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Predictive analysis of independent learning bearing on students' mathematics performance in Davao de Oro, Philippines

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Abstract

The abrupt transition from face-to-face to remote learning due to the COVID-19 pandemic has made independent learning the dominant pedagogical framework globally. As students return to in-person education, there is an increasing expectation for them to demonstrate autonomy in their learning and its impact on academic outcomes. This study aims to evaluate students' level of independent learning across cognitive, metacognitive, and motivational strategies, assess their mathematics performance, and identify which learning strategies predict their performance in mathematics. A descriptive correlational research design was employed to examine the independent learning levels and mathematics performance of secondary school students in Davao de Oro, Philippines. The findings revealed that the students exhibited high levels of independence in their mathematics learning, particularly in cognitive, metacognitive, and motivational strategies, with metacognitive strategies receiving the highest ratings. Additionally, students achieved very satisfactory results in their mathematics courses. A multiple linear regression analysis identified that only cognitive and motivational strategies significantly predicted mathematics performance, with motivational strategies emerging as the strongest predictors. In contrast, metacognitive strategies were found to be non-significant predictors, which contradicts existing literature. These findings provide valuable insights for educational stakeholders to enhance students' independent learning, specifically focusing on cognitive and motivational strategies, to further improve mathematics performance.

Keywords: Cognitive Strategies, Independent Learning, Mathematics Performance, Metacognitive Strategies, Motivational Strategies

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The prediction of student achievement remains a critical issue in educational research, as it necessitates an understanding of the complex and multifaceted factors influencing the learning process. One such factor is independent learning, which has garnered increased attention in the global educational context, particularly in the aftermath of the recent pandemic. During this period, students were compelled to engage in predominantly self-directed learning. This shift has underscored the importance of active learning, where students take a more autonomous role in their educational journey, as opposed to passively absorbing knowledge through traditional instructional methods.

Independent learning, a multifaceted construct, is defined and operationalized in various ways across the literature. Despite differences in terminology and conceptualization, it consistently refers to the degree of responsibility students assume for their own learning (Williamson, 1995). This process encompasses metacognitive, cognitive, and motivational strategies, as outlined in foundational theories by Boekaerts (1997), Garcia and Pintrich (1994), and Zimmerman (1986). Furthermore, independent learning fosters lifelong learning, extending beyond the traditional classroom setting (Kidane et al., 2020).

Nevertheless, fostering independence in students' learning remains a significant challenge for educators, particularly in light of the disruptions caused by the pandemic. The extensive impact of the pandemic on educational practices and student outcomes has heightened the urgency of investigating this issue. As educational institutions transition back to in-person learning, it is essential to understand the role that independent learning plays in supporting students' success in this evolving educational landscape. The pandemic has fundamentally altered instructional delivery methods, emphasizing the need for students to develop the skills necessary for independent learning in order to effectively navigate their learning processes. This period marks a critical juncture that warrants in-depth exploration.

The pandemic, which began in March 2020 following the World Health Organization's (WHO) confirmation of the widespread transmission of the novel coronavirus (COVID-19) (WHO, 2020), had a profound impact on global education (Akat & Karatas, 2020; Prahmana et al., 2021). In response to the health crisis, schools in various countries, including the Philippines, temporarily closed their doors in an effort to mitigate the spread of the virus. Consequently, the Department of Education suspended face-to-face classes and adopted alternative delivery modes to continue educational activities. These alternative modes of instruction—including radio-based, television-based, online, modular, and blended approaches—were supplemented by self-learning modules (SLMs), which were delivered to students' homes, particularly for those with limited or no access to the internet. These materials provided the essential lessons that students were required to complete independently, making self-directed learning the central mode of instruction.

As a result, students faced significant challenges, particularly in the domain of mathematics, where limited parental support and the absence of in-person teacher guidance further complicated the learning process. In the context of remote education, students were given restricted time to prepare for learning tasks, necessitating the development of organizational and self-regulation skills in the absence of the structured routines typically found in traditional classroom settings (Pelikan et al., 2021). Bao (2020) emphasized that the success of learning in these circumstances hinged more on students' independent learning behaviors than on their ability to utilize technological devices. Thus, independent learning emerged as a critical skill, playing a pivotal role in students' academic success during the two-year period of interrupted in-person education.

Independent learning is commonly conceptualized to encompass self-regulatory components, including cognitive, metacognitive, and motivational strategies (Boekaerts, 1997; Garcia & Pintrich, 1994; Zimmerman, 1986). Cognitive strategies involve basic learning processes, such as the processing, storage, and retrieval of information, aimed at achieving specific cognitive goals (Lima & Santos, 2023). These strategies can be broadly categorized into three key areas: rehearsal, elaboration, and organizational skills (Lohbeck & Moschner, 2021). In contrast, metacognitive strategies are methods used to control and regulate cognition, such as planning, checking, and monitoring work (Schunk et al., 2014). Motivational strategies, on the other hand, include techniques and methods that initiate and sustain an individual's motivation to learn (Hapsari, 2013). Together, these multifaceted strategies play a crucial role in helping students navigate their learning processes as they transition back to face-to-face instruction.

