IDENTIFYING THE RELATIONSHIP BETWEEN MATHEMATICAL PISA SCORE AND FINANCIAL KNOWLEDGE

Associate Professor Phd, Laura - Filofteia PĂNOIU
"Constantin Brâncoveanu" University of Pitești,
laurapanoiu@yahoo.com
Associate Professor Phd, Remus GRIGORESCU
"Constantin Brâncoveanu" University of Pitești,
griremus@yahoo.com
Associate Professor Phd, Sorin Daniel MANOLE
"Constantin Brâncoveanu" University of Pitești,
danielsorinmanole@yahoo.com

Abstract: *Financial education is an essential component in making consumers more accountable, as it helps with the understanding of managing finances, with the purpose of avoiding risks and a possible financial exclusion. This is a key element in rebuilding consumers' confidence in the financial system. In the context of the effects of the financial crisis, European regulators are focusing on higher protection of the consumer regarding financial products and services. Considering that financial education and providing access to basic financial services represent national priorities, it creates a necessity to commence national programs, involving the state, with the purpose of reaching an appropriate understanding of the financial phenomenon. Financial education facilitates maintaining a financial balance, reinforces proper behavior regarding managing income and saving money/investing. The paper at hand shows that the mathematical PISA score impacts the level of financial knowledge.*

Keywords: *PISA, financial education, financial literacy*.
JEL classification: *I22, C21, C22.*

1. Introduction

Financial education supports the need to ensure financially literate individuals, that is, individuals who can make conscious financial decisions (Panos and Wilson, 2020). Financial illiteracy is the inability of people to understand basic financial concepts in making decisions about saving, borrowing, investing, in other words the inability to manage their own income and expenditure budget (Budurin-Furculiță and Iovu-Carauș, 2020).

It is considered that financial literacy should focus on understanding financial issues, in particular personal finance, on one hand, and on the use and application of knowledge in concrete personal contexts, on the other. Thus, the creation of specific financial education programs can be seen as a solution to ensure an adequate level of financial literacy and thus a possibility to mitigate the financial problems that individuals may face in society. Financial literacy plays an important role in financial decision-making and is seen as a phenomenon resulting from financial knowledge, i.e. there is a causal relationship between financial knowledge and financial behavior (Lusardi and Mitchell, 2014).

Financial education aims to develop the ability to understand how money works, the acquisition of a set of skills and knowledge with which individuals can make effective, informed decisions about the financial resources available to them at a given time or in general (Sabău, 2021a).

Financial education in the digital age takes on new dimensions, with the use of IT&C technologies in both electronic banking and trading of financial instruments (Sabău, 2021b). This discipline becomes sustainable due to the use of applications to facilitate money transactions and the multitude of learning materials in the physical and online environments.

In 2003, the OECD initiated an inter-governmental project offering ways to improve standards of financial literacy and education by developing common principles of financial

literacy. In 2008, the OECD launched the International Gateway for Financial Education, a major project to support policy makers and public authorities in the design and implementation of national financial education strategies and individual financial education programs (OECD, 2008). Recent analysis by the European Commission highlights the role that low levels of financial knowledge have played in the global crisis. Financial literacy is very important for everyone, but especially for young people, as financial products and services become increasingly complex.

For these reasons, financial literacy must start at an early age, right from kindergarten. When it comes to children's financial education, they need to learn the value of money and how to spend and invest it early on. The earlier financial education starts for children, the more the results will be evident later. Children need to learn to choose between the desire for something and financial possibility, the importance of saving for the achievement of a more important goal, value, in other words the ratio between effort and satisfaction of a desire (Sabău, 2021a).

In Romania, financial education is at an extremely low level, not only among children, but also adults, as the idea that everyone should have financial literacy is becoming more and more popular (European Commission, 2024). At first, financial education was introduced as an optional subject in 3rd or 4th grades. Subsequently, starting with the 2020-2021 school year, it becomes a compulsory subject for 8th grade students, being included in the subject called "Social Education".

2. Short literature review

The literature contains a large number of scientific papers, which shows that financial education is a particularly important topic. Below, we review some more recent representative studies in this field.

