FUTURITY Education

DOI: https://doi.org/10.57125/FED.2025.09.25.12

How to cite: Juric J., Pjanic, K., & Misurac, I. (2025). Correlation between student attitudes and mental calculation. *Futurity Education, 5*(3), 251–270. https://doi.org/10.57125/FED.2025.09.25.12

Correlation Between Student Attitudes and Mental Calculation

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Received: June 8, 2025 | **Accepted:** August 30, 2025 | **Available online:** September 15, 2025

Abstract: Mental computation is central to numeracy, yet its links to students' attitudes, performance, and strategy use remain underexplored. This study examined these relationships with 591 students (Grades 4–8, secondary Years 1–2, and university up to Year 5; 306 female, 285 male) from 11 schools and 4 faculties. Data were collected through a 20-item computation test, a 13-item attitude survey, and strategy interviews with a subsample of 233 students. Factor analysis identified five latent factors of students' attitudes toward mental computation. Multiple regression analysis showed that performance was moderately predicted ($R = 0.438$, $R^2 = 0.192$, $p < .001$) by students' self-assessment of their calculation performance and the frequency of using mental calculation methods in school, while the mental calculation learning method had an adverse effect. The number of strategies used was also moderately predicted ($R = 0.368$, $R^2 = 0.135$, $p < .001$) by self-assessment of performance and use of mental calculation in everyday life. Findings highlight the importance of fostering positive self-assessment, frequent practice in school, and recognition of the everyday value of mental calculation. Educational implications include encouraging diverse strategies, integrating mental computation into lessons regularly, and providing supportive feedback to build confidence.

Keywords: mental calculation performance, student attitudes, mental calculation strategies, conceptual understanding, self-assessment

Introduction

The mental calculation method is employed in various daily life situations (McIntosh, 2005; Pourdavood et al., 2020). It is integrated into children's early learning of numbers. It refers to calculating "in the head" (mentally), without the use of aids such as calculators or pencils, and without applying written calculation techniques (Reys, 1984; McIntosh, 2005). A student with a solid foundation, including an understanding of the concept of number and fundamental principles, is ready to develop further and master numeracy skills (McIntosh et al., 1992; National Council of Teachers of Mathematics, 2000). Manipulating numbers mentally and applying mental calculation strategies develops children's number sense and strengthens their self-confidence in mathematics (McIntosh, 2005; Pajares & Miller, 1994; Threlfall, 2002). In mathematics education, the complex dynamics of attitudes and beliefs about mental calculation may significantly shape pedagogical strategies, student engagement, and overall educational outcomes (Barroso et al., 2021; Ma & Kishor, 1997; Wen & Dubé, 2022).

The review of professional literature has revealed a lack of research on the correlation between students' attitudes and mental calculation, which motivated us to explore this issue (Joung, 2018; McIntosh et al., 1995).

Research Focus

Recent international assessments have revealed a consistent decline in mathematics performance, raising concerns about students' preparedness for everyday numeracy demands. For example, PISA 2022 reported the most significant drop in mathematics achievement since the study began, with nearly one-third of 15-year-olds across OECD countries performing below the baseline level required for functioning in society (OECD, 2023). Similarly, the most recent TIMSS 2023 results highlight persistent gaps in basic arithmetic and strategy use, especially at the primary level (IEA, 2024). These trends underscore the urgency of identifying factors that can strengthen students' numerical competence. Mental computation, as a lifelong skill essential for flexible problem solving in school and beyond, represents one such factor. By clarifying which attitudinal dimensions most strongly predict performance and strategy diversity, this research can help educators and policymakers design targeted interventions to reverse the downward trajectory in achievement and foster more sustainable numeracy outcomes. The purpose of this study was to investigate the relationship between students' attitudes toward mental calculation and their performance in solving mental calculation tasks. Specifically, we aimed to identify the attitudinal factors that serve as significant predictors of mental calculation performance and the variety of strategies employed by students. By examining these relationships across a broad sample of primary, secondary, and university students, the research sought to provide insights that could inform the teaching of mental calculation in schools. A deeper understanding of students' self-assessment, perceptions of the importance of mental calculation, and the role of school practices is expected to support teachers in fostering students' number sense, confidence, and flexibility in mathematical problem solving.

Research Aim and Research Questions

Although numerous studies have explored students' general attitudes toward mathematics, very few have explicitly focused on attitudes toward mental computation. This represents a critical gap, given that mental computation is a lifelong skill essential for everyday numeracy and flexible problem-solving. By targeting this underexplored domain, the present study extends existing research and responds to calls for more nuanced investigations of mathematics-related attitudes (Wen & Dubé, 2022; Alemany-Arrebola et al., 2025). In light of the declining mathematics outcomes reported in PISA 2022 (OECD, 2023) and TIMSS 2023 (IEA, 2024), examining how students perceive and value mental computation provides timely insights with clear educational relevance. This paper aims to identify potential predictors of mental calculation performance and the variety of strategies used, primarily to guide the teaching of mental calculation in schools and to provide a better understanding of students, which is a prerequisite for improving mental calculation performance (Gürbüz & Erdem, 2016; Threlfall, 2002; McIntosh, 2005).

