READINESS OF GRADE 10 STUDENTS ON THE PREREQUISITE SKILLS IN STEM MATHEMATICS: A BASIS FOR STRATEGIC INTERVENTION MATERIAL

Jan Angelo G. Morata
Department of Education, Louella Gotladera Alcoba National High School, Bulan, Sorsogon, Philippines

Corresponding Email: janangelo.morata@deped.gov.ph

Available Online: December 2024
Revised: October 2024
Accepted: October 2024
Received: November 2024

Volume II Issue 4 (2024)
DOI: 10.5281/zenodo.14292913
E-ISSN: 2984-7184
P-ISSN: 2984-7176
https://getinternational.org/research/

Abstract
The preparedness and performance of Grade 10 students in prerequisites of STEM mathematics was the subject discussed in this study. General findings pointed to the fact that most students exhibited "Satisfactory" performance scores in key areas, with some readiness gaps seen in certain areas such as the Law of Exponents and Logarithmic and Exponential Functions rated "Low" to "Moderate". Readiness was highly associated with performance on some of the specific competencies - namely quadratic equation techniques and formula manipulation, but not others; readiness cannot be inferred from performance alone. There is a suggestion to design strategic intervention materials that would close these gaps and refresh skills in critical areas of mathematics. The SIM should have activities that are structured, ways to motivate and support instruction towards the goal, so that there is a bridging between readiness and performance. Overall, it points out that what matters is a focused intervention for improving readiness among students in advanced STEM mathematics-prepared better for future academic and career challenges in STEM disciplines.

Keywords: *Educational Interventions, Strategic Intervention Material*, *Mathematical Readiness, Prerequisite Skills, STEM Mathematics*

Recommended Citation:
Morata, J. A. G. (2024). READINESS OF GRADE 10 STUDENTS ON THE PREREQUISITE SKILLS IN STEM MATHEMATICS: A BASIS FOR STRATEGIC INTERVENTION MATERIAL. 2(4), 36–47. https://doi.org/10.5281/zenodo.14292913

INTRODUCTION

Professional demand in Science, Technology, Engineering, and Mathematics is increasing exponentially around the globe as part of this fast-moving technology world. Almost every country in the world today has decided that they need to lay a strong foundation of education in STEM to survive the pressures of today's transitioned world economy (Widya et al., 2019). The OECD reports that readiness in mathematics, a core element of STEM, remains a persistent challenge area in many regions. Both sides of the Atlantic-from the United States across to Asia and then Europe after study points to a lack of foundational mathematical skills needed to tackle advanced STEM disciplines in higher education. The need thus indicated turns out to be very critical in terms of interventions that could help bridge the gap between basic education and the advanced requirements of STEM.

The Philippines has come to realise this concern at the national level. The Philippines implemented several reforms to education, including the K-12 program and the availability of STEM tracks for students. Filipino students still do not pull through; Filipino students still lag in TIMSS international assessments. The DepEd recognizes that Grade 10 students, who are at a critical turning point of their transition into more specialized STEM education, often lack prerequisite mathematical proficiency. Locally, most schools face challenges in preparing the students for the demands of higher-level STEM courses, which teachers say is almost always augmented by the gaps in conceptual understanding and problem-solving capabilities of the students (Bibon, 2022).

Although many studies discussed the student difficulties in the STEM areas - engineering, mathematics, and natural sciences- there is still a gap in related literature addressing readiness at the Grade 10 level to master prerequisite mathematical skills for the same STEM subjects (Merwe et al., 2020). Most of the studies were only about teacher competence, curriculum gaps, or even general mathematics performance at different grade levels. Very few studies examine in particular the competencies that students need before accessing more advanced courses in the later years of senior high school. This study aims to fill the gap by ascertaining the readiness of Grade 10 student exam scores with a focus on the foundational mathematical skills needed to succeed within STEM pathways.

While previous work may have focused on mathematics achievement as a whole or targeted specific areas in the country, this work is that of focus because the prerequisite skills will be directly assessed and a SIM designed and developed to fill those gaps. The localized and skill-specific intervention in this work can thus be reproduced elsewhere.