Kaiser and Menkhoff (2020) review the literature on school-based financial literacy courses for children and youth through a quantitative meta-analysis of 37 (quasi-)experiments and find that these programs have, on average, considerable effects on financial literacy, similar to those in other disciplines. They also note a smaller impact on financial behaviors for students. In a similar study, Kaiser et al. (2022) study the literature on financial education programs through a meta-analysis of 76 randomly selected experiments with a total of more than 160,000 individuals, and find that these courses have, on average, positive influences on financial knowledge and financial behaviors. The authors also note that the results are robust to the method used, as only papers published in leading economic journals were retained.

Kuchciak and Wiktorowicz (2021) evaluate the involvement of commercial and cooperative banks in Poland from 2010 to 2019 in financial education activities via social networks using descriptive statistical methods and cluster analysis. The study shows that the extent of banks' adoption of social networks for financial education purposes is increasing, but differs between social networks, and that commercial banks use social networks for financial education more than cooperative banks.

Zhu and Xiao (2022), using Probit regressions, showed that financial education was positively associated with holding risky financial assets in China. Based on the mediating model, financial literacy, economic and financial information seeking, and risk tolerance were found to be mediating factors in the association between financial education and risky financial asset ownership.

Goyal and Kumar (2021) conduct a systematic review coupled with a bibliometric analysis of the scholarly literature on financial literacy. The study includes a review of 502 articles - published in the most prominent journals between 2000 and 2019. Several methods

were used to identify influential papers, delineate the intellectual structure of the field and identify gaps. Three major themes were identified: levels of financial literacy among distinct cohorts, the impact that financial literacy has on financial planning and behavior, and the impact of financial education.

Lusardi (2019) reviews research on financial literacy in terms of both knowledge and financial behavior and shows that financial education is low even in advanced economies with well-developed financial markets. It also describes how financial literacy can be measured, literacy levels around the world, the implications of these findings for financial decision-making, and how financial literacy can be improved.

Amagir et al. (2018) conduct a systematic literature review evaluating the effectiveness of financial education programs and interventions for children and adolescents and describe the key features of designing a successful financial education curriculum. They also show that school-based financial education programs can improve children and adolescents' financial knowledge and attitudes.

Harvey (2019), building on the finding that financial education in the United States remains alarmingly low, examines whether financial education impacts the use of alternative financial services. He finds that financial education mandates have significantly reduced the likelihood and frequency of using alternative financial services.

Xiao and Porto (2017), using a large US dataset with detailed financial domain information, find that financial education can affect financial satisfaction (a subjective measure of financial well-being) through financial literacy, financial behavior, and financial capability variables. The study also shows that subjective financial literacy, desirable financial behavior, and an index of financial capability are strong mediators between financial education and financial satisfaction.

Amari et al. (2020) demonstrate that there are significant effects of demographic factors on financial risk aversion using a sample, which included 516 respondents representing different segments of French households. Moreover, they show that financial literacy moderates the relationships between risk aversion and saving behavior.

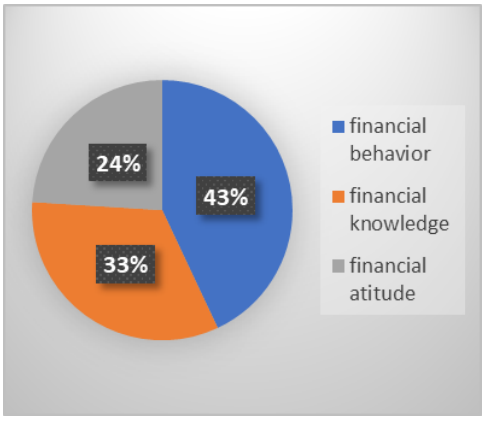
Stolper and Walter (2017) review a large number of studies on the measurement and determinants of financial literacy. They note that previous research documents generally low levels of financial literacy and a high degree of heterogeneity in financial literacy across the population. At the same time, the study suggests that the evidence on the effectiveness of programs is rather disappointing.

Brown et al. (2016) examine the relationship between financial literacy and debt behavior of young adult consumers in the U.S. using Equifax quarterly credit reports from 1999 to 2012. The study demonstrates that financial education has significant effects on young people's debt-related outcomes.

