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Designing for global competency: A PISA – aligned mathematics workbook for developing numerical literacy of Grade 9 students

Villere, Christian A. ✉
University of Nueva Caceres, Philippines (christian.villere@unc.edu.ph)

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Abstract

Mathematical literacy is an integral part of developing students' 21st-century skills, especially for international assessments such as the Program for International Student Assessment (PISA). Candidates' scores, however, do not align with the global average in mathematics, as seen in recent PISA tests, showing the need to improve the teaching of mathematics using materials that emphasize contextualized problem-solving and real-world applications. The goal of this study was to design and develop a mathematics workbook that integrates with PISA and strengthens numerical literacy and reasoning skills for grade 9 students. The design used in this study was a Research and Development (R&D) design, grounded in practical research, to illustrate the pragmatic paradigm. The competencies in the PISA Mathematics Framework were analyzed, and the activities in the Workbooks were aligned with the Department of Education's grade 9 Most Essential Learning Competencies (MELCs). The material focused on selected geometry topics, including quadrilaterals and similarity, and was reflected in contextualized mathematics problems set in real-life contexts. Content validation of the workbook was conducted by three mathematics experts using the Department of Education Evaluation Rating Sheet for Print Resources. Ten teachers (weaving mathematics education) participated in evaluating its acceptability using an evaluation form adapted from the Teacher Acceptability and Usability questionnaire. The results showed that the workbook had satisfactory qualities in terms of content, clarity, relevance, and appropriateness for Grade 9 learners. Feedback from the evaluators led to revisions that improved the organization and contextualization of the material. The study resulted in a validated and accepted "PISA mathematics workbook" for 9th-grade students, which can be used as a supplementary tool to develop mathematical literacy, practical problem-solving, and critical thinking skills.

Keywords: mathematical literacy, PISA-aligned workbook, geometry instruction, contextualized mathematics, Grade 9 mathematics

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1. Introduction

Mathematics education plays a vital role in preparing learners to become critical thinkers, problem-solvers, and globally competitive individuals. In today's rapidly changing and technology-driven society, students are expected not only to master mathematical procedures but also to apply mathematical concepts in solving real-life problems and making informed decisions. This highlights the importance of developing mathematical literacy, which refers to the ability of learners to formulate, apply, and interpret mathematics in various contexts. As emphasized by the Programme for International Student Assessment (PISA), mathematical literacy is an essential competency that enables learners to connect mathematics with everyday experiences and global issues. Research by Chen (2024) revealed that early exposure to mathematics enhances learners' problem-solving, analytical thinking, and decision-making skills, while Blotnicky et al. (2018) emphasized that strong mathematical ability is associated with employability and economic productivity in today's society.

Despite the importance of mathematical literacy, the performance of Filipino learners in international assessments remains a challenge. Results from recent PISA assessments revealed that many Filipino students struggle with higher-order thinking skills, problem-solving, and the application of mathematical concepts in contextualized situations. According to the OECD (2023), the Philippines ranked among the low-performing countries in mathematics, with only a small percentage of Filipino students reaching the minimum proficiency level in mathematical literacy. Bernardo and Isoda (2021) further explained that although the Philippine curriculum contains competencies related to PISA, learners are still less exposed to complex and context-rich mathematical tasks that require critical thinking and real-world application. These findings suggest that while the K to 12 curriculum provides essential competencies, there is still a need for instructional materials that strengthen students' reasoning skills and expose them to meaningful, real-world mathematical tasks aligned with international standards.

One way to address this concern is through the development of contextualized and learner-centered instructional materials. Mathematics workbooks designed with authentic and practical problem-solving activities can help learners engage more deeply with mathematical concepts while improving their analytical and decision-making skills. Studies by Aksu and Colak (2021) and Widada et al. (2025) showed that contextualized and PISA-like mathematical tasks significantly improve students' conceptual understanding, mathematical literacy, and reasoning skills. Moreover, Bautista and Valtoribio (2024) emphasized that contextualized instruction enhances students' mathematical communication and problem-solving abilities by connecting mathematical concepts to real-life experiences. Integrating PISA-aligned tasks into instructional materials allows students to experience mathematics beyond routine computations and encourages them to think critically, interpret data, and solve problems encountered in everyday life.

In line with this, the present study focuses on the development of a PISA-aligned mathematics workbook intended for Grade 9 students. The workbook aims to bridge the gap between the competencies required by the Department of Education curriculum and the mathematical literacy competencies emphasized in PISA. Through contextualized activities, real-world scenarios, and problem-solving tasks, the workbook seeks to enhance students' numerical literacy, reasoning ability, and preparedness for global standards in mathematics education. Costan et al. (2025) highlighted the importance of supplementary mathematics instructional materials aligned with PISA competencies to strengthen mathematics learning outcomes, while Lumabit and Sagge (2023) stressed the need for instructional materials that are relevant, contextualized, and appropriate for competence development. Moreover, this study hopes to contribute to the improvement of instructional resources that support both teachers and learners in promoting meaningful and relevant mathematics learning experiences. This study aimed to design and develop a PISA-aligned mathematics workbook for Grade 9 students to improve their numerical literacy and

prepare them for global competency in mathematics. Specifically, it sought to analyze the key competencies from the PISA framework and integrate them into the mathematics workbook; design mathematics workbook exercises that incorporate real-world, globally relevant scenarios to enable meaningful mathematical problem-solving; and develop a mathematics workbook that is content-validated and evaluated for acceptability based on feedback from mathematics teachers.

