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Development and Validation of a Triangle Trigonometry E-Module

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ABSTRACT

This study validated and evaluated the effectiveness of a developed Triangle Trigonometry E-Module on the mathematical performance of forty Grade 9 students at the University of Northern Philippines-Laboratory High School during the 2020-2021 academic year. The research employed a one-group pretest-posttest design, utilizing a 30-item validated test to assess student performance. Validation by experts rated the E-Module "highly valid" across content objectives, clarity, relevance, design, suitability, and testing. Results revealed a significant improvement in students' mathematical performance, with pretest scores rated "Poor" and posttest scores rated "Very Satisfactory." This demonstrates the E-Module's effectiveness in enhancing students' understanding of trigonometric concepts. The study highlights the potential of e-modules as effective educational tools, especially in remote or blended learning contexts. Recommendations include adopting the Triangle Trigonometry E-Module across similar curricula, integrating e-modules in other subjects, and conducting remedial sessions for low-performing students. Future research is encouraged to validate these findings across different educational settings and subjects.

Keywords: *Validation, triangle trigonometry, e-module.*

INTRODUCTION

Mathematics is evident all around us; it is considered one of the chiefs among disciplines in terms of its rich cultural and historical roots in the practice of ordinary people. This is because Mathematics is always adapting to the needs of society. People can find numbers, measurements, angles, shapes, and the like everywhere. Even when we go to the market and buy our necessities, it involves the basic processes of Mathematics. It has passed through different periods, refining it into the body of knowledge now communicated coherently as a field of study.

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One factor that strengthens an individual's abilities is the problem they are challenged with; putting every effort, time, and resource to come up with an amicable solution is a worthy reward. Generally, students' reflections on the nature of Mathematics through history result in enhanced mathematical literacy, skills, and transverse competencies. It has also been shown to be effective in teaching and learning Mathematics.

Mathematics is defined as a set of numbers, letters, and equations. Some students appreciate the course because it is enjoyable, educative, helpful, and sound. Others criticize the course as confusing, tedious, and difficult (Domondon & Rabanal, 2023). However, after encountering this subject, they have realized a new definition: mathematics is a way of thinking, a method of problem-solving, and an explanation of arguments. On the other hand, they see it as a challenging but worthy subject, considering it requires several hours to answer complex problems only to get an incorrect answer.

Mathematics is a fundamental discipline that fosters critical thinking and problem-solving skills, essential for understanding the world. Its concepts are deeply intertwined with daily life, from basic computations to complex spatial reasoning. However, its abstract nature often makes it challenging for many learners, leading to perceiving mathematics as difficult rather than enjoyable (Torrefranca, 2017). This underscores the need for effective instructional strategies to support student learning.

Instructional design has emerged as a powerful tool in enhancing the teaching and learning process, particularly in mathematics. Modular instruction, for example, provides students with self-directed learning opportunities, allowing them to progress at their own pace while mastering specific topics. This approach enables teachers to transition from traditional roles to facilitators of learning, promoting more profound engagement with mathematical concepts (Torrefranca, 2017).

The ubiquity of technological development is considered a reality today, and it is reflected in society. In the educational field, technological progress is reflected in the development of the so-called information and communication technologies (ICT), which directly influence the development of teaching and learning processes since they improve and promote innovative pedagogical actions, as well as generate new learning spaces, especially with a new learning approach. Education updates were required because of the fast advances in technology. They need to learn at any time, and any place is in its way to be achieved (Wolfinger, 2016). It enables them to access educational resources, connect with friends and peers, and utilize them for entertainment (Paguirigan & Paguirigan, 2022).

The COVID-19 pandemic has highlighted the need for accessible and flexible learning resources. Remote learning environments often pose challenges, such as limited device access and unstable internet connections (Mahyoob, 2020). To address these issues, e-modules offer an innovative solution, combining the flexibility of modular instruction with the accessibility

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of digital platforms. E-modules ensure continuity in education while accommodating diverse learner needs, making them particularly valuable in times of disruption.