The researcher of the present study decided to carry out this research based on observation and experience as an educator. This view was backed by Fadlelmula et al. (2022) who take day-to-day interaction in a classroom into consideration and often point out that most students fail to prepare themselves for STEM courses because of inadequacies in their fundamental mathematical concepts. Such gaps often lead to poor performance, decrease the interest that students show in the subjects, and ultimately lead to a decline in STEM enrollments. Addressing this problem would bring a contribution not only to the improvement of the academic outcomes of students but also to the contributions that can be made toward the development of the country's goal by increasing the production of more STEM professionals to further nation-building efforts.

This study has some legal bases that will support it. The Enhanced Basic Education Act of 2013 or Republic Act No. 10533 must have an educational framework put in place that will prepare the learner for work, entrepreneurship, or further studies, most especially the priority areas like STEM. Moreover, DepEd Order No. 8, s. Specifically, the policy guidelines of 2015 have been set under classroom assessment for the K-12 Basic Education Program. It is a requirement under this policy to have formative assessments that will pave the way for preparing students to compete at the senior high school level. These legal frameworks stress the preparation of the students before their presentation to higher levels of education. A strategic intervention leading to better readiness will be highlighted through the conduct of this research.

Recent studies in the Philippines have investigated the readiness of Grade 10 students in mathematics, particularly concerning their preparedness for Senior High School (SHS) STEM programs. These studies highlight the necessity for targeted interventions to enhance students' foundational skills. Herrera and Dio (2016) assessed the readiness of Grade 10 students in Sorsogon City for SHS General Mathematics. Their findings indicated that students exhibited low mastery in essential competencies, underscoring the need for strategic intervention materials (SIMs) to address these deficiencies. Similarly, Orque (2021) explored the correlation between numerical competence and SHS readiness among Grade 10 learners in Eastern Samar. The study revealed that many students lacked the necessary numerical skills, suggesting that interventions are crucial to prepare them for advanced STEM courses.

These studies collectively emphasize the importance of developing SIMs focused on prerequisite mathematical skills to improve the readiness of Grade 10 students for STEM-related challenges in SHS.

The present study, therefore, aims to provide a comprehensive analysis of Grade 10 students' readiness in prerequisite STEM mathematics skills and to propose targeted solutions to improve their preparedness. In doing so, it seeks to contribute both to the body of literature on STEM education and to the broader goal of improving the quality of mathematics instruction in the Philippines.

Objectives

The present study is designed to assess the readiness level of Grade 10 students on prerequisite skills in STEM mathematics and to generate a SIM that would fill in the gaps identified during the review of the pretest. In more precise terms, the following objectives are set for this study:

Specifically, this study aimed to answer the following questions:

1. What is the level of performance of Grade 10 students on the prerequisite skills in STEM Mathematics?
2. What is the level of readiness of Grade 10 students on the prerequisite skills in STEM Mathematics?
3. How significant is the relationship between the level of readiness and performance on the prerequisite skills in STEM Mathematics?
4. What intervention and its coverage can be proposed based on the findings of the study?

METHODS

Research Design

The study employed a descriptive-correlational research design, as descriptive research enables systematic exploration of the readiness of Grade 10 students in prerequisite skills for STEM mathematics (Creswell & Creswell, 2018). This approach provides clarity about students' preparedness and identifies potential correlations between their readiness and their performance on the researcher-made exam. By adopting this method, the research effectively captures the necessary data to inform interventions and guide strategies for improvement in mathematical competencies (Fraenkel, Wallen, & Hyun, 2019).

Population and Sampling

The study population consisted of 50 Grade 10 students enrolled in a secondary school in Sorsogon, focusing specifically on those interested in pursuing the STEM track for senior high school. A purposive sampling technique, which involves deliberately selecting participants who meet specific criteria, was used to ensure that only students interested in STEM were included in the research (Etikan, Musa, & Alkassim, 2016). This approach allowed the study to concentrate on the target population and excluded those who had no prior consideration of the STEM track. The sample size was determined based on the total number of Grade 10-eligible students in the selected school, aligning with recommendations for purposive sampling in educational research (Palinkas et al., 2015).