2. Methods

Research Design - This study utilized a Research and Development (R&D) design using a descriptive-developmental approach to develop a PISA-aligned mathematics workbook for Grade 9 students. The design was appropriate because the study focused on the creation, validation, and evaluation of a supplementary instructional material aligned with the PISA Mathematics Framework and the Department of Education's Most Essential Learning Competencies (MELCs). The descriptive aspect involved analyzing the PISA competencies and aligning them with the Grade 9 mathematics competencies, while the developmental aspect focused on designing, developing, validating, revising, and evaluating the workbook. The workbook contained contextualized and real-world mathematical tasks intended to enhance students' numerical literacy and problem-solving skills. The developed workbook underwent content validation by mathematics education experts using the Department of Education Evaluation Rating Sheet for Print Resources. It was also evaluated by mathematics teachers to determine its level of acceptability in terms of clarity, relevance, engagement, and suitability for Grade 9 learners. Feedback and recommendations from the validators and evaluators were used to improve the workbook before finalization.

Participants of the Study - The participants of this study consisted of mathematics education experts and Grade 9 mathematics teachers who were selected to validate and evaluate the developed PISA-aligned mathematics workbook. The expert validators were composed of professionals with specialization and experience in mathematics education, curriculum development, and instructional material evaluation. They were chosen to assess the content validity of the workbook in terms of accuracy, clarity, organization, relevance, and alignment with the PISA Mathematics Framework and the Department of Education's Most Essential Learning Competencies (MELCs). The teacher-evaluators were practicing mathematics teachers from selected schools who handled Grade 9 mathematics subjects. They were selected because of their firsthand experience in classroom instruction and their familiarity with the learning needs of Grade 9 students. Their role was to evaluate the acceptability and usability of the workbook in terms of clarity, usefulness, engagement, and suitability for classroom application. Feedback and recommendations from the participants were utilized to improve and finalize the developed workbook.

Data Gathering Instrument - The study utilized two research instruments to gather the necessary data for the validation and evaluation of the developed PISA-aligned mathematics workbook. The first instrument was the Department of Education Evaluation Rating Sheet for Print Resources, which was used by the expert validators to assess the content validity of the workbook. The instrument evaluated the material in terms of content accuracy, clarity, presentation and organization, format, relevance, and alignment with the PISA Mathematics Framework and the Grade 9 Most Essential Learning Competencies (MELCs). The second instrument was an adapted Teacher Acceptability and Usability Questionnaire (TAUQ), which was administered to mathematics teachers to determine the level of acceptability of the workbook. The questionnaire assessed the workbook based on clarity, usefulness, engagement, relevance, and suitability for Grade 9 learners. The instruments provided quantitative and qualitative feedback that served as the basis for revising and improving the developed workbook prior to its finalization.

Data Gathering Procedure - The researcher first analyzed the PISA Mathematics Framework and the Grade 9 Most Essential Learning Competencies (MELCs) as the basis for developing the PISA-aligned mathematics workbook. Relevant literature and studies were also reviewed to support the creation of contextualized mathematical tasks. After the workbook was developed, it was submitted to mathematics education experts for content validation using the Department of Education Evaluation Rating Sheet for Print Resources. The comments and recommendations of the validators were used to revise and improve the workbook. The revised workbook was then evaluated by selected Grade 9 mathematics teachers using the adapted Teacher Acceptability and Usability

Questionnaire (TAUQ). Their feedback regarding the clarity, usefulness, engagement, relevance, and suitability of the workbook served as the basis for the final revision and completion of the instructional material.

Ethical Considerations - The researcher observed proper ethical standards throughout the conduct of the study. Permission was secured from the concerned school authorities and participants before the validation and evaluation of the developed workbook were conducted. The participants were informed about the purpose of the study, and their participation was entirely voluntary. They were also assured that the information and responses gathered would be treated with confidentiality and used solely for academic and research purposes. The researcher ensured that the rights, privacy, and professional opinions of the expert validators and teacher-evaluators were respected throughout the study. Proper acknowledgment and citation of all references, sources, and related literature used in the study were also observed to avoid plagiarism and maintain academic integrity.