As educational paradigms evolve, students are now expected to demonstrate increased independence, assume greater responsibility for their learning, and set clear, actionable goals. This shift empowers students to take ownership of their academic journeys, thereby enhancing academic achievement and fostering the development of essential life skills for lifelong learning. While several empirical studies have examined how cognitive, metacognitive, and motivational strategies, as indicators of independent learning, predict mathematics performance across various student populations (Samadi & Davaii, 2012; Vukman & Licardo, 2010; Gallego et al., 2021; Ramirez-Arellano et al., 2018; Coscos et al., 2022), there remains a gap in research regarding the impact of independent learning behaviors, cultivated during the pandemic, on academic achievement in the post-pandemic educational environment.

Furthermore, the relationship between the use of cognitive, metacognitive, and motivational strategies and academic performance is influenced by various factors, including culture, subject matter, grade level, and mode of learning (Duncan & McKeachie, 2005; Coscos et al., 2022; Savoji, 2013; Gallego et al., 2021). While previous studies have primarily examined strategy use from a Western perspective, focusing mainly on higher education students in traditional academic settings, there is a need for further research exploring strategy use in non-Western cultures, particularly in the context of the current educational landscape. This landscape involves students transitioning from learning through modular and alternative delivery modes to in-person, face-to-face instruction. Consequently, the present study addresses this gap and aims to provide valuable insights into how independent learning strategies influence mathematics performance.

This study holds significant educational implications for educators and policymakers worldwide. Given the recent transformations in educational practices due to the pandemic, understanding the predictors of student achievement, such as independent learning strategies, is increasingly pertinent. The findings could inform the design of teacher and student training programs, as well as targeted interventions that promote independent learning across diverse educational systems. Additionally, shifting the focus to a non-Western context will contribute to a more comprehensive understanding of how cultural variables influence independent learning practices.

In line with these objectives, the study aimed to assess the level of independent learning and mathematics performance among secondary school students who have transitioned beyond alternative delivery modes. It further sought to explore how independent learning, in terms of cognitive, metacognitive, and motivational strategies, predicts students' mathematics performance. Additionally, the study examined the potential interaction and combined effect of these strategies on student outcomes. Finally, the specific research questions (RQs) addressed in this study are as follows:

1. What is the level of independent learning among high school students in terms of cognitive strategies, metacognitive strategies, and motivational strategies?
2. What is the level of mathematics performance among the students?
3. Which of the independent learning components significantly predict students' mathematics performance?

METHODS

Research Design

This study adopted a descriptive-correlational research design to examine students' independent learning levels with respect to cognitive, metacognitive, and motivational strategies, and to assess the potential relationships among these variables. In a correlational design, the variables are not manipulated directly, but rather, the degree of association between two or more variables is evaluated (Bonds-Raacke et al., 2014).

Additionally, multiple regression analysis was employed to investigate the predictive relationships between the independent variables and the criterion variable, as well as the interrelationships among the predictor variables (Marill, 2004). To collect quantitative data on the level of independent learning in terms of self-regulation strategies, a descriptive survey technique was utilized. This approach is well-suited for gathering data from a large target population, allowing for the generalization of findings to the broader population (Fowler, 2013).

Research Respondents

This study was conducted across four selected public junior high schools in Compostela, Davao de Oro, Philippines. The schools exhibit varying levels of internet connectivity due to their distinct geographical locations, which have led to differences in how students adapted to remote learning. Grade 10 students were chosen as the sample for the study due to their cognitive maturity, which is considered necessary for engaging in independent learning. Furthermore, this group is more capable of articulating their experiences and evaluating their learning processes, thereby providing valuable insights and feedback for the study.

A total of 209 junior high school students participated in the survey, with the sample size determined using Slovin's formula. Stratified sampling was employed to ensure the representation of key demographic characteristics. The distribution of respondents included 30 students from School A, 86 from School B, 51 from School C, and 42 from School D. Participants were informed of their right to withdraw from the study at any time, should they feel uncomfortable or intimidated during the survey process.

Research Instrument

This study employed an adapted self-report questionnaire to assess students' levels of independent learning, focusing on their cognitive, metacognitive, and motivational strategies for learning mathematics. The instrument used for measuring students' strategy use was based on the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich et al. (1991), a validated and widely utilized tool in educational research for measuring independent learning (Duncan & McKeachie, 2005). To ensure the relevance and appropriateness of the adapted MSLQ, the items were reviewed and refined with input from local educators. A pilot test, conducted with a similar sample group, provided feedback on the clarity and relevance of the items, leading to further adjustments to align the questionnaire with the specific learning contexts of the students while maintaining its validity.

The MSLQ consists of 44 items; however, for the purposes of this study, 40 items were included, forming four subscales: cognitive strategy use, metacognitive strategy use (self-regulation), and motivational strategy use (self-efficacy and intrinsic value). The Cognitive Strategy Use Scale ($\alpha = 0.83$) included 13 items assessing rehearsal, elaboration, and organizational strategies. The Metacognitive Strategy Use Scale ($\alpha = 0.74$), also referred to as the Self-Regulation Scale, comprised nine items related to metacognitive strategies such as planning, skimming, and comprehension monitoring. The Motivational Strategy Use Scale was divided into two components: the Efficacy Scale ($\alpha = 0.89$) with nine items and the Intrinsic Value Scale ($\alpha = 0.87$) with nine items.