Instrumentation

Two major tools were used in this research; that is, a questionnaire on student readiness for STEM mathematics and the other a researcher-made exam on prerequisite mathematical skills. The questionnaire measured the perception of readiness of the students in terms of knowledge and problem-solving abilities and one's confidence to address the subject matter involved in mathematics in the following mathematical areas. The research-developed test was designed to assess student capabilities in essential mathematical concepts that are to assure attainment of mastery in the stem areas: algebra (quadratic functions, polynomial functions, logarithmic functions, and law of exponents) geometry (plane geometry), trigonometry, formula manipulation, and problem-solving (word problems). These topics will be the centre for the survey questionnaire for readiness and performance evaluation on the prerequisite skills in STEM Mathematics, which is the specialized subjects only offered in the STEM strand, the Pre-calculus and Basic Calculus. Content validation of both tools through the use of a panel of experts in mathematics education validated whether these were appropriate and adequate assessments of what they intended to measure.

Ethical Considerations

The study adhered to the ethical standards. It sought and obtained permission to carry out research from the school administration as well as from authorities in education. Consent was sought from the children and their parents or guardians. The consent form explained what the study entails, the procedures to be followed, what possible risks may be incurred, and the benefits. Participation was based on a voluntary decision and was made to know that at any moment, participation in the study could be withdrawn with nothing worse happening (American Psychological Association, 2020). The researcher coded the responses and kept all data strictly confidential and anonymous. The individual responses were not forwarded to anybody, while aggregate results from the study were only presented.

Data Collection

The data-gathering process was conducted in two stages, ensuring fairness and consistency by adhering to standardized conditions. In the first stage, a readiness survey was administered to the selected Grade 10 students in their classroom, allowing sufficient time for them to complete the questionnaire (Fraenkel, Wallen, & Hyun, 2019). The second stage involved the administration of a researcher-developed exam assessing prerequisite STEM mathematics skills. Both tools were supervised by the researcher to ensure that participants properly followed the instructions, maintaining reliability and validity in data collection (Creswell & Creswell, 2018).

Data Analysis

The collected data were analyzed using both descriptive and inferential statistical methods. Descriptive statistics, including mean, frequency, and percentage, were utilized to summarize the levels of readiness and performance of students in the prerequisite mathematics exam (Creswell & Creswell, 2018). To examine the relationship between students' levels of readiness and their mathematical performance, the Chi-square Test of Independence was employed, as both variables were treated as categorical data (Pallant, 2020). This test enabled the researcher to determine whether a significant relationship existed between perceived readiness and actual mastery of prerequisite skills. All statistical analyses were conducted using SPSS (Statistical Package for Social Sciences), a widely recognized tool for educational and social science research (Field, 2018).

RESULTS and DISCUSSION

Level Of Readiness on The Prerequisite Skills In STEM Mathematics Of Grade 10 Students

The descriptive statistics of the readiness level of Grade 10 pupils in STEM Mathematics, as reflected in Table 1 shows that generally, the students showed "Moderate Readiness" across the skills assessed for prerequisites, with an overall mean score of 3.00 and a standard deviation at 0.571. However, when analyzed individually, competencies display different levels of readiness. For instance, in quadratic equations, logarithmic and exponential functions, polynomial functions, and trigonometry, students show an average level of readiness as Mean = 3.18, SD = 1.351; Mean = 2.96, SD = 1.456; Mean = 3.30, SD = 1.344; and Mean = 3.00, SD = 1.457, respectively, aligned with the overall result. As against this, the student's readiness on the law of exponents was categorized under "Low Readiness" as Mean = 2.56, SD = 1.445. That could be another aspect that requires more support or intervention. Other competencies that fall in moderate readiness are solving word problems which had a Mean = 3.20, SD = 1.471 and formula manipulation which had a Mean = 2.76, SD = 1.422. These findings therefore show that the students have generally been moderately prepared for most aspects except possibly specific areas requiring some targeted efforts to be developed so that they can better understand certain concepts like the law of exponents.

