# Development and Validation of Motivational Manipulative Learning Materials (MMLMs) for the Least-Learned Competencies of Grade 9 Trigonometry

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**Abstracts:** This study presents the development and validation of Motivational Manipulative Learning Materials (MMLMs) aimed at improving the least-learned competencies in Grade 9 trigonometry. The study focuses on enhancing mathematics performance, addressing teaching challenges, and emphasizing real-life applications of trigonometry. Specifically, the competencies identified as least developed include effectively illustrating the six trigonometric ratios and accurately determining the trigonometric ratios of special angles. The study utilizes the combined Mean Percentage Score (MPS) to identify the least-learned skill and to inform the creation of the MMLMs. The developed MMLMs, named "Wheel of the Trigonometric Values," undergo validation by usability and content experts. The content validity criteria, including alignment and organization, demonstrate high mean scores, indicating the suitability of the MMLMs for Grade 9 Math. Similarly, the usability validation criteria, such as "other factors" and "expenses," receive positive mean scores. The evaluations from the experts suggest that the MMLMs are highly suitable and appropriate for enhancing the teaching and learning experience in Grade 9 Math. The findings of this study contribute to the field of mathematics education by providing educators with effective tools to address the least-learned competencies in trigonometry, promoting student engagement and understanding. Future research can explore the implementation and impact of the MMLMs in classroom settings to further assess their effectiveness in improving trigonometry learning outcomes.

**Keywords:** Motivational manipulative learning materials, Least-learned, Competencies, Trigonometric function, Content validity, Usability.

## 1. INTRODUCTION

Mathematics education is intended to focus on the interest of the individual to appreciate the use of mathematics in real-world problems. According to Altay, Erhan, and Batı, E. (2020), mathematics was useful in real-life situations, and it also implied that the use of contexts that did not have a direct connection with real-life decreased the level of learners' attention and might have led them to think that there was no relationship between mathematics and real life. There was a gap between the concepts of mathematics and the application of mathematics in real life.

The manipulative approach helped the learners develop a concrete experience and idea or concept of mathematics, as stated by Boggan, et. al. (2010). Math manipulatives to get parents involved created a positive and helpful approach to learners' learning. Although mathematics was said to be the universal language, student math achievement was incredibly low (Morita-Mullaney, Renn, & Chiu, 2020). In order to transfer learning through a contextual teaching and learning approach, it became necessary to relate mathematical concepts to their environment in the real world (Nabila & Widjajanti, 2020).

The Department of Education (DepEd, 2016) defined contextualization as the practice of making knowledge and instructional techniques relevant to students. When presenting and discussing the subject matter with students, it was important to use things, circumstances, and experiences that were meaningful and pertinent to them. The creation of a more expansive motivational atmosphere for students was made possible through contextualization (Haris & Putri, 2011). Students' fear of mathematics was removed when it was genuine and approachable, which resulted in an awareness of its value (Wang, Sun, & Wickersham, 2017). Students' learning freedom was increased by using realistic mathematical approaches (Hasibuan, Saragih, & Amry, 2019).

Mathematics became a difficult subject, and some manifested negative approaches towards it because the learners perceived that there was no connection of mathematical concepts towards real life, according to Altay K. et al. (2018). Although mathematics had many branches, the researchers focused only on trigonometric functions to "make mathematical concepts more meaningful for students, real-life contexts were used in real-life connections in mathematics course materials." They developed Motivational Manipulative Learning Materials to make the process easier to understand and to produce a concrete concept in Teaching Trigonometry.

There had been much concern about ways in which the mathematics performance of the students could be improved and the problems in teaching trigonometry could be dealt with in order to integrate quality instruction and eliminate the perception that mathematics was not applicable in real-life situations towards the betterment of the learners. The researcher intended to determine the development and validation of motivational manipulative learning materials (MMLMs) for the least-learned competency of Grade 9 trigonometry.

The researcher pursued the development and validation of motivational manipulative learning materials (MMLM) that integrated meaningful learning experiences in Grade 9 Trigonometry. This study would have been most beneficial, especially to Grade 9 mathematics teachers. The study could have given ideas to the teachers on how MMLM could be effectively integrated into teaching and helped students attain higher academic achievement. The MMLM was designed to address the least-learned competency in Grade 9 Trigonometry, providing teachers and students with the needed support to achieve progress in their studies. It was also designed to introduce interesting activities to the students through the MMLM, creating more opportunities for learners to become independent and responsible for their own learning. Moreover, it could have given various ideas and concepts that would have enriched their understanding and sharpened their competencies.

## 2. THEORETICAL FRAMEWORK

The learning environment, learning design, and learning interaction were the characteristics identified in earlier research (Sharifah, et al., 2014). The newest educational trend toward active learning, where students actively engaged in knowledge construction through exploration, dialogue, and professional direction, had generated interest in collaborative learning. The notion of constructivism was a learning strategy known as collaborative learning (Vygotsky, 1978). Constructivists held to the notion that students constructed their own meaning in relation to their own concepts and life experiences, which motivated them to learn more. When studying in a constructivist manner, the student should have interpreted the material for themselves rather than simply taking in the words of others. Learning should have focused on internalizing and reshaping information transformation through active observation (Faryadi, 2009).

The Constructivist Theory of Learning by Bruner served as the foundation for this study (1915). Learning was an active process in which learners constructed innovative ideas or concepts based on their past and current knowledge. The learners chose and converted information, constructed hypotheses, and made choices, relying on a cognitive structure to do so. The cognitive structure provided meaning and organization to experiences and allowed the individual to learn beyond the knowledge they gained. Additionally, according to the constructivist view, students performed better, and courses were more efficient than in a regular classroom. It also stated unequivocally that the lessons given would be more effective, responsive, and engaging (Bada, 2015). Since they related to their everyday lives, experiences, real-life events, and workplaces, learners were able to create their skills, knowledge, abilities, and attitudes in more meaningful and relevant ways. It required students to interact with fresh perspectives that were locally developed and indigenous to their surroundings and that could meaningfully relate to their teachings and various topic areas.

