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Academic Self-Concept and Mathematical Computation on Geometric Sequences and Series: The Confirmatory Factor Analysis

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ABSTRACT

The purpose of this study was to investigate the relationship between academic self-concept and mathematical computation in the field of geometry, particularly on geometric sequences and series. This study employed a quantitative correlational design using Confirmatory Factor Analysis (CFA). Data were collected through a mathematical computation test consisting of eight essay items and an academic self-concept questionnaire administered to 200 senior high school students in Bogor Regency. The results indicated a good model fit, as reflected by the fit indices (CFI = 0.994, TLI = 0.992, and RMSEA = 0.0463). Academic self-concept was significantly associated with mathematical computation, with a correlation coefficient of 0.37. The mathematical computation construct demonstrated strong reliability and validity (CA = 0.923, CR = 0.929, AVE = 0.781), with abstraction as the most dominant factor (0.917). Meanwhile, the academic self-concept construct showed CA = 0.968, CR = 0.977, and AVE = 0.889, with self-confidence identified as the most dominant factor (0.964). These findings indicate that students' self-confidence plays a crucial role in supporting abstraction in mathematical computation. Therefore, it is recommended that mathematics instruction should emphasize learning activities that strengthen students' academic self-confidence and promote abstraction skills to improve mathematical problem-solving performance.

ABSTRAK

Tujuan penelitian ini adalah untuk menyelidiki hubungan antara academic self-concept dan komputasi matematis pada bidang geometri, khususnya pada materi barisan dan deret geometri. Penelitian ini menggunakan desain kuantitatif korelasional dengan metode Confirmatory Factor Analysis (CFA). Data dikumpulkan melalui tes komputasi matematis yang terdiri dari delapan soal uraian serta angket academic self-concept yang diberikan kepada 200 siswa SMA di Kabupaten Bogor. Hasil analisis menunjukkan bahwa model memiliki tingkat kesesuaian yang baik, yang ditunjukkan oleh nilai indeks kecocokan (CFI = 0,994, TLI = 0,992, dan RMSEA = 0,0463). Academic self-concept berhubungan secara signifikan dengan komputasi matematis dengan koefisien korelasi sebesar 0,37. Konstruk komputasi matematis memiliki reliabilitas dan validitas yang kuat (CA = 0,923, CR = 0,929, dan AVE = 0,781), dengan abstraksi sebagai faktor paling dominan (0,917). Sementara itu, konstruk academic self-concept menunjukkan CA = 0,968, CR = 0,977, dan AVE = 0,889, dengan self-confidence sebagai faktor paling dominan (0,964). Temuan ini menunjukkan bahwa kepercayaan diri akademik siswa berperan penting dalam mendukung kemampuan abstraksi dalam komputasi matematis. Oleh karena itu, disarankan agar pembelajaran matematika menekankan pada aktivitas yang dapat meningkatkan academic self-confidence siswa serta mengembangkan keterampilan abstraksi untuk meningkatkan kemampuan pemecahan masalah matematis.

INTRODUCTION

The rapid development of information technology, supported by advances in infrastructure, computer devices, and internet networks, has brought significant changes in various domains of human life. One of the areas that has felt a significant impact of this progress is the education sector. The use of information technology in education not only facilitates the delivery of teaching materials but also expands access to learning resources, enhances communication between educators and students, and encourages the development of more interactive, flexible, and innovative learning methods. With adequate infrastructure support, information technology can transform the educational paradigm from conventional to digital-based learning, which can be accessed anytime and anywhere (Asfiana et al., 2024). Therefore, this requires the world of education to develop curricula and learning experiences that equip pupils with the skills to become globally competitive. A key competency that underpins the growth of using information and technology to engage in mathematical computation (Rosadi et al., 2025). Having the ability to solve mathematical issues appropriately, in dealing with context-based problems, students are required to formulate situations mathematically by employing mathematical computation, such as pattern analysis and problem decomposition, and designing solution steps systematically (algorithmic thinking) (Peng et al., 2025; Astuti et al. 2025). This competency closely aligns with the inherent nature of mathematics, which is built on logical structures, axiomatic systems, and systematic forms of reasoning (Buhaerah et al., 2023). Mathematics relies on both deductive processes, such as formulating conjectures and constructing precise models, and inductive approaches, including analyzing data, identifying patterns, and deriving generalizations. These fundamental characteristics of mathematics form the conceptual foundation that enables students to engage effectively in mathematical computation.

