

Promising research studies between mathematics literacy and financial literacy through project-based learning

By Laela Sagita

Promising research studies between mathematics literacy and financial literacy through project-based learning

Laela Sagita^{1,2} , Ratu Ilma Indra Putri^{2,*} , Zulkardi² , Rully Charitas Indra Prahmana³ 

¹Mathematics Education Department, Universitas PGRI Yogyakarta, Yogyakarta, Indonesia

²Mathematics Education Department, Universitas Sriwijaya, Palembang, Indonesia

³Mathematics Education Department, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

*Correspondence: ratuilma@unsri.ac.id

Received: 12 October 2022 | Revised: 13 January 2023 | Accepted: 24 January 2023 | Published Online: 30 January 2023

© The Author(s) 2022

Abstract

Financial literacy is a knowledge and attitude about finance and is a 21st-century skill. As a knowledge, a cognitive factor of a person will impact their financial literacy skill. Through a bibliometric analysis study of 274 documents published from 1994 to 2022 in the Scopus database, we found that mathematics literacy is the cognitive factor of one's financial literacy skill. The OECD and several studies offer intertwined concepts, financial literacy and mathematics, to be presented in the mathematics curriculum in primary and secondary schools. After we got the bibliometric results, we surveyed several junior high schools in Yogyakarta to learn more about this issue. A total of 15 mathematics teachers participated in this survey, randomly chosen in junior high school. We got information stating that mathematics teachers used financial terms as a social arithmetic context, did not teach financial knowledge and attitudes, and never heard 13 from 17 financial terms in the survey. Furthermore, we present a framework for implementing financial literacy in mathematics through three dimensions, content, context, and process. The dimension content consists of mathematics' and financial content. On the other hand, the dimension context is related to education and work, home and family, and individual and societal. As a cognitive process, the dimensions of the process are based on Bloom's Cognitive stages. The potential for future research is developing learning activities and implementing them in the independent curriculum, which impacts schools' ability to use project-based learning, which is the most approach to implementing financial literacy in mathematics classes.

Keywords: Financial Literacy, Junior High School, Mathematics Literacy, Project-Based Learning

How to Cite: Sagita, L., Putri, R. I. I., Zulkardi, & Prahmana, R. C. I. (2022). Promising research studies between mathematics literacy and financial literacy through project-based learning. *Journal on Mathematics Education*, 13(4), 753-772. <http://doi.org/10.22342/jme.v13i4.pp753-772>

Several countries agree on the importance of Financial Education (FE) for adults and adolescents or school-age children. In line with OECD to provide financial education in the school curriculum as a separate subject or as a cross-curricular subject (OECD, 2015). Students are familiar with financial terms by implementing financial education in schools (Sole, 2014). One of the ways to implement financial literacy in the school curriculum is to integrate related subjects such as mathematics, social science, civic education, and economics (OECD, 2019). They were strengthened by the findings of the three most effective forms of delivering financial education, such as a cross-curricular subject (Salas-Velasco et al., 2021), personal course of business and economics (Dituri et al., 2019; Salas-Velasco et al., 2021), and

part of mathematics subject (Dituri et al., 2019; Salas-Velasco et al., 2021; Bottazzi & Lusardi, 2020; Indefenso & Yazon, 2020; Ozkale & Erdogan; 2020; Cole et al., 2016).

One of the factors that influence individual Financial Literacy (FL) is the ability in mathematical content. According to financial literacy results on PISA 2015, students could not achieve the minimum score on the test even though they had a basic knowledge of financial concepts, almost 22% (OECD, 2015). This issue was addressed in the OECD 2020 report that the right financial decision is influenced by knowledge of financial concepts and basic mathematics (OECD, 2020). The success of implementing FE in the mathematics curriculum depends on several aspects, including learning materials and strategies. The preparation of mathematical material can use real-world financial contexts (Salas-Velasco et al., 2021; Sawatzki & Sullivan, 2018; OECD, 2019). Furthermore, designing learning can use project-based learning with a particular financial problem (Dituri et al., 2019; Opletalova, 2015).

Recently, Indonesia has improved its educational paradigm by implementing an independent curriculum. Some of the things that we underline in the new curriculum include the application of project learning and added financial literacy through mathematics. We will formulate how to prepare teachers to implement financial literacy in mathematics as asked in prior studies. Teachers can use our findings to design mathematics lessons that include financial literacy.

We present the article in a structured manner, with the research background as a starting point to conduct a framework for implementing financial literacy through mathematics classes. We provide a bibliometric study on the relationship between mathematics and financial literacy. In line with the prior study, many studies show the effect of mathematics on financial literacy. Bibliometric as quantitative cross-disciplinary science analyses the patterns of published literature (Singh & Dhir, 2019) and maps the development of a field of science (Aidi Ahmi, 2019). The next chapter explained the research method, consisting of bibliometric literature and the teacher-school readiness survey.

The discussion section is divided into three parts: presentation of bibliometric analysis, theory of financial literacy, and mathematical literacy, and ends with a discussion of applying financial literacy in mathematics class. Afterward, the following discussion is the survey results of school readiness in implementing project learning and teachers' knowledge of financial terms. Finally, in the conclusion section, all findings are summarized, and recommendations for future researchers are proposed.

METHODS

This study is a systematic review based on bibliometric profile articles from the Scopus database using the Biblioshiny for Bibliometrix R package and VOSviewer version 1.6.17. Bibliometric analysis is a statistical method to analyze patterns of published literature (Singh & Dhir, 2019) or specific trends and patterns of scientific development (Aidi Ahmi, 2019). The pattern of development can be seen from the number of citations, citations per year, citations per author, thematic map, world cloud, co-authorship, and co-citation. This study has three focus patterns, thematic map, world cloud, and co-occurrences.

The analysis in this study began with identifying and collecting data from the Scopus database on August 23, 2022. Data collection was based on Moher et al. (2009), as presented in Figure 1. The initial search used three keywords, namely (TITLE-ABS-KEY (mathematics AND literacy) AND TITLE-ABS-KEY (financial AND literacy) OR TI-TLE-ABS-KEY (numeracy)). The subject areas were limited to only social science, mathematics, art, and humanity to ensure the correspondence of the data used.