3. Financial education

Study published by OECD on the financial literacy of adults was conducted by analyzing the results of questionnaires in 25 countries, to which 125787 adults, people aged 18 and over, responded. Financial literacy was determined through three components: financial behavior, financial knowledge and financial attitudes.

Interpretation of the data provided by the questionnaire responses yielded an average financial literacy level of 12.7, while the highest level was recorded by Hong Kong-China with 14.8. In ranking the 25 countries participating in the survey, Romania comes out at rank 22 (score 11.2), ahead of Italy (11.1) and Malta (score 10.3).



A maximum of 21 points can be obtained for the three categories of questions, i.e. 9 - for behavior, 7 - for financial knowledge and 5 - for attitude. Therefore, as can be seen from Figure 1 one third of the score is awarded for the level of financial knowledge, about one quarter of the score is awarded for financial attitude and more than 40% of the score is awarded for financial behavior.

Figure1. Structure of literacy level by question category

For a better representation of the scores obtained for each of the literacy components, they will be converted into scores from 1 to 10. Specifically, the scores obtained were related to the number of questions and the resulting value was multiplied by ten.

Table 1. Distribution of countries by financial knowledge, financial behavior and financial attitudes

Crt. no.	Country	Knowledge financial		Behavior finance		Attitude financial	
A	B	1	2*	3	4*	5	6*
1	Austria	5,30	***7,57***	6,00	***6,67***	3,10	***6,20***
2	Bulgaria	4,10	***5,86***	5,30	***5,89***	2,90	***5,80***
3	Czech Republic	4,50	***6,43***	5,30	***5,89***	3,10	***6,20***
4	Columbia	3,80	***5,43***	4,80	***5,33***	2,60	***5,20***
5	Croatia	4,10	***5,86***	5,30	***5,89***	2,90	***5,80***
6	Estonia	4,90	***7,00***	5,30	***5,89***	3,10	***6,20***
7	Georgia	4,50	***6,43***	5,10	***5,67***	2,50	***5,00***
8	Germany	5,20	***7,43***	5,70	***6,33***	3,10	***6,20***
9	Hong Kong	6,20	***8,86***	5,80	***6,44***	2,90	***5,80***
10	Indonesia	3,70	***5,29***	6,30	***7,00***	3,30	***6,60***
11	Italy	3,90	***5,57***	4,20	***4,67***	3,00	***6,00***
12	Korea	4,60	***6,57***	5,40	***6,00***	3,10	***6,20***
13	North Macedonia	3,90	***5,57***	5,10	***5,67***	2,80	***5,60***
14	Malaysia	3,70	***5,29***	6,10	***6,78***	2,70	***5,40***
15	Malta	4,40	***6,29***	5,30	***5,89***	3,00	***6,00***
16	Moldova	4,00	***5,71***	5,50	***6,11***	3,10	***6,20***
17	Montenegro	4,10	***5,86***	4,70	***5,22***	2,60	***5,20***
18	Peru	4,10	***5,86***	5,10	***5,67***	2,90	***5,80***
19	Poland	5,00	***7,14***	5,50	***6,11***	2,60	***5,20***
20	Portugal	4,00	***5,71***	5,90	***6,56***	3,20	***6,40***
21	Romania	3,50	***5,00***	5,00	***5,56***	2,70	***5,40***
22	Russia	4,80	***6,86***	6,30	***7,00***	3,60	***7,20***
23	Slovenia	4,80	***6,86***	6,30	***7,00***	3,60	***7,20***
24	Hungary	4,60	***6,57***	4,50	***5,00***	3,30	***6,60***

Source: OECD (2020). *OECD/INFE 2020 International Survey of Adult Financial Literacy.* Retrieved September 8, 2022., https://www.oecd.org/financial/education/launchoftheoecdinfeglobalfinancialliteracysurveyreport.htm.

Note: * Data in columns 2, 4 and 6 are converted into scores from 1 to 10.

The average score across all countries surveyed for the financial literacy assessment was 6.29. As can be seen from Table 1 and Figure 2, 12 of the 24 countries scored above or equal to the average score and the rest (50% of the countries surveyed) scored below the average score.