According to Jiang & Li in (Latifah et al., 2024) , two critical abilities are needed to develop mathematical computation: understanding concepts in a structured manner and explaining these concepts coherently. Mathematical computation is an essential competency that students must develop in response to the growing advancements in science and technology during the 21st century. By mastering this ability, students can understand the systematic approach to solving a problem from problem identification to finding the right solution, making the problem-solving process more effective, efficient, and logical. According to Binkley in (Marifah & Kartono, 2023). Mathematical computation is closely related to various key 21st-century competencies, encompassing creativity, critical thinking, and problem-solving. Mathematical computation is a cognitive skill that helps students understand and solve problems systematically. These skills include recognizing and identifying patterns and decomposing complex problems into simpler parts, designing structured solution strategies, and visualizing data through simulations. With these abilities, students can work on a problem coherently, understand the flow of work, and master the concepts underlying the solution.

The cognitive processes underlying the solution of such problems are related to aspects of the fundamental elements of mathematical computation, including decomposition, abstraction, algorithmic thinking, and debugging (Lehmann, 2024). Someone can concentrate on the essential elements of a problem by using abstraction, filtering out unnecessary details, and constructing a simplified mental model that supports analytical reasoning. Decomposition is the process of breaking a complex issue into smaller, easier-to-manage parts, enabling a systematic, step-by-step approach to its solution. Pattern recognition involves recognizing consistent structures or trends in data or contexts, which aids in constructing solutions that can be broadly applied. Algorithmic thinking is the skill of creating logical, efficient, and repeatable steps to solve problems. Debugging is the process of identifying and correcting errors to refine solutions. Together, these processes create a systematic and structured form of reasoning that enhances problem-solving (Castro et al., 2025).

However, the effective application of these cognitive processes does not depend solely on cognitive mastery. Mathematical computation is a fundamental ability in mathematics learning, and its development requires not only theoretical understanding but also support from affective factors. One important affective factor is self-concept, which reflects individuals' perceptions and evaluations of their own academic abilities (Passiatore et al., 2024). A person's self-concept is a good place to start because it influences all facets of their experience, thinking, emotions, perceptions, and attitudes (Calhoun & Acocella, 1983). Academic self-concept, a dimension of Shavelson's (1976) multidimensional and hierarchical self-concept model by Marsh and Shavelson (1985), refers to self-concept in the learning context (Arens et al., 2021a). Academic Self-Concept (ASC) describes how people view their academic ability and perception of general ability in school (Yu & Bailey, 2024). Academic self-concept manifests in learners' emotions and perceptions of their academic endeavors. A learner's academic self-efficacy guides their learning behavior, and motivation helps them solve academic challenges. The opposite can happen if learners perceive themselves as having poor academic quality (Blegur, 2020).

Empirical evidence further supports this reciprocal relationship. A recent meta-analysis synthesizing more than 68 longitudinal studies with 240 effect-size estimates confirms the existence of a reciprocal association between students' academic self-perceptions and academic outcomes (Wu et al., 2021). In particular, the results showed that achievement significantly impacted academic self-concept after adjusting for each variable's initial level ($\beta = 0.16$). Academic self-concept and achievement were significantly predicted, albeit with a lower average coefficient ($\beta = 0.08$, $p < 0.01$), especially as children aged. Their study, Eren et al., (2025) , reported results indicating that students' academic self-concept can improve through positive learning experiences and support from the educational environment. After positive learning experiences, students view their academic abilities more positively, feel more confident in their learning, and show a more optimistic attitude towards future academic achievement.

This pattern can be explained by the mechanism of self-concept formation. Self-concept is constructed through encounters with learning challenges that gradually accumulate into learning experiences. When learners are confident in engaging with and resolving these challenges, a positive academic self-concept is formed. Self-concept is fundamental in understanding mathematical concepts and beliefs during the process. Mathematical computation begins with an internal process within learners (Blegur, 2020).