Participants were asked to select a response that best represented their behavior in mathematics learning, using a Likert-type scale with five points, ranging from '1 = not true at all of me' to '5 = very true of me.' Respondents indicated their choice by placing a checkmark next to the number that most accurately reflected their experience. The reliability of the adapted instrument was assessed using Cronbach's alpha coefficients. Furthermore, students' academic performance was evaluated based on their final grades for the first quarter of the 2023-2024 academic school year, as documented in the official report card data, with the assistance of respective academic advisers.

Statistical Treatment of Data

The researcher employed both descriptive and inferential statistics to ensure a systematic and objective approach to data presentation, analysis, and interpretation. The weighted mean and standard deviation were utilized to assess the students' levels of independent learning in mathematics, specifically in terms of cognitive, metacognitive, and motivational strategies. To describe the distribution of students' academic achievement in the subject, frequency counts and percentages were applied. Additionally, multiple linear regression analysis was conducted to determine which components of independent learning significantly predicted the students' performance in mathematics.

RESULTS AND DISCUSSION

This section addresses the research questions concerning the level of independent learning of respondents, particularly in relation to self-regulation strategies, their performance in mathematics, and the identification of strategies that predict their mathematics performance. The analysis and interpretation of the findings are discussed below.

The Level of Independent Learning of High School Students in Terms of Cognitive Strategies

Cognitive strategies play a crucial role in independent learning, as they involve active engagement in processing and assimilating new information. These strategies, which include rehearsal, elaboration, organization, and critical thinking, are essential for enhancing students' understanding and retention of academic material. The active involvement of students in these strategies fosters cognitive development, contributing to greater efficiency, autonomy, and academic commitment (Tsyganova et al., 2020).

Table 1 illustrates the respondents' level of independent learning in cognitive strategies. The overall weighted mean of 3.71 indicates a high level of independent learning among the respondents. The standard deviation of 1.07 suggests a low variance, implying that the data are concentrated around the mean value.

The term "high" in this context signifies that respondents frequently and consistently employ cognitive strategies. A high level of cognitive strategy use indicates that students actively engage in techniques such as rehearsal, elaboration, and organization to process and retain information effectively. In educational evaluations, a "high" rating generally reflects behaviors or skills that are well-developed and frequently observed within the study group. A high level of cognitive strategy usage suggests that students are likely to be independent learners, as they effectively apply mental techniques that enhance learning outcomes. This is reflected in their ability to engage in deeper learning processes, leading to better retention of complex concepts, particularly in mathematics.

These findings are consistent with the results reported by Biwer et al. (2020), who found that cognitive strategies—such as integrating information from textbooks and lectures (item 1), active recall from class discussions, and memorization techniques for test preparation (item 6)—were also highly rated among higher education students. The incorporation of active learning strategies, such as practice testing, has been shown to promote long-term retention (Biwer et al., 2020). Similarly, Abdul-Ghafour (2019) found that high-achieving students demonstrated a strong use of cognitive strategies, particularly mental processes such as rehearsal, to improve their learning in mathematics.

Table 1. Level of independent learning of the respondents in terms of cognitive strategies

S/N	Indicators	WM	SD	Verbal Description
1	When I study for a test, I try to put together the information from class and from the book.	3.71	1.05	High
2	When I do homework, I try to remember what the teacher said in class so I can answer the questions correctly.	4.01	1.00	High
3	It is easy for me to decide what the main ideas are in what I read.	3.29	1.00	Moderate
4	When I study, I put important ideas into my own words.	3.82	1.09	High
5	I always try to understand what the teacher is saying even if it doesn't make sense.	3.73	1.09	High
6	When I study for a test, I try to remember as many facts as I can.	4.03	0.99	High
7	When studying, I copy my notes over to help me remember material.	3.93	1.12	High
8	When I study for a test, I practice saying the important facts over and over to myself.	3.83	1.07	High
9	I use what I have learned from old homework assignments and the textbook to do new assignments.	3.38	1.05	Moderate
10	When I am studying a topic, I try to make everything fit together.	3.45	1.08	High
11	When I read material for this class, I say the words over and over to myself to help me remember.	3.85	1.06	High
12	I outline the chapters in my book to help me study.	3.57	1.17	High
13	When reading I try to connect the things, I am reading about with what I already know.	3.61	1.09	High
	Aggregate Weighted Mean	**3.71**		**High**
	Aggregate Standard Deviation		**1.07**	

Legend: 4.21-5.00- Very High; 3.41-4.20-High; 2.61-3.40-Moderate; 1.81-2.60-Low; 1.00 – 1.80–Very Low

Furthermore, respondents predominantly employed rehearsal strategies over other cognitive strategies, such as elaboration and organization, as indicated by items 6, 7, and 8. Specifically, students favored repetition-based techniques, such as memorizing as many facts as possible during test preparation. This preference may be attributed to the importance of retaining factual knowledge and concepts essential for higher-level cognitive skills (Marzano & Kendall, 2007), which facilitates the assimilation of lesson content (Kiswardhani & Ayu, 2021). However, this contrasts with the findings of Murphy et al. (2023), who argued that although rote memorization can be effective for test-taking, it may sometimes give the illusion of deep learning. This method, while useful for recall, may lead to superficial learning, where students retrieve concepts without truly understanding their underlying principles. Integrating cognitive strategies with critical reading and knowledge application in instructional settings may improve learning outcomes (Akpur, 2021).