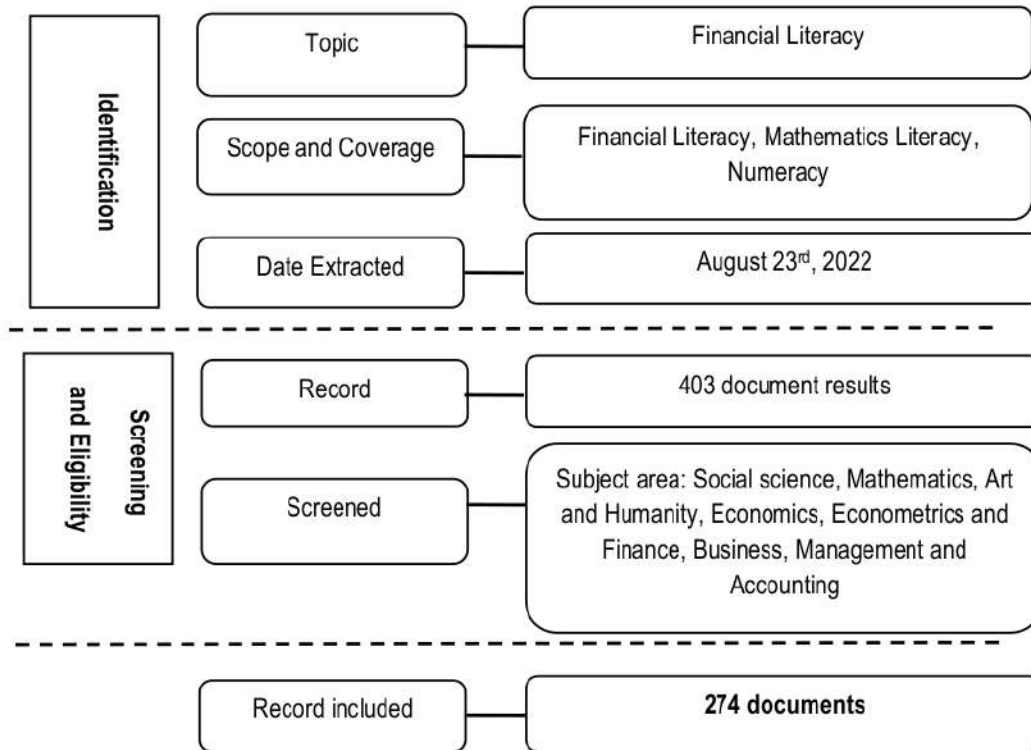


Figure 1. The flowchart in data collection

After conducting a bibliometric analysis, we surveyed to see teachers' prior knowledge regarding financial literacy. The respondents were 15 teachers from five public and ten private schools in the Special Region of Yogyakarta. The teacher's financial literacy knowledge survey consists of two aspects that adopt the 2018 financial literacy questionnaire (OECD, 2019), as shown in Table 1.

Table 1. The rubric of financial literacy questionnaires

Aspect	Indicator	Total Items
Teacher experiences	Financial context in mathematics learning	3
	Knowledge and attitudes about financial in learning mathematics	2
	Teacher's understanding in financial terms	17
Availability of financial literature	Financial literature in the school library	1
	Teacher's financial literature	1

The school readiness survey consists of 10 questions that adopt the Indonesia Ministry of Education, Culture, Research, and Technology readiness survey on driving schools (Kemendikbudristek, 2022). The question items in the survey are adjusted to implement a financial project.



RESULTS AND DISCUSSION

Bibliometric Analysis

Table 2 presents general information from the data sources used in the bibliometric analysis in this article. Which is 274 documents found from 644 authors. The most significant proportion is articles, around 75%, while the rest is a combination of books, book chapters, conference papers, conference reviews, notes, and reviews. These documents were published in 187 sources with an average citation score per document of 16.14 and average citations per year per document of 1.87, indicating the degree of collaboration between researchers.

Table 2. Main information about data

Description	Result
MAIN INFORMATION ABOUT DATA	
Timespan	1994:2022
Sources (journals, books, etc.)	187
Documents	274
Average years from publication	6.55
Average citations per document	16.14
Average citations per year per doc	1.87
References	12146
DOCUMENT TYPE	
Article	206
Book	8
Book chapter	39
Conference paper	11
Conference review	2
Note	1
Review	7
AUTHOR	
Authors	644
Author Appearances	717
Authors of single-authored documents	67
Authors of multi-authored documents	577
Authors	644
Author Appearances	717
Authors of single-authored documents	67
Authors of multi-authored documents	577

We present two types of data visualization based on the most frequent keywords: Word Cloud and Co-Occurrence. The order of keywords in the data search is mathematical literacy, followed by financial literacy and numeracy. The term "numeracy" in Figure 2 has the most significant size or has 54 occurrences of the 274 article documents, followed by the term "financial literacy," which occurs 33 times, the terms "literacy" and "mathematical," which occur 21 times, then "mathematics literacy" that occurs ten times. Based on the VOS Viewer output in Figure 2, the keywords that appear the most are used in the data search. Even though this is natural, we use this output to determine the size or weight and the



When we highlight the keyword financial literacy, all the keywords show that there are networks between keywords. Word analysis aims to determine the conceptual structure using word-occurrence networks (Cole et al., 2011). Figure 4 shows that financial literacy has a direct co-occurrence with several keywords based on circle size: numeracy, mathematics, education, mathematics literacy, article, curriculum, student, financial education, realistic mathematics, PISA, e-learning, finance, and problem-solving. There are four strong networks on keywords presented in Figure 4 based on the size of the circle and the thickness of the links (lines): mathematics, numeracy, financial literacy, and mathematics literacy. It concluded a positive correlation between mathematics, numeracy, financial literacy, and mathematics literacy. It is not surprising because some studies have discovered a strong positive correlation between financial literacy and mathematics literacy (Sole, 2014; OECD, 2019; Ozkale & Erdogan, 2020) or numeracy (Huston, 2010; Lusardi, 2012; OECD, 2019; Bottazzi & Lusardi, 2020; Indefenso & Yazon, 2020).

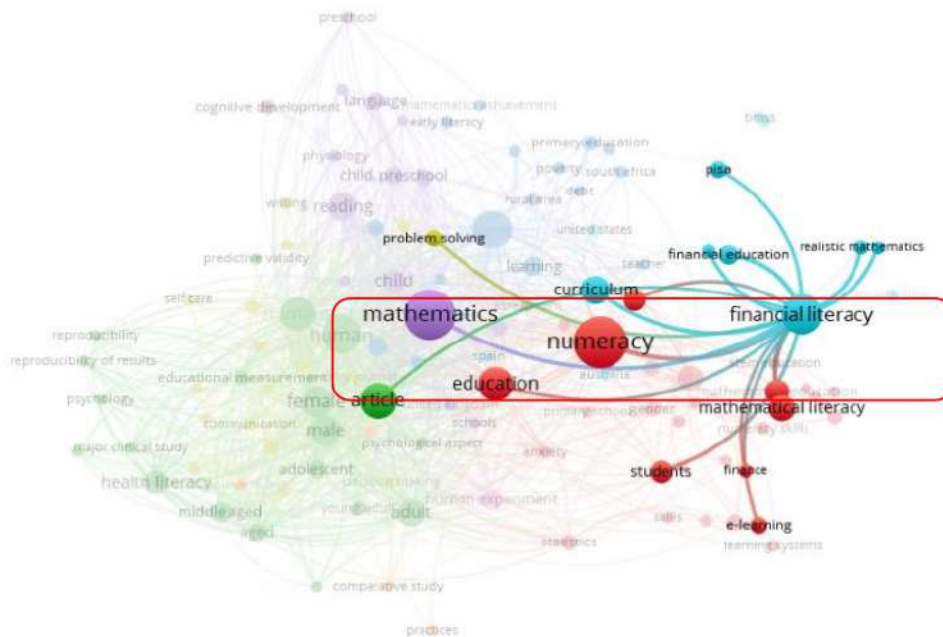


Figure 4. Analysis of the correspondence of VOSviewer keywords

The thematic map is one of the visualizations created using the Bibliometrix-R Package that analyzes the diagram based on co-word network and clustering. This analysis can generate new themes or further research trends in the research domain. The horizontal line (x-axis) shows centrality, and the vertical line (y-axis) represents the density of the theme that appears (Bashir, 2022). Both vertical and horizontal lines divide into four areas, which are four quadrants with different meanings (Cobo et al., 2011). Meanwhile, the size of the circle shows the number of keywords found. Quadrant 1 (top right) is a motor theme; they have low centrality dan high density. The motor themes are highly developed and essential in research themes. Quadrant 2 (top left) is a highly developed and isolated theme, low density but low in centrality, and well-developed but isolated for the field. Quadrant 3 (bottom left) has emerging themes and indicates that the themes in this quadrant will either decline or emerge. Quadrant 4 (bottom



right) has basic and transversal themes, high centrality but low density, and needs further research.