A strong self-concept will help learners solve problems in a structured manner, making it easier to master mathematical abilities, including mathematical computation. Therefore, the relationship between self-concept and mathematical computation has been clarified based on the explanations above.

However, previous studies have predominantly examined self-concept in relation to general academic achievement or mathematics performance, with limited attention given to its relationship with mathematical computation as a specific cognitive skill. This gap is noteworthy, given that mathematical computation plays a fundamental role in problem-solving and the development of mathematical thinking. Therefore, this study focuses on examining the relationship between academic self-concept and students' mathematical computation, addressing an underexplored area in mathematics education research. This condition shows a gap in the literature that needs to be addressed, especially in explaining academic self-concept related to mathematical computation. So, the objectives of this study are 1) Is there a connection between academic self-concept, which encompasses elements like the effort and grade dimension, study and organizational habits, peer assessments of academic proficiency, academic self-confidence, school satisfaction, and self-evaluation with external standards, and mathematical computation, including decomposition, abstraction, algorithmic thinking, and debugging?; and 2) Which factor is most dominant in the aspects of academic self-concept and mathematical computation?

Thus, the hypotheses in this study are 1) There is a connection between academic self-concept, which encompasses elements like the effort and grade dimension, study and organizational habits, peer assessments of academic proficiency, academic self-confidence, school satisfaction, and self-evaluation with external standards, and mathematical computation, including decomposition, abstraction, algorithmic thinking, and debugging and; 2) the most dominant factors in the aspect of academic self-concept are grade and effort, while the most dominant factor in the aspect of mathematical computation is debugging.

Based on previous literature, academic self-concept is crucial in enhancing students' achievement, motivation, and learning performance. Systematic reviews have shown that ASC exerts a positive influence on academic achievement, motivation, performance, and self-efficacy, with effort or perseverance of effort serving as a reinforcing mechanism of this relationship (Wang & Yu, 2023). In line with this, recent findings confirm that subject-specific self-related constructs, particularly academic self-concept, are the strongest predictors of students' academic grades compared to other self-related variables such as need for cognition or consistency of interest (Rost & Feng, 2024). These findings suggest that students' self-perception of their academic abilities significantly contributes to their school achievement. Accordingly, this study assumes that grade and effort are the most dominant indicators within the construct of academic self-concept. In mathematical computation, testing and debugging activities are essential components of the mathematical computation process (Bowers et al., 2023). Students can identify model deficiencies through these activities and deepen their conceptual understanding of the mathematical concepts being studied. Therefore, this study assumes that debugging indicators will be the most dominant aspect of mathematical computation.

Therefore, a more in-depth analysis using the correct method is needed. Confirmatory Factor Analysis (CFA) examines the compatibility between indicators and measured variables. In this way, the research is expected to better understand the academic self-concept factor and the students' mathematical computation factor.

METHOD

This study employed a correlational research design to examine and analyze the relationships among the investigated variables. This study used the Mathematical Computation test instruments and the Academic Self-Concept questionnaire instruments to collect data. This research used a multivariate method with a confirmatory factor analysis technique. CFA is used to evaluate the fit of the measurement model to the observed data, as formulated in the hypothesis (Olmos et al., 2023). There are two types of variables contained in this study. In this research, academic self-concept is designated as the independent variable, and mathematical computation as the dependent variable. This study involved a sample selected using the indicator-based approach. According to the rule of thumb in multivariate analysis, the number of samples should be at least five times the number of estimated parameters or indicators, with an ideal ratio of 10:1 (Hair et al., 2019). This study has k = 10 indicators, so the ideal sample size is 100. According to this opinion, the minimum sample size has been met with 200 students from two high schools in Bogor Regency. Simple random sampling did the sampling. The data were collected using a mathematical computation test comprising 8 items and an academic self-concept questionnaire comprising 40 statements. Furthermore, a Confirmatory Factor Analysis (CFA) was employed.

