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How is financial literacy predicted by mathematics achievement and mathematics-related affective characteristics?

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Abstract

This study focused on determining how financial literacy scores in these countries were predicted by mathematical achievement and affective concepts related to mathematics. The study was conducted using financial literacy data from students in Belgium, Brazil, Costa Rica, Italy, and Portugal, obtained from the OECD's PISA 2022 database. Therefore, analyses were conducted with all of these respondents. Accordingly, data from 1775 students from Belgium, 3038 students from Brazil, 2564 students from Costa Rica, 4581 students from Italy, and 3139 students from Portugal were analyzed. In general, the results show that there is a relationship between students' financial literacy and mathematical achievement.

Introduction

The world will become increasingly globalized (Contractor, 2022). This causes societies and therefore individuals to become more dependent on each other through the economy. In order to gain and sustain a place in such a global economic structure, it is necessary to have many skills. One of these skills is literacy. When it comes to literacy, the first thing that comes to mind is a symbolic decoding approach based on the alphabet. Because this literacy of ours can be said to be the first writing of human beings. Human beings have discovered writing in order to continue their physiological and cultural existence and to transfer the knowledge, skills and behaviors they have acquired to the next generation, and accordingly, they have created the most basic concept of "literacy" that we know. However, today, literacy is not perceived only as decoding an alphabet; it is defined as "communication skills and attitudes that are realized by using many mental skills and languages" (Aşıcı, 2009, p. 12). According to this definition, it is possible to talk about many literacy concepts.

In a globalizing world, the first literacy that individuals should have is "financial literacy" (Beranova, Sima, & Navratilova, 2020). Financial literacy can be defined as "developing financial awareness and understanding of financial concepts and practices" (Mutlu & Özer, 2022). As can be understood from the definition, individuals with financial literacy make their financial decisions more consciously, use their resources more efficiently and protect their individual financial well-being. In this context, it can be said that financial literacy is important in an individual's life (Skagerlund, Lind, Strömbäck, Tinghög, & Västfjäll, 2018). Since an individual has many different aspects, financial literacy has a complex structure that can be affected by the individual's characteristics and environment. Since the concept of financial literacy includes some numerical approaches, the first factor that can affect this literacy is mathematical achievement, skills and literacy. For example, Villagómez Amezcua and Hidalgo Everardo (2017) showed that mathematics has an effect on financial literacy. However, this effect and the underlying relationship are not

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limited to mathematical cognitive skills. Many studies indicate this situation (Mancebón, Ximénez-de-Embún, Mediavilla, & Gómez-Sancho, 2019; Mejía, García-Santillán & Moreno-García, 2022; Mudzingiri, Muteba Mwamba & Keyser, 2018).

Mathematics course and the skills acquired in this course provide the necessary tools for financial literacy (Abylkassymova, , et al., 2020). However, considering that human beings are multifaceted, cognitive abilities and competencies in mathematics alone are not sufficient to explain financial literacy. Factors that can affect mathematical skills and abilities can also affect financial literacy. The most important of these is the affective characteristics related to mathematics. Students' interests, concerns, etc. affective characteristics play a role in mathematical reasoning and can affect individuals' behaviors on financial issues (Dowker, Sarkar & Looi, 2016). However, the role of mathematics educators and the classroom environments where mathematics lessons are taught should not be ignored. For example, teacher behaviors in the classroom affect individuals (Blazar & Kraft, 2017). In this case, teacher behaviors in mathematics lessons can affect students' mathematical skills and therefore their financial literacy. On the other hand, family approaches can also affect lessons (Baron, 2015).

Financial literacy, like other literacies, can be affected by many factors. For example, Riitsalua and Põder (2016) state that social and environmental factors such as socio-economic status and access to financial education can affect financial literacy. However, it is not possible to include each of them. Therefore, the research was limited to only mathematics achievement and affective characteristics related to mathematics. It is thought that these characteristics are effective in the final use of financial knowledge and skills by the factors. Therefore, this research focuses on the relationship between mathematics achievement and affective characteristics related to mathematics and financial literacy.

Method

The study is a survey model. In this study, it was tried to determine how affective characteristics related to mathematics and financial literacy predict mathematical success. For this purpose, the survey model was selected as the most appropriate model.

Participants

The study was conducted using financial literacy data from students in Belgium, Brazil, Costa Rica, Italy, and Portugal, obtained from the OECD's PISA 2022 database. This study focused on determining how financial literacy scores in these countries were predicted by mathematical achievement and affective concepts related to mathematics. Therefore, analyses were conducted with all of these respondents. Accordingly, data from 1775 students from Belgium, 3038 students from Brazil, 2564 students from Costa Rica, 4581 students from Italy, and 3139 students from Portugal were analyzed. The reason for choosing these countries was that they had data on all variables in the focus of the study.

