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# **Development and Validation of TRIBOO: A Supplementary Workbook** for Learning Basic Concepts of Trigonometry

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## ABSTRACT

This study entitled "Development and Validation of TRIBOO: A Supplementary Workbook for Learning Basic Concepts of Trigonometry" aimed to address the poor proficiency of Grade 12 STEM students in trigonometry. A quasi-experimental design with a one-way pre-test and post-test was employed to assess their proficiency level and evaluate the effectiveness of TRIBOO, a supplementary workbook developed by the researchers. The pre-test results revealed a low mean score of 5.06, indicating a need for intervention. TRIBOO was validated by five experts and received an overall rating of 3.71, indicating it was highly recommended. After using TRIBOO, students' proficiency significantly improved, with a mean score of 10.00 in the post-test. This suggests that TRIBOO is a valuable resource for math teachers to enhance their instructional approach and improve student outcomes in trigonometry. However, further research is needed to explore the long-term impact of TRIBOO and its applicability to different student populations and learning contexts.

Keywords: Workbook Validation Criteria, TRIBOO, Supplemental Learning Material, Trigonometry

## 1. Introduction

The Philippines faces a persistent challenge in improving the mathematical proficiency of students. Despite the multiple attempts to address this challenge, Filipino students continue to struggle with mathematics compared to its neighbouring countries. Mathematics is an essential tool used in many fields, including natural science, engineering, medicine, and social sciences. One of the branches of mathematics is trigonometry which is concerned with triangles, its lengths and angles of their sides. Students believe that trigonometry is particularly difficult and abstract compared to other branches of mathematics.

One of the specialized subjects of Science, Technology, Engineering and Mathematics (STEM) students is Calculus where trigonometry is included. At this level, they should understand the basic concepts of trigonometry as it will serve as their foundation in learning more complex topics in Calculus. Students who have a strong foundation on the basics of trigonometry will find it useful in higher level coursework. In the study of Nanmumpuni & Retnawati (2021), students' difficulties in understanding the basic concept of trigonometry can be found at almost every level of creative thinking skill. It further shows that in general, students independent of different cognitive abilities are vulnerable to errors in solving problems in trigonometry.

Therefore, this study aimed to address the poor proficiency of Grade 12 STEM students in trigonometry through the Development and Validation of TRIBOO: A Supplementary Workbook for Learning Basic Concepts of Trigonometry. The workbook was presented and validated by math teachers from different schools. The workbook includes lesson objectives, short lessons, a variety of examples, exercises and real-world problems that will allow students to deepen their understanding on the basic concepts of trigonometry. This study will be beneficial to STEM students, parents, math teachers, school, school admin and for future researchers.

## 2. Literature Review

2.1 Review of Related Literature and Studies

## DIFFICULTIES IN LEARNING TRIGONOMETRY

**Foreign Literature and Studies** 

According to Irawan et al. (2019) students' disinterest in trigonometry, is often rooted in a fundamental lack of understanding of the subject's basic concepts. The difficulty in comprehending these mathematical principles contributes to a sense of discouragement, leading to a diminished motivation to engage with and learn trigonometry.

Students' difficulties in understanding the basic concept of trigonometry can be found at almost every level of creative thinking skill. It further shows that in general, students independent of different cognitive abilities are vulnerable to errors in solving problems in trigonometry (Nannumpuni & Retnawati, 2021). Furthermore, students exhibit inadequate comprehension and problem-solving skills in trigonometry despite prior instruction. While the majority demonstrate a rudimentary grasp of fundamental concepts, their ability to translate this knowledge into practical application is demonstrably lacking. Merely introducing students to trigonometry is insufficient; educators must prioritize the development of deep comprehension through targeted practice, interactive learning methods, and the deliberate closure of specific understanding gaps (Arhin & Hokor, 2021).

In the study of Rahayu and Rosjanuardi (2022), it was found that students experienced several epistemological obstacles that impacted their ability to solve problems. Specifically, students' limited knowledge of fundamental topics in analytic trigonometry contributed to common errors. Addressing these gaps through targeted interventions and practice can help improve student performance.