At the same time, the disparity in scores for each of the three categories analyzed: knowledge, behavior and attitude is surprising. In terms of financial knowledge, the highest score is obtained by Hong Kong (6.2), followed by Austria with 5.3 and Germany with 5.2, and the lowest by Romania (3.5).

The assessment of the level of financial knowledge for the surveyed population was based on the answers to seven questions, with a maximum score of 7. The questions covered the following concepts: time value of money, simple and compound interest, how interest is calculated, financial risk and return, understanding inflation, ways of diversifying risks.

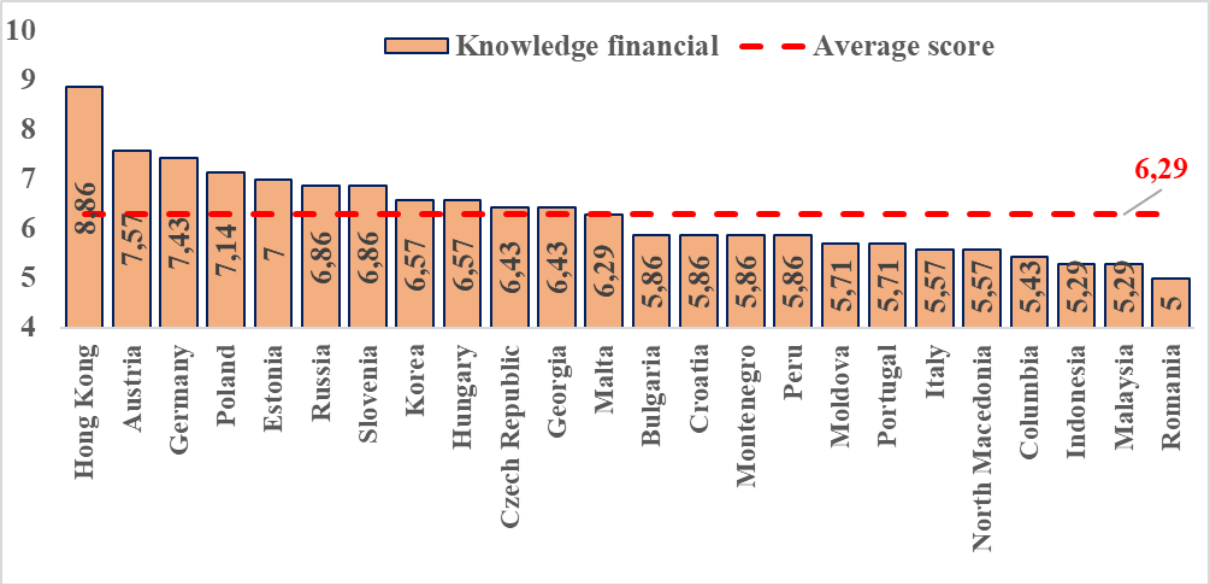


Figure2. Distribution of countries by financial literacy score

Source: Authors' calculations based on data in Table 1, columns (B) and (2).

According to the OECD report (OECD, 2020, p. 20), the percentage of respondents in the countries assessed who know what the time value of money means is 59.9%, the highest percentage being in Germany with 85.9%. In terms of interest paid on a loan, 84.4% of respondents gave the correct answer, with Hong Kong having the highest percentage of people showing an understanding of the concept - 98.9%. When calculating interest, 57.1% of respondents answered correctly, with Hong Kong also having the highest percentage with 95.9%. Survey participants showed poor knowledge of simple and compound interest as only 26.3% of respondents gave the correct answer. In this case, the dispersion of responses is very large, in that 71.1% of Hong Kong respondents gave the correct answer, while in countries such as Colombia and Peru, not even 10% of the adult population showed knowledge of these concepts. For the other three categories of questions, the percentages of correct answers obtained for all respondents were as follows: 58.9% - for knowledge of risk

diversification, 77.1% - for understanding risk and return, and 78% - for understanding inflation.

