IJSES
Volume 10, Issue 5, pp. 88-93, 2026.
International Journal of Scientific Engineering and Science
ISSN (Online): 2456-7361

Development of Meranaw-inspired PISA-like Items on the Applications of Right Triangles for Grade 9 Learners

Janorah M. Aloz[1], Douglas A. Salazar[2]
[1]Department of Science and Mathematics Education, Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines - 9200
[2]Department of Science and Mathematics Education, Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines - 9200

Abstract— *This study aimed to develop and validate Meranaw-inspired PISA-like items on the applications of right triangles for Grade 9 learners, specifically focusing on Meranaw learners in the Philippines. The study anchored on the need to address the consistently low performance of Filipino learners in international large-scale assessment such as the Programme for International Student Assessment, particularly in mathematical literacy. The study employed a quantitative approach with qualitative supports, where the participants are exposed to the Meranaw-inspired PISA-like items. These developed items integrate cultural and local context to enhance relatability and engagement for the learners. Content, construct, level of difficulty, language and ethical/social validity of the items were assessed by a panel of experts, resulting in high ratings for each aspect. The post-test mean score (19.00) was considerably higher than the pretest mean score (0.59), which suggested a significant learning gain. The verbal interpretation also improved from Beginning to Developing, reinforcing the observed progression in proficiency levels. The results suggest that localized PISA-like items can support learners in becoming more capable and motivated of solving real-life mathematical problems and responding to PISA-like questions, while also improving their understanding of key mathematical concepts.*

Keywords— *Meranaw-inspired, PISA-like items, right triangles, mathematical literacy*

I. INTRODUCTION

Teachers continuously seek meaningful approaches to make mathematics, particularly problem solving and trigonometry, more engaging and accessible for learners. Contextualized and culturally responsive materials have shown potential in helping students better understand abstract concepts by connecting them to real-life situations. However, many learners remain unfamiliar with non-routine, application-based problems such as those found in the Programme for International Student Assessment (PISA), which contributes to difficulties in comprehension and performance. This study explores the development of Meranaw-inspired PISA-like items that integrate local context and culture to enhance learners' understanding, engagement, and ability to solve real-life mathematical problems.

A number of factors have been linked to the weak PISA record in mathematics. [12] identified several predictors of low mathematics achievement in PISA, including socioeconomic disadvantage, absenteeism, grade repetition, weak school conditions, and shortages in school personnel and resources. In the Philippine setting, [3] also pointed to family and school experiences, student motivation, and unequal learning environments as important factors behind poor mathematics performance. Beyond these conditions, language barriers appear to be a critical concern. PISA mathematics items are language rich because learners must first read, interpret, and analyze real world situations before they can perform the needed mathematical reasoning. This creates difficulty for many Filipino test takers who come from multilingual communities and who use different home languages, Filipino, and English across learning contexts. [6] found that among Grade 9 learners, the least learned geometry competencies included angle properties and parallel lines, inequalities in triangles, and parallelism and perpendicularity. In addition, [8] reported that in Grade 9 trigonometry, least learned competencies included illustrating the six trigonometric ratios and determining the trigonometric ratios of special angles. These competencies are closely related to the topic of Right Triangle, which serves as a foundation for solving trigonometric problems and for applying mathematics to practical situations. [1] further explained that students often struggle in trigonometry because they experience difficulty in transforming, processing, and encoding solutions. Thus, efforts to improve PISA mathematics performance should address both the language demands of assessment tasks and the conceptual difficulty of topics such as Right Triangle.

However, there are few studies that bring these issues together by developing and validating PISA like mathematics items that are sensitive to learners' language background, grounded in their local culture, and focused on a difficult but essential topic such as Right Triangle. This gap is even more visible in contexts involving culturally distinct learner groups such as the Meranaw, whose language and lived experiences are rarely reflected in standardized style mathematics materials. As [9] and [2] suggested, culturally and linguistically responsive mathematics materials can support better understanding, but more focused assessment development studies are still needed.

Hence, this study addresses that gap by examining the development and validation of Meranaw-inspired PISA-like items on the application of Right Triangle, with the aim of

making mathematics assessment more meaningful, accessible, and responsive to learners' needs.

II. METHODS

This study used a mixed-methods research design that combined quantitative and qualitative approaches to determine the validity of the Meranaw-inspired PISA-like items in improving learners' achievement in solving problems involving right triangles. The quantitative component followed a pretest and post-test design to determine the improvement in learners' achievement after exposure to the Meranaw-inspired PISA-like items. While the qualitative component examined the learners' perceptions of the developed items through an adapted and modified questionnaire.