Meanwhile, respondents reported moderate use of strategies such as identifying main ideas (item 3) and integrating prior knowledge into new assignments (item 9). These findings suggest that students tend to simplify their study materials by focusing on key ideas and applying previously learned knowledge to new tasks, such as completing assignments. According to Ariel and Karpicke (2018), connecting new information with existing knowledge (item 13) and organizing study materials (item 12) are essential for constructing a coherent knowledge base and fostering higher-order thinking skills. This highlights the need to incorporate activities that promote elaboration and retrieval practice, rather than relying solely on repetition, for more durable learning.

The results indicate that while students frequently employ cognitive strategies, they would benefit from engaging in deeper processing techniques that go beyond simple recall, aiming to make sense of the information they encounter. While rehearsal strategies are important, higher-order strategies such as organization and elaboration are equally essential for meaningful learning.

Recent studies have also explored the connection between cognitive strategies and mathematics achievement. Cognitive strategies are shown to enhance mathematical performance and general cognitive abilities, creating a bidirectional relationship (Whitehead & Hawes, 2023; Klizienė et al., 2022). This relationship is influenced by developmental stages and individual learner profiles (Atit et al., 2021). A study by Klizienė et al. (2022) found that students' mathematics performance was closely linked to their ability to use effective cognitive strategies, such as elaboration and organization. Similarly, a strong positive correlation has been observed between the development of cognitive strategies and mathematics achievement among junior high school students, supporting previous research that connects working memory with academic success (Wild & Neef, 2023). Conversely, deficits in cognitive abilities are associated with lower mathematics performance, emphasizing the need to develop these cognitive skills in mathematics learning (Tang et al., 2021).

While the exact role of cognitive strategies in mathematics learning remains not fully understood, their significant impact is evident. Further research is necessary to clarify their specific contributions and long-term effects on mathematics achievement.

The Level of Independent Learning of High School Students in Terms of Metacognitive Strategies

Metacognitive strategies are vital for independent learning. These strategies involve higher-order executive processes, including planning, execution, reflection, monitoring, and self-testing, all of which contribute to enhanced cognitive task performance. Three key metacognitive strategies—planning, monitoring, and evaluation—are essential for regulating and optimizing learning (Spoerer & Brunstein, 2006).

Table 2 illustrates the respondents' level of independent learning in metacognitive strategies. As indicated by the data, the overall weighted mean of 3.73 suggests a high level of independent learning in terms of metacognitive strategies, with students demonstrating a significant use of strategies that facilitate oversight of their learning processes. The standard deviation of 1.08 reflects moderate variation, signifying that while most students consistently apply metacognitive strategies, some variation in usage exists.

Table 2. Level of independent learning of the respondents in terms of metacognitive strategies

S/N	Indicators	WM	SD	Verbal Description
1	I ask myself questions to make sure I know the material I have been studying.	3.81	1.05	High
2	When work is hard, I never give up.	4.01	1.10	High
3	I work on practice exercises and answer end of chapter questions even when I don't have to.	3.17	1.05	Moderate
4	Even when study materials are dull and uninteresting, I keep working until I finish.	3.48	1.11	High
5	Before I begin studying, I think about the things I will need to do to learn.	3.91	1.02	High
6	I know what I have been reading for class.	3.56	1.05	High
7	I find that when the teacher is talking, I listen to what is being said.	4.03	1.06	High
8	When I'm reading, I stop once in a while and go over what I have read.	3.78	1.04	High
9	I work hard to get a good grade even when I don't like a class	3.80	1.20	High
	Aggregate Weighted Mean	**3.73**		**High**
	Aggregate Standard Deviation		**1.08**	

Legend: 4.21-5.00- Very High; 3.41-4.20-High; 2.61-3.40-Moderate; 1.81-2.60-Low; 1.00 – 1.80–Very Low

A high rating in metacognitive strategies indicates that students are not only aware of their learning progress but also actively strive to make adjustments to enhance their learning. This suggests that students engage in strategies such as planning, monitoring, and evaluating their learning processes, reflecting a proactive and reflective approach to their academic tasks. The positive impact of high metacognitive strategy use is evident in students' enhanced self-efficacy, improved problem-solving abilities, and a deeper understanding of content, particularly in mathematics.

This elevated level of metacognitive strategy use aligns with the findings of Marantika (2021), who argued that metacognitive ability is directly linked to student autonomy in the learning process. When students take charge of planning, controlling, and strategizing their learning, they become more independent, thereby positively influencing their academic performance. The results indicate that students demonstrate persistence when facing challenging tasks and remain actively engaged in class discussions, regardless of the subject's difficulty. These behaviors may be driven by students' belief systems and their anticipation of reinforcement, contributing to the consistent use of metacognitive strategies. These habits, in turn, enhance their motivation, improve control over their learning, and foster better academic performance (Michaelides et al., 2019; DiNapoli, 2023).