Confirmatory Factor Analysis (CFA) was employed using a first-order correlated latent variables model, in which all observed indicators were specified to load directly onto their respective latent constructs. This approach requires the a priori specification of the number of latent variables and the relationships between indicators and constructs (Hair et al., 2008; Brown, 2015). The CFA model consists of latent variables, observed indicator variables (ξ), factor loadings (λ), correlations among latent constructs (ρ), and measurement errors (δ), which are simultaneously estimated to evaluate the adequacy of the proposed measurement structure. Although academic self-concept is theoretically multidimensional, it was modeled as a single latent construct represented by multiple indicators to maintain model parsimony.

Students' mathematical computation was measured through a written test consisting of 8 description questions with coverage of row and sequence material adopted from Yasmin's research (2025). This instrument was created based on four key indicators of mathematical computation: problem decomposition, abstraction, algorithmic thinking, and debugging. This instrument has been tested for reliability and resulted in a Cronbach's Alpha value of 0.719, and a validity coefficient that ranges from 0.40 to 0.75. According to Nunnally’s criterion (Lance et al., 2006) A reliability coefficient above 0.70 indicates acceptable internal consistency, supporting the instrument's reliability and adequacy for consistently assessing students’ mathematical computational skills. In addition, the instrument used to measure Academic Self-Concept was developed based on Reynolds (1988), who defines Academic Self-Concept as comprising dimensions of grade and effort, study habits and organizational self-perceptions, peer evaluation of academic ability, academic self-confidence, school satisfaction, self-doubt about one's abilities, and self-evaluation concerning outside norms. Academic Self-Concept data were collected using the Academic Self-Concept questionnaire, adopted from research Zulkarnaen (2018) The instrument was constructed based on six dimensions of Academic Self-Concept (ASC): grade and effort, study habits and organizational self-perceptions, peer evaluation of academic ability, academic self-confidence, school satisfaction, and self-evaluation. Based on these six dimensions, an instrument was developed to measure ASC. The instrument demonstrates excellent reliability, with a Cronbach’s Alpha of 0.919 and a validity coefficient ranging from 0.25 to 0.73. Therefore, it is considered feasible and adequate for consistently assessing students' academic self-concept.

The instruments were administered to students from two public senior high schools in Bogor Regency using a structured data collection procedure. Prior to data collection, formal permission was obtained from the school authorities, and informed consent was secured from all participating students. The data were collected during regular school hours under the supervision of the researchers and teachers to ensure standardized administration procedures.

The collected data were analyzed using Confirmatory Factor Analysis (CFA) to validate the measurement models of academic self-concept and mathematical computation in the context of geometric sequences and series. CFA was conducted to examine the relationships between latent constructs and their observed indicators by evaluating factor loadings, construct reliability, and error variances. Model fit was assessed using several goodness-of-fit indices, including the Chi-square statistic, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). Furthermore, CFA results were used to identify the most dominant indicators contributing to academic self-concept and mathematical computation, thereby providing empirical evidence of the underlying factor structure and the relative influence of each construct.

RESULT AND DISCUSSION

After the data were collected, the next step was to process them using Confirmatory Factor Analysis (CFA). This procedure involved constructing a suitable measurement model that reflects the relationships among the observed indicators and the latent variables. Subsequently, the model was evaluated regarding its validity and reliability to ensure it adequately represents the constructs under investigation. The initial conceptual model for this study is illustrated in **Figure 1**, which provides a visual representation of the hypothesized relationships and the measurement model structure.