Several instruments were employed in this research. The Meranaw-inspired PISA-like items were used as an achievement test to measure learners' achievement level in the subject matter, which consist of five (5) items of questions. The interpretation was based on the Department of Education's norms in interpreting the level of proficiency of a learner (DepEd Order no. 73 s. 2012) will be used and modified in this study. The Validation rating scale adapted and modified from [4] and [10] will be used to assess the Meranaw-inspired PISA-like items by the panel of evaluators. It evaluated the factors: a) Content, b) Construct, c) Level of Difficulty, d) Language, and e) Ethical/Social validity of the items. A panel of evaluators comprising two PISA-experienced mathematics teachers, three native Meranaw math teachers, and 1 Meranaw English teacher will validate the developed items. And lastly, the Perception questionnaire which was adapted and modified from a study by [7]. It consisted of Five open-ended questions wherein the respondents could freely express their opinions in English, Filipino, the vernacular or any combination of such languages.

III. RESULTS AND DISCUSSION

In developing the Meranaw-inspired PISA-like items on the applications of right triangles for Grade 9 learners, this study followed the ADDIE model.

A. Analysis Phase

The first step in this study was to ask permission from the school principal for the conduct of the study in the identified School. The researcher then collects the data from the mathematics teachers through semi-structured interviews. Data were then analyzed, and the results are presented. In the analysis of the educator's responses who were identified as an evaluator of the study answered a question, and used as a basis in the development of the items. The questions ensure that developed items are both locally relevant and appropriate for the target learners, while meeting the expected instructional standards.

During the interview, the educator highlighted that limited instructional time makes it difficult to fully cover the content-heavy competencies in the fourth quarter, resulting in learners having minimal opportunities to develop deeper understanding, particularly in higher-order thinking skills such as reasoning and real-life application. This challenge is further compounded by the fact that students are not yet adequately exposed to assessment formats similar to the Programme for International Student Assessment (PISA), causing them to find such non-routine, context-based problems unfamiliar and difficult to solve. This lack of exposure is reflected in the consistently low performance of Filipino learners in PISA Mathematics. Moreover, the educator observed that students better understand mathematical concepts when problems are presented using familiar language and contexts, especially those related to their lived experiences as Meranaw learners. These findings indicate a clear need to develop Meranaw-inspired PISA-like items in Mathematics, which aim to bridge the gap between abstract concepts and real-life situations, enhance learner engagement, and gradually build students' ability to solve PISA-type problems.

B. Design Phase

The PISA 2022 Mathematics Framework guided the design of the assessment tool. Items were developed to cover the required content knowledge, mathematical reasoning and were set in the relevant personal, societal, or local context. Each item was designed to integrate Meranaw local context to provide familiarity and relevance to learners.

Before the development of the items, a unit plan were created based on the competency specified in the Mathematics K to 12 Curriculum Guide, specifically the Most Essential Learning Competency (MELC) on the use of trigonometric ratios to solve real-life problems involving right triangles and specifically to align with the structure, format and level of difficulty of the developed Meranaw-inspired PISA-like items. The unit plan served as a preparatory framework to familiarize learners with the nature of the assessment task.

C. Development Phase

This focuses on the creation and evaluation of the assessment tool. The Meranaw-inspired PISA-like items were created and then subjected to validation. Based on the statistical results and feedback from evaluators, revisions were made. The items were confirmed by six experts: two mathematics teachers with PISA experience, three native Meranaw mathematics instructors, and one Meranaw English teacher. Each item was evaluated based on a set benchmark to determine if the materials met the expected instructional standards. This diverse panel will assess various aspects of the items, ensuring the quality and appropriateness of the items. The expertise of the panel ensures a comprehensive review covering mathematical content, construct, level of difficulty, language, and ethical/social of the items. *(**PE**: PISA Evaluator, **ME**: Maranao Teacher Evaluator, **EE**: English Evaluator)*

Table I presents the results of the content validation of the developed Meranaw-inspired PISA-like items and shows consistently high ratings across the evaluators. Across all indicators, the scores ranged from 3.50 to 4.00 that was interpreted as All indicators are observed, reflecting a strong level of agreement among the evaluators regarding the quality and appropriateness of the content. This consistency in ratings suggests that the items are well-aligned with the intended

standards and effectively represent the principle of the PISA 2022 Mathematics Framework.