4. Research methodology. Research results

Financial knowledge must be seen in conjunction with the level of knowledge and application of basic mathematical concepts. The questions in the questionnaire call for knowledge that involves the use of percentages in calculation and present value. Thus, the results obtained can also be analyzed in relation to the results obtained by pupils, future adults, in the PISA tests.

PISA is a survey of 15-year-old students around the world, conducted every 3 years. It assesses the extent to which students have acquired knowledge and skills in reading, mathematics and science – areas of the curriculum considered essential for participation in economic and social activities. PISA not only assesses what students know, but examines how well they can extrapolate what they have learned, with the ability to apply this knowledge in the context of real life.

The PISA program was initiated in 1997. Today, PISA tests are used in a large number of countries, both OECD member countries and countries that are not, but have expressed interest in these assessments (Creța and Șandor, 2016).

PISA tests also provide a picture of students in terms of socio-economic background, family, educational career and financial literacy. Since 2018, PISA tests have also included questionnaires for parents and teachers.

Each participating country assessed a representative sample of students. The sampling procedure involved the selection of at least 150 schools and approximately 42 pupils from each school. Across OECD countries, the number of pupils assessed in 2018 was 600,000 from 79 countries.

The age of 15 was chosen because, in many countries, it is 15-year-olds who make the transition from lower secondary to upper secondary education and because the vast majority of countries specify a compulsory level of education at the age of 15/16.

The PISA assessment of mathematics focuses on measuring students' ability to formulate, use and interpret mathematics in a variety of contexts. These include not only familiar settings related to personal experience (such as preparing food, shopping or watching sports), but also professional, societal and scientific contexts (such as the cost of a project, national interpretation, statistics or modeling of natural phenomena). To succeed in PISA, students must be able to reason mathematically and use mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. Mathematical competence, as defined in PISA, helps individuals recognize the role that mathematics plays in the world and to make analytical decisions.

Performance in mathematics, described in this way, encompasses more than the ability to reproduce mathematical concepts and procedures learned in school. PISA aims to measure how well students can extrapolate from what they know and how well they apply mathematical knowledge in a range of situations, including new and unfamiliar ones. To this end, in most PISA mathematics assessment tests, units refer to real-life contexts in which mathematical skills are needed to solve a problem. The focus on real-life contexts is also reflected in the ability to use 'tools', such as a calculator, ruler or spreadsheet, to solve problems (such as in a real-life situation).

The 2018 PISA results in mathematics for OECD countries show that more than 76% of students reached level 2. This means that students can perform interpretation and recognition without direct instruction, i.e. they can use basic algorithms, formulas,

procedures, to solve problems involving numbers, such as: calculating the price of an object in another currency, comparing distances for two alternative routes. They can interpret and recognize contexts based on inference, extract information from a single source or use a single mode of representation (graphs, equations, tables). Students can provide interpretation of data. What is important to note is that, in 24 countries, more than 50% of participating students scored below this level.

As for level 6, data from participating countries show that only 2.4% of students in the survey reached this level, while the highest percentages of students who reached level 6 are: 16% in Beijing, Shanghai, Jiangsu and Zhejiang, 14% in Singapore.

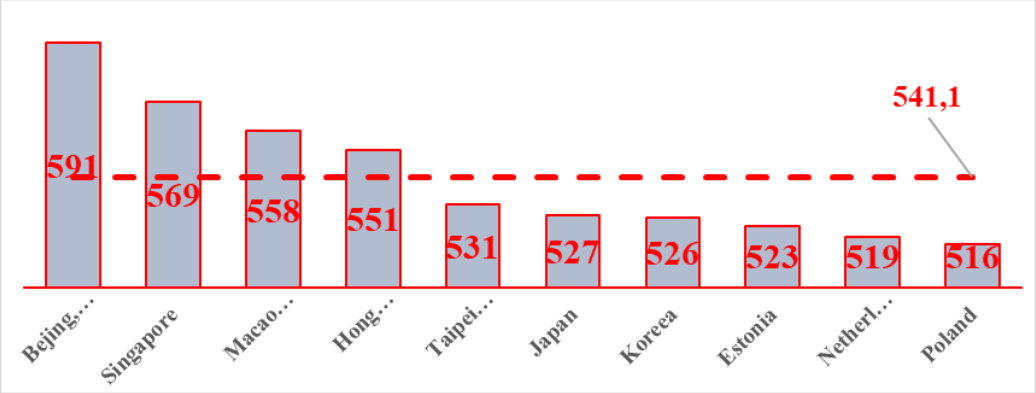


Figure 3. PISA score

Source: Realized by the authors based on information contained in OECD (2019), *PISA 2018 Results (Volume I): What Students Know and Can Do*, PISA, OECD Publishing, Paris. https://doi.org/10.1787/5f07c754-en.