Table 1

Descriptive Statistics on the Readiness Level of Grade 10 students on the prerequisite skills in STEM Mathematics

Competency	Mean	Standard Deviation	Description
1. Quadratic Equation	3.18	1.351	Moderate Readiness
2. Logarithmic and Exponential Function	2.96	1.456	Moderate Readiness
3. Polynomial Function	3.30	1.344	Moderate Readiness
4. Law of Exponents	2.56	1.445	Low Readiness
5. Plane Geometry	2.72	1.278	Moderate Readiness
6. Trigonometry	3.00	1.457	Moderate Readiness
7. Formula Manipulation	2.76	1.422	Moderate Readiness
8. Solving Word Problems	3.20	1.471	Moderate Readiness
Overall	**3.00**	**0.571**	**Moderate Readiness**

Note. 1.00 – 1.80 = Very Low Readiness; 1.81 – 2.60 = Low Readiness; 2.61 – 3.40 = Moderate Readiness; 3.41 – 4.20 = High Readiness; 4.21 – 5.00 = Very High Readiness

There is observed "Moderate Readiness" of Grade 10 students in prerequisite STEM Mathematics skills, in line with the previous literature regarding the readiness of students in advanced-level mathematics and STEM subjects. Incoming freshmen students into the STEM field often struggle with foundational topics such as algebra, trigonometry, and problem-solving necessary for success in advanced work (Robinson et al., 2021). In that regard, Muhassanah and Lukman (2020) reported that many students still face challenges with prerequisites in mathematics, including handling formulas or equations, especially among those who enter from underprepared backgrounds, which is comparable to the low readiness results for the law of exponents in the present study. Furthermore, the readiness level on various topics is consistent with the studies of lacunas in areas of mathematical understanding, such as exponents and logarithms, the usual cited source of trouble for students making their way to more advanced STEM subjects (Chen & Ho, 2012).

A gap of this nature makes the need for special input in mathematics education, especially for students who have their eyes on STEM programs in senior high school, even more imperative. Helping such students overcome readiness issues early will lead to further enhancement in student outcomes in both high school and post-secondary STEM programs (Jaafar & Maat, 2020).

Level Of Performance on The Prerequisite Skills In STEM Mathematics Of Grade 10 Students

Table 2

Descriptive Statistics on the Performance Level of Grade 10 students on the prerequisite skills in STEM Mathematics

Competency	Mean	Standard Deviation	Description
1. Quadratic Equation	4.62	0.567	Outstanding
2. Logarithmic and Exponential Function	3.06	0.793	Satisfactory
3. Polynomial Function	4.58	0.538	Outstanding
4. Law of Exponents	3.00	0.808	Satisfactory
5. Plane Geometry	4.30	0.789	Outstanding
6. Trigonometry	4.58	0.642	Outstanding
7. Formula Manipulation	4.60	0.606	Outstanding
8. Solving Word Problems	3.48	0.789	Very Satisfactory
Overall	**4.03**	**0.266**	**Very Satisfactory**

Note. 1.00 – 1.80 = Poor; 1.81 – 2.60 = Fairly Satisfactory; 2.61 – 3.40 = Satisfactory; 3.41 – 4.20 = Very Satisfactory; 4.21 – 5.00 = Outstanding

The descriptive statistics on the level of performance of Grade 10 students on the prerequisite competencies in STEM Mathematics shown in Table 2 indicate that, as a group, the students performed at the "Very Satisfactory" level since the overall mean was 4.03 and the standard deviation was 0.266. Specific competencies show a significant variation in performance, but "Outstanding" performance is noted in some key areas, such as quadratic equations with Mean = 4.62, SD = 0.567; polynomial functions with Mean = 4.58, SD = 0.538; and plane geometry, trigonometry, and formula manipulation with Mean = 4.30, 4.58, and 4.60, respectively, with SD = 0.789, 0.642, and 0.606. These high levels of achievement indicate that the students are well prepared with the core mathematical concepts that one would deem necessary for the coursework of STEM studies.