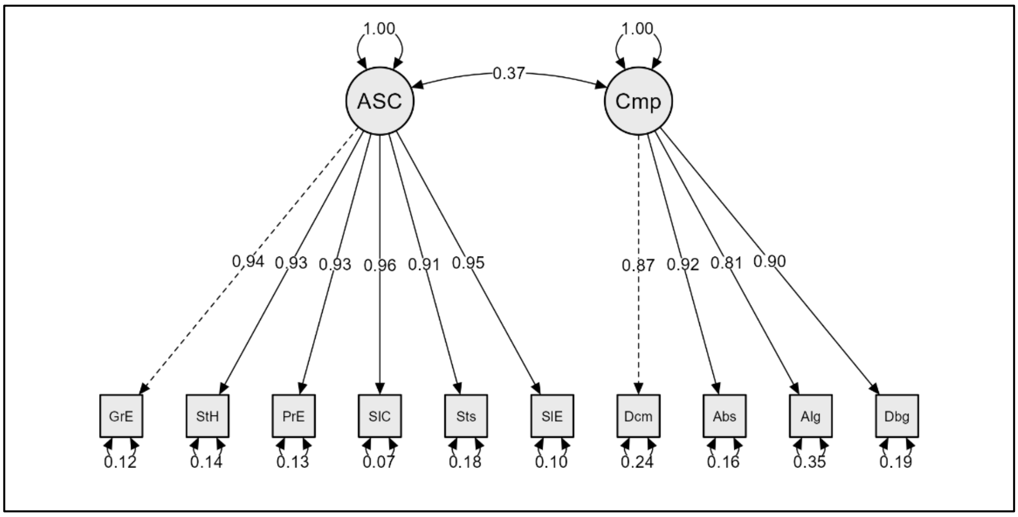

Figure 1. Academic Self-Concept and Mathematical Computation Model

Figure 1 presents the measurement model. Academic Self-Concept (ASC) comprises six first-order dimensions: Grade & Effort (GrE)**,** Study Habits/Organizational Self-Perceptions (StH)**,** Peer Evaluation of Academic Ability

(PrE), Academic Self-Confidence (SiC), School Satisfaction (Sts), and Self-Evaluation with External Standards (SlE). In addition, the Mathematical Computation model comprises four factors: decomposition (Dcm), abstraction (Abs), algorithmic thinking (Alg), and debugging (Dbg). The feasibility of the model in **Figure 1** is determined by the fulfillment of the assumptions of normality, model fit (goodness of fit), and adequate validity and reliability. Using JASP software, the normality test results, goodness-of-fit, and validity and reliability values are presented in **Tables 1, 2, 3, and 4**. The results of the normality test are presented in **Table 1**.

Table 1. Normality Test Results

Normality	GrE	StH	PrE	SiC	Sts	SlE	Dcm	Abs	Alg	Dbg
Shapiro-Wilk	0.983	0.981	0.983	0.981	0.974	0.976	0.875	0.875	0.829	0.794
P-Value	0.019	0.007	0.014	0.009	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
df	200									

As shown in **Table 1**, the data distribution approaches normality, as indicated by a value of 1. Even if the data do not fully meet the normality assumption, confirmatory factor analysis (CFA) can still be performed appropriately when the sample size is sufficiently large. This is supported by Byrne (2016), who explains that violations of the normality assumption have minimal impact on maximum likelihood estimates when the sample size is large. The next step involved testing the model's goodness-of-fit to assess how well the proposed measurement model corresponded with the observed data. The outcomes of the goodness-of-fit tests are summarized and presented in **Tables 2** and **3**.

Table 2. Chi-Square Test Results

Chi-square test			
Model	X^2	df	p
Factor model	48.556	34	0.050

Based on **Table 2**, the Chi-square test results for the factor model indicate X^2 = 48.556 with df = 34 and p = 0.050, suggesting that the factor model fits the data well. Furthermore, the model's suitability was also evaluated using various goodness-of-fit indices presented in Table 3.

Table 3. Goodness of Fit Test Results

Measurement Value	Conformance Index
CFI	0.994
RMSEA	0.0463
TLI	0.992

Based on **Table 3**, the Confirmatory Factor Analysis (CFA) results, and the factor model yielded χ^2 (34) = 48.556, p = 0.050, df = 34, indicating an acceptable level of model fit. Although the p-value is at the threshold of statistical significance, the result suggests that the model adequately represents the observed data, as indicated by a Comparative Fit Index (CFI) of 0.994, a Tucker-Lewis Index (TLI) of 0.992, and a Root Mean Square Error of

Approximation (RMSEA) of 0.0463. These values satisfy the recommended fit criteria, where CFI and TLI should be equal to or greater than 0.90, and RMSEA should not exceed 0.08 (Hair et al., 2008). Therefore, the measurement model demonstrates a good fit and is appropriate for use in subsequent analyses. Following this, the model's validity and reliability were assessed, and they are presented in **Table 4**.