Notably, most of the indicators were rated highly by the students. The indicator with the highest mean, item 7 (WM = 4.03), pertains to students' active listening skills during class discussions. This is closely followed by item 2 (WM = 4.01), which measures students' persistence in the face of difficulty. These results suggest that students not only engage actively in their teachers' instructions but also demonstrate perseverance in their studies. However, caution is warranted, as Sahdra et al. (2022) found that the simultaneous presence of flexibility amidst goal barriers—such as active listening despite distractions—and persistence may not necessarily benefit test performance due to challenges in self-regulation. Therefore, improving these skills and achieving a balance in their application may lead to better test competence. Nevertheless, Anthonysamy (2021) affirmed that metacognitive awareness of such skills is indispensable in creating sophisticated and independent learning environments.

Interestingly, item 3, which focuses on completing practice exercises beyond the required learning tasks, was the only one rated as moderate by the respondents. This suggests that, while students are aware of various strategies necessary for regulating their cognitive processes, they tend to limit their efforts to activities specified within the curriculum. This finding supports the work of Van de Watering et al. (2008), who noted that students often prefer less stressful tasks or assessment types over those that are mandated. This may be attributed to a cost-benefit analysis wherein students perceive the effort required for additional tasks as disproportionate to the benefits gained. This is especially true when students lack a deep understanding of key concepts, making their efforts less effective. Additionally, teachers may not have integrated metacognitive strategies effectively into classroom instruction, leading to a disconnect between students and extra tasks (Wass et al., 2023). Thus, a gradual introduction of practice sets, coupled with focused guidance, is necessary to reinforce student learning and foster greater engagement.

In short, students exhibited a high level of independent learning, particularly in their use of metacognitive strategies, within their mathematics studies. Persistence and active listening were particularly evident among learners. However, there is a need for greater student initiative in extending their knowledge through additional practice, an area that requires attention from both students and teachers.

Furthermore, metacognitive strategies have been shown to positively influence academic performance at various educational levels. Even when applied at a modest level, these strategies can significantly impact academic success, particularly in problem-solving tasks such as those found in mathematics (Abdelrahman, 2020). For instance, Eskandari et al. (2020) reported a positive relationship between metacognitive strategies and improved learning outcomes among medical students, while Ha et al. (2023) identified these strategies as key predictors of academic achievement among sixth-grade students in South Korea. Learners who utilize metacognitive strategies effectively are able to plan their learning, monitor their comprehension, and engage in self-evaluation after completing a learning task (Loksa et al., 2020).

Moreover, integrating metacognitive strategies training for secondary school learners, alongside practice in working memory, can substantially improve mathematical reasoning and problem-solving skills (Agostini et al., 2022; Adrian et al., 2020). A Turkish study by Akyol et al. (2010) identified key metacognitive variables such as self-regulation and higher-order thinking as essential for fostering independent learners and ensuring academic success (Hassan et al., 2022; Az-Zahra et al., 2021; Susanto et al., 2023).

Metacognitive strategies enable students to navigate their learning effectively, even amid the complexities of a demanding curriculum. In contrast, students who lack awareness of how to understand, control, and manipulate their learning processes tend to rely on their teachers or lesson materials for guidance. Consequently, they may be content with merely following instructions. Thus, students who employ more metacognitive skills are likely to experience better academic advancement and may outperform those with limited use of these strategies. The role of metacognitive strategies in enhancing academic performance, particularly in mathematics, is well-established and should be considered by educational institutions for future development.

The Level of Independent Learning of High School Students in Terms of Motivational Strategies

Motivational strategies are equally critical to independent learning, as they involve managing and sustaining motivation while being aware of affective variables such as self-efficacy, value, self-concept, and test anxiety (Guilloteaux & Dörnyei, 2008; Reyes, 1984). These strategies are essential for students to remain engaged in their learning processes, especially when facing challenges or uninteresting tasks.

Table 3. Level of independent learning of the respondents in terms of motivational strategies

S/N	Indicators	WM	SD	Verbal Description
1	Compared with other students in this class I expect to do well.	3.40	1.09	Moderate
2	I'm certain I can understand the ideas taught in this course.	3.41	0.99	High
3	I expect to do very well in this class	3.71	1.03	High
4	Compared with others in this class, I think I'm a good student.	3.17	1.23	Moderate
5	I am sure I can do an excellent job on the problems and tasks assigned for this class.	3.36	1.02	Moderate
6	I think I will receive a good grade in this class	3.33	1.11	Moderate
7	My study skills are excellent compared with others in this class.	2.85	1.12	Moderate
8	Compared with other students in this class I think I know a great deal about the subject.	3.03	1.06	Moderate
9	I know that I will be able to learn the material for this class.	3.54	1.01	High
10	I prefer class work that is challenging so I can learn new things.	3.86	1.03	High
11	It is important for me to learn what is being taught in this class.	4.11	1.00	High
12	I like what I am learning in this class.	4.08	1.06	High
13	I think I will be able to use what I learn in this class in other classes.	4.06	1.06	High
14	I often choose paper topics I will learn something from even if they require more work.	3.42	0.97	High
15	Even when I do poorly on a test I try to learn from my mistakes.	4.02	1.08	High
16	I think that what I am learning in this class is useful for me to know.	3.97	1.04	High
17	I think that what we are learning in this class is interesting.	4.02	1.04	High
18	Understanding this subject is important to me.	4.36	0.98	Very High
	Aggregate Weighted Mean	**3.65**		**High**
	Aggregate Standard Deviation		**1.05**	

Legend: 4.21-5.00- Very High; 3.41-4.20-High; 2.61-3.40-Moderate; 1.81-2.60-Low; 1.00 – 1.80–Very Low

Respondents reported a high level of independent learning in motivational strategies, with an overall weighted mean of 3.65, as reflected in Table 3. The standard deviation of 1.05 indicates a moderate variation in the students' use of motivational strategies, suggesting that while most students employ motivational techniques to sustain their learning, some variations in their utilization still exist.