On the other hand, performances in logarithmic and exponential functions with Mean = 3.06, SD = 0.793 and the law of exponents with Mean = 3.00 and SD = 0.808 fall at "Satisfactory", indicating that the students have conceptual understanding but require further development. The ability to solve word problems is rated "Very Satisfactory," with a mean of 3.48 and a standard deviation of 0.789; it forms a robust foundation in the application of mathematical knowledge in problem-solving situations. At the bottom line, the students excelled in most of the prerequisite skills, but logarithmic and exponential functions plus exponents need more support so that students can generally perform better, thereby fully preparing them for advanced STEM courses.

Giangan and Gurat (2022) showed that the students in STEM generally excelled in core mathematical areas such as calculus despite learning challenges and reflected similar strengths in complex problem-solving skills and mathematical manipulation. In addition, Domondon et al. (2022) mentioned that although they do well in some aspects of mathematics, such as in the areas of geometry and algebra, there may be weaknesses in certain areas, like logarithmic functions and exponents, and thus more support might be a necessity if they wish to join STEM career-related courses. Therefore, these studies indicate that besides general class support, specific areas need to be reinforced to better improve student performance altogether. The strong performance in word problems, as seen in your results, further supports the notion that students benefit from applied problem-solving techniques, as noted by Nuruddin et al. (2020), who found that a higher self-concept in mathematics positively correlates with better performance in subjects requiring analytical thinking and real-world applications.

Correlation Between the Level of Performance and Level of Readiness of Grade 10 Students on the Prerequisite Skills in STEM Mathematics

Table 3

Analysis of the relationship between the Readiness level and Performance level on the prerequisite skills in STEM Mathematics of Grade 10 Students

Competency	X^2 – value	Sig. value	Interpretation	Decision to Ho
1. Quadratic Equation	17.616	0.024	Significant	Reject
2. Logarithmic and Exponential Function	12.729	0.692	Not Significant	Accept
3. Polynomial Function	6.197	0.625	Not Significant	Accept
4. Law of Exponents	25.229	0.066	Not Significant	Accept
5. Plane Geometry	6.841	0.949	Not Significant	Accept
6. Trigonometry	2.745	0.642	Not Significant	Accept
7. Formula Manipulation	18.743	0.016	Significant	Reject
8. Solving Word Problems	15.769	0.202	Not Significant	Accept
Overall	**22.57**	**0.311**	**Not Significant**	**Accept**

α = 0.05 Level of Significance

The analysis done on the readiness and performance levels of Grade 10 students in the prerequisite competencies in STEM Mathematics showed mixed results. According to Table 3, there is a significant relation between readiness and performance in solving quadratic equations X^2 = 17.616 and p-value = 0.024 and formula manipulation with X^2 = 18.743 and p-value = 0.016, thus showing a higher level of performance in these topics at higher readiness levels. In this regard, it might be noted that, in comparison, students who were better prepared in the fundamental algebra skills performed significantly better for related tasks, thereby supporting readiness as an important predictor of success in those competencies.

Other competencies such as logarithmic and exponential functions, polynomial functions, law of exponents, plane geometry and trigonometry showed no significant relationship with ready-to-perform in them since p-values greater than 0.05 for all cases; this means that students' readiness levels in these areas would not predict much their performance, that may imply other factors like the way the teachers train and the way individual learners choose in terms of mastering skills in these competencies.

Overall, while there is a general positive association between readiness and performance in some core skills, the non-significant results for several competencies highlight the need for further investigation into what drives performance beyond mere readiness in specific STEM Mathematics topics. These results align with previous findings that suggest readiness is a key predictor in some but not all mathematical areas (Domondon et al., 2022; Giangan & Gurat, 2022).