Table 4. Validity and Reliability Test Results

Factor Loading	
Mathematical Computation (Cmp); CA = 0.923; CR= 0.929; AVE= 0.781	
decomposition (Dcm)	0.874
abstraction (Abs)	0.917
algorithmic thinking (Alg)	0.808
debugging (Dbg)	0.898
Academic Self-Concept (ASC); CA= 0.968; CR= 0.977; AVE= 0.889	
grade and effort (GrE)	0.940
study habits (StH)	0.926
peer evaluation (PrE)	0.933
self-confidence (SiC)	0.964
satisfaction (StS)	0.906
self-evaluation (SlE)	0.948

Referring to the outcomes of the construct validity and reliability assessments shown in **Table 4**, all indicators for the Mathematical Computation (Cmp) and Academic Self-Concept (ASC) constructs have factor loadings above 0.70, indicating they meet the criteria for convergent validity (Hair et al., 2014). The mathematical computation construct obtained a Cronbach's Alpha (CA) of 0.923, a Composite Reliability (CR) of 0.929, and an Average Variance Extracted (AVE) of 0.781. These results exceed the recommended minimum thresholds (CA > 0.7, CR > 0.7, and AVE > 0.5), indicating that the construct is both valid and reliable for measuring students' mathematical computation. The construct of mathematical computation is multidimensional, including decomposition, abstraction, algorithmic thinking, and debugging (Martínez et al., 2022). The findings of this study indicated that the abstraction indicator made the most dominant contribution (0.917), confirming that some Cmp dimensions have a greater role in shaping overall mathematical computation. This finding strengthens the validity and reliability of the measurement model used.

Although the initial hypothesis assumed that debugging would be the most dominant indicator of the Mathematical Computation (Cmp) construct, the empirical findings revealed that abstraction made the most significant contribution, with a factor loading of 0.917. This difference can be explained by the characteristics of students' cognitive processes and the mathematics learning context, which emphasize the ability to identify patterns and simplify problems into mathematical representations. According to Qian & Choi (2023), abstraction is a core component of mathematical computation that underlies other dimensions such as decomposition and algorithmic thinking. Similarly, Mirolo et al. (2021) emphasize that abstraction represents the fundamental cognitive mechanism in mathematical computation, enabling learners to manage complexity, generalize relationships, and transform concrete phenomena into formal models or algorithmic structures. In this sense, abstraction is not merely a supportive process but a generative and creative one that allows the construction of new conceptual entities in mathematical computation. Empirical evidence from Azizah et al. (2022) further supports this finding, showing that high school students achieved the highest performance in the abstraction indicator (97.5%) on the abstraction indicator when solving mathematical problems involving geometric sequences and series. This indicates that students at the senior high school level tend to excel in abstraction because they are in the stage of formal operational thinking, which enables them to recognize patterns and generalize them into symbolic forms such as general formulas. By studying geometry, students can connect abstract mathematical concepts with concrete representations, facilitating the integration of these forms of knowledge and serving as a catalyst for deeper mathematical understanding (Imami, 2023). This alignment between cognitive development and the structure of geometric learning helps explain why abstraction skills emerge strongly in tasks involving geometric patterns and generalizations. Through abstraction, students can extract essential information, identify structures, and represent relationships among mathematical components in a generalized, computable form. However, their reliance on abstract reasoning rather than procedural debugging may also reflect the instructional emphasis in mathematics classrooms, where students are often trained to recognize and reproduce general patterns or formulas rather than to test and correct algorithmic steps iteratively. Thus, students' ability to perform abstraction appears to represent their mathematical computation competence more strongly than their debugging skills. These findings suggest that the dominant dimension of mathematical computation may vary depending on students' learning experiences and the mathematical problem-solving activities they engage in.

