Students' growth mindset, motivation, and mathematics performance: A correlational study

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ARTICLE INFORMATION

Article History:

Received: May 22, 2023

Received in revised form: June 7, 2023

Accepted: August 24, 2023

Keywords:

growth mindset, fixed mindset, motivation, mathematics performance, COVID-19 pandemic

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ABSTRACT

This study examined the correlation between students' mindset and motivational constructs, such as intrinsic and utility values, self-efficacy, self-regulation, and test anxiety, on their mathematics performance during the COVID-19 pandemic. The researchers used a quantitative approach and gathered data from 310 randomly selected Grade 11 students attending public secondary schools in Quezon City. Findings indicated that many students possessed a fixed mindset during the pandemic, yet they demonstrated motivation in mathematics amidst the COVID-19 situation. Growth mindset and other motivational constructs, such as intrinsic value, utility value, self-efficacy, and self-regulation, showed positive correlations with mathematics performance. At the same time, test anxiety displayed a negative and very weak relationship. Empirical evidence highlights the vital role of a growth mindset and motivational factors in students' mathematics performance, even in challenging circumstances like the pandemic. Recommendations include implementing growth mindset interventions in the classroom and providing engaging activities to sustain students' motivation.

Introduction

Background of the Study

The present pandemic has caused extraordinary disruptions to economic activities and continuously affected lives around the globe. In the Philippines, strict restrictions and quarantine measures have been enforced to mitigate the spread of COVID-19, posing a severe concern for the education sector. With schools closed for over a year, students were required to adapt to various modes of remote learning to continue their education (UNICEF, 2021). However, research has shown that learning

during the pandemic presents numerous challenges, including distractions at home and limited access to learning resources (Barrot et al., 2021). Additionally, the lack of physical interaction between students and teachers has decreased motivation (Collado, 2022), while inadequate instruction and supervision from guardians have further impacted learners' performance (Yacub & Eadie, 2022).

On the other hand, even pre-COVID, the Philippines faced challenges in education, especially in mathematics. In the PISA 2018 assessment, Filipino students scored an average of 353 points in mathematical literacy. This level of mathematical literacy falls well below the OECD average of 489 points and is categorized as below Level 1 proficiency (Organization for Economic Cooperation and Development [OECD], 2019). For this reason, it is critical to examine learner motivation and mathematics performance during the COVID-19 pandemic.

According to Dweck (2017), mindset refers to an individual's beliefs regarding the malleability of intelligence, categorized as either a fixed or a growth mindset. These beliefs have been found to influence motivation, subsequently impacting learners' performance (Dweck & Yeager, 2019). Previous studies have demonstrated that mindset significantly influences students' mathematics performance (Brandisauskiene et al., 2021; Claro & Loeb, 2019; Degol et al., 2018; Kuusisto et al., 2017). While numerous studies support the positive impact of mindset, some studies have reported conflicting results (Glerum et al., 2020; Li & Bates, 2020; Mokhithi et al., 2020). Furthermore, most of these studies were conducted outside the Philippines and before the COVID-19 pandemic.

Moreover, motivational concerns push individuals to act (Ryan & Deci, 2017). Due to this, motivation is highly regarded, especially in the education context. According to Ryan and Deci (2017), intrinsic motivation is a behavior carried out of an individual's interest or satisfaction, which they elicit from the behavior itself. Meanwhile, extrinsic motivation is characterized by behaviors performed, which are crucial in achieving a separate outcome. It is argued that the more autonomous the extrinsic motivation is, the more it will promote high-quality performance and well-being compared to a more controlled extrinsic motivation (e.g., external reward or pressure). Additionally, self-efficacy is about the belief of the students that they have the competence to work well in mathematics (Fiorella et al., 2021). When manifested, it can influence performance (Eccles & Wigfield, 2020). Furthermore, self-regulated learning (SRL) is how students proactively take control of their learning by regulating learning strategies, organizing and managing time, and self-monitoring (Zimmerman, 2015). Evidence suggests SRL is associated with academic success metrics (Zimmerman, 2015). Finally, test anxiety, strongly related to mathematics anxiety (Dowker et al., 2016), is considered in this study. Fiorella et al. (2021) defined this motivational barrier as anxiety that student experiences when being evaluated in mathematics or compared to other students. Intrinsic value, utility value, self-efficacy, self-regulation, and test anxiety are widely recognized motivational constructs that affect motivation and predictors of mathematics performance (Busari, 2013; Fitria et al., 2021; Fomina, 2017; Froiland & Davision, 2016; Kataras et al., 2013; Lohbeck, 2016; Negara et al., 2021; Owan et al., 2019; Pérez-Fuestes et al., 2020; Reyes & Castillo, 2015; Skaalvik et al., 2015; Tran & Nguyen, 2021; Yurt, 2015). However, limited attention has been given to understanding how these motivational constructs relate to students' mathematics performance during the pandemic.