TABLE I. Content Validity of the Items

Indicators	PE1	PE2	Total	Mean	Verbal Interpretation
Questions are according to the PISA 2022 mathematics literacy framework.	4	4	8	4.00	All indicators are observed
Questions are according to the PISA 2022 mathematics literacy framework and Maranao context.	4	4	8	4.00	All indicators are observed
Questions are according to the level of PISA questions.	4	3	7	3.50	All indicators are observed

TABLE II. Construct Validity of the Items

Indicators	PE1	PE2	ME1	ME2	ME3	Total	Mean	Verbal Interpretation
Topics being measured are in the scope of the curriculum.	4	4	4	4	4	20	4.00	All indicators are observed
Items are relevant to the topic/subject being measured.	4	4	4	4	4	20	4.00	All indicators are observed
Developing students' mathematical literacy skills.	4	4	4	4	4	20	4.00	All indicators are observed
Inviting further concept development.	4	4	4	4	4	20	4.00	All indicators are observed
Tables, graphs, images are presented in a clear, legible and functional way.	3	4	4	3	3	17	3.40	Most of the indicators are observed

Table II presents the construct validation results of the developed Meranaw-inspired PISA-like items and reveals high rating across the evaluators. The majority of the indicators obtained a mean of 4.00, while one indicator received a slightly lower mean of 3.40, with all scores still falling within the acceptable range of the scale. Mostly was generally rated as All indicators are observed, indicating that the items are aligned with the curriculum, relevant to the intended competencies, and capable of developing learners' mathematical literacy skills. However, the indicator related to the clarity and functionality of tables, graphs, and images received a comparatively lower mean, interpreted as Most of the indicators are observed. This still indicates that the visual representation is generally effective. Overall, the results confirm that the developed items demonstrate strong construct validity.

TABLE III. Level of Difficulty of the Items

Indicators	PE1	PE2	ME1	ME2	ME3	Total	Mean	Verbal Interpretation
In accordance with the level of students in Grade 9.	3	4	4	4	4	19	3.80	All indicators are observed
Level of difficulty is parallel to the students' academic level.	3	4	4	3	4	18	3.60	All indicators are observed
The instrument indicates the level of performance which increases with equal increment that is parallel to the students' skill level.	3	4	4	4	4	19	3.80	All indicators are observed

Table III presents the validation results for the level of difficulty of the developed Meranaw-inspired PISA-like items. The finding show that all indicators obtained mean score from 3.60 to 4.00, which fall within the highest range of the scale and are interpreted as All indicators are observed. These results suggest that the items are well-calibrated in terms of complexity and cognitive demand. Although slight variations in the ratings were observed, these differences attributed to individuals' evaluators' perception of item difficulty. Nevertheless, the overall results indicate that the items successfully maintain a balance between accessibility and challenge.

TABLE IV. Language Validity of the Items

Indicators	ME1	ME2	ME3	EE1	Total	Mean	Verbal Interpretation
Is free of any errors in punctuation.	4	4	3	3	14	3.50	All indicators are observed
The instrument contains correct capitalization of words.	4	4	3	3	14	3.50	All indicators are observed
Free from grammatical errors.	4	3	3	3	13	3.25	Most of the indicators are observed
Questions do not contain multiple interpretations.	4	3	4	4	15	3.75	All indicators are observed
The questions and answers are clearly delimited.	4	3	4	4	15	3.75	All indicators are observed

Table IV presents the results of the language validation of the developed Meranaw-inspired PISA-like items. The ratings across all indicators ranged from 3.25 to 3.75, reflecting generally high levels of agreement among the evaluators. Most indicators were interpreted as *All indicators are observed.* These results indicate that the items are generally clear, precise, and comprehensible. These suggest that the items are effectively written in a way that minimizes misinterpretation. However, minor inconsistencies in grammar were noted, to further enhance linguistic accuracy and overall quality.

TABLE V. Ethical/Social Validity of the Items

Indicators	ME1	ME2	ME3	EE1	Total	Mean	Verbal Interpretation
The instrument contains relevant or associated texts that are free from offensive language.	4	3	4	3	14	3.50	All indicators are observed
The instrument is free from cultural discrimination.	4	4	4	4	16	4.00	All indicators are observed
In accordance with Maranao and local context.	4	3	4	4	15	3.75	All indicators are observed

Table V presents the validation results for the ethical and social aspects of the developed Meranaw-inspired PISA-like items. The indicators obtained mean scores ranging from 3.50 to 4.00, all of which are interpreted as All indicators are observed. These results suggest that the items are free from offensive language, culturally sensitive and appropriate for the learners. The highest rating obtained in the indicator related to the absence of cultural discrimination reflects that the items successfully uphold inclusive and fairness. The Meranaw-

International Journal of Scientific Engineering and Science
Volume 10, Issue 5, pp. 88-93, 2026. ISSN (Online): 2456-7361

inspired PISA-like items was then revised based on the panel of evaluators' comments and suggestions.