Recognizing the importance of these innovations, this study developed a Triangle Trigonometry E-Module specifically designed for Grade 9 students. Triangle Trigonometry was chosen because it serves as a cornerstone for understanding spatial relationships, essential for advanced mathematics and real-world applications. This topic is often inadequately covered during the fourth grading period due to time constraints, leaving students with limited mastery of its concepts. In addition, Riboroso et al. (2018) discovered a substantial link between students' mathematical self-efficacy and the number of mathematics classes they took in high school. According to the study, students taking more math classes in high school have stronger self-efficacy. This link might be explained by more exposure to the topic because knowledge breeds confidence. The study also found a substantial relationship between math self-efficacy and average high school grades. These results suggest that individuals who perform well in mathematics in high school exhibit stronger confidence and assertiveness toward the subject in their college years due to a solid foundation.

The Triangle Trigonometry E-Module was developed to address these gaps by providing an accessible, comprehensive, and engaging resource. Its features include motivational content, practical exercises, and supplemental materials to enhance student understanding and performance. By emphasizing clarity and interactivity, the module seeks to motivate students and make learning trigonometric concepts more meaningful.

This study situates itself within the broader context of educational innovation, leveraging e-modules to overcome barriers to learning. The development of this module aligns with the global shift toward integrating technology into education, addressing both immediate challenges brought by the pandemic and long-term goals of enhancing instructional strategies.

This research contributes to the growing literature on effective e-learning tools in mathematics education by focusing on Triangle Trigonometry. It highlights the potential of e-modules to improve student performance and engagement with the subject, offering valuable insights for educators and curriculum developers.

Objectives of the Study

The study aimed to 1) validate the Triangle Trigonometry E-Module in terms of content characteristics (objectives, clarity, and relevance) and instructional characteristics (design, suitability, and testing methods) and 2) evaluate its impact on Grade 9 students' mathematical performance in trigonometry.

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METHODOLOGY

This portion presents the research design, population and sample, data gathering instrument, and procedure.

Research Design

This study utilized a Descriptive Research Design to validate the Triangle Trigonometry E-Module in terms of its content and instructional characteristics. Additionally, a One Group Pretest-Posttest Design was employed to assess the effectiveness of the E-Module in improving students' performance in solving trigonometry problems. The Grade 9 Isabelo Delos Reyes students at the University of Northern Philippines were given a pretest, followed by exposure to the E-Module, after which a posttest was administered to evaluate any changes in performance.

Participants of the Study

The sample of this study was the Grade 9 Isabelo Delos Reyes Students enrolled in the University of Northern Philippines during the school year 2020-2021. The sample of this study came from one of the two sections of Grade 9 of the Laboratory School, Isabelo delos Reyes, enrolled in the University of Northern Philippines during the school year 2020-2021, as suggested by the panel members during the proposal defense.

There were 16 male and 24 female students in this section, and they all had cell phones, and the majority of them had laptops used for their learning that suited them in the E-Module. A total of 40 students enrolled in Grade 9 Isabelo delos Reyes participated in the study. While the sample is relatively small and drawn from a single section, the findings should be interpreted cautiously as they may not fully represent the broader Grade 9 population at the university or other institutions.

The validators of this study are two (2) mathematics instructors, one (1) English critic from the University of Northern Philippines, and two (2) DepEd Grade 9 mathematics teachers, specifically from Ilocos Sur National High School and Sinait National High School.

Research Instrument

In pursuit of the study, a validity tool for Triangle Trigonometry E-Module was disseminated through Google Forms to the two Mathematics Instructors, one English Critic from the University of Northern Philippines, and two DepEd Grade 9 Mathematics Teachers specifically from Ilocos Sur National High School and Sinait National High School to evaluate and validate the researcher-made E-Module.

The researchers adapted the validity tool of the study of Alcanciado, Orsino, & Verazon (2019) entitled Potential Development and Validation of Gen Math Lifesaver Booklet to assess and validate the E-Module.

The researchers used the following norm to interpret the validity of the Triangle Trigonometry E-Module.

Scale	Descriptive Rating (DR)
4.21-5.00	Highly Valid (HV)
3.41-4.20	Valid (V)
2.61-3.40	Moderately Valid (MV)
1.81-2.60	Fairly Valid (FV)
1.00-1.80	Not Valid (NV)

The main instrument used in collecting the data needed for the study was a researcher-made test. It consists of a 30-item multiple-choice test that the mathematics teachers validated. Each item was scored one point. The researchers used the following scale to describe the student's level of performance in solving oblique triangles.