According to Nurmeidina and Rafidiyah (2019) the factors hindering students' success in trigonometry problem-solving are inadequate comprehension of problem information, inaccurate application of trigonometric concepts, and unfamiliarity with the problem format itself. Consequently, Adawiyah and Kurniasari (2020) said that the comprehension of basic concepts in trigonometry remains limited among students, indicating a need for improvement. The variation in students' understanding of these basics is closely tied to their individual learning styles. Students struggle with basic trigonometry concepts, and their understanding is influenced by individual learning styles. Likewise, Haryani et al. (2022) stated that students do not understand the material being taught so they cannot distinguish the formula used in determining the area of a triangle according to what is known in the problem.

Students have difficulty learning trigonometry and have misconceptions about the basic concepts, producing obstacles and errors in solving trigonometric problems. The possible errors are in procedural knowledge, conceptual knowledge, or link between these two types of knowledge. It is also found that a teacher needs to incorporate the learners' everyday experiences using materials, diagrams, and equipment for meaningful learning and long-lasting knowledge (Pant et al., 2023). In addition, Zulfa et al. (2019), stated that many students experienced difficulties both in procedural and conceptual. Many students experienced difficulties in interpreting the purpose of the problem and the calculation process. A lack of understanding of trigonometric concepts can result in further challenges in the learning process.

#### Local Literature and Studies

Maghirang and Banzon (2023) underscored the complex interplay of factors influencing trigonometry performance. They emphasized the importance building strong prior knowledge in mathematics, encouraging active learning strategies among students, equipping teachers with effective pedagogy for trigonometry, creating a supportive learning environment and addressing these factors can pave the way for improved student understanding and performance in this challenging subject. In addition of Delima (2022), trigonometry instruction is also regarded as a crucial but difficult to understand an idea in mathematics. Moreover, lessons on trigonometric ratios are seen to be challenging for teachers to explain and understand.

In the study of Batidor and Casinillo (2021) they have found that the student's academic performance remained below satisfactory in Biology, Chemistry, and Trigonometry, and Statistics. Hence, teachers must be experts in their respective fields and undergo rigorous training to improve their strategies and become globally competitive educators. Supported by the findings of the study of Padernal and Diego (2020) they revealed that the level of academic performance in Pre-Calculus of senior high school students was generally average regardless of their school of origin and entrance examination scores.

#### WORKBOOK AS A SUPPLEMENTARY LEARNING MATERIAL

#### **Foreign Literature and Studies**

According to Gyamfi et al. (2021) workbooks are instructional tools that consist of a series of questions and information designed to guide students to understand complex ideas. Workbooks therefore play a complementary role in education. Moreover, workbooks are a type of education material that typically include components to support classroom learning. Workbooks ensure that students get a chance to go through multiple types of exercises that help them get better conceptual clarity (Bordia, 2022).

Based on the study of Collado and Abubo (2021), students in Group A, who were assigned to lectures, and Group B, who were assigned to workbooks, performed poorly prior to the beginning of class. Group B students who used the workbook in the subject performed slightly better than those who received only lectures. Both interventions were beneficial, although the use of a workbook was more effective in increasing students' academic performance when teaching ecology.

The workbook demonstrated its effectiveness as an educational tool by meeting the necessary criteria for acceptability in terms of content, working examples, and assessment. The positive results suggest that the workbook has the potential to serve as a valuable resource in fostering students' learning and competency development in the targeted subject area. Ongoing feedback and revisions may further refine the workbook for continuous improvement in the future (Benitez, 2020).

On the other hand, in the study of Mithans et al. (2022) they have found that most students claim they never use the workbook either in class or at home. Moreover, the results show that they use the workbook more often at school than at home.

#### Local Literature and Studies

The study of Agbunag (2022) demonstrated that the developed contextualized and localized supplementary e-learning materials in science 8 (Physics) helped in the improvement of the teaching and learning process. Thus, it is recommended that the materials be used accordingly and constantly modified for improvement.