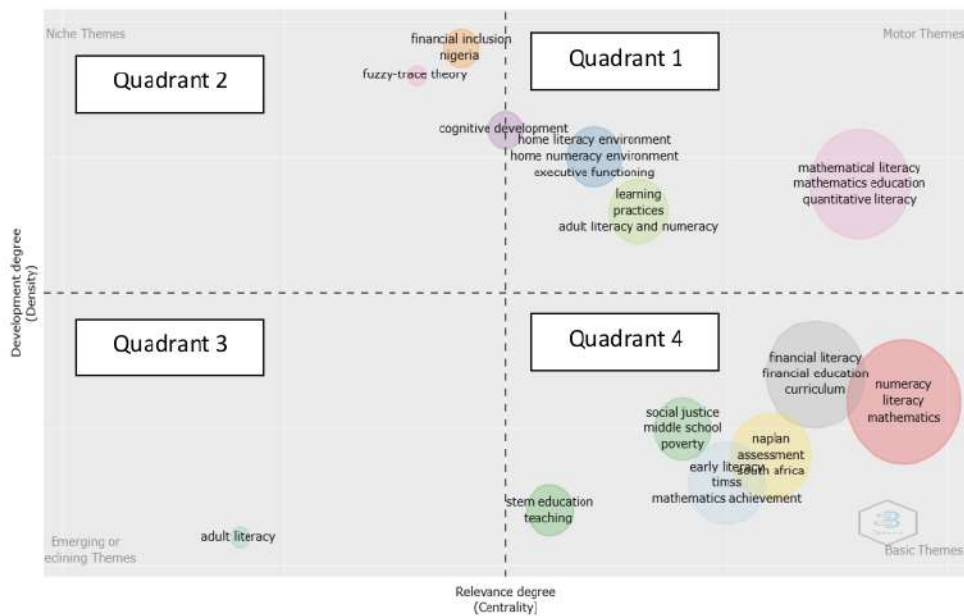


Figure 5. Thematic mapping using Bibliometrix-R package

Quadrant 1 has four themes; one of them is between Quadrant 2. This theme has high density and centrality and is the motor that drives basic themes (Bashir, 2022). Based on the location and size of the circles, one theme is the major theme in this cluster, namely the theme group with pink circles (mathematical literacy, mathematical education, and quantitative literacy). Quadrant 2 is a highly developed but isolated theme: fuzzy-trace theory and financial inclusion. The themes in quadrants 2 and 3 do not affect other themes outside the quadrant (Cobo et al., 2011). So, this is not a focus of attention for us. Fuzzy trace theory is a theme in the health sector, for example, the numeracy health articles by Lipkus and Peters (2009) and Reyna and Brainerd (2008).

Meanwhile, Quadrant 4 of Figure 5 represents a basic theme and enlists six circles of different sizes. The themes in Quadrant 4 have significant research contributions. Based on the circle's location and size, there are two major research themes in this quadrant: the red circle (numeracy, literacy, and mathematics) and the purple circle (financial literacy, financial education, and curriculum). Several researchers who revealed this relationship discuss the effect of mathematics and financial literacy on students (Yildirim & Vardari, 2020). Savard students discovered that Grade 4 has many representations of financial concepts that emerged while learning mathematics (Savard, 2019).

Conceptual Development: What is Financial Literacy?

Financial literacy is divided into two main dimensions: knowledge and attitudes toward managing finances (Ouachani et al., 2020). Knowledge and understanding of financial management will lead to financial attitudes or behavior, for example, deciding to save money for the long term, planning a household budget, budgeting for insurance, choosing financial products, etc. These two dimensions are interrelated, a good knowledge of financials and the right financial attitudes (Kaiser & Menkhoff, 2020; Savard, 2022;



Ozkale & Aprea, 2022).

Financial literacy is a comprehensive concept. It is not only the discipline of economics but also several other disciplines. The comprehensive concept of financial literacy caused experts to define it differently (Goyal & Kumar, 2021). The following are some definitions of financial literacy. Atkinson and Messy (2012) define financial literacy as a combination of awareness, knowledge, skills, attitudes, and behaviors needed to make sound financial decisions and ultimately achieve individual financial well-being.

Meanwhile, Lusardi (2019) defines financial literacy as the ability of individuals to use knowledge, skills, and confidence to make the right financial decisions. Furthermore, Huston (2010) defined financial literacy as an understanding and use of personal finance-related information. People become financially literate when they have the knowledge, understanding, and skills to solve personal financial problems (Goyal & Kumar, 2021).

The concept of financial literacy is not only instilled in adults but also in adolescents. OECD identified specific applications to the definition of financial literacy relevant for students aged 15 years: financial literacy is knowledge and understanding of financial concepts and risks, as well as the skills and attitudes to apply such knowledge and understanding to make effective decisions across a range of financial contexts, to improve the financial well-being of individuals and society, and to enable participation in economic life (OECD, 2019). Meanwhile, JumpStart Coalition, a US non-profit coalition of national organizations seeking to advance the financial literacy of students from pre-kindergarten through to college-aged, defines financial literacy as the ability to use knowledge and skills to manage one's financial resources effectively for a lifetime of financial security (JumpStart Coalition, 2007).

Conceptual Development: Financial Literacy in Mathematic Literacy

This sub-section will present a simple review of financial and mathematics literacy based on the theory proposed by the OECD. In particular, the OECD defines mathematics literacy for the domain of 15-year-olds as the capacity of individuals to reason mathematically and use mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena (OECD, 2019). PISA measures mathematical literacy based on three dimensions:

1. Context: personal, occupational, societal, and scientific.
2. Content: quantity, uncertainty and data, change and relationships, and space and shape.
3. Process: formulating situations mathematically; employing mathematical concepts, facts, procedures, and reasoning; and interpreting, applying, and evaluating mathematical outcomes.