To examine the above, we have set up two hypotheses:

- *There are statistically significant predictors from a set of attitudes that affect mental calculation performance.*
- *There are statistically significant predictors from a set of attitudes that affect the use of various mental calculation strategies.*

Literature Review

The affective domain was a neglected area in mathematics education research until McLeod and Adams highlighted it in their famous book (McLeod and Adams, 1989). The main components of affect are often considered to be beliefs, attitudes, and emotions (McLeod, 1992). These are psychological constructs that influence how individuals perceive and interact with the world. Still, they differ in several important ways: they vary in stability, intensity, cognitive involvement, and length of development.

Emotions or feelings, whether negative or positive, are the most intense and the least stable. They involve the least cognitive appraisal and can come and go rather quickly. Examples of intense negative feelings related to mathematics include fear, anger, horror, or even panic when students are unable to solve a mathematical problem (Op't Eynde et al., 2002).

Beliefs are the conviction or acceptance that something exists or is true, regardless of evidence or proof. They are cognitive representations of the world, often based on personal experiences, cultural upbringing, or acquired knowledge. Beliefs tend to be relatively stable over time and resistant to change, especially if they are sincerely held or tied to core values (Pajares, 1992). Attitudes represent an individual's multifaceted evaluations of people, objects, events, or concepts that include emotional, behavioural, and cognitive elements and can range from favourable to unfavourable or neutral (Ajzen, 2005; Eagly & Chaiken, 1993). They exhibit a degree of flexibility and are susceptible to change in response to new information, experiences, or persuasive influences (Maio & Haddock, 2015). In contrast to beliefs, attitudes are complex constructs shaped by personal experiences, beliefs, emotions, and principles that predispose individuals to specific responses to stimuli (Bohner & Dickel, 2011). They exert considerable influence on decision-making and behaviour, more directly than beliefs (Ajzen, 2005; Eagly & Chaiken, 1993).

As noted by Goldin (2002), attitudes tend to be relatively stable, striking a balance between affective and cognitive aspects. Philipp (2007) distinguishes attitudes from beliefs, describing the former as the expression of one's disposition or point of view through actions, emotions, or thoughts. Clore and Schnall (2005) define attitudes as enduring psychological tendencies towards certain concepts, objects, or entities, characterised by varying degrees of positivity or negativity. In the context of mathematics education, attitudes encompass a range of responses, including liking, enjoyment, interest, or dislike, with extreme cases manifesting as math phobia (Ernest, 1989). In addition, attitudes about mathematics can include reactions to the perceived difficulty or ease of the subject (Ma & Kishor, 1997). This detailed understanding of attitudes helps educators to assess and address students' perceptions and emotional responses, thereby improving their learning experiences and outcomes.

Educators have paid much attention to students' attitudes about mathematics (Hwang and Son, 2021; Chen et al., 2018; Goldin et al., 2016). Students with positive attitudes to mathematics tend to enjoy the subject, understand its value, and have confidence in it; they are therefore likely to prioritize the study of mathematics (Kiwanuka et al., 2020; Mullis et al., 2020), which could lead to high mathematics performance (Chouinard at al., 2007; Guo et al., 2015; Wigfield et al., 2016). Although several studies have reported a positive relationship between students' attitudes about mathematics and mathematics achievement (Bhowmik & Roy, 2016; Bramlett & Herron, 2009; Chen et al., 2018; Dowker et al., 2019; Guo et al., 2015; Hwang and Son, 2021; Kadijevich, 2008; Lipnevich et al., 2016; Ma & Xu, 2004), others have reported a non-significant association between them (Köller et al., 2001; Mubeen et. al., 2013; Papanastasiou, 2000; Phonguttha et al., 2009). Campbell et al. (2025) reported a decline in interest and enjoyment in mathematics from Grade 4 to Grade 8, accompanied by a gradual decrease in confidence. Today, researchers no longer consider attitudes about mathematics as a single entity; instead, they distinguish, for example, attitudes toward geometry, problem-solving, algebra, and so on. On the other hand, research on students' attitudes about mental calculation is somewhat neglected.