The findings that levels of readiness correlate to Grade 10 student's performance in the areas of STEM Mathematics buttress recent studies on achievement and motivation in math contexts. It has been ascertained that readiness or preparedness is a determining factor for student performance especially in foundational areas, which include algebra and quadratic equations, where considerable associations were observed (Fiorella et al., 2021; Han et al., 2021). For example, algebra readiness in solving algebra problems strongly predicts performance, as seen in your result for quadratic equation and formula manipulation, reflecting similar outcomes to the recent studies.

Furthermore, empirical proof also underscores the idea that in some topics, like logarithmic and exponential functions, the student's motivation, self-efficacy, and instructional support significantly impact their performance. For instance, such students who possess higher levels of self-efficacy often maintain effort with more persistence and achievement in STEM subjects, even when the material is tough or, as taught in class, hard to understand (Hu et al., 2022). On the other hand, research has been proven to indicate that readiness in itself, without a targeted intervention and teaching strategy as such cooperative models is effective in enhancing students' performance in domains where readiness alone will not predict success (Mukuka et al., 2021).

Overall, the results of your study are consistent with contemporary literature that underscores that student mathematics achievement is multi-dimensional and should be considered under both cognitive and affective factors, including mindset, motivation, and self-efficacy (Li & Bates, 2020; Dweck, 2017).

Basis for the Strategic Intervention Material

This gave birth to the idea of creating a Strategic Intervention Material, this time for Grade 10, because of findings on specific areas of weakness in STEM Mathematics. The result was "Low Readiness" in the Law of Exponents with Mean = 2.56 and "Moderate Readiness" in Logarithmic and Exponential Functions with Mean = 2.96, yet both of these have only "Satisfactory" performance since Mean = 3.00 for the Law of Exponents and Mean = 3.06 for Logarithmic and Exponential Functions. All these results mark a high emphasis on targeted intervention for addressing these topics.

The Law of Exponents and Logarithmic and Exponential Functions are core topics that play a significant role in complex mathematical problem-solving and STEM applications. Results suggesting that students were poorly prepared despite adequate performance indicate that, indeed, they need better, more structured learning experiences to deepen their conceptual understanding. Thus, the SIM should focus on the development of both procedural fluency with conceptual knowledge through step-by-step instructions, contextualized problems, and real-life applications, making these abstract concepts real. Recent research underscores the necessity of integrating both conceptual understanding and procedural fluency in teaching exponential and logarithmic functions. For instance, a study by Borji et al. (2023) revealed that university students often struggle with these concepts when applied to real-world situations, highlighting the need for instructional strategies that bridge theoretical knowledge with practical application.

Motivation-based strategies should also be incorporated, such as putting self-assessment tools and a growth mindset in place, since these studies suggest that these could eventually play a more important role in students' mathematical performance compared to self-efficacy. This would then promote higher activities of interaction with difficult topics and subsequently improve readiness and consequent achievement. The SIM would target these areas so that knowledge gaps are bridged as well as enhance students' confidence to do well in advanced mathematics, ensuring better preparedness for future STEM-related challenges. Incorporating motivation-based strategies, such as fostering a growth mindset and utilizing self-assessment tools, has been shown to enhance mathematical performance. A study by Yang et al. (2023) demonstrated that students with a growth mindset and high self-efficacy achieved better outcomes in mathematics, suggesting that these psychological factors are crucial for engaging with challenging topics.

Therefore, a Structured Instructional Module (SIM) that combines step-by-step instructions, contextualized problems, real-life applications, and motivation-based strategies can effectively bridge knowledge gaps and boost students' confidence in advanced mathematics, preparing them for future STEM challenges.

CONCLUSION

Generally, Grade 10 students manifested a mixed profile of readiness and performance levels in most of the prerequisite skills for doing STEM Mathematics. There were good representations of having a strong performance in core competencies such as solving quadratic equations and polynomial functions. On the contrary, these students presented with woeful deficiency in readiness as shown in topics like the Law of Exponents and Logarithmic and Exponential Functions. The readiness-performance gap in some areas is less than fully explained by an underlying lack of deep conceptual understanding, at least in abstract mathematical areas, even where the performance outcomes are satisfactory. The outcomes suggest that while some tasks have sufficient readiness, foundational knowledge is poorly developed in the ability to solve more complex problems; readiness levels were reported as being only moderate to low levels in some key areas.

