acceptable fit), the Squared Error Mean of Approximation (RMSEA)=.061 and the Standardized Root Mean Square Residual (SRMR)=.052 (this must be smaller than .06 for an acceptable fit).

3.3. T-test for independent samples

Table 6 shows the results of the Student T-Test, using gender as the independent variable and the factors and variables that define them as the dependent variables.

Table 6
Significant differences between boys and girls in variables and factors

Factor	Item*	Gender	Average	Standard deviation
Attitude toward mathematics Average for boys: .023 Average for girls: -.022	M1*	Boy	3.23	.971
		Girl	3.19	.948
	M2*	Boy	2.18	1,184
		Girl	3.15	1,142
	M3	Boy	2.06	1,142
		Girl	2.06	1,115
	M4	Boy	3.38	.921
		Girl	3.40	.898
	M5	Boy	3.16	1,057
		Girl	3.11	1,057
	M6	Boy	2.87	1,067
		Girl	2.87	1,05
	M7	Boy	3.10	1,059
		Girl	3.04	1,048
	M8	Boy	2.92	1,1
		Girl	2.88	1,081
	M9*	Boy	2.98	1,197
		Girl	2.84	1,191
Mathematics anxiety* Average for boys: -.084 Average for girls: .082	M17*	Boy	2.07	1,105
		Girl	2.21	1,111
	M18*	Boy	1.82	1,077
		Girl	1.99	1,098
	M20*	Boy	1.93	1,087
		Girl	2.04	1,113
	M23*	Boy	1.88	1,124
		Girl	2.09	1,176

	M24*	Boy	2.10	1,122
		Girl	2.25	1,126
Teacher's attitude*	M10*	Boy	3.65	.666
		Girl	3.68	.648
	M11	Boy	3.50	.761
		Girl	3.51	.739
Average for boys: -.041	M12	Boy	3.52	.762
Average for girls: .040		Girl	3.53	.741
	M13	Boy	3.70	.652
		Girl	3.71	.639
	M14*	Boy	3.77	.590
		Girl	3.81	.528
	M15*	Boy	3.59	.776
		Girl	3.68	.705
Self-efficacy in mathematics*	M16*	Boy	3.46	.791
		Girl	3.33	.809
Average for boys: .126	M19*	Boy	3.20	.960
Average for girls: -.123		Girl	3.01	.990
	M21*	Boy	3.06	1,001
		Girl	2.79	1,049
	M22*	Boy	3.12	.992
		Girl	3.05	.983

Note: *Student T-test (P< .05)

Source: Compiled by the author

According to Table 6, boys have a more positive attitude toward mathematics, experience less anxiety, have a more negative view of the teacher's attitude and display greater self-efficacy than girls. Significant differences based on gender were found in three factors (anxiety, teacher attitude and self-efficacy) and in the variables that define them.

In the first factor (Attitude), boys scored slightly higher than girls in all the variables (except for M3 and M6, in which they achieved the same score), with a notably greater difference in the scores for M2 (I wish I did not have to study mathematics) and M9 (Mathematics is one of my favorite subjects). However, significant differences are not seen between boys' and girls' attitudes toward mathematics.

In the second factor (Anxiety), girls scored higher than boys in all the variables, with a larger difference seen in M23 (Mathematics is harder for me than any other subject) and in M18 (I am just not good at mathematics). It is in this second factor where more significant differences are found based on gender.

In the third factor (Teacher attitude), girls scored higher than boys in all the variables, the difference being notably greater in M15 (My teacher explains a topic again when we don't understand).
In the fourth factor (Self-efficacy), boys scored higher than girls in all the variables, and the larger difference in M19 (I learn things quickly in mathematics) and in M21 (I am good at working out difficult mathematics problems) can be highlighted. The first factor is where more significant differences are found based on gender.