Range Of Scores	Descriptive Rating (Dr)
24.01-30.00	Outstanding (O)
18.01-24.00	Very Satisfactory (VS)
12.01-18.00	Satisfactory (S)
6.01-12.00	Poor (P)
0.00-6.00	Needs Improvement (NI)

Data Gathering Procedure

In the study, the researchers developed the E-Module for one month. The crafted E-Module was composed of six parts, constructed through Microsoft Word and converted into an E-Module form. The researchers also constructed a 30-item multiple choice for the pretest and post-test of the respondents. Then, a group of validators asked permission to assess the E-Module in terms of content and instructional characteristics and a 30-item multiple choice test.

After the validation of the E-Module, the researchers utilized the E-Module with the Grade 9 students at the University of Northern Philippines. The researchers administered the pretest, which was composed of a 30-item multiple choice test, via Google Forms. Students were monitored through Google Meetings, which required them to open their cameras while taking the examination.

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Then, the researchers disseminated the Triangle Trigonometry E-Module with the help of the subject teacher to the respondents, who could use it in their online classes in their fourth grading period on the subject Mathematics with the topic Triangle Trigonometry. The implementation of the E-Module lasted for two weeks, with the topics of the Law of Sines and Cosines and Oblique Triangles. The E-Module was in PDF format and sent through their G-mail accounts and on the Group Chat/Google Classrooms of Grade 9 students. After two weeks of implementation, the researchers administered the posttest, which also consisted of a 30-item multiple choice test to determine the effect of the E-Module.

RESULTS AND DISCUSSIONS

This section presents the findings of the study.

1. Extent of Validity of the E-Module in terms of Content Characteristics and Instructional Characteristics

The table presents the summary of the validation of the Triangle Trigonometry E-Module with their corresponding means and descriptive rating.

Table 1
Summary of the Validation of the Validators of the Triangle Trigonometry E-Module

Quality Characteristics	Mean	Descriptive Rating
A. Content Characteristics		
1. Objectives	4.91	Highly Valid
2. Clarity	4.60	Highly Valid
3. Relevance	5.00	Highly Valid
Average	**4.84**	**Highly Valid**
B. Instructional Characteristics		
1. Design Characteristics	4.91	Highly Valid
2. Suitability	4.80	Highly Valid
3. Testing Method	4.93	Highly Valid
Average	**4.88**	**Highly Valid**
Overall	**4.86**	**Highly Valid**

The evaluation result of the E-Module for each of the content characteristics reveals that objectives, clarity, and relevance are all "Highly Valid," implying that the content of the

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E-Module contains appropriate objectives, clear topics and lessons, and relevant concepts that correspond to the Triangle Trigonometry subject's competencies.

Furthermore, all aspects of the instructional characteristics, including design characteristics, suitability, and testing method, are rated "Highly Valid." It specifies that the E-Module comprises appropriate visual components, drawings, and technical features for the target learner audience.

According to the study of Hussaini & Husman (2017) about the analysis of students' errors in learning Triangle Trigonometry among Senior Secondary School Students in Zaria Metropolis, Nigeria, the study found out among others that most students make errors in transformation and process skills in solving problems in trigonometry. No error was found in the reading. The number of students who made encoding errors and carelessness was small. The students' error in solving trigonometrical problems was because of their weaknesses in basic arithmetical operations.

Learning trigonometry is an area of mathematics that students believe to be particularly difficult and abstract compared with other mathematics subjects. Therefore, learning materials for students must contain concepts that correspond with the competencies of triangle trigonometry combined with interactive learning activities to improve their motivation and engagement in understanding the subject.

The table also reveals that the total mean rating (4.86) indicates that the E-Module is "Highly Valid" regarding content and instructional features. The study by Alcanciado, Orsino, & Verazon (2019), entitled Potential Development and Validation of Gen Math Lifesaver Booklet, also shows that the overall mean rating (3.80) from the study's three validators is "Much Valid." The booklet could be utilized as instructional material and help address the problems encountered by the students in learning General Mathematics.

The E-Module was generally evaluated as "Highly Valid" based on the data above. As a result, the null hypothesis is rejected, implying that the development of the proposed material, the Triangle Trigonometry E-Module, is valid.

A. Summary of Evaluation of Validators on Triangle Trigonometry E-Module in terms of *Content Characteristics*

On Objectives

The findings imply that the assessment done by the chosen validators generally judged the objectives of Triangle Trigonometry favorably, as evidenced by the overall mean rating of 4.92.

Table 2 presents the means and corresponding descriptive ratings of each item validated by the validators under the objectives of the Triangle Trigonometry E-Module.