M8: BALO-I CENTRAL MASJID

The Balo-i Central Masjid, a prominent religious and architectural landmark in the Padian of Balo-i, Lanao del Norte, features a majestic golden dome with a pointed top, making it the tallest structure in the area.

Before Maghrib prayer, an Imam observes the golden dome of the Balo-i Central Masjid from different positions.

When he moves closer to the masjid, the angle of elevation changes.

Question: BALO-I CENTRAL MASJID

Why does the angle of elevation increase when the Imam moves closer?

Explain using your understanding of triangles.

Fig 1. Developed Maranao-inspired PISA-like Items

D. *Implementation Phase*

On the implementation of the video lesson, the researcher filled in as the teacher for two weeks. To effectively integrate the development of Meranaw-Inspired PISA-like items into instruction, a learning packet with a unit plan was designed and implemented over approximately 2 weeks. This served as a preparatory framework to familiarize learners with the nature of the assessment task, ensuring that learners not only learn trigonometric concepts but also develop the necessary problem-solving skills required for PISA-like assessments.

Table VI presents the descriptive statistics for the pretest and post-test scores and revealed a substantial difference in performance. The post-test mean score (19.00) was considerably higher than the pretest mean score (0.59), which suggested a significant learning gain. The verbal interpretation also improved from Beginning to Developing, reinforcing the observed progression in proficiency levels.

TABLE VI. Description of Pretests and Post-test results

Level of Proficiency	Pre Test		Post Test	
	f	%	f	%
Advanced	0	0.00	8	25.00
Proficient	0	0.00	7	21.88
Approaching Proficiency	0	0.00	3	9.38
developing	0	0.00	5	15.63
Beginning	32	100.00	9	28.13
Total	32	100.00	32	100.00
Mean	0.59		19.00	
Verbal Interpretation	*Beginning*		*Developing*	

The pretest scores reveal a wide range of prior knowledge among the learners, with most scores falling within the "Beginning" level of proficiency (74% and below). This suggests that the learners, on average, had a limited understanding of the concepts being assessed before the intervention. Additionally, the post-test scores show a significant improvement in the learners' understanding of the concepts, with a majority of scores falling within the "Developing" (80-84%) levels of proficiency. This suggests that the Maranao-inspired PISA-like items, was effective in enhancing their learning.

TABLE VII. Wilcoxon Signed Rank Test (Pretest vs Posttest)

Category	Variables Tested	Mean	p-value	Decision Rule	Decision	Interpretation
1. THE PARADE SHORTCUT	Pre-Test	0.00	0.000	Reject Ho if p-value is less than or equal to alpha (0.05)	Reject Ho	There is a significant difference
	Post-Test	3.84				
2. BALO-I OLD BRIDGE	Pre-Test	0.00	0.000		Reject Ho	There is a significant difference
	Post-Test	3.97				
3. BALO-I CENTRAL MASJID	Pre-Test	0.00	0.000		Reject Ho	There is a significant difference
	Post-Test	3.47				
4. KULLIYAT ABDEL AZIS WADDIRASATIL ISLAMIYYA	Pre-Test	0.00	0.000		Reject Ho	There is a significant difference
	Post-Test	4.09				
5. BALO-I MUNICIPAL FLAGPOLE	Pre-Test	0.59	0.000		Reject Ho	There is a significant difference
	Post-Test	3.63				
OVERALL LEVEL OF PROFICIENCY	Pre-Test	**0.59**	0.000		Reject Ho	**There is a significant difference**
	Post-Test	**19.00**				

Null Hypothesis: There is no significant difference in the achievement level of Grade 9 learners between the pretest and post-test.

Table VII presents all computed p-values were equal to 0.000, which is significantly lower than the established alpha level of 0.05.

The post-test results showed significant improvement in learner achievement levels compared to their pretest. The increase from the mean of 0.59 to 19.00 suggests that the localized approach has a significant impact on enhancing learner understanding and achievement level. Across all item categories, p-values = 0.000, leading to the rejection of the null hypothesis. This means there is a statistically significant difference between pretest and post-test scores.