3. 4. Multiple Regression Analysis

A multiple regression analysis was conducted, using mathematics performance as the outcome or dependent variable and the students' personal factors, gender and number of books at home as the predictor or independent variables (1= None or very few (0-10 books), 2= Enough to fill one shelf (11-25 books), 3= (Enough to fill one bookcase (26-100 books), 4= Enough to fill two bookcases (101-200 books), 5= Enough to fill three or more bookcases (more than 200 books).

Table 7
Model summary

Model	R	R squared	Adjusted R squared	Standard error of the estimation
1	.693[a]	.462	.462	2.073.555

a. Predictors: (Constant), Number of books at home, Gender, Student Attitude, Self-efficacy, Anxiety, Teacher Attitude.

The data in Table 7 provide information about how well the model fits. The R2 or variance explained by the model amounts to 0.462, which means that the model variables explain 46.2% of the variability in mathematics performance.

Table 8
ANOVA

Model	Sum of squares	df	Mean square	F	Sig.
Regression	12640238.5	6	2.106.706.413	518,61	.000
Residual	23260272.7	5726	4.062.220		
Total	35900511.2	5726			

Source: Compiled by the author.

The data in Table 8 show that the critical level (Sig.) is lower than .05, thus leading to the conclusion that there is a significant relationship between the dependent variable and the independent ones.

Table 9
Regression coefficients

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Standard error			
Constant	504,622	3,421		147,50	.000
Number of books at home	15,691	.691	.246	22,71	<.001
Student gender	9,834	1,709	.062	5,753	<.001
Student attitude	2,5	.844	.032	2,963	.003
Student anxiety	-15,585	.856	-.208	-18,206	.000
Teacher attitude	4,979	.849	.063	5,866	<.001
Student self-efficacy	15,023	.858	.189	17,512	<.001

Source: Compiled by the author.

The data in Table 9 indicate that all the coefficients provide a significant contribution to the model, given that the critical level is lower than .05. The number of books at home considerably influences performance in mathematics. Of all the factors, student self-efficacy is the one that contributes most to performance, followed by teacher attitude, whereas anxiety is the only one that negatively affects performance.

The multiple regression equation is expressed as follows:

$$\boldsymbol{Y}_{i} = \beta_0 + \beta_{1X_{1i}} + \beta_2\, x_{2i} + \beta_n x_{ni} + \varepsilon_\iota$$

In which $\boldsymbol{Y_i}$ is the expected value of mathematics performance, $\boldsymbol{\beta_0}$ is the value of the dependent variable or average performance of a student when the predictors are 0, $\boldsymbol{\beta_{1X_{1i}}}$ is the effect of a one-unit increase in the variable X_i over the variable Y, e_i is the error or difference existing between the observed value and the estimated value in the model.

Mathematics performance = 504.62 + 15.69 x Number of books at home + Gender x 9.83 + Self-efficacy x 15.02 + Teacher attitude x 4.97 + Student attitude x 2.50 – Student anxiety x 15.58.

An average student attains 504.62 points in mathematics performance.

Per each unit increase or decrease in the Number of books at home (measured on the Likert scale), their performance also increases or decreases by 15.69 points.

If the student is a boy, the score will increase by 9.83 points. (The variable is coded as 0 for girls and 1 for boys.)

Per each unit increase or decrease in Student self-efficacy, there is also a 15.02 -point increase or decrease.

Per each unit increase or decrease in Teacher attitude, their performance also increases or decreases by 4.97 points.

Per each unit increase or decrease in Student attitude, their performance also increases or decreases by 2.50 points.

Per each unit increase in Student anxiety, there is a 15.58-point decrease in performance.

4. Discussion

In relation to the first hypothesis, it is accepted that the student's attitude towards mathematics influences their self-efficacy, in line with other studies (Cheryan et al., 2017; Prast et al., 2018). Likewise, boys have a more favorable attitude towards mathematics than girls (Else-Quest et al., 2013; Guo et al., 2015; Ganley & Lubienski, 2016), although in this research no significant differences were found in this factor.