Meanwhile, the Academic Self-Concept (ASC) construct also demonstrated good or positive outcomes, with a CA value of 0.968, a CR of 0.977, and an AVE of 0.889. The six indicators comprising the ASC construct have factor loadings ranging from 0.906 to 0.964, indicating that each contributes strongly to the construct. The ASC construct consists of six indicators: grade and effort, study habits and organizational self-perceptions, peer evaluation of academic ability, academic self-confidence, school satisfaction, and self-evaluation, with self-confidence as the key indicator, making the most significant contribution (0.964). Based on research by Arens et al. (2021b) ASC is multidimensional, comprising several interrelated dimensions, so each indicator contributes to representing the overall construct in this study. Analysis using CFA shows that the self-confidence indicator has the most dominant role in shaping the academic self-concept construct, aligning with the idea that some indicators can have greater influence in shaping the overall ASC construct.

The initial hypothesis suggested that grades and effort would be the primary indicators of Academic Self-Concept (ASC). However, the empirical findings revealed that academic self-confidence had the most significant impact. This difference may be attributed to contextual and cultural factors that shape how students view their academic abilities. In this study, students' confidence in their academic competence appears to have a more crucial role in forming their overall academic self-concept than their perceptions of effort or perseverance. These findings indicate that the key factors within the ASC construct may vary by educational level, learner characteristics, and the socio-cultural environment in which the study is conducted. This study is consistent with the research conducted by Yulianto et al. (2024) in which the confidence level of 76.03% provides further evidence that academic self-confidence is a central component of students' Academic Self-Concept (ASC). Granero et al. (2021) found that the Academic Self-Concept Scale, when validated, identified academic confidence and academic effort as its two main subfactors. Their confirmatory factor analysis showed that academic confidence had higher factor loadings (ranging from 0.78 to 0.85) than academic effort (0.59-0.66), indicating that confidence contributes more strongly to the ASC construct. The dominance of self-confidence in this context is further supported by Rubab et al. (2025) who found that academic confidence ($\beta = 0.42$, $p < 0.001$) was a stronger predictor of academic performance than academic effort ($\beta = 0.28$, $p = 0.00$). Their study concluded that students' belief in their academic abilities exerts a greater influence on achievement than the amount of effort they invest. Similarly, Siswanto et al. (2024) found that self-confidence had a more substantial influence ($\beta = 0.490$) on students' academic achievement than self-awareness ($\beta = 0.262$), accounting for 45.2% of the variance in academic performance. This finding suggests that senior high school students tend to rely more on their sense of confidence when approaching academic challenges. At this developmental stage, students are in the process of forming their academic identity and are frequently exposed to evaluative environments, such as examinations and performance-based assessments. These experiences strengthen their belief that confidence in one's own abilities is essential for success. Students with higher self-confidence are therefore more likely to participate actively in learning, take academic risks, and persevere when facing difficulties. Individuals who believe in their capabilities set higher goals, exert more effort, and view success as confirmation of their competence. Over time, such confidence-driven behavior reinforces a positive academic self-concept. Hence, the tendency of senior high school students to exhibit stronger self-confidence can be explained by both psychological and contextual factors, their growing need to prove competence, the increasing academic demands they face, and the social recognition that accompanies confident performance. Taken together, these findings suggest that academic self-confidence serves as the psychological foundation of academic self-concept.

Thus, both constructs meet the criteria for convergent validity and internal reliability for use in the Confirmatory Factor Analysis (CFA) model. Academic Self-Concept (ASC) and mathematical computation are important factors in learning mathematics. The study used a quantitative approach with CFA to determine each indicator's contribution to its construct. **Table 5** presents the magnitude of each indicator's contribution to academic self-concept and mathematical computation.