The high level of motivational strategy use observed here indicates a strong ability among students to maintain interest and effort in tasks. This includes actively choosing between external rewards or internal drive to stay focused, minimize distractions, and reduce procrastination during mathematics learning. It reflects the students' ability to persevere in their studies, even under challenging circumstances, such as during the pandemic, when independent learning in disruptive environments became more prevalent. The use of motivational strategies is thus critical in fostering a positive attitude towards learning, overcoming setbacks, and remaining committed to long-term academic goals.

These findings align with those of Erdil-Moody and Thompson (2020), who found that both students and teachers frequently utilized motivation-enhancing strategies. Furthermore, students themselves reported feeling more motivated and focused when engaged in independent learning.

The highest level of independent learning in terms of motivational strategies was observed in item 18, followed by item 11. Both items emphasize the importance of the subject matter in students' personal lives. This suggests that students recognize the relevance and value of the subject matter, which plays a key role in maintaining their motivation and interest. These findings are in line with Steinmayr et al. (2019), who assert that students are more motivated when they perceive the subject's value and expect to succeed in it.

Additionally, most items fall within the high-level range of independent learning, as seen in items 2 to 3 and 9 to 17. This indicates that students are generally motivated to study the subject matter and actively regulate their thoughts and behaviors when faced with challenging learning tasks in mathematics. This suggests that students maintain a positive attitude towards the subject, even in difficult situations. These findings are consistent with those of Mata et al. (2012), who reported that students often exhibit a positive attitude toward learning, whether they are studying independently or with support from teachers and peers.

Conversely, students reported a moderate level of independent learning in items 4 to 8, which focus on the projection of expectations and comparisons with classmates. These items revealed that students have an average level of self-expectation and self-efficacy when it comes to succeeding in the subject matter compared to their peers and achieving higher grades. Studies have shown that approximately 50% of students report low to average self-confidence in mathematics, as found by Chilca (2017). Additionally, adult learners often demonstrate lower self-confidence levels compared to traditional undergraduates (Jameson & Fusco, 2014). Phillips (2007) suggested that emotions related to self-confidence play a crucial role in how students process and comprehend the information they encounter. Specifically, students with higher confidence in completing tasks are more likely to engage, persist, and succeed in their learning activities (Street et al., 2022).

Motivational strategies play a key role in enhancing academic performance, particularly in independent learning contexts. For example, Liu et al. (2022) emphasized that students with high self-efficacy and motivation tend to put greater effort into their studies, which directly contributes to positive learning outcomes. Therefore, students' academic performance in independent learning is positively influenced when they strategically motivate themselves. It is also argued that, without motivation, even students with extraordinary cognitive abilities may not reach their full potential, as learning is not solely a cognitive activity but also an affective one (Schweinle et al., 2006).

Prior research highlights the significant role of motivational strategies in fostering independent learning, with a strong correlation to academic achievement, particularly in mathematics (Sivrikaya, 2019; Dagnew, 2018; Yu & Shen, 2022). It has been found that students' motivational capacity is not only directly related to enhanced independent learning but can also influence learning in a bidirectional manner.

Highly motivated students typically possess substantial intrinsic motivation, personal interest, mastery goals, and adaptive attributions, which collectively shape their academic engagement and performance in mathematics and science (Nabizadeh et al., 2019). These students find tasks intrinsically enjoyable, aim to fully comprehend the subject matter, and believe that effort is directly linked to success.

Previous research consistently suggests that the application of motivational strategies has a direct impact on mathematics learning outcomes. Generally, students with higher motivation tend to perform better in the long term compared to their less motivated peers. This underscores the advantage of utilizing motivational strategies, as evidenced in the present study. Specifically, the respondents demonstrate an awareness of the perceived value and relevance of the learning task. Self-expectancy and self-confidence are moderately evident, suggesting that students are aware of their potential, though these motivational factors primarily influence engagement and persistence in the subject.

Table 4 provides a summary of the respondents' levels of independent learning, categorized by their cognitive, metacognitive, and motivational strategies. The general mean of 3.70 indicates that the students exhibit a high level of independent learning. This suggests that students possess a strong sense of autonomy and self-regulation in their mathematics learning. This result can be attributed to the cumulative impact of the pandemic on students' independent learning processes, as they were primarily required to study independently through alternative delivery modes, such as modular learning. These findings align with the research of Ekayanti (2021), which revealed that during the COVID-19 pandemic, most students demonstrated high levels of independence by taking initiative, being self-reliant, assuming responsibility, and exercising self-discipline and control in their learning. As students transition back to face-to-face learning, they may have more opportunities to further enhance their independent learning skills.