In conclusion, the findings from the Wilcoxon Signed-Rank Test provide strong statistical evidence that the implementation of Meranaw-inspired PISA-like items had a significant positive effect on the learners' achievement in solving problems involving right triangles. In support of these findings, the study conducted by [11] demonstrated that integrating cultural elements into mathematics assessments, significantly enhances problem-solving skills.

E. *Evaluation Phase*

Following Braun and Clarke's approach, the emerged themes represented shared patterns of meaning across the interview data and showed that the learners generally viewed the items as interesting, culturally connected, easier to understand, and at the same time cognitively demanding in a productive way.

In these statements:

"At first, I didn't understand it but when I realized that the problems were based on situations we see in our place, it became easier to understand." – L4

"Good because the example is Meranaw and the picture is in baloi." – L2

These responses highlight that learners initially experienced difficulty in understanding the problems,

particularly due to their unfamiliarity with PISA-like items, which require higher-order thinking and interpretation of real-life situations. However, when the problems were contextualized or localized using familiar settings and Meranaw cultural elements, learners were able to better comprehend the given situations and apply appropriate mathematical concepts. This indicates that contextualization plays a crucial role in bridging the gap between abstract mathematical ideas and learners' real-life experiences.

Furthermore, learners' responses suggest that the Maranao-inspired PISA-like items helped them understand the application of mathematical concepts in real-life situations. As one learner shared:

"Yes, they helped a lot. The problems showed how right triangle are used in actual situations, making it easier for me to understand their importance and hoe to solve them." – L7

Another learner added:

"Yes, somehow but at least I've learned it even though na like mahina ako sa math." – L1

These responses imply that the use of Meranaw-inspired PISA-like problems supported learners in developing their problem-solving skills, even among those who initially perceived themselves as weak in mathematics. The integration of real-life Meranaw contexts allowed learners to visualize and interpret problems more effectively, thereby improving their confidence and engagement in solving non-routine tasks.

Likewise, when learners are asked whether the use of Meranaw-inspired PISA-like items made learning mathematics more interesting or engaging, one learner shared: *"said the experience made the learner have interest in math even though the learner had not been into mathematics before. "*– L19.

This suggests that when mathematical problems are situated within familiar and meaningful contexts, learners become more motivated and engaged. The use of Meranaw-inspired situations not only made the problems more understandable but also enhanced learners' interest by connecting mathematics to their daily experiences and cultural background.

Another thing, when the learners were asked if it was easy for them to apply the knowledge, they have learned using the Meranaw-inspired PISA-like items to solve math problems effectively, a learned answered:

"stated that it was easy because the problem was familiar and the learner could imagine it and visualize." – L18

The learner's feedback suggests that familiarity with the context of the problem plays a significant role in learners' ability to apply mathematical concepts. When problems are grounded in real-life situations that learners can relate to, they are better able to visualize the given scenario, identify relevant information, and determine appropriate strategies for solving. Moreover, the use of Meranaw-inspired contexts appears to support learners in making sense of abstract mathematical ideas by linking them to their everyday experiences. This indicates that contextualized PISA-like items not only enhance comprehension but also improve learners' confidence in applying their knowledge to solve non-routine problems. Overall, the response implies that incorporating familiar and culturally relevant situations in mathematical tasks can make problem-solving more accessible and meaningful for learners.

And lastly, when asked about the use of Meranaw-inspired PISA-like items as a form of assessment, learners generally expressed positive perceptions. For instance:

"stated that it should be used because it was engaging and based on real life." – L17

"stated that the items could be used as assessment because they could be fun." – L19

These responses suggest that learners view the items not only as instructional tools but also as effective assessment materials that promote engagement and meaningful learning.

On the other hand, one student commented:

"stated that no because the learner preferred the direct formula, felt slow with long formulas, and felt that the brain got scrambled while answering." – L4

This response indicates that not all learners are immediately comfortable with PISA-like problems, particularly those that require extended reasoning and interpretation of real-life situations. Some students tend to prefer routine, formula-based questions where procedures are more direct and familiar. The difficulty experienced by the learner suggests that PISA-like items, while beneficial, demand higher cognitive processing, which may initially challenge students who are more accustomed to traditional problem-solving approaches.