Given the points raised in this study, it aimed to investigate students' growth mindset and motivation and their correlation with mathematics performance amidst the COVID-19 pandemic. By conducting this research within the Philippine context and during the pandemic, the researchers seek to address existing research gaps and provide insights into the discrepancies observed in the results regarding mindset and mathematics performance.

Theoretical Framework

Carol S. Dweck and her research colleagues identified two beliefs about human characteristics that are either fixed or malleable (Dweck, 2017; Dweck & Yeager, 2019). It became clear to them that people with different mindsets behave differently. A fixed mindset (entity theory) holds that human intelligence cannot be developed (Dweck & Yeager, 2019). This means that people with this mindset believe they cannot change their intelligence level. Dweck (2017) stated that challenges, setbacks, and high effort were risky for people with fixed mindsets. They are afraid to face challenges and cannot deal with setbacks because they will reflect poorly on their intelligence.

Furthermore, if one is intelligent, one will not make an effort. That is why working hard on a task implies a lack of intelligence. On the other hand, a growth mindset (or incremental theory) is the belief that intelligence can be developed through various means (Dweck & Yeager, 2019). An individual with this mindset sees the effort as a tool for improving one's ability. However, according to Dweck (2015), having a growth mindset is about more than just effort. An effort is necessary for success but is not the only factor. When necessary, the student should try different strategies and seek assistance from others.

Furthermore, unlike a fixed-mindset individual, a growth-mindset individual reacts differently to a setback. According to Yeager and Dweck (2020), people with a growth mindset are likelier to thrive in the face of setbacks and challenges. They would study more or try different strategies after experiencing setbacks. These students are more likely to face difficulties and setbacks because they see them as opportunities to learn and grow. Thus, these beliefs, known as mindset - growth and fixed - can influence motivation and human behavior.

Research Questions

The main goal of this study is to investigate the correlation between a growth mindset and students' mathematics motivation on their mathematics performance during the COVID-19 pandemic.

Specifically, it sought to answer the following questions:

1. What is the growth mindset of the respondents?

2. What is the mathematics motivation of the respondents in terms of:

    2.1. Intrinsic value;

    2.2. Utility value;

    2.3. Self-regulation;

    2.4. Self-efficacy;

    2.5. Test anxiety; and

    2.6. Overall mathematics motivation?

3. Is there a significant relationship between the following variables and students' mathematics performance?

3.1. Growth Mindset

3.2. Motivation in mathematics

Research Hypotheses

1. There is no significant relationship between the following variables and students' mathematics performance.

    1.1. Growth Mindset

    1.2. Intrinsic value

    1.3. Utility value

    1.4. Self-regulation

    1.5. Self-efficacy

    1.6. Test anxiety

    1.7. Overall mathematics motivation

Methodology

Research Design

This study adopted a quantitative approach with a descriptive research design to investigate the relationship between students' growth mindset and mathematics motivation and their mathematics performance during the COVID-19 pandemic. Moreover, the cross-sectional nature of this study design enabled the examination of these variables at a specific timeframe by providing valuable insights into their correlation with mathematics performance during the pandemic.

Participants

The population in this study was 1200 Grade 11 students from three public secondary schools in District III, Quezon City, for the school year 2022-2023, selected based on geographical considerations. Cochran's sample size formula was utilized to determine an appropriate sample size, resulting in a target of 310 participants. To ensure a random selection, the Grade 11 students were categorized into sections, and the participants were chosen through stratified sampling. These participants comprised 208 male and 102 female students currently enrolled in the General Mathematics subject for the school year 2022-2023. These students were enrolled in various senior high school programs, including Science, Technology, Engineering, and Mathematics (STEM), Humanities and Social Sciences (HUMSS), Accountancy, Business, and Management (ABM), General Academics Strand (GAS), Industrial Arts (IA), Information and Communications Technology (ICT), and Home Economics (HE).