Data Collection Tools

These two variables are related to performance. The first of these is the independent variable, mathematics performance. The other is the financial literacy, which is the focus of the research. These variables are calculated as Plausible Value. In the analysis, "Plausible Value 1 in Mathematics-Plausible Value 10 in Mathematics" was used for mathematics performance; "Plausible Value 1 in Financial Literacy-Plausible Value 10 in Financial Literacy" was used for financial literacy.

Information on the scales used to measure affective characteristics related to mathematics and the modules in which these scales (OECD, 2024) are located are presented below.

Exposure to mathematics content

Exposure to Mathematical Reasoning and 21st century mathematics tasks (EXPO21ST):

In this scale, students were asked questions expressing the frequency of encountering mathematical reasoning and 21st century mathematical tasks such as "Extracting mathematical information from diagrams, graphs, or simulations" during their school years. The scale consists of 10 items and each item is coded as "Frequently", "Sometimes", "Rarely" and "Never".

Exposure to Formal and Applied Mathematics Tasks (EXPOFA):

In this scale, students were assessed on their exposure to formal and applied mathematics tasks through questions such as “Calculating how much more expensive a computer would be after adding tax.” The scale is in the form of “Frequently”, “Sometimes”, “Rarely”, and “Never”.

Mathematics teacher behaviours

Cognitive activation in mathematics: Encourage mathematical thinking (COGACMCO):

In this scale, students were asked about their perceptions of their mathematics teachers' encouragement of mathematical thinking with questions such as “The teacher asked us how different topics are connected to a bigger mathematical idea.” The scale consists of 9 questions and each question is coded as “Never or almost never”, “Less than half of the lessons”, “About half of the lessons”, “More than half of the lessons”, and “Every lesson or almost every lesson”.

Cognitive activation in mathematics: Foster reasoning (COGACRCO):

In this scale, students were asked about their perceptions of their mathematics teachers' encouragement of mathematical reasoning with questions such as “The teacher asked us to defend our answer to a mathematics problem.” The scale consists of 9 questions and each question is coded as “Never or almost never,” “Less than half of the lessons,” “About half of the lessons,” “More than half of the lessons,” and “Every lesson or almost every lesson.”

Disciplinary climate in mathematics (DISCLIM):

In this scale, students were asked about what happened in math classes with questions such as “Students do not listen to what the teacher said.” or “Students get distracted by using <digital resources> (e.g., smartphones, websites, apps).” A scale score was obtained according to the scores obtained from the questions. This scale consists of 7 items and each item is coded as “Every lesson,” “Most lessons,” “Some lessons,” and “Never or almost never.”

Parent Questionnaire

Mathematics Career (PQMCAR):

This data was obtained by scaling the responses to questions such as “Does anybody in your family (including you) work in a mathematics-related career>?” or “Does your child show an interest in working in a <mathematics-related career>?” posed to parents. This scale includes 5 items and the items are coded as “yes” and “no”.

Parent Attitudes Toward Mathematics (PQMIMP):

This scale attempted to determine parents’ views on the importance of mathematics knowledge with questions such as “Most jobs today require some mathematics knowledge and skills.” The scale consists of 4 items. Each item has the options “Strongly agree”, “Agree”, “Disagree”, “Strongly disagree”.

Proactive mathematics study behaviour

Effort and Persistence in Mathematics (MATHPERS):

This scale tries to determine students’ efforts and endeavors towards mathematics with questions such as “I actively participated in group discussions during mathematics class.” The scale consists of 8 items. Each scale has options such as “Never or almost never”, “Less than half of the time”, “About half of the time”, “More than half of the time” and “All or almost all of the time”.

School culture and climate

Mathematics Teacher Support (TEACHSUP):

This scale attempts to determine students’ perceptions of their mathematics teachers’ support in their lessons through questions such as “The teacher shows an interest in every student’s learning.” Scale items have options such as “Every lesson,” “Most lessons,” “Some lessons,” and “Never or almost never.”

Subject-specific beliefs, attitudes, feelings, and behaviours

Mathematics Anxiety (ANXMAT):

This scale tried to determine the anxiety of students, which is a whole of their fears and worries about mathematics, with items such as "I often worry that it will be difficult for me in mathematics classes." The scale consists of 6 items. Each item has the options "Strongly agree", "Agree", "Disagree", and "Strongly disagree".