Data Analysis - The data gathered from the expert validators and teacher-evaluators were analyzed using descriptive statistics. Weighted mean was used to determine the level of content validity and acceptability of the developed PISA-aligned mathematics workbook. The responses of the expert validators were analyzed based on the criteria in the Department of Education Evaluation Rating Sheet for Print Resources, including content, format, presentation and organization, and accuracy of information. Similarly, the responses from the mathematics teachers using the Teacher Acceptability and Usability Questionnaire (TAUQ) were analyzed to determine the workbook's level of acceptability in terms of clarity, usefulness, engagement, relevance, and suitability for Grade 9 learners. The comments and suggestions provided by the participants were also reviewed and used as basis for revising and improving the workbook.

3. Results and Discussion

Analysis of PISA Competencies **-** The table shows that the PISA mathematical competencies closely align with several MELCs in Geometry, including similarity of triangles, properties of quadrilaterals, proportional reasoning, and problem solving involving geometric figures. This alignment demonstrates that the competencies assessed in PISA can be integrated into existing curriculum standards through appropriately designed instructional materials. Based on the analysis of the three PISA competencies, they appear to represent successive steps in the mathematical problem-solving process. In the competency domain "Formulate situations mathematically," the learner is expected to identify relevant information, recognize relationships, and represent real-world contexts mathematically. This competency is linked to MELCs such as solving problems using the similarity of figures and to proportional reasoning. This competency is demonstrated in the developed workbook through real-life scenarios such as measurement situations, spatial layout, and architectural structures, in the form of contextualized problems where students interpret the situation. Students understand the context and identify the geometric ideas that would be helpful in solving the presented problem, such as properties of quadrilaterals or triangle similarity.

The third competency area for interpreting and evaluating mathematical results concerns assessing the reasonableness and applicability of results in real-world situations. The MELCs that involve problem solving with quadrilaterals, trapezoids, kites, and triangle similarity also fall under this category, as learners need to analyze the outcomes and synthesize mathematical solutions to problems in real-world contexts. Students need to find a solution and decide whether it is reasonable for the problem being solved. The use of results to analyze, communicate, and examine the implications of mathematical solutions is developed in this stage. The reflection prompts and the interpretation questions in the workbook encourage students to interpret and expand on their reasoning and responses, considering whether those responses would make sense in the real world.

The results indicate that incorporating these skill sets into the curriculum may markedly improve students' skills in "thinking at the mathematical" level. Of the three competencies, developing mathematical situations is generally the most cognitively demanding, as learners must screen the information provided in their contexts and build models of their situations. Typically, when students are familiar with routine handling procedures, they experience difficulties in understanding the teaching and learning problems presented in the context and in

converting them into a mathematical expression (Bernardo, 2021). Similarly, the ability to interpret and evaluate the suitability of mathematical outcomes of calculations should prompt learners to consider the plausibility and bounds of their calculations. In the evaluative stage, metacognitive processes include checking the plausibility of answers and considering alternative approaches, learning activities that have been limited in studies of mathematics learning when the mathematics learning process emphasizes procedural accuracy. The seamless embedding of all three competencies can, therefore, contribute to a thorough problem-solving process in which learners define problems, use mathematical tools and processes to solve them, and critically evaluate their results.

Table 1
Identified PISA Competencies

Competencies	Description	Aligned DepEd K–12 Grade 9 (Geometry) Competencies (MELCs)
The learners; *Formulate situations mathematically.*	Identifying relevant information, recognizing patterns and relationships, and translating real-world situations into mathematical expressions or models.	Illustrates similarity of figures. (M9GE-IIIg-1) Applies the theorems to show that given triangles are similar. (M9GE-IIIi-1) Describes a proportion. (M9GE-IIIf-1) Applies the fundamental theorems of proportionality to solve problems involving proportions. (M9GE-IIIf-2)
Employ mathematical concepts, procedures, and reasoning.	Selecting and applying appropriate mathematical procedures, representing relationships using symbols/graphs, and using logical reasoning to solve problems.	Identifies quadrilaterals that are parallelograms. (M9GE-IIIa-1) Determines the conditions that make a quadrilateral a parallelogram. (M9GE-IIIa-2) Uses properties to find measures of angles, sides and other quantities involving parallelograms. (M9GE-IIIb-1) Proves theorems on the different kinds of quadrilateral. (M9GE-IIIc-1 & M9GE-IIId-2) Proves the Midline Theorem. (M9GE-IIId-1) Proves the Pythagorean Theorem. (M9GE-IIIi-2)
Interpret and evaluate mathematical results in real-world contexts.	Making sense of mathematical results, interpreting graphs/tables, evaluating the reasonableness of solutions, and communicating mathematical explanations.	Solves problems involving parallelograms, trapezoids and kites. (M9GE-IIIe-1) Solves problems that involve triangle similarity and right triangles. (M9GE-IIIj-1)

The findings suggest that integrating these competencies into instructional materials can significantly enhance students' ability to engage in higher-order mathematical thinking. Among the three competencies, formulating mathematical situations is often the most cognitively demanding, as learners must filter relevant information from complex contexts and construct appropriate mathematical representations. Students who are accustomed to routine procedural exercises may initially find it challenging to interpret contextual problems and translate them into mathematical expressions (Bernardo, 2021). Similarly, the competency of interpreting and evaluating mathematical results requires learners to reflect on the validity and limitations of their solutions. This evaluative stage involves metacognitive processes such as checking the plausibility of answers and considering alternative approaches, which are often underdeveloped when mathematics instruction focuses primarily on procedural accuracy (Dela Cruz, 2024). The integration of all three competencies, therefore, supports a more comprehensive problem-solving cycle in which learners identify problems, apply mathematical strategies, and critically assess their solutions.