Table 4. Summary of the level of independent learning of the respondents

Components	WM	SD	Verbal Description
Cognitive Strategies	3.71	1.07	High
Metacognitive Strategies	3.73	1.08	High
Motivational Strategies	3.65	1.05	High
Grand Mean	**3.70**		**High**
Grand Standard Deviation		**1.07**	

Among the three indicators, metacognitive strategies have the highest mean at 3.73, followed by cognitive strategies with a mean of 3.71, and motivational strategies with the lowest mean of 3.65. All indicators are categorized as high, indicating that students frequently and effectively employ these strategies in their learning. This result highlights a high level of independent learning among students in mathematics. It suggests that students demonstrate a strong capacity for autonomous learning to achieve their academic goals in the subject. Therefore, their independent learning abilities present opportunities for further improvement, which, if maintained, can reach even greater levels of proficiency.

The Level of Academic Performance of the Students in Mathematics

This study also aimed to assess the students' level of performance in mathematics. The findings, as presented in Table 5, show that the students' mean academic performance in mathematics is 85.83, indicating a very satisfactory level of achievement overall. The table further reveals a moderate variation of 5.69, suggesting that the scores are relatively close to the mean, with minimal spread in the performance levels.

Table 5. Level of academic performance of the respondents in mathematics

Level	Numerical Range	f	%
Outstanding	90-100	66	31.58
Very Satisfactory	85-89	61	29.19
Satisfactory	80-84	55	26.32
Fairly Satisfactory	75-79	26	12.44
Did not Meet the Expectations	below 75	1	0.48
Total		**209**	**100.00**
Mean		85.83	
St. Dev.		5.69	

Further analysis of Table 5 reveals that the majority of respondents (87.09% of the 209 samples) scored 80% and above, reflecting strong performance in the subject. In contrast, only one respondent (0.48%) did not meet the subject's expectations. This suggests that most students have mastered the learning competencies in mathematics.

The positive results observed may be attributed to the variety of assessment methods used in the classroom. These findings stand in contrast to the lower mathematics proficiency reported in national assessments such as the National Achievement Test (NAT) (Gonzales, 2019) and the Philippines' relatively low performance in international assessments like the Programme for International Student Assessment (PISA) 2018 (OECD, 2019), which largely rely on standardized tests.

The disparities in national and international assessments echo global trends in student achievement, which are influenced by socioeconomic and educational factors (OECD, 2022; NCES, 2023). This is particularly relevant in regions of the country that were severely impacted by the school closures and the resulting learning gap. The most recent PISA 2022 results revealed a performance far below the OECD average in mathematics (OECD, 2022). Similarly, the 2024 "State of Student Learning" report highlights ongoing concerns about mathematics proficiency at all levels (Curriculum Associates, 2024).

On the other hand, the high level of academic achievement observed among the respondents in this study may be attributed to the use of differentiated assessments in the classroom. Students' grades were calculated based on written works, performance tasks, and quarterly assessments, with weights of 40%, 40%, and 20%, respectively (DepEd, 2015). This demonstrates that students excelled in written assessments, as indicated by their scores on quizzes and unit tests. They also performed well on performance-based tasks, such as product innovation, collaborative exercises, and research projects, which likely contributed to their strong results on periodical examinations. This aligns with Lewohl's (2023) findings, which emphasize the perceived benefits of face-to-face instruction and hands-on learning experiences over online and distance education methods, regardless of attendance figures.

The Independent Learning Components as Significant Predictors of the Respondents' Mathematics Performance

Table 6 shows the regression analysis examining the predictive value of each component of independent learning on students' mathematics performance. As shown in the table, the students' independent learning level accounted for 22.8% of the variance in their mathematics performance. The computed F-ratio of 20.17 and a p-value of 0.000 (which is below the 0.05 significance level) indicate that there is a statistically significant relationship between independent learning and students' mathematics performance.

Table 6. Regression analysis of the respondents' mathematics performance

	R square	df	*F*	Standard coefficients (*β*)	*t*-Stat	*p*-value
Regression		3	20.17			0.000
Residual	0.228	205				
Total		208				
Constant					32.280	.000
Cognitive				.267	2.502*	.013
Metacognitive				-.107	-1.011	.313
Motivational				.336	3.584*	.000

*significant at p < 0.05

Table 6 also reveals that motivational strategies have the highest predictive power on mathematics performance, with a β value of 0.336, followed by cognitive strategies (β = 0.267). Interestingly, metacognitive strategies exhibit a negative beta value (β = -0.107). The significance test for the regression coefficients shows that both cognitive strategies (t = 2.502, p = 0.013) and motivational strategies (t = 3.584, p = 0.00) are significant predictors of mathematics performance. In contrast, metacognitive strategies, despite having the highest mean, do not significantly impact students' mathematics performance.

Thus, cognitive and motivational strategies emerge as the key components of independent learning that make a statistically significant positive contribution to predicting students' performance in mathematics. This finding aligns with the study of Duru and Okeke (2021), who found that independent learning skills significantly predict students' achievements in mathematics, regardless of their ability levels. They further suggested that enhancing self-regulation would improve mathematics performance across both high- and low-ability student groups.