Subjective familiarity with mathematics concepts (FAMCON):

This scale tries to determine how familiar they are with mathematical concepts such as "Exponential function" or "3-dimensional geometry". The scale consists of 10 items. Each item offers options as "Never heard of it", "Heard of it once or twice", "Heard of it a few times", "Heard of it often" and "Know it well, understand the concept".

Perception of Mathematics as easier than other subjects (MATHEASE):

This index attempts to determine how much easier the student perceives mathematics compared to "the test language in PISA 2022" and "science".

Mathematics self-efficacy 8 MATHEF21):

Mathematical reasoning and 21st century skills (MATHEF21): This scale attempts to determine how competent students feel about mathematical reasoning and 21st century mathematical tasks such as "Extracting mathematical information from diagrams, graphs, or simulations", and "Using the concept of statistical variation to make a decision". The scale consists of 10 items. Each item has four options: "Not at all confident", "Not very confident", "Confident", and "Very confident".

Mathematics self-efficacy: formal and applied mathematics (MATHEFF):

This scale attempts to determine how confident students are in formal and applied mathematics topics such as "Calculating how much more expensive a computer would be after adding tax" or "Solving an equation like 2(x+3) = (x+3)(x-3)." The scale item options range from "Very confident" to "Not at all confident."

Relative motivation to do well in mathematics compared to other core subjects (MATHMOT):

This index attempts to determine how much easier the student perceives mathematics compared to "the language of the test in PISA 2022" and "science".

Preference of Math over other core subjects (MATHPREF):

This index attempts to determine how much students prefer mathematics relative to "the language of the test in PISA 2022" and "science".

Descriptive statistics of the scale scores in the countries included in the study are presented in Table 1.

Data Analysis

Since there are complex testing and sampling procedures in international large-scale assessments, the International Database Analyzer (IDB Analyzer) program developed by the International Association for the Evaluation of Educational Achievement was used in both descriptive statistics and multiple regression analysis. While "Plausible Value 1 in Mathematics-Plausible Value 10 in Mathematics" and "Affective Characteristics Related to Mathematics" were independent variables; "Plausible Value 1 in Financial Literacy-Plausible Value 10 in Financial Literacy" was used as the dependent variable.

Results

According to the results of the regression analysis, variables related to mathematics in Belgium explain 78% of the financial literacy score. According to the analysis results, while the variables of mathematics achievement, COGACRCO (Cognitive activation in mathematics: Encourage mathematical thinking), FAMCON (Subjective familiarity with mathematics concepts) and MATHEFF (Mathematics self-efficacy: formal and applied mathematics) make a significant and positive contribution to the financial literacy score in Belgium; MATHEASE (Perception of Mathematics as easier than other subjects), MATHEF21 (Mathematics self-efficacy: mathematical reasoning and 21st century skills) make a significant but negative contribution. There are no significant contributions from variables such as EXPO21ST

(Exposure to Mathematical Reasoning and 21st century mathematics tasks), EXPOFA (Exposure to Formal and Applied Mathematics Tasks), COGACMCO (Cognitive activation in mathematics: Encourage mathematical thinking), DISCLIM (Disciplinary climate in mathematics), PQMCAR (Mathematics Career), PQMIMP (Parent Attitudes Toward Mathematics), MATHPERS (Preference of Math over other core subjects), TEACHSUP (Mathematics Teacher Support), ANXMAT (Mathematics Anxiety), MATHMOT (Relative motivation to do well in mathematics compared to other core subjects) and MATHPREF (Preference of Math over other core subjects).While mathematics achievement provides the greatest contribution to the prediction of financial literacy score in a positive direction, MATHEF21 variable follows it in a negative direction. Another self-efficacy variable, MATHEFF (Mathematics self-efficacy: formal and applied mathematics), provides a significant positive contribution.

Table 1.

Descriptive statistics of the scale scores.