Instruments

This study adopted two instruments: Dweck's Implicit Theories of Intelligence questionnaire to measure growth mindset and the Mathematics Motivation Questionnaire (MMQ) for Secondary School Students (Fiorella et al., 2021) to measure mathematics motivation.

The mindset questionnaire is a well-established one for measuring the mindset shown to have good psychometric properties (Burgoyne & Macnamara, 2021). Moreover, Burgoyne and Macnamara (2021) evaluated the reliability of the questionnaire ($\alpha = .94$), which indicated the excellent reliability of the questionnaire. This questionnaire comprises eight statements to which the students were expected to respond: 1 – strongly agree to 6 – strongly disagree. Odd-numbered statements covered the fixed mindset, while the even-numbered statements pertained to the growth mindset. In analyzing the questionnaire, the six-point Likert scale growth mindset statements are reversed so that the strongly disagree with

fixed mindset item is similar to the strongly agree with growth mindset item. And then, the mean response to the items served as the final score.

Moreover, Fiorella et al. (2021) provided validity and reliability evidence for the mathematics motivation questionnaire. Their study established the validity of MMQ for secondary school students. The questionnaire has five constructs indicated by 19 items in measuring mathematics motivation. Items 1 to 3, 4 to 7, 8 to 11, 12 to 15, and 16 to 19 covered intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety, respectively. The students were expected to respond 1 – never to 5 – always to each item in the MMQ. In addition, the Cronbach's αs of each construct was greater than .70. At the same time, the overall Cronbach's α of MMQ is .86. In analyzing the questionnaire, the test anxiety items' five-point scale is reversed because test anxiety items were stated such that the higher the score means more anxiety. Then, the mean response to the items served as the final score.

Additionally, pilot testing was done to ensure that the two adopted instruments are appropriate in the Philippine context. Thirty participants responded to the survey for pilot testing of the survey instrument. All the values of Cronbach's alpha are greater than .70, which indicates the acceptable reliability of the questionnaire.

Finally, the respondents' mathematics performance was represented by their first quarter grade in their core subject – General Mathematics, which includes their written works, performance tasks, and quarterly assessment in the said subject.

Data Collection

Before data collection, the researcher sought permission from the Schools Division of Quezon City by sending a formal letter requesting approval to conduct the study in public secondary schools. An endorsement letter was obtained as evidence of the granted permission. Subsequently, both the endorsement letter and the letter addressed to the principals were disseminated to the principals of the selected public secondary schools in District III, Quezon City. After obtaining their approval, the principals recommended assigning the researchers to the Grade 11 level coordinator, who would assist with data collection.

To ensure the randomness of the sample and protect the respondents' anonymity, the researchers implemented a systematic approach to data collection. Initially, they obtained the total number of students in each class without revealing personal information. Subsequently, the researchers calculated the target number of respondents for each class using proportion. Each student was assigned a unique number corresponding to their position in the class list. To select the respondents, the researchers utilized a mobile application that generated random numbers. With the assistance of the class adviser, the researchers identified the students corresponding to the randomly generated numbers, ensuring a fair and unbiased selection process.

Obtaining informed consent was carefully managed, particularly for the minor respondents. With assistance from the Grade 11 coordinator and advisers, the researchers ensured the proper distribution of the informed consent forms. To address the considerations around minors' involvement, the researchers worked with advisers through the coordinator to deliver online parental consent forms to the parents or guardians of the respondents. This process, which spanned a week, was implemented to provide adequate time and support for the minor respondents and their parents to understand the study's details, such as the research's purpose, procedure, risks,

benefits, and other pertinent information. Any questions or clarifications sought by the respondents or their parents/guardians were addressed during this discussion. After the respondents of legal age and the minor respondents, along with their parents, reached an informed decision, they signed the consent form to signify their voluntary participation in the study. The questionnaires were then distributed to those who had signed the consent form, and they were given fifteen minutes to complete the questionnaire. After completion, the class adviser collected the questionnaires and returned them to the researcher. Finally, the collected data were tallied, tabulated, and organized using MS Excel. To ensure confidentiality, the data were stored in a secure database accessible only to the researcher.