In the table below we present the mathematical PISA score and financial literacy scores for the 25 countries.

Table 2. PISA - mathematics and financial literacy scores

Position by PISA score	Country	Mathematical PISA	Scores on knowledge assessment financial
1	Indonesia	379	5,29
2	Columbia	391	5,43
3	North Macedonia	394	5,57
4	Georgia	398	6,43
5	Peru	400	5,86
6	Moldova	421	5,71
7	Montenegro	430	5,86
8	*Romania*	*430*	*5,00*
9	Bulgaria	436	5,86
10	Malaysia	440	5,29
11	Croatia	464	5,86
12	Malta	472	6,29
13	Hungary	481	6,57
14	Italy	487	5,57
15	Russia	488	6,86
16	Portugal	492	5,71
17	France	495	6,86

Position by PISA score	Country	Mathematical PISA	Scores on knowledge assessment financial
18	Austria	499	7,57
19	Czech Republic	499	6,43
20	Germany	500	7,43
21	Slovenia	509	6,86
22	Poland	516	7,14
23	Estonia	523	7,00
24	Korea	526	6,57
25	Hong Kong	551	8,86

Source: Data in the table were collected by the authors from *PISA 2018 Results (Volume I): What Students Know and Can Do*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/5f07c754-en and *OECD/INFE 2020 International Survey of Adult Financial Literacy.*

By analyzing the data in Table 2, we can see a correlation between mathematical PISA scores and financial knowledge. In order to show the existence of this link we will use specific statistical methods. In terms of statistical correlation, the mathematical PISA score is the independent variable or factor variable, and financial literacy scores define the dependent variable.

To carry out this research we used the SPSS software package. The application of parametric methods in testing the research hypothesis requires several steps.

First, we test whether the collected data are normally distributed using the Kolmogorov-Smirnov test, for which we obtained the results below.

Table 3. Kolmogorov-Smirnov test results

		Mathematics (PISA)	Financial knowledge (10)
N		25	25
Normal Parameters[a,b]	Mean	464,8400	6,3152
	Std. Deviation	49,15170	,88452
Most Extreme Differences	Absolute	,154	,177
	Positive	,106	,177
	Negative	-,154	-,083
Kolmogorov-Smirnov Z		,770	,883
Asymp. Sig. (2-tailed)		***,594***	***,417***
a. Test distribution is Normal.			
b. Calculated from data.			

Source: Realized by the authors

As the table above indicates, the data follow a normal distribution, which is highlighted by the Sig. values (p-value) for both the independent variable (PISA, 0.594) and the dependent variable (financial knowledge, 0.417), which are greater than 0.05. In other words, the null hypothesis (H0) is accepted.

After testing the normality of the distribution of the data, we decide which mathematical model expresses the relationship between the two variables using graphical representation.