The results align with the mathematical literacy PISA framework, which broadly considers mathematical competence as the capacity to make, use, and understand mathematics in different authentic situations (OECD, 2022). As mentioned in Chapter II, mathematical literacy should enable students to reason, model and make decisions using mathematics and not simply to carry out routine calculations. The findings are also consistent with the principles of Realistic Mathematics Education (RME), which hold that mathematical concepts are built by making new experiences meaningful. Likewise, constructivist learning theories of Piaget (1973) and Vygotsky (1978) state that knowledge is built by linking existing knowledge to new knowledge within context. Another context in which structured scaffolding can assist learners in handling the complexity of contextualized problems is when Piaget's theory of cognitive development suggests that learners will need aids for identifying relevant information and building mathematical models in the problems (1950). Within the Filipino context, the DepEd

Mathematics Curriculum focuses on reasoning, modeling, and problem solving as learning outcomes. Therefore, the mathematics competencies in PISA and their alignment with Grade 9 MELCs showcase the potential of contextualized instructional materials to reinforce learners' mathematical competencies and achieve the national curricular goals.

Based on these findings, the developed workbook incorporated several instructional strategies designed to support the integration of the three PISA competencies into Grade 9 Geometry learning activities. First, contextualized mathematical tasks were included to encourage learners to identify relevant information and translate real-world situations into mathematical representations. Second, scaffolded problem-solving activities were designed to guide students in applying mathematical concepts and justifying their procedures. Third, reflective prompts were embedded throughout the activities to encourage learners to interpret their results and evaluate the reasonableness of their solutions. Additional features such as guiding questions, graphic organizers, and step-by-step modeling templates were also incorporated to support learners in navigating complex problem situations. These strategies aim to assist teachers and instructional designers in embedding mathematical reasoning, modeling, and evaluation into classroom practice, thereby strengthening students' ability to apply mathematics meaningfully in real-world contexts.

Designed Mathematics Workbook with Aligned PISA Competencies - Designing mathematics workbook exercises that integrate real-world and globally relevant situations to help Grade 9 students develop meaningful mathematical problem-solving skills. The workbook was limited to the topics of Quadrilaterals and Similarity and was designed based on the PISA Mathematics Framework and the Grade 9 Most Essential Learning Competencies (MELCs). Instead of focusing only on routine computations and memorization, the workbook emphasized reasoning, interpretation, and the application of mathematical concepts in authentic situations. The workbook design process started with identifying the PISA mathematical competencies and aligning them with the Grade 9 Geometry MELCs to ensure consistency with the Philippine curriculum. After identifying the competencies, contextualized activities and problem-solving tasks were developed using real-life situations related to architecture, construction, farming, health, environmental planning, and community settings. The workbook included several real-world scenarios such as the Dockland, Billboard Frame, Trapezoid Farm, Wheelchair Ramp, Tree Shadow, and Rescue Mission activities. These tasks required students to analyze situations, identify geometric relationships, apply mathematical procedures, and interpret solutions based on the given context. Through these activities, learners were encouraged to connect geometry concepts with practical situations encountered in everyday life.