Country	Module	Scales	Min	Max	M	sd
Belgium	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	-2.64	3.05	-.13	.88
		Exposure to Formal and Applied Mathematics Tasks	-3.07	2.64	-.12	.82
	Mathematics teacher behaviors	Cognitive activation in mathematics: Encourage mathematical thinking	-2.13	2.54	-.17	.86
		Cognitive activation in mathematics: Foster reasoning Version	-2.85	3.54	-.10	.85
		Disciplinary climate in mathematics	-2.49	1.85	.01	.91
	Parents' perceptions of mathematics	Mathematics Career	-1.22	1.75	-.11	1.07
		Parent Attitudes Toward Mathematics	-3.17	1.30	-.61	.87
	Proactive mathematics study behavior	Effort and Persistence in Mathematics	-3.10	2.83	.01	.89
	School culture and climate	Mathematics Teacher Support	-2.91	1.56	-.19	1.06
	Subject-specific beliefs, attitudes, behaviors	Mathematics Anxiety	-2.39	2.64	.10	1.03
		Subjective familiarity with mathematics concepts	-3.53	4.48	.67	1.35
		Perception of Mathematics as easier than other subjects	0	1	.08	.28
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	-2.49	2.87	-.16	.85
		Mathematics self-efficacy: formal and applied mathematics	-3.49	2.33	-.40	1.03
		Relative motivation to do well in mathematics compared to other core subjects	0	1	.06	.24
		Preference of Math over other core subjects	0	1	.12	.33
Brazil	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	-2.75	3.27	.39	1.07
		Exposure to Formal and Applied Mathematics Tasks	-3.09	2.64	.22	1.06
	Mathematics teacher behaviors	Cognitive activation in mathematics: Encourage mathematical thinking	-2.16	2.62	.32	1.08
		Cognitive activation in mathematics: Foster reasoning Version	-2.98	3.72	-.07	1.10
		Disciplinary climate in mathematics	-2.49	1.85	-.33	.87
	Parents' perceptions of mathematics	Mathematics Career	-1.22	1.75	.02	1.01
		Parent Attitudes Toward Mathematics	-3.17	1.30	.03	.87
	Proactive mathematics study behavior	Effort and Persistence in Mathematics	-3.13	2.83	-.20	1.06
	School culture and climate	Mathematics Teacher Support	-2.91	1.56	.28	1.09
	Subject-specific beliefs. attitudes. feelings. and behaviors	Mathematics Anxiety	-2.51	2.63	.48	1.12
		Subjective familiarity with mathematics concepts	-4.42	4.67	-.22	1.58
		Perception of Mathematics as easier than other subjects	0	1	.07	.26
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	-2.48	2.90	-.13	1.02
		Mathematics self-efficacy: formal and applied mathematics	-3.51	2.36	-.81	1.18
		Relative motivation to do well in mathematics compared to other core subjects	0	1	.04	.20
		Preference of Math over other core subjects	0	1	.12	.32
Costa Rica	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	-2.64	3.15	.05	1.02
		Exposure to Formal and Applied Mathematics Tasks	-2.84	2.64	-.09	.91
	Mathematics teacher behaviours	Cognitive activation in mathematics: Encourage mathematical thinking	-2.16	2.62	.38	1.09
		Cognitive activation in mathematics: Foster reasoning Version	-2.82	3.67	.07	1.00
		Disciplinary climate in mathematics	-2.49	1.85	-.06	.90
	Parents' perceptions of	Mathematics Career	-1.22	1.75	.39	.99

	mathematics	Parent Attitudes Toward Mathematics	-3.17	1.30	.02	1.11
	Proactive mathematics study behaviour	Effort and Persistence in Mathematics	-3.37	3.12	.21	.99
	School culture and climate	Mathematics Teacher Support	-2.91	1.56	.56	1.05
	Subject-specific beliefs. attitudes. feelings. and behaviours	Mathematics Anxiety	-2.39	2.64	.53	1.13
		Subjective familiarity with mathematics concepts	-3.89	4.39	.10	1.33
		Perception of Mathematics as easier than other subjects	0	1	.11	.31
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	-2.49	2.91	.03	.97
		Mathematics self-efficacy: formal and applied mathematics	-3.51	2.34	-.68	1.01
		Relative motivation to do well in mathematics compared to other core subjects	0	1	.02	.14
		Preference of Math over other core subjects	0	1	.13	.34
Italy	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	-2.75	3.19	-.36	.95
		Exposure to Formal and Applied Mathematics Tasks	-9.89	2.64	-.54	1.22
	Mathematics teacher behaviours	Cognitive activation in mathematics: Encourage mathematical thinking	-2.16	2.62	-.13	.93
	Mathematics teacher behaviours	Cognitive activation in mathematics: Foster reasoning Version	-2.98	3.67	.06	.90
		Disciplinary climate in mathematics	-2.49	1.85	-.04	.91
	Parents' perceptions of mathematics	Mathematics Career	-1.22	1.75	-.12	.98
		Parent Attitudes Toward Mathematics	-3.17	1.30	-.20	.88
	Proactive mathematics study behaviour	Effort and Persistence in Mathematics	-3.08	2.85	.00	.92
	School culture and climate	Mathematics Teacher Support	-2.91	1.56	-.16	1.12
	Subject-specific beliefs. attitudes. feelings. and behaviours	Mathematics Anxiety	-2.39	2.64	.31	1.06
		Subjective familiarity with mathematics concepts	-4.06	4.38	.42	1.27
		Perception of Mathematics as easier than other subjects	0	1	.10	.30
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	-2.49	2.77	-.12	.90
		Mathematics self-efficacy: formal and applied mathematics	-3.51	2.36	-.38	1.00
		Relative motivation to do well in mathematics compared to other core subjects	0	1	.05	.22
		Preference of Math over other core subjects	0	1	.11	.31
Portugal	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	-2.75	3.27	.07	.97
		Exposure to Formal and Applied Mathematics Tasks	-3.09	2.64	-.18	.93
	Mathematics teacher behaviours	Cognitive activation in mathematics: Encourage mathematical thinking	-2.16	2.62	.27	1.04
		Cognitive activation in mathematics: Foster reasoning Version	-2.86	3.72	.27	1.03
		Disciplinary climate in mathematics	-2.49	1.85	.07	.89
	Parents' perceptions of mathematics	Mathematics Career	-1.22	1.75	.34	1.10
		Parent Attitudes Toward Mathematics	-3.17	1.30	.04	.83
	Proactive mathematics study behaviour	Effort and Persistence in Mathematics	-3.13	2.83	.10	1.03
	School culture and climate	Mathematics Teacher Support	-2.91	1.56	.33	1.11
	Subject-specific beliefs. attitudes. feelings. and behaviours	Mathematics Anxiety	-2.39	2.64	.14	1.02
		Subjective familiarity with mathematics concepts	-4.03	4.86	.78	1.43
		Perception of Mathematics as easier than other subjects	0	1	.16	.37
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	-2.49	2.79	.12	.93
		Mathematics self-efficacy: formal and applied mathematics	-3.50	2.35	-.36	1.13
		Relative motivation to do well in mathematics compared to other core subjects	0	1	.03	.17
		Preference of Math over other core subjects	0	1	.20	.40