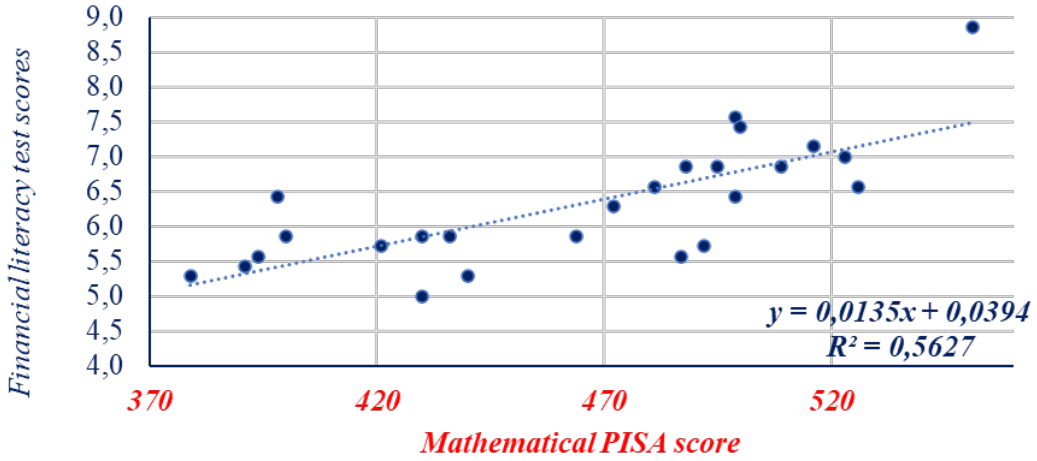


Figure 4. Correlation between mathematical PISA score and financial literacy scores
Source: Realized by the authors

From the analysis of the graph, it can be seen that the relationship between the two variables is direct and linear. Thus, an increase (decrease) in the PISA score in mathematics leads to an increase (decrease) in the financial literacy score.

Next, we test whether the model described above can be validated, and for this purpose we use the ANOVA test. Thus, the model is valid because the probability associated with F-statistic (Sig.) is less than 0.05, as can be seen from Table 4.

Table 4. ANOVA test results[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10,550	1	10,550	29,496	***,000[b]***
	Residual	8,227	23	,358		
	Total	18,777	24			

a. Dependent Variable: Financial knowledge (10)
b. Predictors: (Constant), Mathematics (PISA)

Source: Realized by the authors

It is also necessary to test the significance of the coefficients in the linear model. Coefficients are significant if the probability associated with t-statistic (Sig.) is less than 0.05.

Table 5. *t-test* results

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
		B	*Std. Error*	*Beta*		
1	(Constant)	,045	1,161		3,039	,015
	Mathematics (PISA)	,013	,002	,750	5,431	***,000***

Source: Realized by the authors

The regression coefficient (coefficient of the independent variable, 0.013) is positive and significantly different from zero (Sig. value is less than the specific threshold).

Therefore, the relationship between the two variables is directly significant and is described by a linear model. Also, the value of the coefficient of determination (R2) is 0.5627, which shows that the score obtained in the financial literacy assessment is significantly influenced by more than 56% of the score obtained in the PISA mathematics tests.

Finally, we still need to determine the strength of the relationship between the variables studied. For this, we use the Pearson linear correlation coefficient.

Table 6. Correlation between variables

		Financial knowledge (10)	Mathematics (PISA)
Pearson Correlation	Financial knowledge (10)	1,000	,750
	Mathematics (PISA)	,750	1,000
Sig. (1-tailed)	Financial knowledge (10)	.	*,000*
	Mathematics (PISA)	*,000*	.
N	Financial knowledge (10)	25	25
	Mathematics (PISA)	25	25

Source: Realized by the authors

The probability associated with the Pearson coefficient (Sig.) is much less than 0.05, which shows that the statistical significance of the link is high. The value of the Pearson coefficient (0.75) is positive and large (close to 1), indicating that the link is direct, of high intensity and highly statistically significant.

5. Conclusions

This study sought to identify the relationship between mathematical knowledge as assessed by PISA test scores and financial knowledge as an element of financial literacy. It was shown that there is a direct and linear relationship between the two variables, which means that a change in mathematical PISA test scores generates a change in the financial literacy score in the same direction. Specifically, an increase in the mathematical PISA score by 1 point leads to an increase in the financial literacy score (on a scale from 1 to 10) by 0.013, which is not insignificant given the orders of magnitude of the two assessments. The development of viable financial education programs is necessary to improve financial literacy scores.

Financial education can prove its effectiveness to the extent that it relates to the needs and learning possibilities of learners both in terms of content and teaching-learning-assessment methods.

Studies assessing the effects of financial education on the actual financial behavior of children and adolescents are rare and show almost no effect (Amagir et al., 2018). An appropriate method of teaching financial education to children and adolescents in primary and secondary school is "experiential learning". In college, emphasis should be placed on students' specific "life events".

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