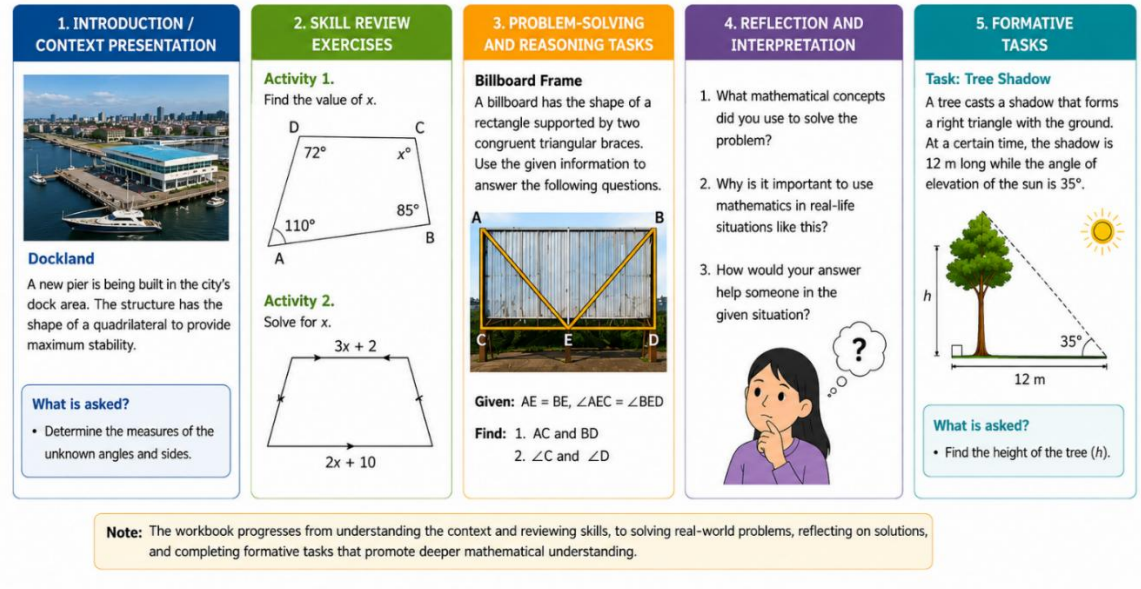

Figure 1. Organization of the PISA-Aligned Grade 9 Geometry Workbook

Figure 1 shows the organization of the workbook, which included Introduction/Context Presentation, Skill

Review Exercises, Problem-Solving and Reasoning Tasks, Reflection and Interpretation, and Formative Tasks. This structure allowed students to gradually progress from understanding basic concepts to solving complex contextualized problems. The workbook also provided reflective questions and reasoning activities that encouraged learners to explain and evaluate their mathematical thinking. The workbook design was supported by studies emphasizing the importance of contextualized and PISA-like mathematical tasks. According to Aini et al. (2022), geometry tasks connected to real-life situations improve students' reasoning and spatial visualization skills. Similarly, Meryansumayeka et al. (2022) found that contextualized mathematical activities increase student engagement and conceptual understanding. OECD (2022) also emphasized that mathematical literacy involves the ability to formulate, apply, and interpret mathematics in real-world contexts. The findings imply that designing mathematics workbook exercises using real-world and globally relevant scenarios helps students develop mathematical literacy, critical thinking, and problem-solving skills. The workbook provided meaningful opportunities for learners to apply geometry concepts beyond classroom situations and prepared them for higher-order thinking tasks aligned with international standards such as PISA.

Develop a Mathematics Workbook that is Content-Validated and Evaluated for Acceptability Based on Feedback from Mathematics Teachers - The content of the designed PISA-aligned workbook underwent content validation by the experts, and their suggested comments were recorded in the workbook. Later, the designed workbook was evaluated for its level of acceptability. The intent of this assessment was to explore the workbook's success in the following areas: clarity, usefulness/relevance, engagement, and suitability for learners. These results are intended to predict the quality of the workbook and its potential use as an instructional asset in the classroom.

The level of acceptability in terms of clarity as of the designed PISA-aligned mathematics workbook is indicated in Table 2. Based on the overall mean score of 4.45 which respondents' rate as Acceptable, the workbook is clear and is understandable. Individual indicators reveal that the language used is age-appropriate, precise, and free from ambiguity (M = 4.70), and redundancy or content overlap is absent (M = 4.70), all rated as Very Acceptable. The clarity of instructions and explanations and mathematical concepts are logically and systematically presented also received a strong rating (M = 4.00, Acceptable), demonstrating that while most components are clear, minor refinements could further enhance comprehension. These findings suggest that the workbook is well-structured, precise, and largely accessible. The high level of acceptability might be explained by deliberate attention paid to the cognitive and linguistic appropriateness: the learners are given clear explanations; the information is presented in a structured flow; terminology is carefully selected. The extremely high language scores and non-redundancy could reflect the workbook's ability to reduce ambiguity and cognitive overload and aid comprehension of mathematical tasks. The slightly lower, but still high rating for instructions, may indicate that some activities may need more examples, step by step instructions, or some visual supports. In summary, these results suggest that the workbook is useful and student friendly, but may be refined a little for better understanding particularly for other student groups.

Table 2
Level of Acceptability in Terms of Clarity

Indicators	Sum	Mean	Descriptive Rating
Instructions and explanations are clear, simple, and easy to follow.	40	4.00	Acceptable
Language is age-appropriate, precise, and free from ambiguity.	47	4.70	Very Acceptable
Mathematical concepts are presented logically and systematically.	44	4.40	Acceptable
No redundancy or overlapping of content.	47	4.70	Very Acceptable
Mean		4.45	Acceptable

Legend: 4.50 - 5.00 = Very Acceptable; 3.50 - 4.49 = Acceptable; 2.50 - 3.49 = Moderately Acceptable; 1.50 - 2.49 = Slightly Acceptable; 1.00 - 1.49 = Not Acceptable

The findings indicate a high degree of clarity and transparency of instruction in the designed workbook critical for the PISA aligned tasks which require students to interpret complex and challenging problems independently. Reliable scores for systematic presentation of concepts and precise language were fairly good, which means that the material has the potential to facilitate good learning and problem-solving. As seen from the results, students will tend to understand the indicated task, and minimize misunderstanding that can be caused by unclear instructions or the use of language. Although there is some room for slight improvement in the instructions, the current workbook is a good and clear introduction to Grade 9 mathematics.