Table 2.

Regression analysis results.

Country	Module	Scales	Short	b	*SE*	β
Belgium	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	EXPO21ST	-1.04	2.14	.02
		Exposure to Formal and Applied Mathematics Tasks	EXPOFA	2.94	2.08	.02
	Math performance	Math performance	PV_MATH	.81	.02	.83***
	Mathematics teacher behaviours	Cognitive activation in mathematics: Encourage mathematical thinking	COGACMCO	-2.23	1.99	-.02
		Cognitive activation in mathematics: Foster reasoning Version	COGACRCO	4.54	1.82	.04*
		Disciplinary climate in mathematics	DISCLIM	.74	1.74	.01
	Parents' perceptions of mathematics	Mathematics Career	PQMCAR	.01	1.45	0
		Parent Attitudes Toward Mathematics	PQMIMP	.82	1.73	.01
	Proactive mathematics study behaviour	Effort and Persistence in Mathematics	MATHPERS	-.23	1.72	0
	School culture and climate	Mathematics Teacher Support	TEACHSUP	-2.58	1.47	.01
	Subject-specific beliefs. attitudes. feelings. and behaviours	Mathematics Anxiety	ANXMAT	.76	1.46	.01
		Subjective familiarity with mathematics concepts	FAMCON	2.92	1.32	.04*
		Perception of Mathematics as easier than other subjects	MATHEASE	-1.61	4.77	-.03*
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	MATHEF21	-6.28	2.12	-.06**
		Mathematics self-efficacy: formal and applied mathematics	MATHEFF	4.36	1.72	.05*
		Relative motivation to do well in mathematics compared to other core subjects	MATHMOT	5.24	4.93	.01
		Preference of Math over other core subjects	MATHPREF	4.07	4.53	.01
Brazil	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	EXPO21ST	-.83	1.93	-.01
		Exposure to Formal and Applied Mathematics Tasks	EXPOFA	.05	1.79	0
	Math performance	Math performance	PV_MATH	1.04	.03	.81***
	Mathematics teacher behaviours	Cognitive activation in mathematics: Encourage mathematical thinking	COGACMCO	-1.71	1.84	.02
		Cognitive activation in mathematics: Foster reasoning Version	COGACRCO	2.56	2.11	.03
		Disciplinary climate in mathematics	DISCLIM	3.04	1.93	.03
	Parents' perceptions of mathematics	Mathematics Career	PQMCAR	1.45	1.96	.01
		Parent Attitudes Toward Mathematics	PQMIMP	-3.02	2.01	-.03
	Proactive mathematics study behaviour	Effort and Persistence in Mathematics	MATHPERS	6.1	1.71	.06***
	School culture and climate	Mathematics Teacher Support	TEACHSUP	-1.06	1.41	-.01
	Subject-specific beliefs. attitudes. feelings. and behaviours	Mathematics Anxiety	ANXMAT	4.26	1.55	.02**
		Subjective familiarity with mathematics concepts	FAMCON	-.03	1.15	0
		Perception of Mathematics as easier than other subjects	MATHEASE	-7.13	6.37	-.02
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	MATHEF21	-6.08	1.86	-.06**
		Mathematics self-efficacy: formal and applied mathematics	MATHEFF	2.9	1.77	.03
		Relative motivation to do well in mathematics compared to other core subjects	MATHMOT	-9.84	7.79	-.02
		Preference of Math over other core subjects	MATHPREF	2.17	4.62	.01
Costa Rica	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	EXPO21ST	-3.15	1.28	-.04**
		Exposure to Formal and Applied Mathematics Tasks	EXPOFA	.93	1.53	.01
	Math performance	Math performance	PV_MATH	1.12	.02	.85***
	Mathematics teacher behaviours	Cognitive activation in mathematics: Encourage mathematical thinking	COGACMCO	-1.16	1.59	-.01
		Cognitive activation in mathematics: Foster reasoning Version	COGACRCO	1.65	1.42	.02
		Disciplinary climate in mathematics	DISCLIM	1.72	1.59	.02
	Parents' perceptions of mathematics	Mathematics Career	PQMCAR	1.27	1.39	.01
		Parent Attitudes Toward Mathematics	PQMIMP	-.17	1.33	0