The results of this study support the initially expected direction that cognitive and motivational strategies significantly predict mathematics performance, despite the assumption that all components would predict similarly. This finding aligns with existing literature, which highlights the role of cognitive strategies—such as rehearsal, elaboration, and organization (Alloway & Alloway, 2010; Akyol et al., 2010; Finn et al., 2014; Reimann et al., 2012)—and motivational strategies (Ng et al., 2012; Savoji, 2013; Skaalvik, 1994; Trigueros et al., 2020) in explaining significant variations in student achievement in mathematics. This indicates that enhancing students' cognitive abilities and their use of motivational strategies can directly contribute to improved mathematics performance.

However, the results also deviate from initial expectations based on the literature, which generally suggests that metacognitive strategies are the most significant predictors of mathematics performance (Samadi & Davaii, 2012; Veenman et al., 2006; Thiede et al., 2003; Coscos et al., 2022). Samadi and Davaii (2012) emphasize that metacognitive strategies, including the ability to monitor and regulate one's learning, account for a substantial portion of the variation in academic achievement. Similarly, Coscos et al. (2022) found that metacognitive strategies are key predictors of achievement among primary school children in the Philippines, supporting the notion that such strategies are effective in managing learning.

In contrast to these findings, this study revealed that motivational strategies had the most robust predictive value for optimal learning. This result is consistent with previous studies conducted by Tülübaş (2022) and Kuyper et al. (2000). Motivational strategies, such as enhancing self-efficacy, self-perception, and self-concept, reinforce the idea that affective constructs play a significant role in improving students' performance in mathematics (Onoshakpokaiye, 2024; Torres et al., 2020). Kuyper et al. (2000), in their longitudinal study, found that achievement motivation significantly predicted long-term attainment in secondary education. Interestingly, they observed that metacognitive variables had minimal correlation with achievement, suggesting that the discrepancy could be attributed to the type of data used in the dependent variable. Most educational research in self-regulated learning relies on standardized test scores, which may not fully capture actual performance. Kuyper, van der Werf, and Lubbers (2000) used real attainment measures, which aligns with this study's use of final grades from varied forms of assessment. Therefore, the consistency of the results is not surprising.

This finding also resonates with the work of Teng and Yue (2022), who suggested that metacognitive strategies might not always be significant predictors of mathematics performance in all contexts. While metacognitive strategies are essential, their correlation with academic achievement may vary depending on the learning environment. Ramadhanti and Yanda (2021) illustrated the complexity of the relationship between metacognition and academic performance, asserting that its effectiveness may differ across contexts. Their research, for example, found that metacognitive awareness influenced writing skills but did not improve overall academic performance.

Finally, this study found that cognitive and motivational strategies significantly predict mathematics performance, in line with the broader literature on academic achievement. However, metacognitive strategies were not significant predictors of mathematics performance in this context. This suggests that different independent learning strategies may have varying effects across academic domains.

CONCLUSION

This study offers valuable insights into the relationship between students' levels of independence and their learning outcomes, particularly in mathematics. The findings clearly indicate that the degree of independent learning among high school students significantly influences their mathematics performance. Notably, the high levels of independence demonstrated by students—characterized by the use of cognitive and motivational strategies—are closely linked to their academic achievement. In light of this crucial connection, it is essential for students to continue fostering and refining their independent learning strategies, particularly those that enhance motivation, in order to further improve their mathematics performance.

The role of teachers, parents, and school administrators is pivotal in supporting the implementation of programs and policies that promote students' independent learning. Such efforts should provide students with abundant opportunities to engage in independent learning while simultaneously cultivating a sense of responsibility. Additionally, the curriculum should extend beyond basic cognitive skills to emphasize higher-order thinking, and an environment should be created that encourages students to build self-confidence and develop heightened expectations of success.

Specifically, educators can assist students in enhancing their cognitive and motivational strategies by integrating reflective practices, goal-setting, and self-monitoring activities into their instructional approaches. For example, students can be guided to set and evaluate SMART (Specific, Measurable, Attainable, Relevant, and Time-bound) goals, which can be supported by programs that focus on self-assessment and the use of learning journals. These initiatives will foster greater self-awareness and intrinsic motivation. Furthermore, strategies such as Think-Aloud exercises, self-reflection activities, and growth mindset workshops can strengthen students' planning and evaluation skills, ultimately encouraging persistence and a positive view of challenges.

Instructors should also consider incorporating real-world problem-solving scenarios into their lessons, along with collaborative learning opportunities through group projects and peer feedback. Such activities encourage the exchange of ideas, fostering deeper connections between students. Furthermore, curriculum revisions should aim to promote critical thinking, the application of knowledge, and the development of advanced cognitive skills. When these strategies are integrated, they will create a supportive atmosphere conducive to independent learning and lifelong educational growth.

Despite the valuable contributions of this study, there are several limitations that should be acknowledged. First, while the sample size is adequate for preliminary analysis, it may not fully represent the broader student population. Future research should employ larger, more diverse samples to enhance the generalizability of the findings. Second, the reliance on self-report questionnaires in this study may introduce bias, as students may not accurately reflect their true abilities and levels of engagement. To address this limitation, future studies could complement self-report measures with objective, performance-based assessments to better capture independent learning behaviors. Lastly, the cross-sectional nature of the research design precludes the determination of causal relationships between the strategies employed and students' mathematical performance. Longitudinal research or structural equation modeling could be employed in future studies to examine the complex interactions between these variables.

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