Attitudes about Mental Calculation

Studies define mental calculation as the process of calculating an accurate arithmetic result without the use of external aids such as pencils, paper, or a calculator (Hartnett, 2007; Kilpatrick et al., 2001; Linsen et al., 2015; Reys et al., 1995; Threlfall, 2002; Varol & Farran, 2007). Recent studies have defined mental calculation as a thought process that combines the understanding of numbers and operations in the human brain without the aid of external devices (Yang & Huang, 2014).

Cognitive theories of mathematics learning emphasise the mental processes involved in understanding, manipulating, and applying numerical data. Mental calculation is seen through this lens as a cognitive skill that relies on both procedural and conceptual knowledge (Baroody, 1985; Siegler & Jenkins, 1989). Anderson's (1990) Adaptive Character of Thought (ACT) theory suggests that mental calculation processes can become more efficient and automatic through practice, thereby freeing up cognitive resources for complex problem-solving tasks, which is crucial for the development of mathematical fluency and expertise (Ericsson & Kintsch, 1995). The notion of 'mindset', as conceptualised by Carol Dweck (2006), offers profound insights into how beliefs about intelligence and ability influence mathematics learning and achievement. Dweck (2006) distinguishes between a 'fixed mindset', in which individuals perceive their abilities as static and unchangeable, and a 'growth mindset', in which abilities are seen as flexible and capable of improvement through effort. Applied to mental calculation, a growth mindset encourages perseverance, a willingness to take risks, and a constructive approach to mistakes as opportunities for learning (Boaler, 2016; Dweck, 2006). Vygotsky's (1978) sociocultural theory highlights the importance of social interaction and cultural tools in shaping the development of cognitive skills. From this perspective, attitudes and beliefs about mental calculation are influenced by cultural norms, educational practices, and the resources available for mathematical thinking (Lave, 1988; Saxe, 1991). The importance of 'mathematical talk' and collaborative learning in fostering positive attitudes about mental calculation is emphasised, highlighting the considerable influence of social contexts on mathematical beliefs and practices (Yackel & Cobb, 1996).

An integrative theoretical framework that combines cognitive, psychological, and sociocultural perspectives offers a holistic approach to understanding attitudes and beliefs about mental calculation (Vygotsky, 1978; Sfard, 1998; Schoenfeld, 2016). This framework posits that mental calculation skills develop through the interplay of cognitive processes, individual mindsets, and sociocultural influences (Boaler, 2016; Dweck, 2006). It emphasises the importance of educational strategies that cultivate a growth mindset, facilitate cognitive automation through practice, and foster a supportive sociocultural milieu for mathematical learning (Dweck, 2006; Boaler, 2016; Siegler, 2016). This multidimensional theoretical framework provides the basis for exploring the complex factors that shape attitudes and beliefs about mental calculation in mathematics education. By identifying the interrelationship between cognitive abilities, psychological mindsets, and sociocultural contexts, educators and researchers can develop more effective approaches to fostering positive attitudes about mental calculation and enriching mathematical learning outcomes (Schoenfeld, 2016; Sfard, 1998; Vygotsky, 1978).

Research on students' attitudes and beliefs regarding mental calculation is scarce. They show how students prioritise mental calculation over written calculation because they see these skills as more applicable to everyday life (McIntosh & Reys, 1997). Japanese students, as observed by Reys et al. (1995), recognise the importance of both mental and written calculation. While they expected to use more mental calculation in adulthood, they had reported spending more time in school on written calculation, with less than half reporting formal instruction in mental calculation. McIntosh et. al. (1995) found that students in Years 5, 7, and 9 place a high value on proficiency in mental calculation, with about half considering it more important than written calculation. Most students believe that written calculation is primarily taught in school, whereas mental calculation is acquired outside the classroom. Despite the limited focus on mental calculation in the classroom, students seem to be learning its skills and becoming aware of its importance.

Comparative international studies provide valuable insights into how different education systems shape both mathematics achievement and students' attitudes. East Asian systems such as Singapore, Korea, and Japan continue to score at the top in TIMSS 2023, where mental computation and flexible strategies are emphasised from the early grades. In contrast, many OECD countries (e.g., Germany, France, and even some Nordic systems) reported both declining performance and weaker self-confidence in mathematics in PISA 2022 (OECD, 2023; IEA, 2024). Interestingly, countries like Finland, which maintain relatively high performance, show a decreasing student enjoyment of mathematics, highlighting the importance of supporting both achievement and positive attitudes simultaneously. PISA background questionnaires explicitly capture students' self-efficacy, interest, and anxiety in mathematics, and the 2022 results document marked cross-country differences in these non-cognitive dimensions (OECD, 2023; OECD, 2021). These differences suggest that curricular and cultural emphases on mental strategies can shape not only performance outcomes but also how students value and approach mathematics.

McIntosh et. al. (1995) found an increasing preference for mental calculation among students as they progressed through the grades. As expected, these preferences correlated closely with students' abilities.