The definition of financial literacy has been mentioned in the previous sub-section. Financial literacy on PISA assessment has three domains: context, content, and process. The domain context describes personal or global situations where knowledge and understanding of financial literacy, namely education and work, home and family, and individual and societal. Meanwhile, the domain process describes students' cognitive abilities in the context and content of financial literacy relevant to understanding, analyzing, evaluating, and selecting solutions (OECD, 2019). More specifically, processes in the financial literacy domain include identifying financial information; analyzing financial information and situations; evaluating financial issues; understanding and applying financial knowledge. Furthermore, the financial literacy content area is knowledge and understanding of financial context. PISA financial literacy contains four content areas: money and transactions, planning and managing finances, risk and reward, and financial landscape (OECD, 2019).



Recently, the OECD completed the 2021 literacy financial framework, which shows an intersection in the domain's content of mathematics literacy and financial literacy, as presented in Figure 6. Operationally, there are two main points in the intersection between mathematics and financial literacy. The first point, basic arithmetic, is mathematics literacy content contained in financial literacy. These basic arithmetic operations include addition, subtraction, multiplication, and division of integers, decimals, and percentages (OECD, 2019). The second point is applying financial knowledge to solve financial problems. The financial context presented everyday problems. An example, students are faced with a choice between an educational insurance product that provides some information about its policy and benefits and a traditional savings account. This case fosters critical thinking about the financial situation regarding choosing a product from the various products offered and understanding that certain financial decisions may have different consequences.

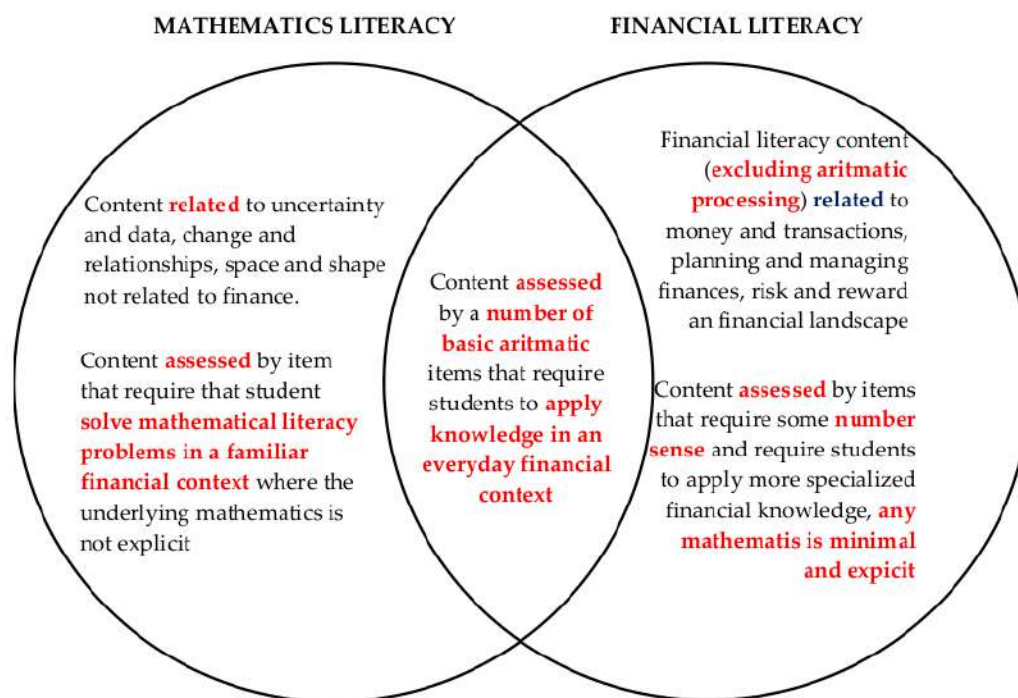


Figure 6. Relationship between the content of financial literacy and mathematical literacy

OECD explained that using formulas to solve financial problems in financial literacy assessment does not require algebraic skills. However, more complex financial problems require other mathematical content, such as quantity, uncertainty, data, change and relationships, and space and shape. Ozkale and Erdogan (2020) found an interaction between financial literacy and mathematical literacy, such as quantity, change and relationship, uncertainty and data, and space and shape. Dituri et al. (2019) combine financial education with mathematics coursework in algebra topic. Savard (2022) taught financial concepts that emerged while learning about probability for grade 4 students. Another aspect from Skagerlund et al. (2018) found numeracy and the emotional attitude toward numbers to be a central point of financial literacy.



Implementation of Financial Literacy in the Mathematics Curriculum

How to implement financial literacy in mathematics? The findings on bibliometrics concluded that financial literacy would be related to mathematics, numeracy, or mathematics literacy. For a while, the OECD stated intersection between mathematics and financial literacy is basic arithmetic for 15 years old. These basic arithmetic operations include addition, subtraction, multiplication, and division of integers, decimals, and percentages (OECD, 2019). OECD emphasized that using formulas to solve financial problems does not require algebraic skills. We stand behind OECD in financial literacy only in primary and secondary schools. However, financial literacy not only requires basic arithmetic skills but also requires broader mathematical concepts. High-level mathematical content is used in completing financial content (Dituri et al., 2019; Ozkale & Erdogan, 2020; Savard, 2022). For example, the idea of exponents calculating compound interest and derivatives to determine the minimum and maximum functions. The second point is applying financial knowledge to solve financial problems. The financial context presented can be everyday problems that have been or will be faced by students. An example is when students are faced with a choice between an educational insurance product that provides some information about its policy and benefits and a traditional savings account. This case fosters critical thinking about the financial situation in terms of choosing the financial product from the various products offered and understanding that certain financial decisions may have different consequences.

OECD uses three content, context, and process domains to assess financial and mathematical literacy. Learning design can use the three domains as a reference. In this discussion, we will divide three domain formulations of content, context, and process in applying financial literacy to learning mathematics.

The content dimensions set by the OECD in the financial literacy framework consist of money and transactions; risks and rewards; planning and managing; and financial landscape (OECD, 2019). More specifically, an institution that provides financial courses for school age (4th grade, 8th grade, and 12th grade) contains six financial contents, namely earning income, spending, saving, investing, managing credit, and managing risk (JumpStart, 2007). A specific and in-depth study conducted by Amagir et al. (2021) found that literacy content at the secondary school level focused on content related to shopping and credit, savings and investment, budgeting, banking services, insurance, income, and careers. Financial literacy content is based on studies measuring high school students financial literacy levels. These include income, programming and money management, credit, debt, saving, and investment (Helen & Ilias, 2019). Different viewpoints in the Interaction Model of Mathematics and Financial Literacy (IMMFL) framework, which combines mathematical content (quantity, change and relationships, space and shape, uncertainty, and data) with financial content financial literacy in the PISA assessment (Ozkale & Erdogan, 2020). However, the IMMFL framework does not explicitly explain the financial literacy content used.

Our article presents content dimensions that can be used in applying financial literacy as part of mathematics material. We have similarities with Ozkale and Erdogan (2020) in the mathematical content, including quantity, change and relationship, space and shape, and change and relationship. Table 3 presents the specific mathematical content we formulate to implement financial literacy.

