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# STUDENTS' MATHEMATICS SELF-EFFICACY AND MATHEMATICAL LITERACY ABILITIES

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## Abstract

Mathematics self-efficacy refers to an individual's belief in their ability to effectively and successfully handle mathematics-related tasks and overcome challenges at predetermined levels. The research literature frequently emphasizes the statistically significant positive correlation between mathematics self-efficacy and both mathematics performance and mathematical literacy achievement. In this research, the mathematics self-efficacy index is calculated as a single composite measure; however, it is further subdivided into four distinct subcategories: self-efficacy in solving mathematical exercises or equations without context, self-efficacy in addressing real-world problems, self-efficacy in mathematical literacy skills, and self-efficacy in information literacy skills. This present study aims to examine students' mathematical literacy skills upon completion of compulsory education in Greece and to address the research question of whether a statistically significant correlation exists between students' mathematical literacy performance and the mathematics self-efficacy factor, both as a single composite measure and when divided into the four previously identified subcategories. The study was conducted with a sample of 650 students from across Greece who were completing their compulsory education. The schools attended by the sampled students were selected based on the level of urbanization of their respective areas, specifically categorized into three levels: major urban centers, small urban centers, and rural areas. The findings of the study indicate a statistically significant positive correlation between performance in mathematical literacy and the single factor of mathematics self-efficacy. Additionally, a statistically significant positive correlation was observed between performance in mathematical literacy and each of the four distinct subcategories within the single factor of mathematics self-efficacy: (1) self-efficacy in solving abstract mathematical exercises or equations, (2) self-efficacy in addressing real-world problems, (3) self-efficacy in mathematical literacy skills, and (4) self-efficacy in information literacy skills.

***Keywords:*** *Mathematical literacy, mathematics self-efficacy, Greece.*

## 1. Introduction

The term self-efficacy refers to an individual's belief in their capacity to achieve desired outcomes through their actions or abilities, which serves as a significant motivational factor in overcoming challenges and difficulties (Bandura, 1994, 1997). It refers to an individual's confidence in their ability to exhibit the necessary behavior that will result in specific, desired outcomes (Delcourt & Kinzie, 1993). Within this broader framework, mathematics self-efficacy pertains to an individual's confidence in their ability to effectively engage with and successfully complete mathematics-related tasks, even when facing obstacles, at varying levels of complexity (Fast et al., 2010; OECD, 2013; Schunk, 1991; Stankov et al., 2014). More precisely, mathematics self-efficacy encompasses the belief and self-assurance that one can competently manage a range of mathematics-related activities, from comprehending fundamental concepts to solving complex problems (Sharma & Nasa, 2014).

Extensive research has consistently demonstrated a statistically significant positive correlation between mathematics self-efficacy and mathematics performance (Anjum, 2006; Ayotola & Adedeji, 2009a, 2009b; Fast et al., 2010; Goodwin et al., 2009; Jiang et al., 2014; Pajares & Miller, 1994). Additionally, this relationship has been observed specifically in the context of mathematical literacy performance (Cheema, 2018; Cheema & Galluzzo, 2013; Cheema & Skultety, 2017; Hiller et al., 2022; Kalaycioğlu, 2015; Karakolidis et al., 2016a, 2016b; Lee, 2009; Lee & Stankov, 2013; OECD, 2004, 2013; Pitsia et al., 2017).

The concept of mathematical literacy, as outlined in the most recent definition developed for the Programme for International Student Assessment (PISA 2022) and adopted for the purposes of this study (Nolka & Sofianopoulou, 2024a, 2024b), is characterized as "students' capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena" (OECD, 2019).

It is important to highlight that, in this study, the mathematics self-efficacy index was initially considered as a single measure. However, it was later subdivided into four distinct subcategories for further analysis, namely: self-efficacy in solving mathematical exercises or equations without context, self-efficacy in solving real-world problems (contextualized tasks), self-efficacy in mathematical literacy skills, and self-efficacy in information literacy.

## 2. Research

This study involved a sample of 650 students from various regions across Greece who were either in the final stages of the 9th grade or at the beginning of the 10th grade, coinciding with the completion or recent conclusion of compulsory education. The schools included in the sample were selected based on the degree of urbanization in their respective areas, encompassing large urban centers, small urban centers, and rural regions.

To address the objectives of the research, two distinct instruments were developed and utilized: a mathematical test and a questionnaire. The mathematical test consisted of five authentic, real-world problems, each divided into sub-questions or items. In total, students were required to respond to eleven items. These problems were presented as word problems embedded in real-life contexts, each introduced by a contextual stimulus or narrative. The dependent variable for mathematical literacy achievement was defined as the students' performance or scores on this mathematical test.

The second instrument, the questionnaire, comprised 16 statements designed to assess an index of self-efficacy in mathematics. This index was constructed based on students' responses on a four-point Likert scale, which ranged from "very confident" (4) and "confident" (3) to "not very confident" (2) and "not at all confident" (1), in relation to their perceived ability to handle situations requiring mathematical reasoning or application.