Data Analysis

The data were analyzed using the statistical software IBM SPSS 23. The frequency distribution was employed to provide an organized representation of the participant's responses to the distribution of mindset profiles from the participants. In addition, the mean was utilized to calculate the final score for each student in both the growth mindset and mathematics motivation questionnaires. This statistical measure quantitatively represented the participants' overall scores on their growth mindset and mathematics motivation constructs. Furthermore, Spearman's rank-order correlation is used to assess the relationship between the students' growth mindset and mathematics motivation and their mathematics performance during the COVID-19 pandemic. In this study, it was the most appropriate statistical test to determine the degree of correlation when the data do not follow a normal distribution.

Ethical Consideration

To make sure that this study complies with ethical standards, the researcher successfully underwent evaluation by their institution's Research Ethics Committee with approval code UREC-2022-0273. Respondents of legal age and minor respondents, along with their parents/guardians, were given informed consent forms containing detailed information about the study's purpose, procedures, possible benefits, and risks. Additionally, all information gathered is handled confidentially, used only for research, and is only accessible by the researcher following the Data Privacy Act. Also, it was stated that after three years, data would be securely destroyed by shredding paper records and permanently erasing digital files. Moreover, participants were informed of their unrestricted right to refuse or withdraw their data. By considering this ethical consideration, this study guarantees participant rights and privacy protection.

Result and Discussion

Mindset Profile of the Respondents

Table 1

Distribution of Mindset Profile Among the Respondents

Mindset	Frequency	Percentage (%)
Fixed Mindset	207	66.8
Undecided	94	30.3
Growth Mindset	9	2.9
Total	**310**	**100.0**

Table 1 presents the distribution of mindsets among the respondents, indicating that 66.8% of participants hold a fixed mindset, believing intelligence to be innate. In comparison, only 2.9% (9 out of 310) hold a growth mindset, recognizing intelligence as malleable. The congestion of topics from the current curriculum could influence students' prevalence of fixed mindsets. Since teachers need to cover all topics, the students need to follow the pacing to complete it, which

could contribute to fostering a fixed mindset. Also, in Filipino culture, where respect for authority is highly valued, students might be more prone to perceive mistakes as signs of incompetence, reinforcing a fixed mindset. Finally, societal pressure to excel academically could further discourage risk-taking and experimentation, which are fundamental to a growth mindset.

The study findings align with the OECD (2018) report, which ranked the growth mindset of Filipino students as one of the lowest among PISA-participating countries. In contrast, Dweck and Molden (2017) reported an equal distribution of mindsets at 40%. A plausible explanation for these results may lie in the timing of the mindset questionnaire administration, which coincided with the quarterly exam period. The OECD (2018) identified that the fear of judgment from others in the face of failure is prevalent among Filipino students, indicative of a fixed mindset (Dweck, 2017). A potential factor contributing to the prevalence of a fixed mindset could be the challenges posed by the COVID-19 pandemic. As mindsets can evolve through exposure to different circumstances (Dweck, 2017), participants were pushed to adopt a fixed mindset.

Mathematics Motivation Level of the Respondents

Table 2

The Mathematics Motivation Level of the Respondents

Mathematics Motivation	Mean	Verbal Interpretation
Intrinsic Value	3.52	Usually
Utility Value	3.78	Usually
Self-regulation	3.65	Usually
Self-efficacy	3.21	Sometimes
Test Anxiety	3.77	Usually

Legend:

"Never (1.00 – 1.50)", "Rarely (1.51 – 2.50)", "Sometimes (2.51 – 3.50)", "Usually (3.51 – 4.50)", "Always (4.51 – 5.00)"