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Table 2
Item Mean Analysis of the Objectives of the Triangle Trigonometry E-Module

Objectives	Mean	Descriptive Rating
1. Content is suitable to the student's level of development.	5.00	Highly Valid
2. E-Module contributes to the achievement of specific objectives of the subject area and grade/year level for which it is intended.	5.00	Highly Valid
3. E-Module provides for developing higher cognitive skills such as critical thinking, creativity, learning by doing, inquiry, problem-solving, etc.	5.00	Highly Valid
4. E-Module is free of ideological, cultural, religious, racial, and gender biases and prejudices.	4.60	Highly Valid
5. E-Module enhances the development of desirable values and traits such as: 5.1 Scientific attitude and reasoning 5.2 Desire for excellence 5.3 Individual Learning 5.4 Ability to know right from wrong 5.5 Critical and creative thinking 5.6 Productive work	4.97	Highly Valid
6. The topics presented in the E-Module will increase the student's knowledge and adequately cover the requirements in terms of Triangle Trigonometry.	5.00	Highly Valid
7. The Passage Breather can arouse students' interest and motivation.	4.80	Highly Valid
8. The Practice Makes Perfect provides interactive activities about trigonometric concepts.	5.00	Highly Valid
9. The Mathematical Vocabs containing the Triangle Trigonometry jargon will increase the student's understanding of the different topics and concepts of Triangle Trigonometry.	4.80	Highly Valid
10. The Supplemental Link-ning Material provides video learning resources that are helpful to further the students understanding.	5.00	Highly Valid
Overall	**4.92**	**Highly Valid**

The result of the table is noticeable that the validators gave a 5.00 rating in items 1, 2, 3, 6, 8, and 10, which visualizes that the objectives of the E-Module are highly valid and don't need more improvement with given aspects. However, item 4 garnered a mean rating of 4.60, but the module is still valid and free of ideological, cultural, religious, racial, and gender biases and prejudices.

The validators rated it "Highly Valid" and said the E-Module has the appropriate objectives corresponding to the student's learning needs and capabilities. Mullis (2016) pointed out how important the objectives of every mathematics curriculum are as they aim to help all learners develop a positive attitude toward mathematics and appreciate its practical applications in life. Additionally, Dilay (2012) found out that one of the reasons for students' low motivation is the inappropriateness of the Mathematics curriculum to certain types of students. The objectives of the E-Module must correspond with the learning needs and capabilities of the students, and most especially, it should be aligned with the MELCs of the grade 9 mathematics curriculum.

On Clarity

The Clarity Feature of the Triangle Trigonometry E-Module is emphasized in Table 3. The overall mean of the items presented is 4.60, indicating that the validators rated "Highly Valid" on the statements used to assess the content of the E-Module's clarity. With these findings, the Triangle Trigonometry E-Module is clear enough to develop understanding and appropriateness concerning the student's reading ability and comprehension skills.

The clarity of the E-Module clearly shows that the validators strongly agree that the solutions for the different examples and problems in the E-Module follow a correct sequence, and the terms used in the E-Module are well-defined in a simple way.

Table 3

Item Mean Analysis on the Clarity of the Triangle Trigonometry E-Module

Clarity	Mean	Descriptive Rating
1. The topics and concepts in the E-Module are presented clearly and understandably.	4.20	Valid
2. The solutions for the different examples and problems in the booklet follow a correct sequence.	5.00	Highly Valid
3. The terms used in the E-Module are well-defined simply.	4.60	Highly Valid
Overall	**4.60**	**Highly Valid**

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Additionally, the validators also agreed that the topics and concepts in the E-Module are presented clearly and understandably, as shown by its rating, which is 4.20.

On the development and validation of career guidance modules for college students, the researchers found out that the modules are “Entirely Clear” with a combined mean from students and experts as a whole of 4.60 in the indicator quality; this only states that the ideas in the models are clear and well presented (Palacpac, 2012).

Blaich (2016) found that instructional clarity and organization are decisive in promoting student growth in important liberal education outcomes. Clarity of instruction has consistently been linked with increases in student achievement. Some research indicates that instructional clarity may cause increases in student achievement.

The findings further imply that the validators are in favor and generally judged the Clarity features of the Triangle Trigonometry E-Module positively.

On Relevance

The Relevance of the Triangle Trigonometry E-Module is described in Table 4.