The results are echoed by studies that underscore the importance of clarity in teaching materials to improve understanding, learning and achievement. Mayer (2020) has made it clear that logically ordered content and comprehensible explanations lowers cognitive demands and enhance problem solving. Further, since the language and structure are vital in designing task items that align with the PISA rapidly and accurately gauge mathematical literacy, rather than reading ability, OECD (2019) states this is also a crucial element to be addressed in the language and structure of materials designed to measure mathematical literacy. High ratings for non-redundancy and precise language are consistent with the findings from recent studies that have underscored the importance of instructional clarity in mathematics, especially language responsive and language structured instructional materials, where students' success is tied to materials that offer linguistic support, eliminate ambiguities and obstacles to concept learning, and boost conceptual understanding (Li et al., 2024). Together, they show that good, transparent teaching resources can be used to promote both thinking and hands-on learning outcomes, which is an important contribution to the quality of the PISA-aligned teaching resources.

Educators and curriculum developers are encouraged to adhere to the clarity rubric outlined and further develop media instruction by incorporating worked examples, visual cues, or step-by-step instructions to more difficult problem-solving tasks. Maximizing the refinement of tasks in higher order tasks may allow all students, including those who have difficulty with self-directed learning, to grasp the concepts. Guided discussions or demonstrations can be used as a method to reinforce understanding when working with the workbook. The actions are within reach and instructed by the findings of the study and literature review supporting this study, which demonstrates that clarity and structure help better comprehension, engagement and performance of students in mathematics (Mayer, 2020; Sweller et al., 2019).

In general, the score of usefulness and relevance that the work book earned is: 4.58 Very acceptable, as seen in Table 3, the result shows that the respondents judge the work book to be very useful and relevant in learning mathematics. Tasks relating to mathematical literacy and the application to real-life situations scored the highest (M = 4.80 and 4.90 respectively). The opportunities for problem-solving, critical thinking, analytical tasks were very high (M = 4.50) and opportunities for active participation in independent or group tasks were acceptable (M = 4.10). As a whole, the findings indicate a strong rapport between the workbook and curriculum goals and that the workbook is effective in providing students with opportunities for authentic mathematical thinking.

Based on the data, it can be deduced that the workbook is successful in producing meaningful experience of learning, by setting a mathematical problem in the context and linking it with the competencies described in the PISA. The high scores that were received for real-world applicability show that tasks were challenging students to apply abstract concepts to real world examples which may increase student's critical thinking abilities. The low rating for interaction and discussion might indicate that the workbook further enhances independent thinking while scaffolding group tasks may improve interaction and discussion further. In general, the workbook is quite useful, but could benefit from more interactive components.

The study's results indicate that the workbook used is theoretically relevant and practically beneficial for learners to develop their higher-order thinking ability. The very high scores achieved in tasks that foster mathematical literacy, problems solving and "real life" application suggest that learners are likely to develop skills that extend beyond the classroom. Engagement with the material by students could be improved by further independent and group engagement but there are good opportunities for meaningful learning throughout the

material making it a valuable resource for skills development within a PISA framework.

Table 3
Level of Acceptability in Terms of Usefulness / Relevance

Indicators	Sum	Mean	Descriptive Rating
Activities promote PISA mathematical literacy (formulating, employing, interpreting mathematics in context).	48	4.80	Very Acceptable
Tasks prepare learners to apply mathematical reasoning in real-world situations.	49	4.90	Very Acceptable
Exercises help strengthen problem-solving, critical thinking, and analytical skills.	45	4.50	Very Acceptable
Activities encourage students to actively engage in independent and group work	41	4.10	Acceptable
Mean		4.58	Very Acceptable

Legend: 4.50 - 5.00 = Very Acceptable; 3.50 - 4.49 = Acceptable; 2.50 - 3.49 = Moderately Acceptable; 1.50 - 2.49 = Slightly Acceptable; 1.00 - 1.49 = Not Acceptable

The findings are consistent with previous studies that have shown how relevant and applicable the mathematics material into mathematics education. OECD (2022) state that students' understanding of the relevance of mathematics to the real world promotes the development of their reasoning skills, which aids them to perform to the best of their ability on any test of their reasoning abilities, such as PISA. In addition, studies conducted in the field of mathematical modeling show that students' mathematical thinking and analytical ability are improved through problem solving and modeling works (Çevikbaş et al., 2022; Stillman et al., 2020). Contextual and meaningful tasks in mathematics learning can also deepen understanding and interest in mathematics (Aini et al., 2022), and collaborative and reflective learning can also improve mathematical achievement and reasoning (Asoy & Dagohoy, 2023). The present results build upon this literature by providing evidence of the possibility of applying and implementing relevant and practice-oriented instructional tasks aligned to PISA and identify areas of potential support for collaborative engagement.