Consequently, more proficient students were better able to assess their ability to perform mental calculation. However, there was considerable variation in self-confidence, both among students within the same year level and between different year levels, indicating significant differences in confidence levels. Gender differences favoured boys in Years 3 and 9, but there were no significant differences in Years 5 and 7. Similarly, Piht and Eisenschmidt (2008) compared the attitudes of Estonian and Finnish students about mental calculation and found differences between boys and girls. They observed a trend of increasingly negative attitudes among girls as they progress through the grades. This decline in motivation may be due to learning difficulties and ineffective teaching methods. The difference in attitudes may affect the learning behaviour of boys and girls differently. Teachers perceive boys as having more learning difficulties, but girls as having less motivation to learn. Teaching methods should therefore be tailored to the specific challenges faced by girls, particularly in mathematics and mental calculation, where their reluctance seems to be more pronounced.

Ashcraft and Kirk (2001) and Ashcraft and Faust (1994) have investigated students' fear in relation to mental calculation. They find that fearful students struggle most when asked to add two-digit numbers and when problems involve crossing decimals. Even when these students calculate correctly, they take three times as long as non-fearful peers who are not intimidated by mathematics and mental calculation (Ashcraft & Kirk, 2001).

Teachers' attitudes and support are crucial factors in making mental calculation skills more engaging and varied for students. Mardjetko and Macpherson (2007) propose six principles to guide teachers in promoting the development of mental calculation: encouraging students to share and demonstrate different mental calculation strategies builds confidence through classroom discussion; delaying formal teaching of pencil and paper algorithms until students have developed flexible mental calculation strategies; accepting the diversity of students' creative approaches to mental calculation; emphasizing the importance of mental calculation by demonstrating how to check the reasonableness of answers; including questions that relate to real-life experiences to increase students' understanding and engagement; presenting questions verbally, and writing algorithms both horizontally and/or vertically to accommodate different learning styles.

Joung (2018) investigated the attitudes of preservice teachers about mental calculation. The majority of them reported having been exposed to mental calculation strategies during their schooling. They acknowledged the practical importance of learning mental calculation for real-life situations and its benefits in enhancing their overall mathematics learning. However, despite this awareness, they expressed discomfort and uncertainty in using mental calculation due to a lack of confidence and teaching skills. These findings are consistent with those of Hartnett (2007), who highlighted that a lack of teachers' knowledge of mental calculation contributes to a lack of confidence and teaching skills in this area. Cipora et al. (2024) found that both anxiety and self-concept significantly predicted arithmetic outcomes among teachers and university students. Joung (2018) investigated the responses of pre-service teachers regarding their levels of anxiety in relation to mental calculation. While these teachers expressed interest in learning mental calculation and showed some confidence in solving problems mentally, they showed slightly higher levels of anxiety when using mental calculation compared to written methods. This finding is consistent with Swan and Sparrow's (2001) suggestion that teaching specific strategies for mental calculation may limit flexibility in thinking, but could potentially reduce anxiety compared to using methods that are less familiar to individuals.

Materials and Methods

Sample and Participants

A total of 591 respondents participated in the research, ranging from Grade 4 of primary school (11-year-old children) to university students in Year 5 of the integrated study program (or Year 2 of the graduate study program). Respondents were selected from 11 schools and 4 faculties to ensure diversity about their prior mathematical knowledge and to minimise the influence of specific teaching methods used in individual institutions.

The distribution of participants was as follows: 50 respondents from Grade 4 (three classes from one school), 69 from Grade 5 (one class from two schools and two classes from one school), 70 from Grade 6 (one class from three schools and two classes from one school), 123 from Grade 7 (one class from two schools and two classes from three schools), and 78 from Grade 8 (one class from one school and four classes from another school). From secondary school, there were 68 respondents from Grade 1 (participants from the Excellence Centre and one class from one school) and 53 from Grade 2 (participants from the Excellence Centre and one class from two schools). The university subsample consisted of 80 students from four faculties.

Instrument and procedure

Three instruments were used for data collection: a survey questionnaire, a mental calculation test, and an interview.

The survey questionnaire consisted of 13 items that measured students' attitudes toward mental calculation. Some items were deliberately contradictory (e.g., *I am better in written than in mental calculation* vs. *I am better in mental than in written calculation*) to check whether respondents carefully read the items. Cases with inconsistent answers were excluded from the analysis. Considering that the youngest participants were nine years old, the scale included three response levels (*I disagree, I neither agree nor disagree, I agree*), following consultations with psychologists and speech therapists. The 13-item attitude scale demonstrated good internal consistency, with a Cronbach's alpha of 0.83 (after the pilot study), exceeding the commonly accepted threshold of 0.70 (Nunnally & Bernstein, 1994). Incomplete questionnaires were excluded from the dataset before analysis, ensuring that only fully completed responses were included in the final sample (N = 591).