Similarly, in the study of Decoriña (2022), showed that the supplementary learning resource package is acceptable for use by teachers and students for independent learning particularly in the new normal education. It is recommended that the supplementary learning resource package be further validated in order to provide more effective instructional materials to both learners and teachers, and that other science teachers be encouraged by their school heads to develop similar learning packages. In addition, Talas and Panoy (2023) found that supplemental material assisted the students in improving their critical thinking skills, as evidenced by their pre and post-test scores. There were considerable disparities in the respondents' pre and post-test scores.

On the other hand, Besonia, et al. (2023) suggested that the use of culturally relevant supplemental materials can enhance students' motivation and engagement in e-learning by creating connections between the content and their personal experiences. Moreover, Saldo and Walag (2023) proposed that educators may utilize supplemental learning methods and integrate activities in their instruction, for it improves students' learning and can advance students' 21st-century skills. Likewise, Alejandria, et al. (2023) created educational supplemental tool in learning the concepts of the periodic table of elements. In addition, the interview revealed that participants enjoyed the supplemental tool and recommended that it should be utilized in learning the periodic table of elements.

#### WORKBOOK DEVELOPMENT AND VALIDATION

#### Foreign Literature and Studies

According to Nopita, Utami and Subroto (2023), a validated workbook is decent to be used in the classroom. It can be seen that the workbook got good responses from the students. The workbook also met the students' characteristics which were classified as generation Z. In addition, Fran (2022) found that the validated workbook has been assessed as suitable, clear, coherent, attainable, and beneficial for both teachers and students engaged in research-based learning. Consequently, it is recommended as instructional material for teaching the subject, holding the potential to make a meaningful contribution to education and the learning experience.

Sulistina and Salimaturosidah (2023) studied the developed workbook and was validated by 5 experts and read by 10 high school students to determine its feasibility as a teaching material. The results of the content validation showed the CVR and CVI values of 1, which means it was feasible and the results of the readability test showed an average score of 88.5%, which means it was very feasible. In contrast, Rahayu et al. (2022), showed in the validation that the e-workbook they created is valid, practical, and effective. The results of limited trial showed that collaboration skills improved in the good category and critical thinking skills improved in the medium category.

In contrast, Araza and Magnaye (2023) showed that the MELCS-based workbook has met the standard and could be used as a learning material. This finding highlights the effectiveness of well-designed workbooks in supporting student learning and bridging the gap between theoretical knowledge and practical application. The positive evaluation of the MELCS-based workbook suggests that such materials can play a crucial role in enhancing educational outcomes.

On the other hand, in the study of Akouaydi, et al. (2021) showed that the efficiency and robustness of their suggested workbook that do help teachers and children by offering positive feedback throughout the handwriting learning process using tactile digital devices. This indicates that well-designed workbooks, even in digital formats, can offer valuable support in educational settings by enhancing the learning experience through interactive and responsive features.

Perkins et al. (2023) said that it was thought that a Student Workbook would benefit both the students and SPC Physiotherapy clinical educators in order to provide guidance for self-directed study and evidence for grading at the end of the placement.

While in the results showed in the study of Greubel et al. (2023) that students had fun while working on the exercises of the workbook and both the students and their tutors evaluated the workbook to be educationally relevant. Therefore, a well-designed workbook can make learning enjoyable and meaningful, reinforcing their role as valuable supplemental learning materials.

#### Local Literature and Studies

A study by Comay-Ao et al. (2019) sought to improve the basic arithmetic skills of primary school students using specially designed workbook. Five master teachers from the district reviewed and evaluated the materials, giving them a very high rating of 4.6. The workbook contains a variety of exercises tailored to the needs of the learners and it was found to be effective in improving the basic arithmetic skills of primary school students.