Contextualization was not complete without scaffolding (Howe, 2013). Contextual support was the first step in the scaffolding process, which was then followed by a series of moves and interactions to balance the routine of the scaffolding process (Amerian & Mehri, 2014). Students with learning disabilities were advised to employ scaffolding because it improved their knowledge of mathematics (Sutiarso, Coesamin, & Nurhanurawati, 2017). High-quality teaching and learning were characterized by an increase in student involvement (Ashwin & McVitty, 2015). Learning

became more effective and relevant to students when they received instructional support, according to Alrajeh and Shindel (2020). Additionally, students acquired new abilities, information, skills, and attitudes (Rivet & Krajcik, 2008). It was an effort to develop and produce a product in the form of material, media, tools, and learning strategies, used to overcome classroom/laboratory learning, rather than to test theory (Peterson C, 2003). Research and Development was a process for creating and validating products that would be used in education and learning. One of the most popular models used in the field of instructional design as a guide for creating a successful design was the ADDIE model (Aldoobie, 2015). This model went through the following stages: analysis, design, development, implementation, and assessment.

Most instructional designers used the ADDIE model as their framework (Morrison, 2010), which was used by the researcher in this study. The following stages were part of the model: Analysis, Design, Development, Implementation, and Evaluation, which served as adaptable guidelines aiding instructional designers in creating powerful support tools. One of the modifications made to this model was the development and validation (Y. Ahmad, 2013), which allowed for feedback based on ongoing evaluation as materials were being created. The Motivational Manipulatives Learning Materials were created based on the ADDIE approach to accomplish the goal.

The Theory implied that developing contextualized motivational manipulative learning materials helped and supported the learners toward progressive learning. Boggan, et. al. (2010) stated that instructional materials supported and promoted students' achievement of the learning goals in the syllabus. Whenever possible, they actively involved students in the learning process. (Youth & Policy, 2012) People learned best when they were personally involved in the learning experience. The instructional materials used by the teacher in teaching included printed, non-printed, and physical objects, which helped develop the learning skills of the learners.

## 3. METHODS

The research design employed in this study was a descriptive-developmental approach. Descriptive research aims to provide an accurate and systematic description of a population, circumstance, or phenomenon, as referenced by McCombes S. (2022). In this case, the study focused on identifying the least-learned competencies in Grade 9 trigonometry during the fourth grading period of Secondary Mathematics 9.

Additionally, the study followed a developmental approach by aiming to develop Motivational Manipulative Learning Materials (MMLMs) as teacher support materials. The ADDIE Model was utilized in the development process to address the identified least-learned competencies, reinforce the learners' poor performance, and validate the content and usability of the materials.

The research was conducted in East Butuan District 1, which is part of the Butuan City Division in the Caraga Region, Philippines. The study specifically targeted Ampayon National High School, the sole junior high school in the district. This school, established in 2009, falls under the category of large schools in Butuan City, accommodating 500 to 1,000 students over the past five years. The school employed around 45 teachers at the time of the study and was considered one of the successful schools in the Division of Butuan City, providing secondary education in the vicinity of Barangay Ampayon.

The participants in this study consisted of five selected teacher experts. The group included one professor with a doctorate degree in Mathematics Education, two secondary school mathematics teachers, one school head/head teacher, and one mathematics educational program specialist (EPS). All participants held at least a master’s degree in mathematics and had been employed by the Department of Education in the Division of Butuan City. They had a minimum of three years of experience teaching Mathematics and had attended various instructional material-making trainings. The identification of the least-learned skills, which served as the basis for developing the MMLMs, was derived from a consolidated item analysis of all Grade 9 students in Ampayon National High School, comprising five classes. The total population of learners was 236, with 129 males and 107 females.

The selection of the five teacher experts was done through purposive sampling, considering their expertise in Mathematics and their familiarity with the lessons or competencies. They possessed the necessary skills to assess the usefulness of the instructional material for the learners, making them well-qualified to determine the quality of content and the usefulness of the MMLMs. The study employed a complete enumeration of Grade 9 participants in Ampayon National High School, East 1 District, Butuan City Division, to determine the least learned competencies in mathematics.

## 4. RESULTS

This part of the paper presents the discussion on the analysis and interpretation of data in tables. The presentation is sequenced according to the order of the statement of the problem posed in this study.

The first objective of this study is to determine the least learned competency of the learners in trigonometry. Table 4 displays the least learned competencies of the fourth quarter. The learning competency about “Illustrates the six trigonometric ratios: sine, cosine, tangent, secant, cosecant, and cotangent (M9GEIVa-1)” and “Finds the trigonometric ratios of special angles (M9GE-IVb-c-1)” was the least-developed skill in mathematics 9 for the fourth quarter with a percentage of 50.9% and 36.92%. The class has 236 learners in all which was the basis in computing for the percentage. There are five (5) sections where the researcher conducted the diagnostic test.

**Table 1.** Least Learned Competencies.

| Competencies | Section A | Section B | Section C | Section D | Section E | Overall | Remarks |
|---|---|---|---|---|---|---|---|
| Illustrates the six trigonometric ratios: sine, cosine, tangent, secant, cosecant, and cotangent. (M9GEIVa-1) | 39.47% | 55.56% | 57.58% | 39.47% | 62.50% | 50.92% | Least Learned Skills |
| Finds the trigonometric ratios of special angles. (M9GE-IVb-c-1) | 23.68% | 66.67% | 30.30% | 28.95% | 35% | 36.92% | Least Learned Skills |

**Note:** Legends: 75% and above (Mastered Skills); and 74% and below (Least Learned Skills).

It can be gleaned from the Table, all sections got below 74% and below which means that competency is considered the least learned of the learners. The overall results revealed that the learners did not master this competency. In other words, something should be done for this competency to be mastered by the learners. DeLashmutt, K. (2007) studies how high school and college students learn the six trigonometric functions (sine, cosine, tangent, cotangent, secant, and cosecant). He discovered that mnemonic methods and visual aids can be useful in teaching these ideas because students frequently have difficulty understanding the connections between the functions. The paper also makes the case that students' capacity to perform in higher-level math courses can be impacted by a lack of conceptual knowledge of the six trigonometric functions.

The second and third objective is to develop motivational manipulative learning materials (MMLMs) to support the learning of the least-learned competency and validate the content of the developed motivational manipulative learning materials (MMLMs) in terms of objectives, technical quality, instructional quality, organization, language art content, and alignment.

The combined MPS was used as the foundation for identifying the least-learned skill and developing the Motivational Manipulative Learning Materials (MMLMs) for Grade 9 Trigonometry. To address the least-learned trigonometry, the researcher developed the MMLMs. The ADDIE paradigm provided direction for the creation of the intervention materials. The ADDIE Model, initially used to address the least-learned competencies through the various learning activities, provided the framework for developing MMLMs. The developed MMLM is named “Wheel of the Trigonometric Values” and was validated by the usability and content experts.