The mental calculation test consisted of 20 basic tasks (5 addition, 5 subtraction, 5 multiplication, 5 division). Tasks were tailored to three age groups (Grades 4–6, Grades 7–8, and secondary/university students) and adjusted to curricular expectations. Each task was designed to encourage the application of different mental calculation strategies. Correct responses were scored with one point (maximum 20).

The interview focused on the strategies used. After each task, respondents were asked: *What strategy did you use?* Or, if they had not solved the task: *What strategy would you use?* This format was chosen over open-ended or multiple-choice questions, since students often lack formal knowledge of strategy names. Interviews were coded by one of the authors according to the framework, allowing systematic categorisation of strategies. On average, each interview lasted 10 minutes.

A pilot study was conducted with 17 primary school students and 14 university students. Based on feedback, the number of test items was reduced from 28 to 20, and the number of survey items was reduced from 14 to 13, to avoid fatigue and improve clarity.

The procedure lasted two months during the school year. Parental consent was obtained for minors, and participation was voluntary and anonymous. Tasks were presented orally through a speaker to ensure equal testing conditions. Each student used a personal code to link their test and questionnaire with the interview data. For the mental calculation test, the first set of tasks was completed by 189 respondents, while the second and third sets were each completed by 201 respondents. From the total sample, 233 respondents (39%) were randomly selected to participate in additional interviews, in addition to the questionnaire and mental calculation test. All interviews with the subsample of 233 students were conducted by one of the authors, which ensured consistency in the administration and phrasing of the interview questions.

Data Analysis

To test the normality of the data, a portion of the obtained results was examined using the Kolmogorov-Smirnov test. Factor analysis was applied to form latent structures, using the Guttman-Keiser criterion and varimax rotation. Statistical significance was set at $p < 0.05$. For each hypothesis, descriptive statistics (arithmetic mean ± standard deviation (AS ± SD), median (MED)) are presented first, followed by the test results. All analyses were conducted using Statistica 13.5 software.

In testing the hypotheses, multiple regression analysis was performed, with factor analysis used to reduce the dimensionality of the observed predictor system. The Guttman-Keiser criterion was used to determine the number of significant latent dimensions, and varimax rotation was applied. The factor structure of the observed system was established, together with the amount of explained variance. Beta (β) and unstandardized (b) weights, as well as the multiple correlation coefficient (R) and the coefficient of determination (R^2), were also calculated.

Results

The latent structure of the space of attitudes about mental calculation

In this section, we aim to elucidate the latent structure of the space of attitudes regarding mental calculation. We aim to identify a set of variables that describe a structure that potentially affects mental calculation performance and the number of related strategies. For this purpose, we present the results of a factor analysis of 13 items from a survey completed by 591 respondents, which exceeds the sample size recommended for reliable factor analysis (Mundfrom et al., 2005; Opić, 2012). The Kaiser further confirmed the adequacy of the sample–Meyer–Olkin measure, which exceeded the recommended threshold of .50, indicating that the correlation matrix was suitable for factor analysis. Exploratory factor analysis using the Guttman–Keiser criterion and varimax rotation suggested multiple latent dimensions, and based on the scree test (Figure 1), five factors were retained (which exhaust 45% of the variability of the manifest space) as the most interpretable and theoretically meaningful solution.

Figure 1

Cattell scree plot

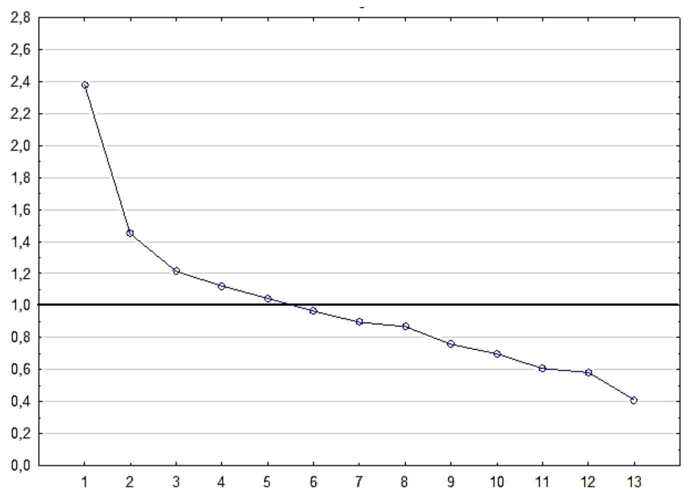

Table 1 contains descriptive data on the mentioned variables.