	Proactive mathematics study behaviour	Effort and Persistence in Mathematics	MATHPERS	1.87	1.36	.02
	School culture and climate	Mathematics Teacher Support	TEACHSUP	-3	1.32	-.04*
	Subject-specific beliefs. attitudes. feelings. and behaviours	Mathematics Anxiety	ANXMAT	-.57	1.32	-.01
		Subjective familiarity with mathematics concepts	FAMCON	1.58	1.19	.02
		Perception of Mathematics as easier than other subjects	MATHEASE	-.28	4.58	0
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	MATHEF21	.33	1.81	0
		Mathematics self-efficacy: formal and applied mathematics	MATHEFF	-1.22	1.76	-.01
		Relative motivation to do well in mathematics compared to other core subjects	MATHMOT	-16.12	9.79	-.03
		Preference of Math over other core subjects	MATHPREF	.54	4.25	0
Italy	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	EXPO21ST	-2.72	1.33	-.03*
		Exposure to Formal and Applied Mathematics Tasks	EXPOFA	-2.39	1.1	-.03*
	Math performance	Math performance	PV_MATH	.78	.02	.79***
	Mathematics teacher behaviours	Cognitive activation in mathematics: Encourage mathematical thinking	COGACMCO	-2.07	1.46	-.02
		Cognitive activation in mathematics: Foster reasoning Version	COGACRCO	3.44	1.45	.04*
		Disciplinary climate in mathematics	DISCLIM	2.59	1.3	.3*
	Parents' perceptions of mathematics	Mathematics Career	PQMCAR	-2.96	1.45	-.03*
		Parent Attitudes Toward Mathematics	PQMIMP	.08	1.74	0
	Proactive mathematics study behaviour	Effort and Persistence in Mathematics	MATHPERS	-1.63	1.7	-.02
	School culture and climate	Mathematics Teacher Support	TEACHSUP	-1.3	1.35	-.02
	Subject-specific beliefs. attitudes. feelings. and behaviours	Mathematics Anxiety	ANXMAT	.42	1.44	.01
		Subjective familiarity with mathematics concepts	FAMCON	2.05	1.08	.03
		Perception of Mathematics as easier than other subjects	MATHEASE	-6.07	4.14	-.02
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	MATHEF21	-2.57	1.76	-.03
		Mathematics self-efficacy: formal and applied mathematics	MATHEFF	6.11	1.97	.07*
		Relative motivation to do well in mathematics compared to other core subjects	MATHMOT	-8.11	6.22	-.02
		Preference of Math over other core subjects	MATHPREF	-1.75	4.28	-.01
Portugal	Exposure to mathematics content	Exposure to Mathematical Reasoning and 21st century mathematics tasks	EXPO21ST	-2.44	1.55	-.03
		Exposure to Formal and Applied Mathematics Tasks	EXPOFA	-.57	1.78	-.01
	Math performance	Math performance	PV_MATH	.82	.02	.84***
	Mathematics teacher behaviours	Cognitive activation in mathematics: Encourage mathematical thinking	COGACMCO	-2.8	1.62	-.03
		Cognitive activation in mathematics: Foster reasoning Version	COGACRCO	4.49	1.21	.05***
		Disciplinary climate in mathematics	DISCLIM	1.88	1.33	.02
	Parents' perceptions of mathematics	Mathematics Career	PQMCAR	-1.32	1.1	-.02
		Parent Attitudes Toward Mathematics	PQMIMP	1.03	1.96	.01
	Proactive mathematics study behaviour	Effort and Persistence in Mathematics	MATHPERS	-.1	1.72	0
	School culture and climate	Mathematics Teacher Support	TEACHSUP	2.27	1.72	.03
	Subject-specific beliefs. attitudes. feelings. and behaviours	Mathematics Anxiety	ANXMAT	.2	1.44	0
		Subjective familiarity with mathematics concepts	FAMCON	-1.09	.75	-.02
		Perception of Mathematics as easier than other subjects	MATHEASE	-2.13	3.42	-.01
		Mathematics self-efficacy: mathematical reasoning and 21st century skills	MATHEF21	-1.29	1.58	-.01
		Mathematics self-efficacy: formal and applied mathematics	MATHEFF	1.36	1.39	.02
		Relative motivation to do well in mathematics compared to other core subjects	MATHMOT	-11.45	8.53	-.2
		Preference of Math over other core subjects	MATHPREF	-.9	2.95	0