In relation to the second hypothesis, it is accepted that student anxiety about mathematics influences their attitude, in line with other research (Geary et al., 2021; Li et al., 2021; Ramírez, 2017; Sutter-Brandenberger et al., 2018). It is the second factor in which more differences were found based on gender. Girls experience more math anxiety than boys (Bieg et al., 2015; Goetz et al., 2013), which explains gender-related math learning difficulties (Mammarella et al., 2019) due to a girls' low belief in their abilities for STEAM areas (Bieg et al., 2015; Goetz et al., 2013).

In relation to the third hypothesis, it is accepted that student anxiety has a negative influence on self-efficacy, in line with other studies (Du et al., 2021; Pitsia et al., 2018). Self-efficacy is the first factor in which more differences were found based on gender, in favor of boys (Recber et al., 2018; Reilly et al., 2019). This difference is due to gender stereotypes and the fact that a higher self-efficacy score in boys implies better performance.

In relation to the fourth hypothesis, it is accepted that the attitude of the mathematics teacher influences the attitude of the student (Toropova et al., 2019; Vidic & Duranovic, 2020). The fifth hypothesis, the positive influence of the teacher's attitude on student anxiety (Lazarides & Buchholz, 2019), and the sixth hypothesis, such an influence on student self-efficacy (Blazar & Kraft, 2017), are also accepted.

In relation to the seventh hypothesis, it is accepted that the student's attitude towards mathematics predicts performance (Stoet & Geary, 2018), since it reinforces the self-efficacy of students.

In relation to the eighth hypothesis, it is accepted that math anxiety predicts student performance, in line with other studies (Geary, 2021; Sutter-Brandenberger et al., 2018), which demonstrate the negative influence of anxiety that generate mathematics in students.

In relation to the ninth hypothesis, it is accepted that the teacher's attitude predicts student performance (Blömeke & Vegar, 2019; Yu & Singh, 2018). It is the second factor that most contributes to performance, since it reinforces the student's self-efficacy and attitude and acts as a moderating variable of anxiety.

In relation to the tenth hypothesis, it is accepted that the student's self-efficacy predicts her performance (Jiang et al., 2014; Rodríguez et al., 2020). It is the factor that most contributes to performance (Grigg et al., 2018; Lee et al., 2014), as it also acts as a moderating variable of anxiety and is reinforced by the attitude of the student and the teacher.

In relation to the eleventh hypothesis, it is accepted that the student's gender influences her performance, which explains the difference of ten points between American boys and girls. This difference can be explained by the great anxiety that girls experience in mathematics and by the high self-efficacy of boys. Research demonstrates the influence of other factors, such as parents' high expectations for their sons' performance compared to low expectations for their daughters' performance (Mejía-Rodríguez et a., 2021).

Regarding the twelfth hypothesis, it is accepted that the number of books at home influences performance (Chmieleweski, 2019; Engzell, 2021). The number of books at home as an indicator of the socioeconomic level of students is a factor with a great influence on academic performance (Cleary & Kitsantas, 2017; Coleman et al., 1996; Dietrichson et al., 2017), which explains the difference between the performance of students who come from advantaged and disadvantaged contexts.

5. Conclusions

In this research, the following relevant conclusions are reached in the STEM field.

First, self-efficacy is the factor that contributes the most to achievement and in which more gender differences are found, followed by math anxiety, in favor of boys, which explains the gender gap in the United States. This highlights the importance of reinforcing students' belief in their own abilities to perform mathematical tasks.

Second, the attitude of the teacher, which is the second factor that most contributes to performance, reinforces both the attitude and the self-efficacy of the student and acts as a moderating variable of mathematical anxiety. This suggests the need to approach the teaching of mathematics from a more competent approach, focused on the use of different teaching strategies to help students learn.

Thirdly, number of books at home is a factor that has a great influence on the academic achievement of students. This suggests the need to provide more resources to schools that are in disadvantaged contexts to relieve the lack of economic resources.

In conclusion, it can be stated that this research has shown the influence of the factors of the American student body on performance in mathematics in primary education, which contributes to reducing the gender gap in secondary education.

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