Table 4

Item Mean Analysis on the Relevance of the Triangle Trigonometry E-Module

Relevance	Mean	Descriptive Rating
1. The E-Module demonstrates lessons that reinforce students' skills in terms of Triangle Trigonometry.	5.00	Highly Valid
2. The topics presented in the E-Module are appropriate to the concepts of Mathematics subject.	5.00	Highly Valid
3. The contents of the E-Module correspond with the subject's goals.	5.00	Highly Valid
Overall	**5.00**	**Highly Valid**

As can be seen from the table, all of the items in the Triangle Trigonometry E-Module relevance category have the same mean rating of 5.00. It simply states that the validators "strongly agree" that the content is appropriate for the Triangle Trigonometry Mathematics Topic and may reinforce students' proficiency in the area above. From this interpretation, the E-Module is an excellent tool for a clear and better understanding of the concepts and competencies of Triangle Trigonometry.

In his study, Olubukola (2015) recommended that the topics to be taught to the students must be found in the curriculum review. In this way, it can reduce the difficulties experienced by the students in their learning. Additionally, Ajoke (2017) pointed out that the

success of achieving what they are to achieve in an instructional situation depends on the suitability and appropriateness of the instructional materials, adequacy, and effective utilization of the materials. Instructional materials are meant to improve the quality of education and improve the effective academic performance of students in schools.

The careful assessment of the value of the mean ratings signifies that the validators were unanimous. They were all in accord with the relevance of the Triangle Trigonometry E-Module. Therefore, the content characteristics of the said E-Module were found to be favorable in terms of its relevance.

B. Summary of Evaluation of Validators on Triangle Trigonometry E-Module in terms of Instructional Characteristics

On Design Characteristics

Table 5 presents the means and corresponding descriptive ratings of each item validated by the validators under the design characteristics of the Triangle Trigonometry E-Module.

The table reveals that the validators rated the design characteristics of the E-Module remarkably with a mean of 4.91, which suggests that the E-Module is "Highly Valid" that the design features of the E-Module were interactive, properly made and does not overwhelm students with its visual elements.

Table 5

Item Mean Rating on Design Characteristics of the Triangle Trigonometry E-Module

Design Characteristics	Mean	Descriptive Rating
1. The size of the letters is appropriate to the intended users.	5.00	Highly Valid
2. Font is easy to read.	5.00	Highly Valid
3. The graphic design of the E-Module was not overdone.	4.60	Highly Valid
4. The texts are complemented with readable designs that do not overwhelm students with too many visual elements.	4.80	Highly Valid
5. The sequencing of the topics in the E-Module matches the sequence of the concepts of Mathematics subject.	5.00	Highly Valid
6. Illustrations clarify and supplement the text.	5.00	Highly Valid
7. Illustrations are simple and easily recognizable.	5.00	Highly Valid
Overall	**4.91**	**Highly Valid**

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The validators rated “Highly Valid” that the E-Module contains appropriate and readable with the correct sequencing of the topics and proper illustrations that keep the student interested in the material, as evidenced by the mean rating of 4.91.

It was found in the study of Talledo (2012) about the facilitator's guide on leadership skills training that the design characteristic was evaluated as "Excellent Design" with a mean of 4.86. The facilitator's guide is valid regarding its presentation and organization. It can be proven by Tarzimah & Thamby (2012), who found that building a connection between problems and diagrams is also challenging for their respondents, especially those in suburban and rural schools. It visualizes that the correct and proper sequencing of the topics in learning material plays a vital role in students' understanding and knowledge.

These results indicate that the validators were homogeneous in their assessment of the Triangle Trigonometry E-Module design characteristics, which is favorable.

On Suitability

The Suitability features of the Triangle Trigonometry E-Module are shown in Table 6. The findings imply that the validators find the Triangle Trigonometry E-Module suitable for instruction with the students, as evidenced by the overall mean rating of 4.80.

It is notable from the table that the validators gave a 5.00 rating to items 4 and 5, which shows that the E-Module increases the students' understanding of trigonometry and graphs. The lines and figures presented accurately represent the desired topics of the material that need representation. It is also remarkable to note that the validators gave a 4.80 for items 1 and 3 and 4.40 for item 2; this further indicates that the validators strongly agree with the rest of its aspects.