It is recommended that developers incorporate structured collaborative and interactive elements together with real-world problem-solving learning activities are recommended for the incorporation by developers. Clear directions for group, role or discussion topics can improve interaction with others and active engagement. When conducting workbook activities, teachers may have a class discussion and prompt further participation. The idea behind these recommendations is to enhance the usefulness and relevance of the workbook, and to ensure its alignment with PISA competencies (Aini et al., 2022; Çevikbaş et al., 2022; OECD, 2022).

Table 4 presents the ratings of the workbook's engagement features by the respondents. The weighted mean of 4.20 (Acceptable) is an overall indication that learners may found the workbook engaging and motivating. This was reflected in the high level of Acceptable ratings for indicators stimulating curiosity and problem-solving interest (M = 4.40); making activities interesting and motivating (M = 4.30). Design and layout (M = 4.10) and encouragement of active participation and exploration (M = 4.00) were also rated acceptable. Overall, the findings from these results indicate that the workbook has a potential motivation, but there is a need for improvement regarding the interactive and visual aspects for stimulating learners' interests.

The high scores for curiosity and problem-solving indicate that the tasks are well-designed to challenge students cognitively while maintaining interest. The slightly lower ratings for design and layout, as well as active participation, suggest that the workbook may benefit from more visually stimulating elements or structured opportunities for inter-active learning. It is possible that the current format encourages independent work over collaborative exploration, which may affect engagement levels. Overall, the findings imply that the workbook is

moderately effective in engaging students, though strategic enhancements could further elevate learner involvement and enjoyment.

Table 4
Level of Acceptability in Terms of Engagement

Indicators	Sum	Mean	Descriptive Rating
The activities are interesting and motivating for learners.	43	4.30	Acceptable
The design and layout make learning enjoyable.	41	4.10	Acceptable
The workbook encourages active participation and exploration.	40	4.00	Acceptable
The tasks stimulate curiosity and problem-solving interest.	44	4.40	Acceptable
Mean		4.20	Acceptable

Legend: 4.50 - 5.00 = Very Acceptable; 3.50 - 4.49 = Acceptable; 2.50 - 3.49 = Moderately Acceptable; 1.50 - 2.49 = Slightly Acceptable; 1.00 - 1.49 = Not Acceptable

These results indicate that the workbook can effectively capture students' attention and stimulate curiosity, key factors in sustained learning and motivation. The very acceptable ratings for problem-solving and interest suggest that learners are likely to engage with challenging tasks and persist in finding solutions. However, the slightly lower ratings for design and layout point to a potential area for improvement, as visual appeal and opportunities for active exploration are known to influence engagement and motivation. Consequently, the workbook demonstrates promising engagement potential while highlighting areas where refinements could enhance learner experience.

The findings are consistent with educational research emphasizing the role of engagement in effective learning. Recent work by Shernoff and Vandell (2019) highlights that cognitive and emotional engagement in mathematics classrooms is strongly linked to sustained interest, persistence, and academic achievement. Similarly, Dorn and Soffos (2020) assert that learning materials that stimulate curiosity and provide opportunities for meaningful problem exploration foster intrinsic motivation and deeper student involvement. In mathematics education specifically, Razzaq and Naseem (2021) found that thoughtfully designed tasks with clear visual supports and opportunities for interaction significantly increase active participation and sustained interest in problem-solving. The slightly lower scores for design and active participation align with research showing that layout, visual elements, and collaborative task structures are important contributors to engagement, reinforcing the need to balance cognitive challenge with visual appeal and interactive opportunities.

It is recommended that developers enhance the workbook's design and layout by incorporating visual aids, diagrams, or interactive elements that invite exploration. Activities could be structured to include collaborative tasks or inquiry-based learning exercises, which may further stimulate engagement and curiosity. Teachers may also integrate supplemental strategies, such as group problem-solving sessions or interactive discussions, to maximize participation. These actions, supported by both the study's findings and relevant literature, are practical measures to improve learner engagement while maintaining the workbook's educational rigor (Aini et al., 2022; Niño & Lomibao, 2026; OECD, 2022).

Table 5 presents respondents' ratings of the workbook's suitability for Grade 9 learners. With a mean of 4.38 (Acceptable), the findings suggest that the material is well-matched to students' developmental needs and curricular expectations. The alignment of content with both the DepEd K–12 curriculum and PISA framework (M = 4.60), and accommodation of diverse learners and classroom contexts (M = 4.50) earned a particularly strong rating (Very Acceptable) indicating that the workbook reflects current curricular emphases and international competencies. Developmental appropriateness (M = 4.30) was also viewed acceptable. The indicator addressing the balance between challenge and attainability received a slightly lower but still positive rating (M = 4.10, Acceptable). Overall, the workbook demonstrates a high degree of suitability for its intended educational purpose.

The very acceptable scores for alignment with standards and accommodation of diverse learners imply that the workbook was thoughtfully designed with curriculum alignment and inclusivity in mind. This may be due to intentional integration of both local standards and global benchmarks like PISA into tasks. The slightly lower score for challenge and attainability could suggest that some activities may require added scaffolding to ensure that learners of all proficiency levels can engage successfully. The pattern of responses indicates that the material is apt for the learners' current stage while pointing to areas for refinement to fully optimize accessibility and motivation across learner ability levels.