The self-efficacy index was initially analyzed as a single construct, encompassing all 16 sentences listed in Table 1. Additionally, the index was categorized into four subcategories for further analysis:

- Self-efficacy in solving mathematical exercises/equations without a real-world context (S.1–3).
- Self-efficacy in solving real-world problems within a contextual framework (S.4–9).
- Self-efficacy in the abilities of mathematically literate individuals (S.10–14).
- Self-efficacy in information literacy abilities (S.15–16).

*Table 1. Self- efficacy index.*

| Sentences | **How confident are you in your ability to succeed in the following mathematics tasks?** |
|---|---|
| 1 | To solve an equation like this: $3x+5=17$ |
| 2 | To solve an equation like this: $6x^2+5=29$ |
| 3 | To solve an equation like this: $2(x+3)=(x+3)(x-3)$ |
| 4 | To calculate how much more expensive a computer will be after tax is added. |
| 5 | To calculate, based on a table of train schedules, how long it takes to get from one place to another. |
| 6 | To calculate how many square meters of tiles are needed to cover a floor. |
| 7 | To calculate the weekly consumption of an electronic device. |
| 8 | To find the actual distance between two places on a map with a scale of 1:10,000. |
| 9 | To calculate the properties of an irregularly shaped object. |
| 10 | To derive information from diagrams, graphs or simulations. |
| 11 | To interpret the mathematical solutions, you used to answer a problem in everyday life. |
| 12 | To recognize the mathematical aspects of a problem from real life. |
| 13 | To represent a situation mathematically, using variables, symbols or diagrams. |
| 14 | To understand scientific tables presented in an article. |
| 15 | To work with mathematical computing systems (e.g. excel, programming software, graphing calculators). |
| 16 | To write a code/program on computers. |

The study aimed to address the following research questions:

Is there a statistically significant correlation between mathematical literacy performance and overall self-efficacy in mathematics?

Is there a statistically significant correlation between mathematical literacy performance and self-efficacy in solving mathematical exercises/equations without a real-world context?

Is there a statistically significant correlation between mathematical literacy performance and self-efficacy in solving real-world problems?

Is there a statistically significant correlation between mathematical literacy performance and self-efficacy in the abilities of mathematically literate individuals?

Is there a statistically significant correlation between mathematical literacy performance and self-efficacy in information literacy abilities?

## 3. Results

Among the individual propositions constituting the self-efficacy in mathematics factor, students reported the highest levels of confidence in solving a first-degree equation (with over 81% expressing confidence or strong confidence) and a second-degree equation (with over 79% expressing confidence or strong confidence). Conversely, students exhibited the lowest levels of confidence in calculating the properties of an irregular shape, with only 21.5% reporting confidence or strong confidence.

To address the research questions, the study first employed Cronbach's Alpha reliability test to evaluate the internal consistency of both the overall self-efficacy in mathematics variable and its four subcategories. The Cronbach's Alpha values for all variables exceeded the acceptable threshold of .700, with the exception of self-efficacy in information literacy abilities. However, as demonstrated in Table 1, this construct is composed of only two statements.

Spearman's rho correlation analysis was conducted to account for the non-normal distribution of the variables. The analysis was performed in two stages: in the first stage, self-efficacy in mathematics was treated as a single variable, while in the second stage, it was disaggregated into its four subcategories.

The results indicated that performance in mathematical literacy exhibited a positive, statistically significant correlation with the single variable of self-efficacy in mathematics ($r=.400$, $p<.01$). This finding suggests that higher levels of self-reported self-efficacy in mathematics are associated with improved performance in mathematical literacy.

In the second stage of analysis, performance in mathematical literacy also showed positive, statistically significant correlations with the four subcategories of self-efficacy. The strongest correlation between the aforementioned variables and mathematical literacy performance is observed with self-efficacy in solving real-world problems ($r=.379$, $p<.01$).

Specifically, the correlations were as follows:

- self-efficacy in solving mathematical exercises/equations without a real-world context ($r=.338$, $p< .01$),
- self-efficacy in solving real-world problems ($r=.379$, $p<.01$),
- self-efficacy in the abilities of mathematically literate individuals ($r=.325$, $p<.01$), and
- self-efficacy in information literacy abilities ($r=.086$, $p<.01$).

These findings provide evidence supporting the research hypotheses.

## 4. Conclusion

The findings of this study provide a clear answer to the research questions, demonstrating a positive, statistically significant correlation between performance in mathematical literacy and the single variable of self-efficacy in mathematics. This conclusion aligns with the results of several prior studies and researchers (Hiller et al., 2022; Kalaycioğlu, 2015; Karakolidis et al., 2016a, 2016b; Lee, 2009; OECD, 2004, 2013; Pitsia et al., 2017).

The 16 propositions forming the self-efficacy in mathematics variable were further categorized into four distinct subcategories: a. Self-efficacy in solving mathematical exercises/equations without a real-world context, b. Self-efficacy in solving real-world problems, c. Self-efficacy in the abilities of mathematically literate individuals, and d. Self-efficacy in information literacy abilities. All four subcomponents were found to have positive, statistically significant correlations with mathematical literacy performance. Notably, the subcategory self-efficacy in solving real-world problems exhibited the strongest positive correlation with mathematical literacy performance compared to the other three subcomponents.

As an extension of this research, it is recommended to compare its findings with the corresponding results from the PISA 2022 programme.

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