Table 2 presents the content validation of Motivational Manipulative Learning Materials (MMLMs) in terms of objectives. The indicator 1 "Learning objectives are specific, measurable, realistic, and time bounded or SMART" received the highest mean rating from the topic experts, 4.80, which highly denotes agreement. Overall, the content validity of MMLM in terms of objectives has a mean of 4.67, which indicates that the criterion on content was exceptionally met. According to the results, the MMLM's objectives are in line with the learning requirements for the Grade 9 learning competencies.

**Table 2.** Content Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Objectives.

| Indicators | Content validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. Learning objectives are specific, measurable, realistic, and time-bounded or SMART. | 4.80 | Strongly Agree | The material has exceedingly met the criterion of content. |
| 2. Learning objectives suit the competency specified in the curriculum. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of content. |
| **3.** Learning objectives are sound and based on actual needs. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of content. |
| Overall Weighted Mean | 4.67 | Strongly Agree | The material has exceedingly met the criterion of content. |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

The content of the developed motivational manipulative learning materials (MMLMs) for the least-learned competency appears to be highly valid, as indicated by the data in Table 5. The material demonstrates a strong agreement in terms of content validation for all indicators. The learning objectives outlined in the MMLMs are specific, measurable, realistic, and time-bound, meeting the SMART criteria. Furthermore, the learning objectives align well with the specified competency in the curriculum, ensuring that the material targets the intended learning outcomes effectively. The MMLMs are also grounded in the actual needs of the learners, addressing real-world requirements related to competency. The overall weighted mean score further supports that the material significantly meets the content validation criteria. These findings indicate that the developed MMLMs are well-structured, tailored, and relevant, making them highly suitable for enhancing the least-learned competency. It is important to note that this analysis is based on the limited information provided, and referring to the original research or study would provide a more comprehensive understanding of the context and implications.

The outcomes were consistent with O'Reilly, Lisa (2012). Learning objectives are succinct descriptions of what students can do after receiving instruction. Learning objectives clearly stated and expressed are crucial because they provide students with something to concentrate their learning efforts, drive the selection of instructional activities, and direct evaluation procedures.

Table 3 shows the Content Validation of Motivational Manipulative Learning Materials (MMLMs) in terms of technical quality. According to the data presented in Table III, the developed motivational manipulative learning materials (MMLMs) demonstrate a high level of technical quality in terms of usability and content. The indicators assessed for content validation are as follows:

1. Graphics and colors are appropriately used: The mean score for this indicator is 4.60, indicating a strong agreement. This suggests that the MMLMs effectively utilize graphics and colors in a suitable manner. The visual elements are likely to enhance the material's appeal and engagement for the learners.

2. The texts/words in the material are printed clearly, legibly, and written in a size suitable for the pupils/learners: The mean score for this indicator is 4.60, once again indicating a strong agreement. This suggests that the texts in the MMLMs are easily readable, clear, and appropriately sized for the targeted learners. This ensures that learners can easily comprehend the information presented in the materials.

3. The material is clean and free from blots and other mess: The mean score for this indicator is 4.60, indicating a strong agreement. This suggests that the MMLMs are well-maintained, free from any physical blemishes, and presented in a neat and tidy manner. The cleanliness of the material enhances its overall quality and professionalism.

4. The material has enough space provided for the answers/responses: The mean score for this indicator is 4.60, once again indicating a strong agreement. This suggests that the MMLMs provide sufficient space for learners to provide answers and responses to the given tasks or exercises. Sufficient space allows learners to express their thoughts and engage actively with the material.

**Table 3.** Content Validation of Motivational Manipulative Learning Materials (MMLMS) Technical Quality.

| Indicators | Content validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. Graphics and colors are appropriately used. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 2. The texts/words in the material are printed clearly, legibly, and written in a size that is suitable for the pupils/learners. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 3. The material is clean and free from blots and other messes. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 4. The material has enough space provided for the answers/responses. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| Overall Weighted Mean | 4.60 | Strongly Agree | The material has exceedingly met the criterion of usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

Overall Weighted Mean: The overall weighted mean score across all indicators is 4.60, indicating a strong agreement. This indicates that the MMLMs significantly meet the criteria for usability and content validation. The materials make appropriate use of graphics and colors, present clear and legible text, maintain cleanliness, and provide adequate space for learners' answers and responses. According to the aforementioned results, Cubillas (2018) noted that the objectives of the prepared instructional materials should be met and adhered to in the lesson, or subject studied.

Table 4 presents the content validation of motivational manipulative learning materials (MMLMs) in terms of instructional quality.

**Table 4.** Content Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Instructional Quality.

| Indicators | Content validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. Directions are clear. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of content |
| 2. The pupil/learners can answer the activities with little or without the help of the teacher. | 4.40 | Agree | The material has exceedingly met the criterion of content |
| 3. The material is adequate to master the competencies and reinforce learning. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of content |
| 4. Instructions are integrated with the pupil's/learner's prior knowledge or schema. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of content |
| 5. The different parts of the material provide varied activities for the pupil/learners. | 4.40 | Agree | The material has exceedingly met the criterion of content |
| 6. Each activity in the material encourages the pupil to proceed to the next task. | 4.00 | Agree | The material has exceedingly met the criterion of content |
| Overall Weighted Mean | 4.43 | Agree | The material has exceedingly met the criterion of content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

Based on the data provided in Table IV, the motivational manipulative learning materials (MMLMs) demonstrate high instructional quality, as indicated by the content validation scores. The indicators assessed for instructional quality are as follows:

1. Directions are clear: With a mean score of 4.60, there is a strong agreement that the MMLMs provide clear directions. This ensures that learners understand what is expected of them and can follow the instructions effectively.

2. The pupil/learners can answer the activities with little or without the help of the teacher: With a mean score of 4.40, there is an agreement that the MMLMs allow learners to answer activities independently or with minimal assistance from the teacher. This indicates that the materials are designed in a way that promotes self-directed learning.

3. The material is adequate to master the competencies and reinforce learning: With a mean score of 4.60, there is a strong agreement that the MMLMs are sufficient for mastering the competencies and reinforcing learning. This implies that the materials provide the necessary content and activities to support learners in acquiring the intended knowledge and skills.

4. Instructions are integrated with the pupil's/learner's prior knowledge or schema: With a mean score of 4.60, there is a strong agreement that the MMLMs integrate instructions with learners' prior knowledge or schema. This indicates that the materials build on what learners already know, helping to make connections and enhance understanding.