** p<0.05 ($t_{critical}$ = 1.96); ** p<0.01 ($t_{critical}$ = 2.58); *** p<0.001 ($t_{critical}$ = 3.29)*

According to the regression analysis results for Brazil, variables related to mathematics explain 69% of the financial literacy score. According to the analysis results, while mathematics achievement, MATHPERS and ANXMAT variables make a significant and positive contribution to the financial literacy score in Belgium; MATHEF21 variable makes a significant but negative contribution. There is no significant contribution of EXPO21ST, EXPOFA, COGACMCO, COGACRCO, DISCLIM, PQMCAR, PQMIMP, TEACHSUP, FAMCON, MATHEASE, MATHEFF, MATHMOT, and MATHPREF variables.

While mathematics achievement makes the greatest positive contribution to the prediction of financial literacy score, it is followed by the MATHPERS variable. The variables EXPOFA, COGACMCO, COGACRCO, DISCLIM, PQMCAR, PQMIMP MATHPERS, ANXMAT, FAMCON, MATHEASE, MATHEF21, MATHEFF, MATHMOT, and MATHPREF do not have any significant contributions.

In the analysis conducted for Costa Rica, variables related to mathematics explain 76% of the financial literacy score. According to the analysis results, while mathematics achievement makes a significant and positive contribution to the financial literacy score in Costa Rica, EXPO21ST and TEACHSUP variables make a significant but negative contribution. EXPOFA, COGACMCO, COGACRCO, DISCLIM, PQMCAR, PQMIMP MATHPERS, ANXMAT, FAMCON, MATHEASE, MATHEF21, MATHEFF, MATHMOT and MATHPREF variables do not have any significant contribution.

In the regression analysis conducted for Italy, variables related to mathematics explain 68% of the financial literacy score. According to the analysis results, while the variables mathematics achievement, COGACRCO, MATHEFF and DISCLIM make a significant and positive contribution to the financial literacy score in Italy, the variables EXPO21ST, EXPOFA and PQMCAR make a significant but negative contribution. The variables COGACMCO, PQMIMP, MATHPERS, TEACHSUP, ANXMAT, FAMCON, MATHEASE, MATHEF21, MATHMOT and MATHPREF do not have any significant contribution. While mathematics achievement makes the greatest positive contribution to the prediction of the financial literacy score, it is followed by the DISCLIM variable.

In the regression analysis conducted for Portugal, variables related to mathematics explain 72% of the financial literacy score. According to the analysis results, while mathematics achievement and COGACRCO variables make a significant and positive contribution to the financial literacy score in Portugal; EXPO21ST, EXPOFA, COGACMCO, DISCLIM, PQMCAR, PQMIMP, MATHPERS, TEACHSUP, ANXMAT, FAMCON, MATHEASE, MATHEF21, MATHEFF, MATHMOT and MATHPREF variables do not have any significant contribution. Mathematics achievement made the greatest positive contribution to the prediction of the financial literacy score.

Discussion, Conclusion & Suggestions

In this study, it was attempted to determine how the affective characteristics of students who participated in the PISA 2022 financial literacy and mathematics study in Belgium, Brazil, Costa Rica, Italy and Portugal and how mathematical achievement predict financial literacy through regression analysis. When the results obtained are evaluated in general, they show that there is a relationship between students' financial literacy and mathematical achievement. This result shows that mathematics education plays an important role in the development of financial literacy, even in different countries. In the regression equations where high levels of explained variance rates (68%-78%) were obtained, it can be stated that mathematical success (.79 to .85) is the strongest determinant of financial literacy scores, and that students' mathematical skills provide a solid foundation for the development of this literacy. Both PISA 2012 (OECD, 2014) and studies conducted in previous years (Ilgaz & Güvenç, 2020) are parallel to these results.