The difference lies in the financial literacy content used. Financial literacy contains content appropriate to financial activities carried out by high school students (Sole, 2017), including money and transactions, spending, saving, investment, managing credit, and financial awareness. These two contents must be related, for example, when students are faced with buying pizza through a delivery



order or visiting a store in person. Of course, you are not charged shipping costs when you visit the store in person, but you must take the time to visit the store. Delivery order services, of course, will add to shipping costs and possibly other costs. In this case, the students learned to calculate the tax percentage of pizza purchases they made. In addition, students learn to make effective decisions according to their needs, namely choosing to spend less money but extra time or choosing to spend more money but being able to complete other work. This case teaches percentages and introduces students to financial awareness.

Table 3. Mathematics-financial literacy content in the mathematics learning process

Mathematics Content	Subject
Quantity	Integers, rational and irrational numbers, decimal, arithmetic operations on real numbers, scale, proportion.
Change and Relationship	Algebra, commutative, associative, distributive, relation and function, nonlinear functions of graphically linear functions, linear equations and inequalities, rate of change
Space and Shape	Prisms, cylinders, pyramids and cones, congruence and similarity in triangles and quadrilaterals, reflection, translation, rotation, and dilation, lines, and plane
Change and Relationship	Bar charts, pie charts, sample, population, mean, median, modus, range of the data to solve problems in a simple experiment

Furthermore, the context dimension describes personal to global situations where knowledge, skills, and understandings from financial literacy are used. OECD (2019) confirms that a decision regarding financial matters often depends on the context or situation in which they are presented. The context used in the PISA assessment serves as a medium for problems that can make it possible to connect different individual roles in real life around them. We present the same context identified for PISA financial literacy, including education and work, home and family, and individual and societal.

Lastly, the process of financial literacy describes students' cognitive abilities to recognize and apply relevant concepts to understand, analyze, evaluate, and choose solutions. Cognitive processes in financial literacy are divided into four activities: identifying financial information, analyzing financial information and situations, evaluating financial problems, and applying financial knowledge and understanding (OECD, 2019; Lusardi, 2019). In contrast, Ozkale and Erdogan (2020) formulated a process dimension in IMMFL based on processes in the mathematical and financial literacy literature, including identifying financial situations, reasoning, problem-solving and modeling, manipulating and estimating, reflecting and transferring, representing, using technology, and communicating.

The verbs used in the financial literacy process are like the cognitive structure of Bloom's Taxonomy, namely remembering, understanding, applying, analyzing, evaluating, and creating. The fundamental difference is that cognition in financial literacy is parallel or does not have a hierarchy. The sequence of processes presented in financial literacy relates to the sequence of thought and action processes, not difficulties or challenges (OECD, 2019). Bloom's taxonomy creates a two-dimensional framework separating cognitive processes and knowledge and can be used flexibly by focusing on one or more pieces of knowledge together (Anderson & Krathwohl, 2001). Adopting the Revised Bloom's Taxonomy makes it easier to formulate skills that will be produced in learning mathematics and finance, which we use in formulating process dimensions presented in Table 4.

The financial literacy process of applying financial knowledge and understanding is adjusted to



Bloom's Cognitive Revision stage into two different processes: applying financial knowledge and understanding financial information and mathematical concepts. In addition, this separation was carried out based on Savard and Cavalcante (2021), stating that knowledge is not enough to apply knowledge in life and requires understanding.

Table 4. The relationship of revised bloom's taxonomy to the dimensions of the financial literacy process

Process	Competencies
Remember	Recognize information that has been learned or known before, such as definitions, facts, sequential lists related to student financial activities and mathematical concepts
Understand	Explaining a financial concept using its own sentence, interpreting, concluding mathematical concepts that are related to a financial problem
Apply	Apply mathematical concepts, knowledge, or information to relevant financial situations
Analyze	Exploring the relationship/correlation between mathematical concepts, determine the relationship between the concepts in the relevant financial situation
Evaluate	Make decisions, systematically evaluate the completion of cases/projects undertaken
Create	Assemble a variety of financial knowledge in the search for project ideas and the ability to add value to an existing product.

(Adaptation: Radmehr & Drake, 2019; Tim, 2022)

Therefore, we use terminology that mathematics literacy becomes more general for all school levels. Figure 7 presents the interrelationships between financial and mathematical literacy domains. Financial and mathematic literacy has three main domains: context, process, and content (OECD, 2019).

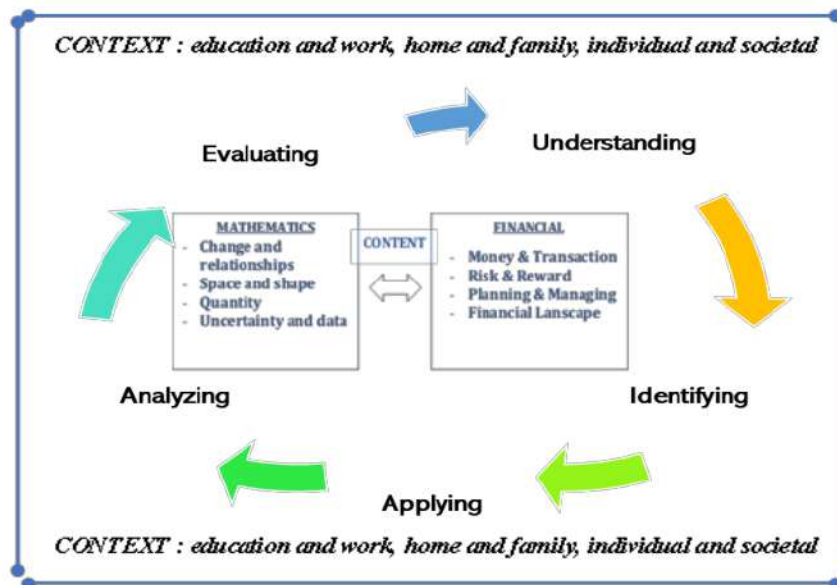


Figure 7. Framework financial literacy in mathematics classes

To complete our conceptual framework, we discuss the implementation of Project-Based Learning (PjBL) as a learning model in the classroom. Eickholt et al. (2019) stated that PjBL is a precise and realistic method for student-centered learning. In mathematics classes, PjBL emphasizes the application



of mathematics in an interdisciplinary, holistic approach, integrated with practice and complex problems in the real world, where students must be able to carry out investigations to understand and product-oriented (Kokotsaki et al., 2016; Rahayu & Putri, 2021). The projects in PjBL are related to student's culture and daily life problems (Markham, 2011; Jalinus et al., 2017; Eickholt et al., 2019; Oguz-Unver & Arabacioglu, 2014), which financial context is an activity that students experience daily.

On the other hand, using PjBL results in a broader and deeper student understanding of a topic and increased motivation to learn (Bell, 2010). In addition, a uniqueness of PBL is the construction of the final product, a 'concrete artifact' that represents students' new understanding, knowledge, and attitudes regarding the problem under investigation (Helle et al., 2006). To present the project using videos, photographs, sketches, model reports, and other collected artifacts (Holubova, 2008). Figure 8 shows the modified PjBL syntax groupings in this study. The three main stages of PjBL in the learning process are initial material, project work, and evaluation.