As supported by this study, results revealed that the students' performance in science before the use of the teacher-made workbook is fairly satisfactory based on the pretest mean. Meanwhile, their performance in science after the use of the teacher-made workbook is very satisfactory based on the post-

test mean. According to the findings, there is a substantial difference in students' Science performance before and after using the teacher-made Science workbook (Inocencio & Calimlim, 2021).

The study of Basilio and Sigua (2022) showed that all of the validators agreed that the developed module met all the criteria found in each parameter on the validation tool. The criteria include content, design/format, technical/technological, and pedagogical aspect of the workbook. Therefore, it was concluded that the developed instructional module can be used as instructional material by learners.

Bernido (2020) discussed the need for self-directed, independent, and inquiry-based learning material. The results of the study showed that guided inquirybased learning materials were effective in promoting student learning. The study concludes that the guided inquiry-based learning materials can be used to promote Senior High School students' self-directed, independent, and inquiry learning.

Manzano (2023) studied that the learning material evaluated by the instructional materials review committee was rated excellent in terms of content quality, instructional quality, and technical quality. Further, results indicated that the developed instructional material is valid and can be utilized by the intended audience.

While, Lacea and Buscano (2023) said that the evaluators found the developed LAS to be effective and useful in terms of objectives, concepts, skills, usability, appropriateness, and adequacy with an interpreted mean rating of very high extent.

Additionally, Pallado et al., (2022) said that it is recommended for the TESDA management to purchase resources such as workbook that can be used effectively by the trainees and the management must make sure that the allowances for trainees shall be given on time.

Also, in the study of Bulaun et al., (2023) it showed that the material can serve as supplementary material since the students were engaged in learning and had shown interest when the lesson involved educational technology, and since there are insufficient modern instructional materials in Physics.

Supported by Cruz and Rivera (2022) he said that there were ten identified validators for the learning module who were given a set of rubrics that assisted them in terms of evaluating the researcher-made project-based learning module. Through the validation process, the module was marked as excellent, as all of the expected elements of the modules were met.

Aspillaga (2021) found that the development and validation of instructional materials like Strategic Intervention Material (SIM) is very important to answer the call for the need of instructional materials that helps students develop their reading skills and for effective learning to happen.

Rogayan Jr. and Dollete (2019) developed a workbook for SHS based on the students' least learned concepts in a government-owned university in Central Luzon, the Philippines. Results revealed that the developed workbook was found to be very much acceptable by expert validators. In particular, the workbook was acceptable in terms of adequacy, coherence, appropriateness, and usefulness. Student-validators who were enrolled in the course also rated the workbook acceptable.

According to Homillano (2023), the instructional module developed in Science, Technology and Society was found effective based on the scores on pretest and post-test. This means that instructional module can contribute to the student's quality of learning. Additionally, this can be a potent material top use by students taking STS subject.

## 3. Theoretical Framework

#### Figure 1

Research Paradigm



This study adheres to the ASSURE Model of instructional design, developed by Heinrich and Molenda. The acronym ASSURE encapsulates the six key components: Analyze learners, State objectives, Select methods, Utilize media and materials, Require learner participation, and Evaluate and revise. This model aligns with constructivist principles by considering learners' prior knowledge and experiences when designing instruction and by emphasizing the use of learner-centered methods (Pappas, 2023).

On the other hand, the principles of Revised Bloom's Taxonomy, developed by Anderson and Krathwohl in 2002, ensure that education remains relevant in a rapidly evolving world. This six-level hierarchy of cognitive complexity provides a clear progression for educators to guide students toward deeper thinking and understanding. Well-crafted learning objectives based on the taxonomy offer students a sense of direction and purpose, motivating them to actively engage in their learning (Zandstra, 2023).

Furthermore, Dual Coding Theory, developed by Allan Paivio plays a crucial role in improving memory retention, enhancing learning capabilities, and transforming information into knowledge. Our memory utilizes two separate channels to store information: visual and verbal. While these channels function independently, they can also work together to establish connections between words and images (Wagenaar, 2024).