While readiness and performance were correlated in some competency areas, such as quadratic equations and formula manipulation, readiness was not correlated with performance in some others in that performance does not reflect students' preparedness for more complex subjects. Such findings necessitate the inclusion of strategic intervention materials meant to fill the gaps identified in areas of weakness. The Strategic Intervention Material (SIM), therefore, should concentrate on the reinforcement of core skills specific to those where readiness skills are poor, by providing, for example, structured instructional support, practical exercises, and motivational strategies that enable students to have a better conceptual base.

In conclusion, while the students fairly excel in almost all areas, their advanced preparedness for mathematics is not uniform. Hence, to ensure that students are adequately prepared to face the challenges of subsequent STEM courses, targeted interventions on topics such as the Law of Exponents and Logarithmic and Exponential Functions, among others will serve to close the gap between readiness and performance, thus leading to a more significant understanding and better long-term results in mathematics.

REFERENCES

American Psychological Association. (2020). Publication manual of the American Psychological Association (7th ed.). American Psychological Association.

Bibon, M B. (2022, February 27). Teachers' Instructional Practices and Learners' Academic Achievement in Science. , 3(1), ep22007-ep22007. https://doi.org/10.30935/conmaths/11816

Borji, V., Surynková, P., Kuper, E., & Robová, J. (2023, July 10). University students' understanding of exponential and logarithmic concepts: in case of real-world situations. https://hal.science/hal-04404329v1

Chen, X., & Ho, P. (2012). STEM in Postsecondary Education: Entrance, Persistence, and Degree Attainment. NCES. https://nces.ed.gov/pubs2013/2013152.pdf

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). Sage Publications.

Department of Education (DepEd). (2015). Policy guidelines on classroom assessment for the K to 12 basic education program (DepEd Order No. 8, s. 2015).

https://www.deped.gov.ph/wp-content/uploads/2015/04/DO_s2015_08.pdf

Domondon, C., Pardo, C., Rin, E. (2022). Analysis of student learning difficulties in calculus subjects. Science International (Lahore), 34(6), 1-4. http://www.sci-int.com/pdf/638066898447788849.pdf

Dweck, C. S. (2017). The journey to children's mindsets—and beyond. Child Development Perspectives, 11(2), 139–144. https://doi.org/10.1111/cdep.12225

Fiorella, L., Yoon, S. Y., Atit, K., Power, J. R., Panther, G., Sorby, S., Uttal, D. H., & Veurink, N. (2021). Validation of the Mathematics Motivation Questionnaire (MMQ) for secondary school students. International Journal of STEM Education, 8(1). https://doi.org/10.1186/s40594-021-00307-x

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2019). How to design and evaluate research in education (10th ed.). McGraw-Hill Education.

Giangan, Bonifacio & Gurat, Melanie (2022). Perception and Academic Performance of STEM Students in Learning Calculus. Psychology and Education: A Multidisciplinary Journal 4 (1), 2-7. https://doi.org/10.5281/zenodo.7065825

Han, J., Kelley, T., & Knowles, J. G. (2021). Factors influencing student STEM learning: Self-Efficacy and outcome expectancy, 21st century skills, and career awareness. Journal for STEM Education Research, 4(2), 117–137. https://doi.org/10.1007/s41979-021-00053-3

Herrera, J. R., & Dio, R. V. (2016). Extent of readiness of Grade 10 students for General Mathematics of Senior High School in Sorsogon City, Philippines. Asia Pacific Journal of Education, Arts and Sciences, 3(4), 1-8. https://oaji.net/articles/2017/1710-1485756132.pdf

Hu, X., Jiang, Y., & Bi, H. (2022). Measuring science self-efficacy with a focus on the perceived competence dimension: using mixed methods to develop an instrument and explore changes through cross-sectional and longitudinal analyses in high school. International Journal of STEM Education, 9(1). https://doi.org/10.1186/s40594-022-00363-x

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics, 5(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Fadlelmula, F K., Sellami, A., Abdelkader, N N., & Umer, S. (2022, January 3). A systematic review of STEM education research in the GCC countries: trends, gaps and barriers. Springer Science+Business Media, 9(1). https://doi.org/10.1186/s40594-021-00319-7

Field, A. (2018). Discovering statistics using IBM SPSS Statistics (5th ed.). Sage Publications.