Table 6

Item Mean Analysis on the Suitability of the Triangle Trigonometry E-Module

Suitability	Mean	Descriptive Rating
1. Adequate illustration of text.	4.80	Highly Valid
2. The E-Module contains clear topics and instructions.	4.40	Highly Valid
3. The topic in the E-Module is presented in sufficient detail.	4.80	Highly Valid
4. The E-Module will increase the students' understanding of trigonometry.	5.00	Highly Valid
5. The E-Module contains graphs, lines, and figures that accurately represent the desired topics of the material that need representation.	5.00	Highly Valid
Overall	**4.80**	**Highly Valid**

This is similar to the study of Talledo (2012), as the facilitator's guide, validated by experts and students, was shown to be "Exceptionally Suitable" with a mean and descriptive rating of 4.52, respectively. This means that the facilitator guide is suitable for its target beneficiaries. The wholeness of the booklet is appropriate for its intended viewers, who are the student leaders of the Diocesan schools in Abra. According to the study by Barile (2017), it is found out that giving clear instructions to students can ensure that they fully comprehend what they need to do to achieve in every classroom. It will ease students' nerves, assuage their insecurities, and help them confirm their expectations so that they can be happy and successful in school.

On Testing Method

Table 7 presents the means and corresponding descriptive rating of each item validated by the validators under the Triangle Trigonometry E-Module Testing Method.

Table 7

Item Mean Analysis on Testing Method of the Triangle Trigonometry E-Module

Testing Method	Mean	Descriptive Rating
1. The E-Module can be used to increase the motivation and engagement of the students in Triangle Trigonometry.	4.80	Highly Valid
2. The E-Module can be used as an instructional material by the mathematics instructors.	5.00	Highly Valid
3. The E-Module can enhance the students' mathematical knowledge.	5.00	Highly Valid
Overall	**4.93**	**Highly Valid**

The validators assessed the Instructional Characteristics of the E-Module in terms of testing method, wherein the overall mean is 4.93. This means that the validators strongly agree that the E-Module is highly valid and can be used as an instructional tool by teachers to enhance the knowledge and increase the motivation and engagement of the students in learning triangle trigonometry.

According to the study of the correlation between motivation and academic achievement by Woolfolk & Margetts (2017), it is stated and proved that together with motivation, engagement is viewed as very important for enhanced learning outcomes for all students. It was found that motivation is necessary for students to be engaged in learning. Motivation can boost one person's cognitive aspect, allowing them to commit to the craft they are involved in and set higher goals. Both motivation and engagement may lead to higher academic achievement throughout students' lives.

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The above findings imply that, in general, the validators favored the testing method developed in this study's Triangle Trigonometry E-Module.

2. Students' Level of Performance in Mathematics Before and After Exposure to Triangle Trigonometry E-Module

Table 8 shows the level of performance in Mathematics of the students before and after being exposed to the Triangle Trigonometry E-Module.

Table 8

Students' Level of Performance as a Whole in Triangle Trigonometry

LEVEL	PRETEST		POSTTEST	
	F	*%*	*F*	*%*
Outstanding	-	-	1	2.5
Very Satisfactory	6	15	14	35
Satisfactory	9	22.5	24	60
Poor	25	62.5	1	2.5
Total	40	100	30	100
Overall Mean (DR)	11.98 **(Poor)**		18.03 **(Very Satisfactory)**	
Standard Deviation	**4.46**		**3.10**	

The table reveals that in the pretest, the majority (25 or 62.5%) of the students obtained a "Poor" rating, and six (6 or 15%) of the students obtained a "Very Satisfactory" rating. Meanwhile, in the posttest, a notable percentage (14 or 35%) of the students obtained a "Very Satisfactory" rating, and a significant percentage (24 or 60%) of them obtained a "Satisfactory" rating.

Furthermore, the overall mean rating of the students in solving triangle trigonometry during the pretest was Poor (11.98), while in the posttest was Very Satisfactory (18.03), which means that there was a significant improvement in the student's performance after being exposed to Triangle Trigonometry E-Module. The standard deviation of the student's scores during the pretest was sd = 4.46, while in the posttest was sd = 3.10. This means that the scores of the students after being exposed to the Triangle Trigonometry E-Module were closed around the mean of 18.03 in terms of performance.

This shows an improvement in the student's performance in solving Triangle Trigonometry through E-Module.

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Difference between the Pretest and Posttest Mean Scores of The Students

Table 9 shows the t-test result for significant differences between the students' performance in Solving Triangle Trigonometry before and after the Triangle Trigonometry E-Module used in teaching.