## 4. Methodology

## 4.1 Research Design

This study utilized a quantitative research method a systematic, empirical inquiry that attempts to describe, explain, and predict phenomena using numerical data. (Ishtiag, 2021). This is an appropriate research design to use for this study as the researchers aim is to gain an in-depth understanding of Grade 12 STEM B students' proficiency level in basic concepts of trigonometry by analyzing numerical data gathered from pre- and post-tests administered before and after the implementation of TRIBOO.

This specific approach, a Quasi-Experimental using one-way pre-test and post-test design, enabled a clear comparison of students' performance before and after using TRIBOO, revealing its impact on student learning.

#### 4.2 Research Locale

The study was conducted at Laguna University, Laguna Sports Complex, Barangay Bubukal, Santa Cruz, Laguna. The researchers selected Laguna University, specifically in the Senior High School Department as the research site as it offers the necessary information and data regarding the student respondents that are required for this study.

## 4.3 Population and Sampling Design

This study employed a convenience sampling which is a non-probability sampling in which the researchers uses the subjects that are nearest and available to participate in the research study. This technique is also referred to as "accidental sampling," and is commonly used in pilot studies prior to launching a larger research project, Crossman (2019).

The researchers employed convenience sampling in choosing the respondents for this study. Thirty-five (35) Grade 12 STEM B students for development and implementation of TRIBOO and five (5) qualified experts for workbook validation.

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#### 4.4 Research Instrument

A questionnaire, as emphasized by Taherdoost (2022), is crucial for collecting relevant data in research. In this study, a 15-item pre-test was given to thirty-five (35) Grade 12 STEM B students to assess their trigonometry proficiency and identify weak areas. Five Master Teachers then validated TRIBOO using a workbook validation questionnaire, evaluating its objectives, content, format, language, and relevance. TRIBOO was implemented as an intervention, and a post-test was conducted afterward to measure its impact on student proficiency.

#### 4.5 Data Gathering Procedure

The researchers were granted a permit to conduct a one-way pre-test and post-test through pen and paper type of examination. Through these assessments, they gathered data on the least learned concepts, which is valuable for the development of TRIBOO. Additionally, this allow them to analyzed the students' proficiency level in trigonometry before and after the intervention, highlighting areas that required more focus. The gathered data provided insights into the effectiveness of the validated workbook as a supplemental learning material.

This table shows the six (6) phases of ASSURE model followed by the researchers in gathering relevant data for the study.

#### Table A

Six (6) phases of ASSURE Model

Phase 1: Analysis	In this phase, researchers used a survey followed by a pre-test to identify the least learned concepts and assess the proficiency level of Grade 12 STEM B students in basic concepts of trigonometry.				
Phase 2: Stating Objectives	The result of survey and pre-test served as the basis of researchers in creating specific objectives for the workbook.				
Phase 3: SelectingMethodandMaterials	TRIBOO is made available in printed and soft copy to provide Grade 12 STEM B students with a <b>flexible and accessible</b> tool to enhance their learning. For the selected method, its content followed a <b>structured sequence</b> for each topic.				
Phase 4: Utilizing the Method	The researchers used the Most Essential Learning Competencies (MELCs) of the Science, Technology, Engineering, and Mathematics (STEM) Strand as a guide to organize the workbook content. This resulted in a systematic and layered approach to content presentation, optimizing learning through sequential steps. Each topic kicks off with a pre-assessment gauging students' prior knowledge, followed by a focused recall activity to refresh their memory. Then, a concise lesson to deliver key information, and engaging exercises to solidify understanding and build mastery.				
Phase 5: Requires learners' participa- tion	To cater to the identified needs of students, TRIBOO was designed to integrate a variety of engaging activities aligned with its learning objectives. These include hands-on exercises, problem-solving tasks, and open-ended questions for self-reflection opportunities. To determine if the workbook's objective is achieved, the students undergone post-test.				
Phase 6: Evalua- tion	After undergoing rigorous validation by five experts, the workbook was pilot-tested in Grade 12 STEM B. Students engaged with TRIBOO and subsequently took a post-test to assess their understanding of specific basic trigonometry concepts, providing valuable feedback for further refinement.				