Li, Y., & Bates, T. C. (2020). Testing the association of growth mindset and grades across a challenging transition: Is growth mindset associated with grades? Intelligence, 81, 101471. https://doi.org/10.1016/j.intell.2020.101471

Merwe, R V D., Groenewald, M., Venter, C., Scrimnger-Christian, C., & Bolofo, M. (2020, November 1). Relating student perceptions of readiness to student success: A case study of a mathematics module. Elsevier BV, 6(11), e05204-e05204. https://doi.org/10.1016/j.heliyon.2020.e05204

Muhassanah, N., & Lukman, H S. (2020, October 1). Analysis of mathematics student understanding: calculus concepts. IOP Publishing, 1657(1), 012069-012069. https://doi.org/10.1088/1742-6596/1657/1/012069

Mukuka, A., Mutarutinya, V., & Balimuttajjo, S. (2021). MEDIATING EFFECT OF SELF-EFFICACY ON THE RELATIONSHIP BETWEEN INSTRUCTION AND STUDENTS' MATHEMATICAL REASONING. Journal on Mathematics Education, 12(1), 73–92. https://doi.org/10.22342/jme.12.1.12508.73-92

Nuruddin, M., Noor, C. N., & Abidin, A. W. Z. (2020). Exploring the Relationship between Self-efficacy and Mathematics Performance in Integral Calculus among Applied Science University Students. Journal of Physics Conference Series, 1496(1), 012018. https://doi.org/10.1088/1742-6596/1496/1/012018

Organisation for Economic Co-operation and Development (OECD). (2020). PISA 2018 results: Where all students can succeed (Volume II). OECD Publishing. https://doi.org/10.1787/b5fd1b8f-en

Orque, J. (2021). Correlation of numerical competence and senior high school readiness of grade 10 learners. TARAN-AWAN Journal of Educational Research and Technology Management, 2(1), 35-45. https://journal.evsu.edu.ph/index.php/tjertm/article/view/259

Pallant, J. (2020). SPSS survival manual: A step by step guide to data analysis using IBM SPSS (7th ed.). Routledge.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Administration and Policy in Mental Health and Mental Health Services Research, 42(5), 533-544. https://doi.org/10.1007/s10488-013-0528-y

Republic of the Philippines. (2013). Enhanced Basic Education Act of 2013 (Republic Act No. 10533). Official Gazette. https://www.officialgazette.gov.ph/2013/05/15/republic-act-no-10533/

Robinson, C., Galligan, L., Hussain, Z.,Abdullah, S., Frederiks, A., & Wandel, A. (2019). Student Perceptions of Mathematics Readiness from a University Preparation Program to Undergraduate Studies. Adults Learning Mathematics: An International Journal, 14(2), 6-22. https://files.eric.ed.gov/fulltext/EJ1259509.pdf

Trends in International Mathematics and Science Study (TIMSS). (2019). TIMSS 2019 international results in mathematics and science. TIMSS & PIRLS International Study Center. https://timss2019.org/reports/

Yang, Y., Maeda, Y. & Gentry, M. The relationship between mathematics self-efficacy and mathematics achievement: multilevel analysis with NAEP 2019. Large-scale Assess Educ **12**, 16 (2024). https://doi.org/10.1186/s40536-024-00204-z

Widya, W., Rifandi, R., & Rahmi, Y L. (2019, October 1). STEM education to fulfil the 21st century demand: a literature review. IOP Publishing, 1317(1), 012208-012208. https://doi.org/10.1088/1742-6596/1317/1/012208