When the results are considered one by one for each country, it is seen that mathematical cognitive activities aimed at encouraging reasoning within the behaviors of mathematics teachers and formal and practical self-efficacy variables within the “Subject-specific beliefs, attitudes, feelings, and behaviors” module contribute positively to financial literacy. This finding suggests that cognitive engagement and self-efficacy in formal and practical mathematics are important for financial literacy. However, different results were obtained in terms of concepts related to cognitive and self-efficacy. It can be said that variables such as mathematical self-efficacy for mathematical reasoning and 21st century skills and perceiving mathematics more easily than other courses may have a negative effect on financial literacy and may even prevent this situation. This result points to the complex relationship between financial literacy and perceiving mathematics as easy and self-perceptions of some self-efficacy areas related to mathematics.

When the results are examined for Brazil, while mathematics performance continues to make a positive contribution in the first place, mathematical reasoning and mathematical self-efficacy for 21st century skills have a negative effect on financial literacy, similar to Belgium. This situation shows that the effect of students' affective characteristics towards mathematics on financial literacy has cultural similarities. On the other hand, mathematics anxiety also makes a significant contribution to financial literacy. In general, the relationship between anxiety and success resembles a normal curve. Whether it predicts financial literacy should be re-examined.

In the regression analyses conducted for Costa Rica, a positive correlation is observed between financial literacy and mathematics achievement. However, the same situation is not valid for the variables “Exposure to Mathematical Reasoning and 21st century mathematics tasks” and “Mathematics Teacher Support”, which significantly predict financial literacy. The negative contribution of these two variables indicates that certain educational approaches or support structures are not effective in this context. Based on these findings, the teaching-learning process approaches used and their possible negative consequences on financial literacy warrant further investigation.

The analysis conducted for Italy shows that in addition to mathematical success, actions aimed at encouraging reasoning, which is a mathematical cognitive activation, and having a disciplined climate in mathematics contribute significantly to students' financial literacy. Based on these findings, it can be stated that an environment that encourages mathematical reasoning and discipline is critical for students' financial literacy in Italy. However, similar to Costa Rica, the negative results of the variables “Exposure to Mathematical Reasoning and 21st century mathematics tasks” and “Mathematics Teacher Support” and the career perception related to the field of mathematics and applied mathematics studies indicate that these fields should be re-evaluated in terms of financial literacy.

The last country to be evaluated is Portugal. In Portugal, it is seen that other variables do not have a significant effect on students' financial literacy except for mathematical achievement and actions aimed at encouraging reasoning, which is a mathematical cognitive activation. These two variables made a significant and positive contribution. This finding shows that active participation in mathematical reasoning contributes significantly to students' financial literacy.

This study shows that mathematics achievement is of critical importance in predicting students' financial literacy in the five countries included in the study, while other variables contribute to varying degrees. While formal mathematics self-efficacy generally contributes significantly to students' financial literacy, it has also been revealed that some educational approaches and attitudes may have complex and sometimes contradictory effects. Based on these findings, it can be stated that the relationship between financial literacy and mathematics education should be examined by taking into account certain cultural and contextual factors. In this direction, future studies are expected to examine these complex situations in more depth and reveal findings that can improve educational practices and policies that will improve financial literacy.

Limitation

Although this study produces meaningful results in understanding how mathematical variables affect financial literacy, it should be noted that there are some limitations. First, this study was conducted with data from Belgium, Brazil, Costa Rica, Italy and Portugal. Since the education systems, economic conditions and cultural values of these countries differ from each other, generalization of these findings is limited. Similar analyses in other countries may confirm the findings from a broader perspective.

Suggestion

Based on the results of the study, the following recommendations can be made to education policies and practitioners:

1. Prioritizing mathematical success: In line with research findings, the development of mathematical skills should be prioritized as the cornerstone of financial literacy education.
2. Promoting Cognitive Engagement: Include cognitive activation activities and thinking skills with financial context applications in mathematics classes.
3. Re-evaluating Self-Efficacy Approaches: How self-efficacy elements, especially those related to 21st century skills, are developed should be reconsidered to avoid potential negative impacts.

4. Re-examining the learning-teaching processes: More research should be conducted to better understand the tasks students undertake, especially in the mathematics education process, and the negative effects of actions taken towards a mathematics career.

These recommendations aim to make educational processes more efficient, contributing to students' financial literacy and ultimately enabling students to make better financial decisions when they become adults.

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