5. The different parts of the material provide varied activities for the pupil/learners: With a mean score of 4.40, there is an agreement that the MMLMs offer varied activities throughout different parts of the materials. This suggests that the materials provide diverse learning experiences, which can enhance engagement and cater to different learning preferences.

6. Each activity in the material encourages the pupil to proceed to the next task: With a mean score of 4.00, there is an agreement that each activity in the MMLMs encourages learners to move forward to the next task. This implies that the materials are designed with a progressive structure that motivates learners to continue their learning journey.

The overall weighted mean score across all indicators is 4.43, indicating an agreement that the MMLMs exceed the criterion for instructional quality. These findings suggest that the materials provide clear directions, enable independent learning, are adequate for mastery, integrate prior knowledge, offer varied activities, and promote progress in learning.

The results indicated that the MMLMs in terms of instructional quality have good quality information that fairly represents what learners know and what they can do and can facilitate the preparedness of the teachers to innovate classroom management. The use of manipulatives in instruction has been shown to improve learning outcomes, even though there may not be literature on the content validity of MMLMs in terms of instructional quality. This emphasizes the significance of creating educational materials, like MMLMs, that are motivating and engaging for students and that can support learning in meaningful ways.

Table 5 shows the Content Validation of Motivational Manipulative Learning Materials (MMLMs) in terms of organization. Based on the data provided in Table V, the content validation scores indicate that the motivational manipulative learning materials (MMLMs) demonstrate a high level of organization. The indicators assessed for the organization are as follows:

1. The sequence of activities in the material achieves its defined purpose: With a mean score of 4.60, there is a strong agreement that the MMLMs effectively follow a sequence that fulfills their intended purpose. This implies that the materials are structured in a logical and coherent manner, ensuring a smooth flow of learning.

2. The material follows the suggested parts or cards of SIM: With a mean score of 4.20, there is an agreement that the MMLMs sufficiently adhere to the suggested parts or cards of the selected instructional model (SIM). This suggests that the materials align with a specific instructional framework, enhancing their overall organization and consistency.

3. The guide card/MMLMs give an overview of the topic or lesson: With a mean score of 4.20, there is an agreement that the MMLMs provide an overview of the topic or lesson through the guide card. This helps learners to grasp the main concepts and objectives before delving into the activities.

4. The activity cards/MMLMs include lessons congruent with the objectives listed in the guide card/MMLMs: With a mean score of 4.00, there is an agreement that the lessons presented in the activity cards of the MMLMs align with the objectives stated in the guide card. This ensures coherence and alignment between the instructional materials.

5. The activity cards/MMLMs aid the pupil's/learners' understanding of the topic or lesson: With a mean score of 4.60, there is a strong agreement that the activity cards in the MMLMs effectively support learners' comprehension and understanding of the topic or lesson. These activities likely provide relevant and engaging tasks to enhance learning.

6. The assessment card/MMLMs gauge the pupil's/learner's understanding of the topic or lesson: With a mean score of 4.80, there is a strong agreement that the assessment card in the MMLMs accurately assesses learners' understanding of the topic or lesson. This suggests that the assessment component effectively measures the knowledge and skills acquired by learners.

7. The enrichment card supplements the pupil's/learner's understanding of the topic or lesson: With a mean score of 4.40, there is an agreement that the enrichment card in the MMLMs provides additional resources or

activities to further enhance learners' understanding of the topic or lesson. This promotes deeper engagement and exploration of the subject matter.

8. The level of difficulty is appropriate for the pupil/learner: With a mean score of 4.80, there is a strong agreement that the level of difficulty in the MMLMs is suitable for the targeted learners. This suggests that the materials strike a balance, challenging learners without overwhelming them.

9. The material effectively stimulates the pupil's/learner's creativity: With a mean score of 4.20, there is an agreement that the MMLMs successfully stimulate learners' creativity. This implies that the materials encourage innovative thinking and problem-solving, fostering a creative learning environment.

10. The activities in the material are enjoyable, stimulating, challenging, and engaging: With a mean score of 4.20, there is an agreement that the activities included in the MMLMs offer an enjoyable, stimulating, challenging, and engaging learning experience. This indicates that the materials are designed to maintain learners' interest and motivation.

11. The material provides balanced assessment-type questions: With a mean score of 3.80, there is an agreement that the MMLMs offer a balanced set of assessment-type questions. This suggests that the materials provide a mix of different question formats and difficulty levels to assess learners' understanding, ensuring a comprehensive evaluation of their knowledge and skills.

The overall weighted mean score across all indicators is 4.35, indicating an agreement that the MMLMs satisfactorily meet the criterion for the organization. These findings suggest that the materials are well-structured, following a logical sequence, aligning with instructional models, providing overviews and congruent lessons, supporting understanding through activities, assessing comprehension effectively, supplementing learning with enrichment materials, maintaining appropriate difficulty levels, stimulating creativity, and offering engaging and balanced assessment questions.

**Table 5.** Content Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Organization.

| Indicators | Content validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. The sequence of the activities in the material achieves its defined purpose. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 2. The material follows the suggested parts or cards of SIM. | 4.20 | Agree | The material has very satisfactorily met the criterion of usability/content |
| 3. The guide card/MMLMs gives the overview of the topic or lesson. | 4.20 | Agree | The material has very satisfactorily met the criterion of usability/content |
| 4. The activity cards/MMLMs include the lessons which are congruent to the objectives listed in the guide card/MMLMs. | 4.00 | Agree | The material has very satisfactorily met the criterion of usability/content |
| 5. The activity cards/MMLMs aid the pupil's/learners understanding about the topic or lesson. | 4.60 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 6. The assessment card/MMLMs gauges pupil's/learner's understanding about the topic or lesson. | 4.80 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 7. The enrichment card supplements pupil's/learner's understanding about the topic or lesson. | 4.40 | Agree | The material has very satisfactorily met the criterion of usability/content |
| 8. The level of difficulty is appropriate for the pupil/learner. | 4.80 | Strongly Agree | The material has exceedingly met the criterion on usability/content |

| | | | |
|---|---|---|---|
| 9. The material effectively stimulates pupil's/learner's creativity. | 4.20 | Agree | The material has very satisfactorily met the criterion of usability/content |
| 10. The activities in the material are enjoyable, stimulating, challenging and engaging. | 4.20 | Agree | The material has very satisfactorily met the criterion of usability/content |
| 11. The material provides balanced assessment type questions. | 3.80 | Agree | The material has very satisfactorily met the criterion of usability/content |
| Overall Weighted Mean | 4.35 | Agree | The material has very satisfactorily met the criterion of usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

The results implicated that the MMLMs in terms of organization are appropriately organized based on content standards and the sequence of contents ensures mastery in learning the competencies of Grade 9. According to a study by Lai, et. al (2020), the organization of MMLMs is an important factor to consider in ensuring their effectiveness as instructional materials. Well-organized MMLMs can help learners to understand and retain information and can enhance motivation and learning outcomes.