Table 1

Descriptive statistics on attitudes S1 – S13

Claim	AS ± SD	MED
I'm better at written than mental calculation.	2.748±0.507	3
When seeing a task, I will first try to calculate it mentally, and then reach for the calculator.	2.465±0.824	3
In school, I learned many ways to calculate mentally.	2.085±0.887	2
When I can, I always reach for the calculator first, rather than calculating in writing or mentally.	1.631±0.869	1
In school, we often count mentally.	1.849±0.903	2
In school, I counted more often in writing than mentally.	2.613±0.723	3
When I grow up, I think I'll use mental calculation in everyday tasks such as shopping, timekeeping, paying bills, etc.	2.401±0.781	3
It is important to be good at mental calculation.	2.592±0.670	3
I'm better at mental than written calculation.	1.354±0.612	1
After calculating the result with a calculator, I use mental calculation to check if I have got the result I expected.	1.949±0.923	1
For the most part, I learned various ways to calculate mentally on my own.	2.320±0.852	3
In school, I learned written calculation.	2.883±0.438	3
I use written calculation only in school and in solving school tasks.	1.971±0.952	2

Results show that respondents assess their written calculation performance better than their mental calculation performance (S1 and S9). Respondents mostly agree that mental calculation is implemented and necessary in everyday life and will use it rather than reach for an aid such as a calculator (S2, S4, and S7). We can conclude that this is contrary to the practice of doing calculations in school, where written calculations are mainly used, despite the awareness of the importance of mental calculation. This is what variables S5, S6, and S8 indicate, namely, that most of the time in school classes is devoted to written calculation, and less to mental calculation. Accordingly, most respondents agree that they have learned mental calculation strategies on their own (S11). Table 2 shows the structure matrix for 13 variables after the varimax factor rotation.

Table 2

Factor structure matrix after varimax factor rotation

	F1	F2	F3	F4	F5
I'm better at written than mental calculation.	**-0.866**	-0.023	-0.006	-0.109	-0.038
I'm better at mental than written calculation.	**0.865**	0.111	-0.010	0.065	0.010
When seeing a task, I will first try to calculate it mentally, and then reach for the calculator.	0.137	**0.701**	-0.021	0.172	-0.137
When I can, I always reach for the calculator first, rather than calculating in writing or mentally.	-0.050	**-0.778**	0.069	0.103	-0.147
When I grow up, I think I'll use mental calculation in everyday tasks such as shopping, timekeeping, paying bills, etc.	0.062	**0.589**	0.265	0.190	0.106
It is important to be good at mental calculation.	0.016	0.040	**0.698**	0.095	0.081
After calculating the result with a calculator, I use mental calculation to check if I have got the result I expected.	0.067	0.102	**0.344**	0.126	0.134
In school, I learned written calculation.	-0.065	-0.049	**0.648**	-0.169	-0.065
In school, we often count mentally.	0.040	0.093	-0.013	**0.820**	0.054
In school, I counted more often in writing than mentally.	-0.196	0.023	-0.011	**-0.762**	0.069
In school, I learned many ways to calculate mentally.	0.202	0.135	0.150	0.084	**0.758**
For the most part, I learned various ways to calculate mentally on my own.	0.224	0.270	0.185	0.205	**-0.560**
I use written calculation only in school and in solving school tasks.	0.232	-0.211	0.287	0.038	**-0.463**

The first factor explains 13% of the total variance. Due to the above claims, which indicate the respondents' self-assessment of which method of calculation is better, we refer to this variable as *Self-assessment of calculation method performance*. The second factor, which explains 12% of the total variance, is the *Self-assessment of using mental calculation in everyday situations,* as it indicates the preferred individual calculation method used in the problems and challenges individuals encounter or will encounter in life. The third factor explains 10% of the total variance. These three claims that comprise the third factor demonstrate a person's attitude toward the importance of mental calculation performance and its use as a method for verifying the accuracy of results, which we refer to as the *Assessment of the importance of mental calculation performance*. Here, claim S12 is interesting; *In school, I learned written calculation*, which also determines the factor. We can conclude that the above was classified in this variable as a remark to indicate the predominance of written calculation in school, despite the great importance of mental calculation. The fourth factor, which explains 11% of the total variance, was called the *Assessment of the frequency of using the calculation method in school*. The fifth factor, explaining 9% of the total variance, refers to the place of learning mental calculation – whether at school or independently. Moreover, the claim S13, '*I use written calculation only in school and for solving school tasks*,' is classified under this variable because it emphasises that written calculation is mainly done in school and is primarily used only in school tasks. At the same time, students are often required to learn mental calculation independently. That is why we call it the *Mental Calculation Learning Method*.