## 4.6 Management and Treatment of Data

The researchers used mean and standard deviation to identify the proficiency level of Grade 12 STEM B students on the basic concepts of trigonometry before and after the utilization of TRIBOO. It was also used to determine the overall rating of TRIBOO among the five expert validators. Moreover, paired t-test was used to compare the pre-test and post-test scores of Grade 12 STEM B students, with the aim of determining whether the utilization of TRIBOO had a significant impact on their proficiency level of Grade 12 STEM B students.

## 5. Findings and Discussion

## Table 1

Mean level of Grade 12 STEM B students' proficiency on the Basic Concepts of Trigonometry

TEST	MEAN	SD	VERBAL INTERPRETATION
PRE-TEST	5.06	2.00	POOR

The table presents the mean proficiency level of Grade 12 STEM B students in the basic concepts of trigonometry, as measured by their pre-test scores. With a mean score of 5.06 out of 15, students, on average, performed just above the midpoint of the test. However, the moderate standard deviation of 2.00 reveals a spread in scores, indicating that some students performed significantly higher or lower than the average. Notably, this average score falls within the "Poor" range according to the predefined interpretation scale. This indicates that the Grade 12 STEM B students have a low proficiency in the basic concepts of trigonometry.

Based on the study of Obeng et al. (2024), students often perceive trigonometry as more challenging and abstract compared to other mathematical topics. This difficulty arises from the need to connect triangle diagrams with numerical concepts and symbols, a skill many students find unfamiliar, leading to low proficiency. To address this issue, it is crucial to provide additional support and resources that can help bridge the gap between conceptual understanding and practical application. Implementing targeted interventions, such as workbook, can significantly improve students' proficiency and confidence in tackling trigonometry problems. Conversely, as supported by the study of Inocencio & Calimlim (2021), the use of teacher-made workbooks

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can significantly improve student performance. This suggests that incorporating workbooks into trigonometry instruction can provide the structured support needed to overcome these challenges and enhance students' understanding and proficiency in the subject.

## Table 2

Mean level of Grade 12 STEM B students' proficiency on the Basic Concepts of Trigonometry

	TEST	MEAN	SD	VERBAL INTERPRETATION	
	POST-TEST	10.00	1.55	GOOD	
Legen	egend: 13 – 15 Very Good, 10 – 12 Good, 7 – 9 Fair, 4 – 6 Poor, 0 – 3 Very Poor				

The table shows the mean proficiency level of Grade 12 STEM B students in the basic concepts of trigonometry based on their post-test scores. The mean score of the students is 10.00, which falls under the "Good" category, while the standard deviation is 1.55, indicating the spread of scores around the mean. A lower standard deviation suggests that most students scored close to the mean, while a higher standard deviation would indicate a wider range of scores. Overall, the students' proficiency level is interpreted as "Good," based on the legend where a score between 10 and 12 is considered "Good." This suggests that Grade 12 STEM B students improved their proficiency in the basic concepts of trigonometry after the utilization of TRIBOO.

The workbook played a significant role in the students' performance by guiding them through practical applications of trigonometric principles, ultimately contributing to their overall proficiency level, which is categorized as "Good" according to the scoring legend (10 to 12). Collado and Abubo (2021) said that more students were able to get scores higher when using a workbook than those students who learned only through the lecture method.

## Table 3

Pre-Test and Post-Test Results

ITEM	MEAN	SD	MEAN DIFFERENCE T-TEST		CRITICAL VALUE	VERBAL INTERPRETATION
PRE-TEST	5.06	2.00				
POST-TEST	10.00	1.55	4.94	12.18	2.032	Significant

The table shows the difference between the pre-test and post-test results in Grade 12 STEM B students' proficiency on the basic concepts of trigonometry, having a mean difference of 4.94 and a computed T-value of 12.18 which is greater than the critical T-value of 2.032 at 0.05 level of significance which leads to the rejection of the null hypotheses and interpreted as "significant". Therefore, there is a significant difference between the pre-test and post-test results.