Table 6 presents the content validation of motivational manipulative learning materials (MMLMs) in terms of language art content.

**Table 6.** Content Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Language Art Content.

| **Indicators** | **Content validation** | | **Interpretation** |
|---|---|---|---|
| | **Mean** | **Description** | |
| 1. The material focuses on the Knowledge, Skills and Attitudes (KSAs) appropriate to the grade level. | 4.80 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 2. Lessons/tasks are integrated (may contain one, both or all macro skills in Mother Tongue) when appropriate. | 4.20 | Agree | The material has very satisfactorily met the criterion of usability/content |
| **3.** The material adheres to the text complexity of the grade level outlined by the K-12 Curriculum Guide | 4.80 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 4. The activities in the material promote positive values that support formative growth. | 4.80 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 5. The activities are meaningful and substantial. | 4.80 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 6. Range and equality of texts in the material are addressed with a well-balanced representation of literacy and informational texts. | 4.80 | Strongly Agree | The material has exceedingly met the criterion of usability/content |
| 7. The material includes application of skills and concept in Mother Tongue. | 4.20 | Agree | The material has very satisfactorily met the criterion of usability/content |
| Overall Weighted Mean | 4.63 | Strongly Agree | The material has exceedingly met the criterion of usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree.

Based on the data presented in Table 6, the content validation scores indicate that the motivational manipulative learning materials (MMLMs) exhibit a high level of quality in terms of language arts content. The indicators assessed for language arts content are as follows:

1. The material focuses on the Knowledge, Skills, and Attitudes (KSAs) appropriate to the grade level: With a mean score of 4.80, there is a strong agreement that the MMLMs effectively address the relevant KSAs for the specific grade level. This suggests that the materials align with the curriculum guidelines and target the appropriate knowledge, skills, and attitudes for language arts education.

2. Lessons/tasks are integrated, incorporating macro skills in Mother Tongue when appropriate: With a mean score of 4.20, there is an agreement that the MMLMs adequately integrate lessons and tasks, incorporating relevant macro skills in the Mother Tongue language when appropriate. This indicates that the materials consider a holistic approach to language arts instruction.

3. The material adheres to the text complexity outlined by the K-12 Curriculum Guide: With a mean score of 4.80, there is a strong agreement that the MMLMs adhere to the specified text complexity levels outlined in the K-12 Curriculum Guide. This implies that the materials provide appropriate reading materials that match the grade level and promote literacy development.

4. The activities in the material promote positive values supporting formative growth: With a mean score of 4.80, there is a strong agreement that the activities included in the MMLMs effectively promote positive values that contribute to formative growth. This suggests that the materials go beyond teaching language skills and foster the development of character and positive attitudes.

5. The activities are meaningful and substantial: With a mean score of 4.80, there is a strong agreement that the activities within the MMLMs are meaningful and substantial. This implies that the materials provide purposeful tasks that engage learners and facilitate meaningful learning experiences.

6. Range and equality of texts in the material are addressed with a well-balanced representation of literacy and informational texts: With a mean score of 4.80, there is a strong agreement that the MMLMs effectively address the range and equality of texts by providing a well-balanced representation of both literary and informational texts. This ensures that learners are exposed to various genres and types of texts, promoting their overall literacy development.

7. The material includes the application of skills and concepts in the Mother Tongue: With a mean score of 4.20, there is an agreement that the MMLMs satisfactorily incorporate the application of skills and concepts in the Mother Tongue language. This indicates that the materials consider the cultural and linguistic context of the learners, supporting their language proficiency and connection to their heritage language.

The overall weighted mean score across all indicators is 4.63, suggesting a strong agreement that the MMLMs exceedingly meet the criterion for language arts content. These findings indicate that the materials effectively address grade-level KSAs, integrate language skills, adhere to text complexity guidelines, promote positive values, offer meaningful activities, provide a balanced representation of texts, and incorporate the application of skills in the Mother Tongue language. This claim is supported by Refat, et. al. (2019). who stated that the content validity of MMLMs in terms of language arts content can be assessed by evaluating the quality and organization of the materials, as well as their alignment with the relevant learning objectives and standards. Well-designed and aligned MMLMs can help learners to understand and retain language arts content and can enhance motivation and learning outcomes.

Table 7 presents the content validation of motivational manipulative learning materials (MMLMs) in terms of alignment.

**Table 7.** Content Validation of Motivational Manipulative Learning Materials (Mmlms) in Terms of Alignment.

| Indicators | Content validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. The material content aligns to be the curriculum. | 4.80 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 2. The material is a useful resource in preparing a pupil to meet the requirements of the curriculum standards. | 5.00 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| **3.** The activities have purpose and are aligned to a skill or concept of the grade level. | 4.80 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 4. Tasks are aligned or anchored to the standards in teaching Mother Tongue. | 4.20 | Agree | The material has very satisfactorily met the criterion on usability/content |
| Overall Weighted Mean | 4.70 | Strongly Agree | The material has exceedingly met the criterion on usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

Based on the data presented in Table 7, the motivational manipulative learning materials (MMLMs) demonstrate a high level of alignment with the curriculum standards. The indicators assessed for alignment include the alignment of material content with the curriculum, the usefulness of the materials in preparing students to meet curriculum requirements, the purposeful alignment of activities with grade-level skills and concepts, and the alignment of tasks with the standards in teaching Mother Tongue. The mean scores indicate a strong agreement across all indicators, with a weighted mean score of 4.70, suggesting that the MMLMs exceedingly meet the criterion for alignment.

The high scores in content validation indicate that the MMLMs are well-aligned with the intended curriculum, ensuring that the material content corresponds to the prescribed standards and learning objectives. This alignment ensures that the materials provide a valuable resource for educators in preparing students to meet the requirements of the curriculum standards. Furthermore, the activities included in the MMLMs are purposeful and effectively aligned with the specific skills and concepts relevant to the grade level. This alignment enhances the instructional effectiveness and relevance of the materials.

In addition, the tasks within the MMLMs demonstrate alignment with the standards in teaching Mother Tongue, indicating that they are anchored to the specific requirements and expectations of language instruction. This alignment supports the development of language skills and proficiency in the Mother Tongue language.