Analysis of the impact of attitudes about mental calculation on mental calculation performance

Based on the factor analysis from the previous paragraphs, this section will analyse the impact of the formed factors on *Mental calculation performance* in the context of the first hypothesis: *There are statistically significant predictors from the set of attitudes 1–13 that affect Mental calculation performance*. The table below (Table 3) presents the results of a multiple regression analysis, where R represents the multiple correlation coefficient and R^2 represents the coefficient of determination.

Table 3

Results of multiple regression analysis

Factor	β	Se(β)	b	Se(b)	P
F1 – *Self-assessment of the calculation method performance*	0.229	0.037	0.967	0.157	<0.001
F2 – *Self-assessment of using mental calculation in everyday situations*	0.097	0.037	0.409	0.157	<0.001
F3 – *Assessment of the importance of mental calculation performance*	0.153	0.037	0.658	0.157	0.001
F4 – *Assessment of the frequency of using the calculation method in school*	0.261	0.037	1.103	0.157	<0.001
F5 – *Mental calculation learning method*	-0.198	0.037	-0.838	0.157	<0.001
R			0.438		
R^2			0.192		
p			<0.001		

Table 3 shows a statistically significant linear relationship between the criterion variable, *Mental calculation performance,* and the predictor variables F1–F5. The results of this regression analysis model indicate a correlation between the variables of mean strength, as the value of the multiple correlation coefficient (R = 0.438) falls within the range of 0.25 to 0.64. By analysing the coefficient of determination, it was found that the independent variables explained 19.2% of the variation in the dependent variable. Weight b shows the most significant influence of factors F4 and F1. Therefore, the awareness of using a calculation method in school, i.e., the representation of a particular method in class and the self-assessment of calculation performance, has an impact on mental calculation performance. Further research is certainly needed for more detailed results on how this affects mental calculation performance.

Analysis of the impact of attitudes about mental calculation on different mental calculation strategies

Based on the above factor analysis, this section will analyse the impact of the formed factors on the *number of mental calculation strategies* in the context of the second hypothesis: *There are statistically significant predictors from the set of attitudes 1–13 that affect the Number of mental calculation strategies*. The table below (Table 4) presents the results of a multiple regression analysis, where R represents the multiple correlation coefficient and R^2 represents the coefficient of determination.

Table 4

Results of multiple regression analysis

Latent variable (factor)	β	Se(β)	b	Se(b)	p
F1 – *Self-assessment of the calculation method performance*	0.283	0.062	0.776	0.170	<0.001
F2 – *Self-assessment of using mental calculation in everyday situations*	0.192	0.062	0.594	0.192	<0.001
F3 – *Assessment of the importance of mental calculation performance*	0.111	0.062	0.316	0.178	0.077
F4 – *Assessment of the frequency of using the calculation method in school*	0.140	0.062	0.417	0.185	0.025
F5 – *Mental calculation learning method*	-0.083	0.062	-0.258	0.193	0.182
R			0.368		
R^2			0.135		
P			<0.001		

Table 4 shows a statistically significant linear relationship between the criterion variable, *Number of mental calculation strategies,* and predictor variables F1–F5. The results of this regression analysis model indicate a correlation between the variables of mean strength, as evidenced by the value of the multiple correlation coefficient (R = 0.368), which falls within the range of 0.25 to 0.64. The analysis of the coefficient of determination revealed that the independent variables can explain 13.5% of the variation in the dependent variable. From weight b, it is evident that factors F1 and F2 have the most significant influence. Other factors have a lower impact and are even statistically unreliable. Thus, self-assessment of mental calculation skills, in general, and in everyday situations, in particular, affects the number of mental calculation strategies an individual will apply. Further research is certainly needed to obtain more detailed results on how this affects the use of various mental calculation strategies.

Discussion

This study examined the relationship between students' attitudes toward mental computation, their performance, and their use of strategies. The results showed that performance was most strongly associated with students' self-assessment of their knowledge and the frequency of using mental calculation in school. These findings underscore the significance of both classroom practices and self-perception in influencing mathematical outcomes. Previous research has similarly emphasised the role of self-confidence in mathematics, showing that students who believe in their abilities are more willing to tackle complex tasks and persist in the face of challenges, which in turn promotes flexibility in strategy use (Blackwell et al., 2007). Relatedly, affective factors such as feeling discouraged after failure have also been shown to predict mathematical performance (Dowker et al., 2019).

The present findings further suggest that students' beliefs about their abilities influence their intrinsic motivation. Motivated students are more likely to exert effort, set higher goals, and persist when facing obstacles, while a positive self-perception fosters resilience and a willingness to explore multiple strategies. Perera and John (2020) emphasise that emotional support in the classroom, including constructive feedback and praise, can strengthen these self-perceptions and promote engagement. The role of classroom practices is also reflected in the finding that the most frequently taught areas of mathematics are those to which students devote the most attention, indicating that curricular focus shapes learning priorities. Previous research has underscored the importance of nurturing number sense and mental computation early in schooling as precursors to later mathematical success (Maghfirah & Mahmudi, 2018).