Table 2 presents the mean scores for the five mathematics motivation constructs. Notably, self-efficacy received the lowest score of 3.21, suggesting that the respondents occasionally believe in their mathematical abilities. On the contrary, they frequently expressed concerns regarding mathematics assessments and being compared to others (test anxiety). It appears that the grading system in the Philippines might influence this result, where 25% of students' grade comes from one quarterly examination, which can trigger anxiety. These findings also align with the OECD (2019) report, which identified that many students in the Philippines worry about how others perceive them when facing failure. The comparison between the mean self-efficacy score and the test anxiety is of particular interest. It seems that the students' self-efficacy appears to be undermined relative to their level of test anxiety. Rozgonjuk et al. (2020) highlighted a strong negative correlation between test anxiety and self-efficacy. Following this, there may be a cultural influence within the Philippines, where fear of public judgment is rooted, which could contribute to students harboring doubts about their mathematical ability when faced with complex problems. This cultural trait may lead them to exhibit lower self-efficacy and higher test anxiety due to a hesitance to make mistakes in public settings. The findings also reveal that the respondents are willing to exert effort and employ strategies in learning mathematics (self-regulation). It appears that the students develop self-regulated learning strategies while in the remote learning setup, where minimal supervision fosters a greater sense of autonomy and responsibility in managing their academic progress.

Moreover, relatively high scores in intrinsic value (recognition of the personal value in learning mathematics) and utility value (its relevance to their lives and future careers) could be attributed to specific cultural perspectives in the Philippines. For instance, Filipino students often have

a strong appreciation for education. It is frequently regarded as a pathway to succeed and a way to uplift one's family and community. Additionally, many Filipino families view education, including subjects like mathematics, as a means to enhance their children's opportunities for employment and social mobility. This perspective on education's role in shaping one's future could explain this result, as the students recognize the tangible benefits of mathematics education for their personal and career aspirations.

Relationship between Growth Mindset, Motivation, and Mathematics Performance

Table 3

A Summary of the Result of Spearman's Rank-Order Correlation Between Students' Growth Mindset, Motivation, and Mathematics Performance

	Variable	*n*	*1*
1.	**Mathematics Performance**	310	-
2.	**Growth Mindset**	310	0.228**
3.	**Intrinsic Value**	310	0.185**
4.	**Utility Value**	310	0.171**
5.	**Self-regulation**	310	0.250**
6.	**Self-efficacy**	310	0.116*
7.	**Test Anxiety**	310	-0.076
8.	**Overall mathematics motivation**	310	0.189**

*** Correlation is significant at the 0.01 level (2-tailed)*

** Correlation is significant at the 0.05 level (2-tailed).*

Table 3 presents the correlation between growth mindset, motivation, and mathematics performance. It shows a correlation coefficient of r = .228 between students' growth mindset and mathematics performance, indicating a weak and positive correlation. The p-value of less than .001, less than the significance level of .01, rejects the null hypothesis and suggests a significant relationship between mindset and mathematics performance. Additionally, the correlation coefficients for intrinsic and utility values, self-regulation, self-efficacy, and overall mathematics motivation were .185, .171, .250, .116, and .189, respectively, indicating a weak positive correlation. The p-values for these constructs and overall mathematics motivation were all below the significance level, leading to the rejection of the null hypothesis. Therefore, intrinsic and utility values, self-regulation, self-efficacy, and overall mathematics motivation were found to have a significant relationship with mathematics performance. However, test anxiety showed a correlation coefficient of -.076, indicating a weak inverse correlation. The p-value for test anxiety was .182, greater than the significance level ($p>.05$), resulting in insufficient evidence to reject the null hypothesis. Thus, no significant relationship was found between test anxiety and math performance.

Based on the correlation between students' growth mindset and mathematics performance, the finding contradicts previous studies by Li and Bates (2020), Mokhithi et al. (2020), Doleck et al. (2018), Bahnik and Vranka (2017), and Macnamara and Rupani (2017) that did not find such a link. On the contrary, it supports Dweck's (2017) theory and extends the existing body of research (Yeager et al., 2019; Claro and Loeb, 2019; Haimovitz and Dweck, 2017; Kuusisto et al., 2017) by demonstrating the association between mindset and mathematics performance even during the COVID-19 pandemic. Notably, variations in mindset questionnaires used by different researchers may explain inconsistencies across studies, emphasizing the importance of carefully considering the choice of mindset measurement tools. Furthermore, the findings of this study support the results of previous studies by Froiland and Davison (2016), Tran and Nguyen (2021), Lohbeck (2016), Skaalvik et al. (2015), Pérez-Fuestes et al. (2020), Negara et al. (2021), Yurt (2015), Fitria et al. (2021), Busari (2013), and Fomina (2017), which demonstrated a significant positive association between