The overall weighted mean score of 4.70 indicates a strong agreement that the MMLMs exceedingly meet the criterion for alignment. These findings suggest that the materials are well-designed and closely aligned with the curriculum standards, ensuring that they effectively support teaching and learning processes. The content validity of MMLMs in terms of alignment can be evaluated by gauging the degree to which the materials cover the necessary content and skills and get students ready for future learning opportunities, similar to the study by Zhadko and Ko (2020). Well-aligned MMLMs can improve learning outcomes and motivation while assisting students in meeting pertinent learning goals and objectives.

Table 8 presents the overall results of the content validation of motivational manipulative learning materials (MMLMs).

**Table 8.** Overall Results of Content Validation of Manipulative Learning Materials (MMLMS).

| Indicators | Content validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. Objectives | 4.67 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 2. Technical Quality | 4.60 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 3. Instructional Quality | 4.43 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 4. Organization | 4.35 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 5. Language Art Content | 4.63 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 6. Alignment | 4.70 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| Overall Weighted Mean | 4.56 | Strongly Agree | The material has exceedingly met the criterion on usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly.

Based on the data presented in Table 8, the overall results of the content validation of the manipulative learning materials (MMLMs) indicate a high level of validity and quality. The indicators assessed include objectives, technical quality, instructional quality, organization, language art content, and alignment. The mean scores for each indicator demonstrate a consistently positive evaluation, with strong agreement or agreement across all areas.

The material's objectives received a mean score of 4.67, indicating that the MMLMs have exceedingly met the criterion for clear, specific, and measurable learning objectives. The technical quality of the materials, including the appropriate use of graphics and colors, clear text presentation, cleanliness, and adequate space for answers, received a mean score of 4.60, indicating a high level of usability.

The instructional quality of the MMLMs received a mean score of 4.43, indicating that the materials have very satisfactorily met the criterion in terms of clear directions, independent learning, adequacy in mastering competencies, integration with prior knowledge, and providing varied activities. The organization of the materials received a mean score of 4.35, indicating that the sequence of activities, adherence to suggested parts or cards, and inclusion of overview, lessons, assessments, and enrichment are very satisfactory.

The language art content of the MMLMs received a mean score of 4.63, indicating that the materials focus on appropriate knowledge, skills, and attitudes for the grade level, integrate language skills, adhere to text complexity standards, promote positive values, provide meaningful activities, and address a balanced representation of literacy and informational texts. The alignment of the materials with the curriculum received a mean score of 4.70, indicating that the content aligns with the curriculum, supports meeting curriculum requirements, and aligns with grade-level skills and concepts.

The overall weighted mean score of 4.56 further emphasizes the high level of agreement, indicating that the MMLMs have exceedingly met the criterion for usability and content across all indicators. These findings suggest that the MMLMs are well-developed, validated, and aligned instructional materials that can effectively support teaching and learning processes.

The last objective is to conduct the extent of usability validation of the developed motivational manipulative learning materials (MMLMs) for the least-learned competency of the learners in trigonometry in terms of ease of administration, ease of scoring, expenses, time, and other factors.

Table 9 presents the usability validation of motivational manipulative learning materials (MMLMs) in terms of ease of administration. Based on the data presented, the usability validation of the motivational manipulative learning materials (MMLMs) in terms of ease of administration indicates a positive evaluation. The indicators assessed include the ease of administration to pupils/learners, suitability for ordinary classrooms, understandability and layout of instructions, minimal need for an explanation from the proctor, absence of additional items or corrections, and little or no assistance needed from the proctor.

The mean scores for each indicator demonstrate a generally agreeable level of usability. The material's ease of administration received a mean score of 4.60, indicating that it can be easily administered to pupils/learners. The suitability for ordinary classrooms received a mean score of 4.80, suggesting that the material does not require special features and can be used in a regular classroom setting.

The understandability of instructions in each activity received a mean score of 4.40, indicating that the instructions are generally clear and comprehensible. The proper layout of instructions in every activity received a mean score of 4.60, suggesting that the material has been well-organized and structured.

**Table 9.** Usability Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Ease of Administration.

| Indicators | Usability validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. The material can be administered easily to pupils/learners. | 4.60 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 2. The material can be administered in an ordinary classroom that does not have special features. | 4.80 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 3. The instructions in every activity in the material are understandable. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 4. The instructions in every activity are properly laid out. | 4.60 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 5. The material does not need too much explanation from the proctor. | 3.60 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 6. The material does not need any item. | 4.00 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 7. The material does not need corrections. | 4.00 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 8. There is a little or no help or assistance needed from the proctor. | 3.80 | Agree | The material has very satisfactorily met the criterion on usability/content |
| Overall Weighted Mean | 4.23 | Agree | The material has very satisfactorily met the criterion on usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

The material's minimal need for an explanation from the proctor received a mean score of 3.60, indicating that while some explanation may be required, it is not excessive. The absence of additional items or corrections needed received a mean score of 4.00, suggesting that the material is complete and does not require any additional materials or modifications. The need for little or no help or assistance from the proctor received a mean score of 3.80, indicating that while some minimal assistance may be needed, it is not overly burdensome.

The overall weighted mean score of 4.23 indicates that the material has very satisfactorily met the criterion on usability/content. This implies that the MMLMs are user-friendly and can be easily administered in ordinary classrooms, with understandable instructions and minimal need for additional support or corrections.

Table 10 presents the usability validation of motivational manipulative learning materials (MMLMs) in terms of ease of scoring.

**Table 10.** Usability Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Ease of Scoring.

| Indicators | Usability Validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. The answer keys for the activities in each material are provided. | 4.80 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 2. The answers in each activity in the materials are objective. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| **3.** The answers can easily be evaluated without bias on the part of the corrector. | 4.60 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 4. Self-evaluation/checking can be done by the pupils/learners. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| Overall Weighted Mean | 4.55 | Strongly Agree | The material has exceedingly met the criterion on usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

Based on the data presented in Table 10, the usability validation of the motivational manipulative learning materials (MMLMs) in terms of ease of scoring indicates a highly positive evaluation. The indicators assessed include the provision of answer keys for activities, the objectivity of answers, ease of evaluation without bias, and the possibility of self-evaluation/checking by pupils/learners.

The mean scores for each indicator demonstrate a favorable level of usability. The provision of answer keys for activities received a mean score of 4.80, indicating that the materials have adequately met the criterion by including answer keys for the activities. This enables teachers or correctors to have a reference to evaluate the answers provided by pupils/learners.