Figure 8. The PjBL's stage in mathematics classes

Referring to Imafuku et al. (2014) and Jalinus et al. (2017) the following activities are carried out at each stage, presented in Table 5.

Table 5. The PjBL stage activity on the application of financial literacy in mathematics learning

PjBL Stages	Class Activity
Initial material	<ol style="list-style-type: none"> 1. Determine the project. In this step students determine the topic of the project based on the assignment given by the teacher. 2. Project step planning. Design a project step plan according to financial literacy content
Project Work	<ol style="list-style-type: none"> 3. Arrange the schedule. This step describes how long the project must be completed step by step. 4. Teacher monitoring. Implement projects based on financial literacy content activities in completing project assignments. 5. Preparation and Presentation of Reports. At this stage students compile reports / products that have been made. After that, students appear in front of the class to present their work.
Evaluation	<ol style="list-style-type: none"> 6. Project evaluation. Students are allowed to bring their experiences while completing project assignments. At this stage, feedback is also provided on the processes and products that have been produced. At this stage the teacher can give several questions to students to measure student understanding.

Finally, PjBL's interdisciplinary and holistic learning model is appropriate for implementing financial literacy in the mathematics curriculum. Mathematical material can be applied interdisciplinary with financial literacy. Through PjBL, students carry out complex practice problems in the real world and investigations to understand and be product-oriented (Imafuku et al., 2014; Oguz-Unver & Arabacioglu, 2014).

We have conducted a preliminary survey of mathematics teacher knowledge in implementing



mathematics learning, including financial literacy. The sample survey is a school that implements an independent curriculum in Yogyakarta Province. The results show that 66.67% of mathematics teachers use the financial context in learning, such as in social arithmetic material and exam questions. Moreover, teachers rarely provide knowledge and attitudes about finances in mathematics, such as the purpose and use of money, needs, desires, ways of making payments, consumer awareness, changes in the value of money over time, and investing in the stock market. In line with one of the survey results is the need for teachers' knowledge of financial literacy terms. Previous studies found that most teachers need more knowledge to teach financial topics (Otter, 2010; Henning & Lucey, 2017). It is rare to find a teacher professional development in financial literacy (Compen et al., 2019; Björklund, 2019). Nevertheless, teachers are essential for students' financial literacy (Totenhagen et al., 2015; Sawatzki & Sullivan, 2017).

Of the 17 terms we present, only four are familiar to teachers. Figure 9 summarizes the teacher's answers. Meanwhile, all schools have been equipped with financial books in the library but still need a teacher's book on learning financial literacy in mathematics.

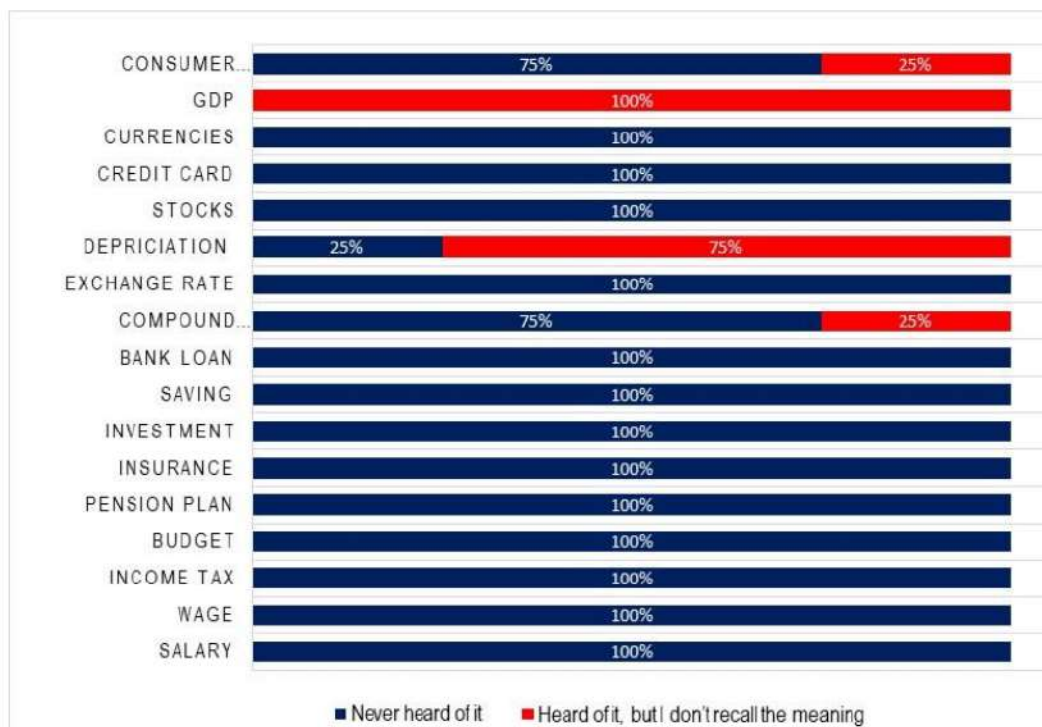


Figure 9. Teachers' initial knowledge of financial terms

Next, we surveyed school readiness in implementing PjBL, specific to a project on financial literacy. Of the 10 question items that contain school characteristics, project-based learning support systems, the application of an independent curriculum, and the application of financial literacy in learning, we grouped two types of schools. First, nine of 15 schools are in the "early stages," meaning that less than 50% of the teachers in these schools have implemented project-based learning. Meanwhile, six out of 15 schools are in the "developing stage," meaning that schools are ready to implement project-based learning.



Schools in our sample's developing stage have implemented entrepreneurial-based learning and implemented project-based learning for more than two years. Based on this survey, we conclude that schools are ready to implement mathematics learning that integrates financial literacy through project-based learning.

The results of this research show clear evidence of the link between mathematics and financial literacy skills, the application of financial literacy to learning outcomes in mathematics, and the readiness of schools to apply financial literacy using projects. However, mathematics teachers' knowledge of financial terms and teacher experience using financial contexts could have been more extensive. As a result, the application of financial literacy to mathematics lessons is limited to financial contexts or knowledge, not students' attitudes toward finances. It implies that a financial literacy learning environment is a clear need for mathematics teachers. So that teachers can use suitable material in teaching mathematics-financial literacy.

CONCLUSION

This research further discovered the intertwined concept between mathematics, financial literacy, and numeracy through the visualization of a thematic map created using the Bibliometrix R-Package. The intertwined concept, in this case, is obtained based on themes that often occur and support and affect each other. The findings offered financial literacy skills through PjBL in the mathematics school curriculum. Three-dimensional formulations need to be considered in the preparation of learning tools. The formulation of this dimension is an intersection of mathematical and financial content. The context uses the formulation in the PISA assessment of financial literacy. The process uses Bloom's cognitive stage. The results of this study can also provide a new interdisciplinary study of mathematics learning in financial investigations. So, problems or math problems that use an economic context, especially in finance, are more than just a camouflage context that seems traditional. For example, when studying percent material, students are not only asked to calculate discounts on an item, but students are also given knowledge about what and how discounts can occur. However, the finding of teachers' need for knowledge of financial terms requires further research in teacher professional development. However, this study has several limitations, including only discussing descriptively the empirical evidence of the link between mathematics and financial literacy found in previous studies. The framework for financial literacy in mathematics through PjBL is not yet at the practical implementation stage, even though the survey shows that it is ready to implement project-based learning. Thus, the potential effect on students' financial literacy skills has yet to be discovered. Therefore, future research needs to study developing the learning environment in mathematics classes along with learning tools, project activities, and assessments.