Table 9

Difference between the Pretest and Posttest Mean Scores of the Students

Statistics	Pretest	Posttest
Mean	11.98	18.03
SD	4.46	3.10
$\bar{d}$	6.05	
t-comp	8.002	
t-tab (two-tailed)	2.00	
Decision	Reject H_o	

The computed t-value is 8.002, which exceeds the required tabular t-value 2.00 at a 0.05 significance level. Thus, the study rejected the null hypothesis, stating that there is no significant difference in the student's mathematical performance before and after exposure to Triangle Trigonometry E-Module at 0.05 significance level. This infers a significant difference in the student's mathematical performance before and after exposure to the Triangle Trigonometry E-Module. The table shows that the pupils' performance improved, as shown by the computed mean difference of 6.05. The instructional material significantly affects the students' mathematical performance in solving problems involving Triangle Trigonometry because, from a poor rating in the pretest, the posttest rating became very satisfactory after the exposure to E-Module.

This conforms to the study of Columbano (2019), who asserts that teaching basic mathematics using the modular approach is a practical approach to enhancing mathematics learning. The developed and validated modules on basic mathematics enhance students' mathematical performance, are valid and reliable, and could supplement the learning of concepts. Gabor (2020) stated in his study entitled Development and Validation of an Electronic Module in Linear Motion for First-Year College Students of Iloilo City that findings revealed increased students' performance in the pretest and post-test. T-test results revealed a significant difference in the student's test scores before and after using the electronic module, which can be used as a future reference for linear motion as an additional teaching and learning tool.

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Additionally, Roman's (2018) study on the development and validation of modules in statistics shows that they have a very high extent of validity regarding specific objectives, content, language used, and evaluation activities. The utilization of the developed module leads students to perform very satisfactorily. Similarly, Torrefranca's (2017) findings revealed that all evaluators strongly agreed that the instructional modules satisfied the criteria for evaluating the modules.

CONCLUSIONS

This study emphasizes the effectiveness of the E-Module in improving students' performance in solving Triangle Trigonometry problems. The findings highlight that the E-Module significantly contributed to students' mastery of the subject, with a marked improvement in their post-test results. This suggests that digital learning tools, like the E-Module, can be powerful in enhancing mathematical learning outcomes. The successful implementation of the E-Module also points to the potential of digital resources in modernizing education. The study supports that E-Modules can complement traditional teaching methods by providing students with flexible, self-paced learning opportunities, particularly in subjects with complex concepts such as trigonometry.

For future research and policy development, this study advocates for incorporating E-Modules in mainstream education. It calls for further exploration of digital learning strategies in various subjects and educational levels. Additionally, educational policies should consider the integration of E-Modules as part of a broader digital learning strategy, especially in enhancing student engagement and performance during challenging times, such as the COVID-19 pandemic.

RECOMMENDATIONS

Based on the findings of this study, administrators and teachers are encouraged to adopt the Triangle Trigonometry E-Module in Grade 9 classes. Additionally, using e-modules in other subjects should be explored to enhance students' learning and performance. However, to ensure successful implementation, teachers should receive adequate training on effectively using e-modules in the classroom, including integrating them with traditional teaching methods and addressing potential challenges in online learning environments. Mathematics teachers should also consider conducting remedial sessions through synchronous modalities for students with lower performance to help them grasp Trigonometric concepts. These sessions can provide individualized attention and support to improve students' understanding, especially in the context of online learning during the

COVID-19 pandemic. Teachers must have the skills to manage these sessions effectively and provide timely feedback.

Finally, future research should focus on conducting parallel studies using different topics or subjects to validate the effectiveness of e-modules across various disciplines. This will help assess the broader applicability of the findings and contribute to the development of best practices for implementing digital learning tools in diverse educational settings.

ETHICAL STATEMENT

The researchers adhered to several ethical guidelines during the study. They ensured respect for the dignity and worth of all participants, being mindful of their sex, religion, economic, and cultural backgrounds. Participants were informed of their right to withdraw from the study at any stage should they choose to do so. Before participating, respondents were asked to sign an informed consent form granting permission to be part of the study. Throughout the research process, confidentiality was maintained, and all collected data was kept secure. The anonymity of the respondents was preserved by not disclosing their names or identities during data collection, analysis, or in the discussion of the study's findings.

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