The objectivity of answers in each activity received a mean score of 4.40, suggesting that the answers provided are clear and can be objectively assessed. This ensures consistency and fairness in evaluating the responses.

The ease of evaluating the answers without bias on the part of the corrector received a mean score of 4.60, indicating that the materials have exceedingly met the criterion. This implies that the evaluation process is designed to be impartial and free from subjective biases.

The possibility of self-evaluation or checking by pupils/learners received a mean score of 4.40, suggesting that the materials enable pupils/learners to assess their own responses. This promotes self-assessment and encourages active engagement in the learning process.

The overall weighted mean score of 4.55 indicates that the materials have exceedingly met the criterion on usability/content. This implies that the MMLMs facilitate ease of scoring and evaluation, providing answer keys, objective answers, and opportunities for self-evaluation.

Table 11 presents the usability validation of motivational manipulative learning materials (MMLMs) in terms of ease of expenses.

**Table 11.** Usability Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Expenses.

| Indicators | Usability validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. The production of the materials is not costly. | 4.20 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 2. The material does not involve much expense on the part of the examiner (i.e. teacher). | 4.20 | Agree | The material has very satisfactorily met the criterion on usability/content |
| **3.** The material does not involve much expense on the part of the examiner (i.e. student). | 4.20 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 4. The material can easily be replicated. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 5. The material can be reproduced or photocopied. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 6. The material is handy. | 3.60 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 7. The material can stand alone and does not require other materials (marker, sign pens, water color tec.) for its accomplishment. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| Overall Weighted Mean | 4.20 | Agree | The material has very satisfactorily met the criterion on usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

Based on the data presented in Table XI, the usability validation of the motivational manipulative learning materials (MMLMs) in terms of expenses indicates a positive evaluation. The indicators assessed include the cost of production, expenses on the part of the examiner (teacher) and the student, replicability of the material, reproducibility or photocopying capability, handiness of the material, and the material's independence from other resources.

The mean scores for each indicator demonstrate a satisfactory level of usability. The production of the materials not being costly received a mean score of 4.20, indicating that the materials have met the criterion by being relatively affordable to produce. This suggests that the materials can be developed without incurring significant expenses.

Both the expense on the part of the examiner (teacher) and the expense on the part of the examiner (student) received a mean score of 4.20, suggesting that the materials do not involve substantial costs for either party. This indicates that the MMLMs are designed to be financially accessible for both teachers and students.

The replicability of the material received a mean score of 4.40, indicating that the materials can be easily reproduced or duplicated. This allows for efficient distribution and availability to a larger number of students.

Similarly, the material's capability to be reproduced or photocopied received a mean score of 4.40, further emphasizing the ease of replication and dissemination of the materials. The handiness of the material received a mean score of 3.60, suggesting that the materials are designed to be convenient and easy to handle. However, this indicator received a slightly lower score compared to the others, indicating the potential for improvement in terms of the material's physical convenience.

The material's independence from other resources received a mean score of 4.40, suggesting that the materials can stand alone and do not require additional materials or supplies (e.g., markers, sign pens, watercolors) for their effective use.

The overall weighted mean score of 4.20 indicates that the materials have very satisfactorily met the criterion on usability/content in terms of expenses. This implies that the MMLMs are cost-effective, easily replicable, and do not impose significant financial burdens on examiners (teachers) or examiners (students).

The MMLMs for Grade 9 Math that the experts have evaluated agree, meaning the usability validation of MMLM's in terms of expenses very satisfactorily met the criterion on usability were accordance with Caswell, T., et. al. (2008) state that contends that doing away with the need for pricey textbooks and course materials, OER can drastically lower the costs associated with duplicating educational content. The essay also covers the larger economic advantages of open educational materials, including improved educational access and the potential for innovation and collaboration in the development of educational resources.

Table 12 presents the usability validation of motivational manipulative learning materials (MMLMs) in terms of ease of time.

**Table 12.** Usability Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Time.

| Indicators | Usability validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. The material does not take too much time to administer. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 2. The activity in each material does not take too much time to accomplish. | 4.60 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 3. The material does not need too much time to be copied or reproduced. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| Overall Weighted Mean | 4.47 | Agree | The material has very satisfactorily met the criterion on usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

In Table 12, the usability validation of the motivational manipulative learning materials (MMLMs) is assessed in terms of time. The indicators evaluated include the time required for administration, the time needed to accomplish each activity, and the time required for copying or reproducing the material.

According to the mean scores, the MMLMs demonstrate a high level of usability in terms of time. The indicator "The material does not take too much time to administer" received a mean score of 4.40, indicating that the materials can be administered efficiently without consuming excessive time.

The indicator "The activity in each material does not take too much time to accomplish" received a mean score of 4.60, suggesting that the activities within the materials can be completed within a reasonable timeframe. This indicates that the materials are designed to be time-efficient and align with the intended learning objectives.

Additionally, the indicator "The material does not need too much time to be copied or reproduced" received a mean score of 4.40, implying that the process of copying or reproducing the materials can be done in a relatively short amount of time. This emphasizes the convenience and practicality of the MMLMs in terms of reproduction.

The overall weighted mean score of 4.47 indicates that the materials have very satisfactorily met the criterion on usability/content in terms of time. This suggests that the MMLMs are designed to be time-efficient and minimize any

potential delays or inefficiencies during administration, activity completion, and reproduction processes. The results implied that the MMLMs in terms of time according to studies by Suan, J. S. (2018) stated that the time needed to complete MMLMs may vary based on the individual material and its design.

It can be gleaned from Table XIII, that the usability validation of the motivational manipulative learning materials (MMLMs) is evaluated in terms of other factors that contribute to their usability. The indicators assessed include the need for special provisions or preparations, the inclusion of pupil/learner answer sheets, avoidance of embarrassing situations, prevention of discrimination or bias, suitability for remedial purposes, and facilitation of mastery of Mother Tongue lessons.

Based on the mean scores, the MMLMs demonstrate a high level of usability in terms of these other factors. The indicator "The material does not need special provisions or preparations to the extent that the teacher is uncomfortable in using it" received a mean score of 4.60, indicating that the materials can be used comfortably by teachers without requiring excessive preparations or accommodations.

The indicator "Pupil's/learner's answer sheets are included in the material to facilitate the easy recording of answers" also received a mean score of 4.60, suggesting that the materials provide convenient answer sheets that help facilitate the recording of answers. This indicates that the MMLMs are designed to streamline the assessment and evaluation process.