After using the workbook, the researchers conducted a post-test on the respondents, which revealed significantly higher scores compared to the pre-test. This suggests that the implemented workbook has a positive influence on student proficiency in basic trigonometry concepts. As supported by the study of Talas and Panoy (2023) supplemental material can assist the students in improving their critical thinking skills, as evidenced by their pre and post-test scores. By integrating such resources into the curriculum, educators can help students develop the necessary skills to analyze, evaluate, and synthesize information more effectively. On the other hand, Collado and Abubo (2021) said that the use of workbooks can improve the academic performance of students but regardless of whether the teaching and learning process relies on the use of a workbook, students can still enhance their academic performance if the teacher carries out their responsibilities strategically. This underscores the importance of effective teaching methods and the teacher's role in fostering a positive learning environment. While workbooks are valuable tools, their impact is maximized when combined with strategic and thoughtful instruction.

#### Table 4

Overall Rating of the TRIBOO among the five expert validators

MEAN

1 Workbook Objectives	3.92	0.28	Highly Acceptable
	0.64	0.20	
2. Workbook Content	3.64	0.49	Highly Acceptable
3. Workbook Format and Language	3.72	0.46	Highly Acceptable
4. Workbook Relevance	3.72	0.46	Highly Acceptable
OVEDALL WEICHTED MEAN	3 71	0.55	Highly Pacammandad

The table presents the overall ratings of TRIBOO by five expert validators. The criteria assessed included workbook objectives, content, format and language, and relevance. The workbook objectives received a mean rating of 3.92 with a standard deviation of 0.28. The content had a mean of 3.64 and a standard deviation of 0.49. The format and language scored a mean of 3.72 with a standard deviation of 0.46, and relevance also had a mean of 3.72 and a standard deviation of 0.46. Each criterion was interpreted as "highly acceptable." The overall weighted mean was 3.71 with a standard deviation of 0.55, resulting in a "highly recommended" verbal interpretation. This indicates that the TRIBOO Workbook is considered an effective supplemental learning material in basic concepts of trigonometry.

The objectives, content, format, and language of a workbook are essential elements in its effectiveness as an instructional tool. The objectives should be clearly stated, measurable, and aligned with the intended learning outcomes, guiding both the teacher and students toward the desired skills and knowledge. The content must be relevant to the course syllabus, designed to stimulate creative and analytical thinking, and organized in a manner that progresses from simple to complex concepts. Format and language play a vital role in maintaining the workbook's visual appeal while ensuring readability. The relevance of the material is crucial, as it should not only align with academic requirements but also resonate with the students' experiences and interests to make the learning process more meaningful and effective (Adora, 2019). Hence, validation is highly advisable to improve the overall characteristics of any supplementary learning material made. This will allow teachers to change certain parts that need revision. Validating instructional materials is critical before they are widely used to ensure quality (Mijares III, 2023).

#### 5. Conclusion

In summary, this research focused on enhancing the proficiency level of Grade 12 STEM students on the basic concepts of Trigonometry with the use of a validated workbook as intervention. The main objective was to determine the significant difference on the pretest and post test results before and after the intervention. The study concluded that there is a significant difference between the pre- and post-test results of Grade 12 STEM B students' proficiency on the basic concepts of trigonometry after the utilization of the intervention. Hence, the result shows that the hypothesis between these variables is rejected.

Based on the findings of this research, several recommendations are offered to guide the future implementation and development of TRIBOO. The following are: Students can utilize TRIBOO as a valuable study tool to review concepts and engage in self-paced learning at their own convenience. Math teachers are recommended to adopt the validated TRIBOO as a valuable supplemental learning material to enhance their instructional approach. TRIBOO should be made available online to accommodate the needs of both students and teachers. Pilot testing of TRIBOO with a broad population is recommended for future investigations.

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