An essential contribution of this study is the identification of specific predictors of mental computation performance. The strongest were the frequency of using mental calculation methods in school and self-assessment of performance, while the factor related to the learning method acted as a negative predictor. This suggests that students who primarily learned mental computation outside school achieved weaker results, which points to a gap in formal education. Such reliance on informal learning may disadvantage students without sufficient support in their home or community environments.

When considering flexibility and the use of multiple strategies, both self-assessment and awareness of applying mental computation in everyday situations emerged as significant predictors of success. These results align with prior work that stresses the role of mental calculation in daily life, where reliance on calculators is often impractical (Varol & Farran, 2007). Moreover, the finding that students generally expressed a desire to be more proficient in mathematics than they perceived themselves to be aligns with studies showing the high value placed on mathematics in both in- and out-of-school contexts (Markovits & Forgasz, 2017).

The proportion of explained variance in this study, 19.2% for performance and 13.5% for strategy use, was modest but consistent with patterns in educational research, where multiple factors contribute to shaping outcomes. Mental computation is influenced not only by attitudes but also by cognitive variables such as working memory, prior achievement, and general problem-solving skills, which were not examined in this study. Additionally, teaching practices and classroom environments have a significant impact on students' approaches. At the same time, curricular traditions—such as the prevailing emphasis on written algorithms in many education systems—may moderate the influence of these attitudes. Thus, while attitudes represent a vital predictor, they capture only part of the broader picture.

Finally, these findings align with earlier studies that highlight the strong positive links between mathematical self-confidence, perceived usefulness, and enjoyment (Kiwanuka et al., 2017). Attitudes toward mathematics, therefore, remain a key factor in explaining students' engagement and willingness to persist in problem solving. In particular, the classroom environment created by teachers—whether students perceive mathematics as meaningful for their present and future lives—plays a crucial role in shaping confidence and interest. It may help explain the differences observed across educational systems.

Limitations of the Study

A key limitation concerns the cultural and curricular context in which the study was conducted. In our system, written algorithms are strongly emphasised, while mental computation receives less systematic attention. This may have shaped students' attitudes and self-assessments, making the findings less generalizable to contexts where mental strategies are more consistently integrated into instruction (e.g., Singapore, Korea, Japan; IEA, 2024; OECD, 2023).

Another limitation relates to the measurement of attitudes. Self-report instruments are sensitive to social desirability and context, and attitudes themselves are complex, multidimensional constructs that are difficult to capture with surveys alone (Ajzen, 2005; Bohner & Dickel, 2011). Finally, the cross-sectional design of this study does not allow for conclusions about causality or changes in attitudes over time, which could be better addressed in future longitudinal research.

Conclusion

This study demonstrated that students' self-assessment of their abilities and the frequency of using mental computation in school significantly influence both performance and the diversity of strategies applied. Mental computation, although often overshadowed by written algorithms, deserves a more transparent and more systematic role in mathematics education. Since the findings stem from a specific educational context, their generalizability to other systems should be considered with caution. For teachers, the results suggest the importance of integrating mental computation more frequently into lessons, not only in arithmetic but also in areas such as geometry, while simultaneously motivating students to develop greater confidence in their knowledge. Providing opportunities for repeated practice across different topics encourages students to use a broader range of strategies, improves accuracy, and fosters self-assurance in solving mathematical tasks. Moreover, explicitly connecting classroom activities to everyday life situations and prompting students to reflect on their own self-assessment of abilities can help build confidence, enhance engagement, and strengthen persistence when facing mathematical challenges. At a broader level, curriculum designers and educational authorities should ensure that mental computation and number sense are more explicitly embedded into curricula as essential skills that support both academic success and lifelong numeracy.

Suggestions for Future Research

Indeed, this paper is only the beginning of studying the connection between attitudes and mental calculation. Future studies should place greater emphasis on the individual learner, considering factors such as type of intelligence, preferences for natural or social sciences, and motivational profiles, and explore how these interact with mental calculation performance and strategy use. Longitudinal research could track how attitudes and self-assessments develop over time and how these trajectories affect achievement. Experimental studies introducing targeted interventions — such as teaching multiple mental calculation strategies or fostering a growth mindset — would allow stronger conclusions about causality. Comparative cross-national research could further clarify the role of cultural and curricular traditions. In addition, examining teachers' knowledge and beliefs about mental computation remains a vital avenue, since their instructional practices shape how students perceive and use these skills.

Acknowledgements

None.

Conflict of Interest

None.

Funding

The Authors received no funding for this research.

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