Table 5. Effect of Academic Self-Concept and Mathematical Computation

Construct	Factor	Squared Multiple Correlation
Mathematical Computation (Cmp)	decomposition (Dcm)	0.765
	abstraction (Abs)	0.842
	algorithmic thinking (Alg)	0.652
	debugging (Dbg)	0.807
Academic Self-Concept (ASC)	grade and effort (GrE)	0.883
	study habits (StH)	0.857
	peer evaluation (PrE)	0.871
	self-confidence (SiC)	0.929
	satisfaction (StS)	0.822
	self-evaluation (SlE)	0.898

Table 5 shows that the Mathematical Computation (Cmp) construct is influenced by decomposition (76.5%), abstraction (84.2%), algorithmic thinking (65.2%), and debugging

(80.7%). These results indicate that the abstraction indicator makes the most dominant contribution to the formation in the mathematical computation construct. This is in line with the findings from the research of Martínez et al. (2022) which states that some Cmp dimensions can have a greater influence on overall mathematical computation. Abstraction has been recognized as the core of mathematical computation (Qian & Choi, 2023). In mathematics learning, particularly geometric sequences and series, abstraction allows students to identify patterns, generalize rules, and simplify complex problems. This is in line with the findings of this study, where the abstraction indicator showed the highest contribution among the components of mathematical computation, signifying its dominant role in shaping students' mathematical computation.

In addition, the ASC construct is influenced by grade and effort by 88.3%, study habits by 85.7%, peer evaluation by 87.1%, self-confidence by 92.9%, satisfaction by 82.2%, and self-evaluation by 89.8%. These results indicate that the self-confidence indicator contributes most to the ASC construct. This result is consistent with earlier studies showing that the self-confidence dimension in academics is important in shaping students' academic self-concept. Students who feel proud tend to be more optimistic and confident in designing the steps of solving geometric sequences and series problems. This confidence encourages them to think systematically and use mathematical computation strategies such as decomposition, abstraction, and algorithmic thinking, thereby increasing planning quality and enabling them to overcome challenges in complex mathematical problems more effectively (Chen et al., 2020).

Based on **Figure 1**, the Academic Self-Concept (ASC) construct shows a relationship value of 0.37 with mathematical computation. This indicates a moderate but meaningful association between the two constructs. These findings imply that students who possess a stronger sense of academic self-belief tend to perform better in mathematical computation. The confidence students hold about their academic abilities motivates them to persist when facing difficulties, apply abstract reasoning, and develop algorithmic strategies to reach solutions. Conversely, students with lower academic self-concepts may experience uncertainty and hesitation, which can hinder their ability to decompose problems or apply abstraction effectively. Therefore, this study's results emphasize that academic self-concept, particularly the self-confidence dimension, serves as an internal driver that enhances students' engagement with mathematical computation processes. This interaction aligns with the theoretical assumption that affective factors, such as self-belief, can influence cognitive strategies in mathematics learning (Zhao et al., 2021; Alkhateeb et al., 2022).

CONCLUSION

The findings of this study reveal that Academic Self-Concept (ASC) and Mathematical Computation (Cmp) are strongly interrelated and have a pivotal role in mathematics learning, particularly within the topic of geometric sequences and series. The self-confidence indicator contributes most to the ASC construct, whereas in Cmp, the abstraction indicator makes the highest contribution. This indicates that students' confidence, a component of ASC, and their ability to abstract a component of Cmp are the key factors shaping mathematical computation. Students with higher levels of self-confidence and abstraction tend to plan, analyze, and solve complex mathematical problems more systematically.

The interaction between ASC and Cmp emphasizes the importance of developing both constructs simultaneously to enhance students' mathematical learning outcomes. In practical application, these findings can inform the design of instructional activities that progressively cultivate abstraction while reinforcing students' self-confidence in recognizing mathematical patterns. For example, in teaching geometric sequences and series, instruction can be structured in progressive stages: beginning with the presentation of concrete examples to build initial conceptual understanding, followed by the introduction of variables and verbalization of general forms to promote generalization, then deriving the algorithm for the partial sum to strengthen procedural reasoning; continuing with peer debugging activities using deliberately embedded errors to foster evaluative thinking, and concluding with self-reflection through a self-explanation rubric to reinforce abstraction and self-confidence.

Although this study emphasizes the importance of confidence and abstraction in mathematical computation, it has limitations related to its cross-sectional research design and homogeneous sample. Therefore, further research is recommended, using a longitudinal design to capture the development of ASC and Cmp over time and a mixed-methods approach to more comprehensively explore students' cognitive and affective processes.

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