intrinsic and utility value, self-regulation, self-efficacy, overall mathematics motivation, and mathematics performance. Moreover, this study extends these findings by suggesting that these motivational constructs can still predict mathematics performance even during the COVID-19 pandemic. In contrast to Karatas et al. (2013) and Owan et al. (2019), who found a negative association between test anxiety and performance, the current study revealed an inverse and very weak relationship between test anxiety and mathematics performance, which was not significant. One possible explanation for this finding is that test anxiety may be more closely linked to mathematics examination results than overall performance. This explanation aligns with the findings of Reyes and Castillo (2015), who observed a strong correlation between test anxiety and departmental examination results in mathematics. Another factor that may contribute to the results is the impact of the COVID-19 pandemic, particularly the shift to alternative learning modalities and the removal of summative examinations as mandated by DepEd Order No. 031 s. 2020 (DepEd, 2020), which could have influenced students' perceptions of test anxiety.

Conclusion and Recommendation

The main objective of this study is to investigate the relationship between students' mindset, mathematics motivation, and their mathematics performance during the COVID-19 pandemic. Previous studies have primarily focused on settings outside of the Philippines and pre-pandemic conditions, creating a gap in understanding these variables in the context of a global crisis. Hence, this study helped address a gap in the literature and provided valuable insights that can inform stakeholders, leading to improved students' mathematics learning outcomes.

The findings show that the majority of respondents hold a fixed mindset. The same respondents generally agree with statements related to intrinsic and utility value, self-regulation, and test anxiety and sometimes agree with the self-efficacy statement. It also reveals a direct and weak correlation between mindset, intrinsic and utility values, self-regulation, self-efficacy, overall mathematics motivation, and mathematics performance, which is statistically significant. However, the test anxiety variable demonstrates an inverse and weak correlation with mathematics performance, which is not statistically significant.

Moreover, the results of this investigation have important theoretical and practical implications for educators and policymakers to develop interventions and strategies that promote a growth mindset and motivation, especially during similar crises like the COVID-19 pandemic. Firstly, it implies the need for interventions to promote a growth mindset among students. Teachers can explicitly promote that intelligence can be developed through effort and learning. They can also provide specific and constructive feedback that highlights areas for improvement. This helps students see mistakes as a stepping stone toward improvement rather than failure. Secondly, it highlights the resilience and dedication of the learners despite the challenging circumstances. Thirdly, it also emphasizes the crucial role of mathematics motivation in enhancing students' mathematics performance, particularly during the pandemic. Teachers are encouraged to connect mathematics concepts to real-life situations and applications relevant to students' lives. This can enhance engagement and motivation by demonstrating the practical value of what they are learning.

Additionally, they can encourage students to share their struggles and successes, fostering a sense of community and reducing anxiety. Also, teachers can use various assessment methods, including

projects, presentations, and collaborative activities, to reduce the singular focus on high-stakes exams that can trigger anxiety. Moreover, encourages students to reflect on their learning journey and set personal goals. This helps them take ownership of their learning and build self-efficacy.

The researchers acknowledge several limitations that may affect the study's findings. Firstly, assessing students' growth mindset and mathematics motivation was conducted only once. To address this, future research can employ a longitudinal study design. Secondly, the study relies on self-reported data. Future research can use a mixed-method approach to enhance the validity of findings. Future studies can provide a more comprehensive understanding of these variables by addressing these limitations.

Finally, future research should investigate growth mindset and motivation across diverse populations, including private schools, to enhance the generalizability of the findings. Additionally, developing a culturally relevant growth mindset questionnaire specific to the Philippine context would improve the accuracy of assessments. Furthermore, conducting experimental studies on the impact of growth mindset interventions on mathematics performance in the Philippines would offer practical insights to inform educational practices. These research directions will contribute to a deeper understanding of how growth mindset and motivation influence mathematics performance in the Philippine context and support educators in implementing effective strategies for enhancing students' learning outcomes.

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