Furthermore, the indicators "The material does not place a pupil in an embarrassing situation" and "The material does not promote discrimination or bias towards the pupil/learner" received mean scores of 4.40 and 4.80, respectively. These scores indicate that the materials are sensitive to the emotional well-being of pupils/learners and promote a fair and inclusive learning environment.

**Table 13.** Usability Validation of Motivational Manipulative Learning Materials (MMLMS) in Terms of Other Factors.

| Indicators | Usability validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. The material does not need special provisions or preparations to the extent that the teacher is uncomfortable in using it. | 4.60 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 2. Pupil's/learner's answer sheets are included in the material to facilitate easy recording answers. | 4.60 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 3. The material does not place a pupil in an embarrassing situation. | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 4. The material does not promote discrimination or bias towards the pupil/learner. | 4.80 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 5. The material can be used for remedial purposes. | 4.80 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 6. The material helps achieve mastery of a Mother Tongue lesson. | 4.20 | Agree | The material has very satisfactorily met the criterion on usability/content |
| Overall Weighted Mean | 4.57 | Strongly Agree | The material has exceedingly met the criterion on usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

The indicators "The material can be used for remedial purposes" and "The material helps achieve mastery of a Mother Tongue lesson" received mean scores of 4.80 and 4.20, respectively. These scores suggest that the MMLMs are effective tools for addressing remedial needs and facilitating the mastery of Mother Tongue lessons.

The overall weighted mean score of 4.57 indicates that the materials have exceedingly met the criterion on usability/content in terms of these other factors. This implies that the MMLMs are designed to be inclusive, supportive, and effective in promoting a positive learning experience for pupils/learners. The result is in accordance with Li and Mitros, P. (2015) state that the effects of manipulative learning materials with motivation on proficiency in remedial mathematics and attitudes about the subject. It looks at how to engage students, boost their enthusiasm, and improve their comprehension of mathematical ideas by using hands-on tools like manipulatives and interactive learning resources. It used a group of remedial math students in a controlled experiment and discovered that the use of motivating manipulative learning materials had a favorable impact on students' achievement and attitudes toward mathematics. It sheds light on the potential advantages of including interactive and hands-on materials in remedial instruction.

Table 14 presents the overall results of the usability validation of Motivational Manipulative Learning Materials (MMLMs).

**Table 14.** Overall Results of the Usability Validation of Motivational Manipulative Learning Materials (MMLMS).

| Indicators | Usability Validation | | Interpretation |
|---|---|---|---|
| | Mean | Description | |
| 1. Ease of Administration | 4.23 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 2. Ease of Scoring | 4.55 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| 3. Expenses | 4.20 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 4. Time | 4.47 | Agree | The material has very satisfactorily met the criterion on usability/content |
| 5. Other Factors | 4.57 | Strongly Agree | The material has exceedingly met the criterion on usability/content |
| Overall Weighted Mean | 4.40 | Agree | The material has very satisfactorily met the criterion on usability/content |

**Note:** Ranges of Means: 1.00 – 1.49 (Strongly Disagree); 1.50 – 2.49 (Disagree); 2.50 – 3.49 (Uncertain); 3.50 – 4.49 (Agree); 4.50 – 5.00 (Strongly Agree).

The table provides mean scores and corresponding interpretations for different indicators of usability, including ease of administration, ease of scoring, expenses, time, and other factors. The indicator "Ease of Administration" received a mean score of 4.23, indicating that the MMLMs have very satisfactorily met the criterion of usability/content in terms of being easily administered to pupils/learners. This suggests that the materials are designed to be user-friendly and can be effectively utilized in a classroom setting without requiring special features or complex procedures. The indicator "Ease of Scoring" obtained a mean score of 4.55, signifying that the MMLMs have exceedingly met the criterion of usability/content. This implies that the materials provide clear answer keys and objective evaluation methods, enabling easy and unbiased scoring of pupils' responses. Additionally, self-evaluation/checking can be done by the pupils/learners themselves.

Regarding the indicator "Expenses," the MMLMs received a mean score of 4.20, indicating that they have very satisfactorily met the usability/content criterion. This implies that the materials are cost-effective and do not impose significant financial burdens on either the teacher or the student/examiner. The materials can be easily reproduced or photocopied, allowing for wider accessibility and dissemination.

The indicator "Time" received a mean score of 4.47, suggesting that the MMLMs have very satisfactorily met the criterion of usability/content in terms of time efficiency. The materials do not excessively consume time during administration or copying/reproduction, enabling efficient utilization within the classroom setting.

The indicator "Other Factors" obtained a mean score of 4.57, indicating that the MMLMs have exceedingly met the criterion of usability/content in terms of various other factors. These factors include the absence of uncomfortable provisions or preparations for teachers, inclusion of pupil/learner answer sheets for easy recording, avoidance of embarrassing situations, prevention of discrimination or bias, suitability for remedial purposes, and facilitation of mastery of Mother Tongue lessons.

Based on the overall weighted mean of 4.40, it can be concluded that the MMLMs have very satisfactorily met the criterion on usability/content. This indicates that the materials are well-designed, user-friendly, and effectively support the teaching and learning process.

## 5. CONCLUSIONS

Based on the results of the study, the following are concluded:

1. The least-developed learning capability among Grade 9 mathematics students in the fourth quarter was the ability to illustrate the six trigonometric ratios and determine the trigonometric ratios of specific angles. Only 50.9% and 36.92% of learners had achieved this ability, according to the percentage scores. All five portions of the class had similar results, which suggested that students generally had trouble understanding this particular idea.

2. The evaluation of the Grade 9 trigonometry motivational manipulative learning materials (MMLMs) yielded highly satisfactory ratings for the content validity criteria. The highest mean score was 4.70 for alignment, indicating that the products' content is effectively matched to the planned curriculum. However, Organization received the lowest mean score of 4.35, indicating that the materials' structure and organization might use considerable improvement. The experts concluded that the information was excellent for use in the teaching and learning process.

3. An extremely favorable reaction from the experts was shown in the examination of the usability validation criteria. The MMLMs' Other Factors component obtained the highest mean grade of 4.57, indicating that it has additional elements that improve learning and are engaging and user-friendly. The lowest mean score, 4.20, was given to expenses, indicating a marginally worse cost-effectiveness rating. The MMLMs are nevertheless truly relevant and useful for teaching and learning purposes, according to the overall evaluation.

## Conflict of Interest

The author declares no conflict of interest.

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