IV. Conclusions and Recommendations

The study's findings show that the use of Meranaw-inspred PISA-like items helped improved learners' understanding, especially in solving real-life problems involving right triangle. The descriptive statistics reveal a substantial improvement in learner performance between the pretest and post-test, with a significant shift in scores from the "Beginning" level to the "developing" levels. The wilcoxon signed-rank test further supports this conclusion, the increase from the mean of 0.59 to 19.00 suggests that the localized approach has a significant impact on enhancing learner understanding and achievement level. Across all item categories, p-values = 0.000, leading to the rejection of the null hypothesis. In support of these findings, the study conducted by [11] demonstrated that integrating cultural elements into mathematics assessments, significantly enhances problem-solving skills. Moreover, localized PISA-like items can support learners in becoming more capable and motivated of solving real-life mathematical problems and responding to PISA-like questions, while also improving their understanding of key mathematical concepts.

In addition, the researcher would like to recommend the following:

- The study suggests that teacher should integrate more localize-based problems in classroom instruction, especially in topics that require visualization and real-life application.
- Learners should be exposed to these types of questions regularly and over a longer period of time, not only during a short intervention.

- The need to develop more Meranaw-inspired PISA-like items covering different topics in Mathematics.
- The increase of number of evaluators in assessing the quality of the items.
- Compare this approach with other teaching methods to further understand its strengths in improving learners' achievement level.
- Explore the potential of code-switching in video lessons for other subjects, particularly those that rely on visual representations and complex concepts.

REFERENCES

[1] Arhin, J., & Hokor, E. K. (2021). Analysis of high school students' errors in solving trigonometry problems. Journal of Mathematics and Science Teacher, 1(1), 1-16.
[2] Bacan, C. J. D. Exploring the Role of Mother Tongue in Mathematics Education: Benefits and Challenges of Language Localization.
[3] Bernardo, A. B. I., Cordel, M. O., Lapinid, M. R. C., Teves, J. M. M., Yap, S. A., & Chua, U. C. (2022). Contrasting Profiles of Low-Performing Mathematics Students in Public and Private Schools in the Philippines: Insights from Machine Learning. Journal of Intelligence, 10(3), 61. https://doi.org/10.3390/jintelligence10030061
[4] Nizar, H., Putri, A. D., & Septy, L. (2022). Islamic context on PISA-Like mathematics problem in junior high school. Jurnal Didaktik Matematika, 9(2), 298-313Philippine Journal of Science, 148(4), 735-749. Retrieved from https://archium.ateneo.edu/mathematics-faculty-pubs/46/ in January 2025.
[5] Patel, S. R., Margolies, P. J., Covell, N. H., Lipscomb, C., & Dixon, L. B. (2018). Using instructional design, analyze, design, develop, implement, and evaluate, to develop e-learning modules to disseminate supported employment for community behavioral health treatment programs in New York State. Frontiers in Public Health, 6, Article 113. https://doi.org/10.3389/fpubh.2018.00113
[6] Robles, R. L., & Chua, E. V. (2024). Geometry Competencies of High School Students: Basis for an Intervention Program. INTERNATIONAL JOURNAL OF RESEARCH, 8, 3122-3131.
[7] Said, M. G. H., Oledan, A. M. B., Buan, A. T., Luga, M. J. F., & Saromines, C. J. C. (2024). Development of Contextualized Learning Packet in Inequalities in Triangle for Grade 8 Learners. Development, 8(6), 7-10. Retrieved from https://ijses.com/wp-content/uploads/2024/06/146-IJSES-V8N5.pdf
[8] Tagupa, E. R., & Arnado, A. A. (2023). Development and Validation of Motivational Manipulative Learning Materials (MMLMs) for the Least-Learned Competencies of Grade 9 Trigonometry. International Journal of Membrane Science and Technology, 10(2), 1002-1022..
[9] Tungul, K. T. S., & Lapinid, M. R. (2024). Assessing the mother tongue-based multilingual education policy in the Philippine mathematics education. CAKRAWALA PENDIDIKAN, 43(3).
[10] Veloso, A (2014). Student Attribute Correlates of Academic Achievement in High School Chemistry between Grade 9 & 10 Students
[11] Verner, I., Massarwe, K., & Bshouty, D. (2013). Constructs of engagement emerging in an ethnomathematically-based teacher education course. The Journal of Mathematical Behavior, 32(3), 494-507.
[12] Wang, X. S., Perry, L. B., Malpique, A., & Ide, T. (2023). Factors predicting mathematics achievement in PISA: A systematic review. Large-Scale Assessments in Education, 11(1), 24.