Acknowledgments

The authors are grateful to Universitas PGRI Yogyakarta, Universitas Sriwijaya, and Universitas Ahmad Dahlan for giving us a research collaboration opportunity and Prof. Annie Savard from McGill University for valuable suggestions and discussion during analysis the research data.

Declarations

Author Contribution : All authors contributed to the study conception and design. The idea for the article were performed by LS and RIIP. Furthermore, the first draft was written by LS and RCIP and the critically revised of the manuscript was



written by ZZ and RIIP. Lastly, the literature search and data analysis were performed by LS and RIIP. All authors read and approved the final manuscript.

Conflict of Interest : The authors declare no conflict of interest.

REFERENCES

- Aidi Ahmi, R. M. (2019). Bibliometric analysis of global scientific literature on web accessibility. *International Journal of Recent Technology and Engineering (IJRTE)*, 7(6), 250-258
- Amagir, A., van den Brink, H. M., Groot, W., & Wilschut, A. (2021). SaveWise: The impact of a real-life financial education program for ninth grade students in the Netherlands. *Journal of Behavioral and Experimental Finance*, 33, 100605. <https://doi.org/10.1016/j.jbef.2021.100605>
- Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman
- Atkinson, A., & Messy, F. (2012). Measuring financial literacy: Results of the OECD/International Network on Financial Education (INFE) pilot study. *OECD Publishing*. <https://doi.org/10.1787/5k9cfs90fr4-en>.
- Bashir, M. F. (2022). Oil price shocks, stock market returns, and volatility spillovers: A bibliometric analysis and its implications. *Environmental Science and Pollution Research*, 1-20. <https://doi.org/10.1007/s11356-021-18314-4>
- Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, 83(2), 39-43. <https://doi.org/10.1080/00098650903505415>
- Björklund, M. (2019). Teaching financial literacy: Competence, context and strategies among Swedish teachers. *Journal of Social Science Education*, 18(2), 28-48. <https://doi.org/10.4119/jsse-1426>
- Bottazzi, L., & Lusardi, A. (2020). Stereotypes in financial literacy: Evidence from PISA. *Journal of Corporate Finance*, 71. <https://doi.org/10.1016/j.jcorpfin.2020.101831>
- Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for information Science and Technology*, 62(7), 1382-1402. <https://doi.org/10.1002/asi.21525>
- Cole, S., Sampson, T., & Zia, B. (2011). Prices or knowledge? What drives demand for financial services in emerging markets?. *The Journal of Finance*, 66(6), 1933-1967. <https://doi.org/10.1111/j.1540-6261.2011.01696.x>
- Cole, S., Paulson, A., & Shastry, G. K. (2016). High school curriculum and financial outcomes: The impact of mandated personal finance and mathematics courses. *Journal of Human Resources*, 51(3), 656-698. <https://doi.org/10.3368/jhr.51.3.0113-5410R1>
- Compen, B., De Witte, K., & Schelfhout, W. (2019). The role of teacher professional development in financial literacy education: A systematic literature review. *Educational Research Review*, 26, 16-31. <https://doi.org/10.1016/j.edurev.2018.12.001>
- Dituri, P., Davidson, A., & Marley-Payne, J. (2019). Combining financial education with mathematics coursework: Findings from a pilot study. *Journal of Financial Counseling and Planning*, 30(2), 313-322. <https://doi.org/10.1891/1052-3073.30.2.313>
- Eickholt, J., Jogiparthi, V., Seeling, P., Hinton, Q., & Johnson, M. (2019). Supporting project-based learning through economical and flexible learning spaces. *Education Sciences*, 9(3), 212. <https://doi.org/10.3390/educsci9030212>



- Goyal, K., & Kumar, S. (2021). Financial literacy: A systematic review and bibliometric analysis. *International Journal of Consumer Studies*, 45(1), 80-105. <https://doi.org/10.1111/ijcs.12605>
- Helen, T., & Ilias, S. (2019). Financial literacy of graduate high school students. *American Journal of Educational Research*, 7(3), 232-236. <https://doi.org/10.12691/education-7-3-7>
- Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education—theory, practice and rubber sling shots. *Higher Education*, 51(2), 287-314. <https://doi.org/10.1007/s10734-004-6386-5>
- Henning, M. B., & Lucey, T. A. (2017). Elementary preservice teachers' and teacher educators' perceptions of financial literacy education. *The Social Studies*, 108(4), 163-173. <https://doi.org/10.1080/00377996.2017.1343792>
- Holubova, R. (2008). Effective teaching methods—project-based learning in physics. *Online Submission*, 5(12), 27-36.
- Huston, S. (2010). Measuring financial literacy. *Journal of Consumer Affairs*, 44(2), 296-316. <http://dx.doi.org/10.1111/j.1745-6606.2010.01170.x>
- Indefenso, E. E., & Yazon, A. D. (2020). Numeracy level, mathematics problem skills, and financial literacy. *Universal Journal of Educational Research*, 8(10), 4393-4399. <https://doi.org/10.13189/ujer.2020.081005>
- Imafuku, R., Kataoka, R., Mayahara, M., Suzuki, H., & Saiki, T. (2014). Students' experiences in interdisciplinary problem-based learning: A discourse analysis of group interaction. *Interdisciplinary Journal of Problem-Based Learning*, 8(2), 1. <https://doi.org/10.7771/1541-5015.1388>
- Jalinus, N., Nabawi, R. A., & Mardin, A. (2017). The seven steps of project-based learning model to enhance productive competences of vocational students. In *International Conference on Technology and Vocational Teachers (ICTVT 2017)* (pp. 251-256). Atlantis Press. <https://doi.org/10.2991/ictvt-17.2017.43>
- JumpStart Coalition. (2007). *National Standards in K-12 Personal Finance Education*. Retrieved from <http://www.jumpstart.org/guide.html>
- Kaiser, T., & Menkhoff, L. (2020). Financial education in schools: A meta-analysis of experimental studies. *Economics of Education Review*, 78, 101930. <https://doi.org/10.1016/j.econedurev.2019.101930>
- Kemendikbudristek. (2022). *Panduan Pengembangan Projek Penguatan Profil Pelajar Pancasila [Guidance in Developing the Pancasila Student Profile Strengthening Project]*. Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi.
- Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, 19(3), 267-277. <https://doi.org/10.1177/1365480216659733>
- Lipkus, I. M., & Peters, E. (2009). Understanding the role of numeracy in health: Proposed theoretical framework and practical insights. *Health Education & Behavior*, 36(6), 1065-1081. <https://doi.org/10.1177/1090198109341533>
- Lusardi, A. (2012). *Numeracy, financial literacy, and financial decision-making (No. w17821)*. National Bureau of Economic Research. <https://doi.org/10.3386/w17821>
- Lusardi, A. (2019). Financial literacy and the need for financial education: Evidence and implications. *Swiss Journal of Economics and Statistics*, 155(1), 1-8. <https://doi.org/10.1186/s41937-019-0027-5>
- Markham, T. (2011). Project based learning a bridge just far enough. *Teacher Librarian*, 39(2), 38.



- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine*, 151(4), 264-269. <https://doi.org/10.7326/0003-4819-151-4-200908180-00135>
- OECD. (2015). *PISA 2015 Results (Volume IV): Students' Financial Literacy*. OECD Publishing. <http://dx.doi.org/10.1787/9789264270282-en>
- OECD. (2019). *PISA 2018 Assessment and Analytical Framework*. OECD Publishing.
- OECD. (2020). *PISA 2018 Results (Volume IV): Are Students Smart about Money?*. OECD Publishing. <https://doi.org/10.1787/48ebd1ba-en>
- Oguz-Unver, A., & Arabacioglu, S. (2014). A comparison of inquiry-based learning (IBL), problem-based learning (PBL) and project-based learning (PJBL) in science education. *Academia Journal of Educational Research*, 2(7), 120-128.
- Opletalova, A. (2015). Financial education and financial literacy in the Czech education system. *Procedia-Social and Behavioral Sciences*, 171, 1176-1184. <https://doi.org/10.1016/j.sbspro.2015.01.229>
- Otter, D. (2010). *Teaching financial literacy in K–12 Schools: A survey of teacher beliefs and knowledge*. The University of New Mexico.
- Ouachani, S., Belhassine, O., & Kammoun, A. (2020). Measuring financial literacy: A literature review. *Managerial Finance*, 47(2), 266-281. <https://doi.org/10.1108/MF-04-2019-0175>
- Ozkale, A., & Erdogan, E. O. (2020). An analysis of the interaction between mathematical literacy and financial literacy in PISA. *International Journal of Mathematical Education in Science and Technology*, 53(8), 1-21. <https://doi.org/10.1080/0020739X.2020.1842526>
- Ozkale, A., & Aprea, C. (2022). Designing mathematical tasks to enhance financial literacy among children in Grades 1–8. *International Journal of Mathematical Education in Science and Technology*, 55, 1-18. <https://doi.org/10.1080/0020739X.2022.2157342>
- Radmehr, F., & Drake, M. (2019). Revised Bloom's taxonomy and major theories and frameworks that influence the teaching, learning, and assessment of mathematics: A comparison. *International Journal of Mathematical Education in Science and Technology*, 50(6), 895-920. <https://doi.org/10.1080/0020739X.2018.1549336>
- Rahayu, P. T., & Putri, R. I. I. (2021). Project-based mathematics learning: Fruit salad recipes in junior high school. *Journal on Mathematics Education*, 12(1), 181-198. <https://doi.org/10.22342/jme.12.1.13270.181-198>
- Reyna, V. F., & Brainerd, C. J. (2008). Numeracy, ratio bias, and denominator neglect in judgments of risk and probability. *Learning and Individual Differences*, 18(1), 89-107. <https://doi.org/10.1016/j.lindif.2007.03.011>
- Salas-Velasco, M., Moreno-Herrero, D., & Sánchez-Campillo, J. (2021). Teaching financial education in schools and students' financial literacy: A cross-country analysis with PISA data. *International Journal of Finance & Economics*, 26(3), 4077-4103. <https://doi.org/10.1002/ijfe.2005>
- Sawatzki, C., & Sullivan, P. (2017). Teachers' perceptions of financial literacy and the implications for professional learning. *Australian Journal of Teacher Education*, 42(5), 51-65.
- Sawatzki, C. M., & Sullivan, P. A. (2018). Shopping for shoes: Teaching students to apply and interpret mathematics in the real world. *International Journal of Science and Mathematics Education*, 16(7), 1355–1373. <https://doi.org/10.1007/s10763-017-9833-3>
- Savard, A. (2019). How teaching mathematics in elementary school can support financial education. *In International Symposium Elementary Mathematics Teaching* (p. 19).



- Savard, A. (2022). What did they have to say about money and finance? Grade 4 students' representations about financial concepts when learning mathematics. *Education 3-13*, 50(3), 316-328. <https://doi.org/10.1080/03004279.2020.1850826>
- Savard, A., & Cavalcante, A. (2021). Financial education and mathematics education: A cross-cutting analysis of the epistemological intersection of financial numeracy. In *Financial Numeracy in Mathematics Education* (pp. 3-8). Springer, Cham. https://doi.org/10.1007/978-3-030-73588-3_1
- Singh, S., & Dhir, S. (2019). Structured review using TCCM and bibliometric analysis of international cause-related marketing, social marketing, and innovation of the firm. *International Review on Public and Nonprofit Marketing*, 16(2), 335-347. <https://doi.org/10.1007/s12208-019-00233-3>
- Skagerlund, K., Lind, T., Strömbäck, C., Tinghög, G., & Västfjäll, D. (2018). Financial literacy and the role of numeracy—How individuals' attitude and affinity with numbers influence financial literacy. *Journal of Behavioral and Experimental Economics*, 74, 18-25. <https://doi.org/10.1016/j.socec.2018.03.004>
- Sole, M. A. (2014). Financial literacy: An essential component of mathematics literacy and numeracy. *Journal of Mathematics Education at Teachers College*, 5(2), 55-62. <https://doi.org/10.7916/jmetc.v5i2.655>
- Sole, M. A. (2017). Financial education: Increase your purchasing power. *The Mathematics Teacher*, 111(1), 60-64. <https://doi.org/10.5951/mathteacher.111.1.0060>
- TIM. (2022). *Panduan Pembelajaran dan Asesmen Pendidikan Anak Usia Dini, Pendidikan Dasar, dan Menengah [The Guidance of Learning and Assessment for Early Childhood, Elementary, and Secondary Education]*. Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi
- Totenhagen, C. J., Casper, D. M., Faber, K. M., Bosch, L. A., Wiggs, C. B., & Borden, L. M. (2015). Youth financial literacy: A review of key considerations and promising delivery methods. *Journal of Family and Economic Issues*, 36, 167-191. <https://doi.org/10.1007/s10834-014-9397-0>
- Van Eck, N. J., & Waltman, L. (2020). *Manual for VOSviewer version 1.6.15*. Univeriteit Leiden
- Yildirim, M. M., & Vardari, L. (2020). Mathematical and financial literacy: A research with Prizren University students. *Cypriot Journal of Educational Sciences*, 15(6), 1574-1586. <https://orcid.org/0000-0003-3212-5783>





Promising research studies between mathematics literacy and financial literacy through project-based learning

ORIGINALITY REPORT

11%

SIMILARITY INDEX

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

★www.fek.zcu.cz

Internet

1%

EXCLUDE QUOTES OFF

EXCLUDE SOURCES OFF

EXCLUDE BIBLIOGRAPHY ON

EXCLUDE MATCHES OFF