These results indicate that the workbook is pedagogically appropriate in terms of content alignment, developmental appropriateness, and inclusivity, which are critical considerations for instructional effectiveness. The very acceptable ratings suggest that students are likely to find the activities both relevant and manageable, supporting sustained participation and learning progression. Although some tasks may pose moderate difficulty for certain learners, the workbook's strong overall suitability reinforces its potential as a meaningful instructional resource that resonates with both national standards and international assessment frameworks

The study's findings are supported by recent research highlighting the importance of aligning instructional materials with curriculum standards and learner readiness. A comprehensive review of mathematics textbooks indicates that well-structured materials aligned with curricular reform and targeted learning goals provide more coherent support for classroom instruction and student learning outcomes (Qi et al., 2025). Similarly, research into student-perceived instructional quality across European contexts underscores the role of well-designed materials in promoting effective mathematics teaching and achievement, emphasizing the value of cognitive activation embedded in curricular tasks (ZDM – Mathematics Education, 2024). Moreover, studies on digital pedagogies in mathematics indicate that materials accommodating diverse learning contexts and technologies can enhance engagement and achievement, further validating the importance of suitability across learner levels and environments (Saliao & Cajandig, 2025). Collectively, these studies reinforce that instructional materials built on sound curriculum alignment and developmental considerations can support meaningful mathematical engagement and growth.

Table 5
Level of Acceptability in Terms of Suitability

Indicators	Sum	Mean	Descriptive Rating
Activities are developmentally appropriate for the target learners.	43	4.30	Acceptable
Content reflects both DepEd K–12 curriculum standards and PISA framework.	46	4.60	Very Acceptable
Tasks are challenging yet attainable, fostering motivation and persistence	41	4.10	Acceptable
Workbook accommodates diverse learners and classroom contexts.	45	4.50	Very Acceptable
Mean		4.38	Acceptable

Legend: 4.50 - 5.00 = Very Acceptable; 3.50 - 4.49 = Acceptable; 2.50 - 3.49 = Moderately Acceptable; 1.50 - 2.49 = Slightly Acceptable; 1.00 - 1.49 = Not Acceptable

Based on the findings, it is recommended that developers ensure a balanced challenge level throughout the workbook by integrating differentiated supports such as scaffolding prompts, hints, and optional extensions to help learners at varying proficiency levels access complex tasks. Educators are encouraged to implement the workbook flexibly, pairing it with guided discussions and small-group work to support learners who may find some tasks challenging. These strategies are practical and align with literature suggesting that well-aligned, developmentally appropriate materials promote deeper understanding and achievement in mathematics (OECD, 2022).

Beyond demonstrating content validity and acceptability, the developed workbook was also examined in terms

of its extent of alignment with the PISA mathematical literacy framework. The analysis indicates that the instructional material integrates the three core mathematical processes emphasized in the PISA framework: formulating mathematical situations, employing mathematical concepts and procedures, and interpreting and evaluating mathematical results. These competencies serve as the foundation for the development of mathematical reasoning and problem-solving abilities expected in PISA-oriented mathematics instruction.

The workbook reflects these competencies through the design of its learning activities. Contextualized introductory tasks encourage learners to interpret real-world situations and translate them into mathematical representations, thereby supporting the competency of formulating mathematical situations. Research indicates that contextual learning environments help learners connect mathematical ideas with real-life experiences, improving their ability to understand and model mathematical problems (Iskandar et al., 2024). In the workbook, real-world contexts such as architectural structures, infrastructure planning, and environmental scenarios are used to introduce geometric concepts and stimulate students' interpretation of mathematical relationships.

Similarly, the skill review exercises and reasoning-based problem-solving tasks included in the workbook require students to apply geometric principles, logical reasoning, and mathematical procedures, thereby addressing the competency of employing mathematical concepts and procedures. Studies have shown that problem-solving tasks modeled after PISA assessments promote deeper conceptual understanding and encourage students to apply mathematical knowledge beyond routine computation (Aini et al., 2022). These tasks often involve multi-step reasoning, interpretation of contextual information, and justification of mathematical solutions, which are essential elements of mathematical literacy.

The workbook also incorporates reflection activities and interpretation questions that encourage learners to examine the reasonableness of their solutions and relate mathematical results to real-world contexts. These activities correspond to the competency of interpreting and evaluating mathematical outcomes, which is an essential component of the PISA mathematical literacy cycle. Research suggests that reflective learning strategies and metacognitive prompts help students develop stronger reasoning and analytical thinking skills when solving contextual mathematics problems (Tabuyo, 2024). By engaging students in reflection and evaluation of their mathematical reasoning, the workbook supports the development of critical thinking and deeper conceptual understanding.

Furthermore, the workbook integrates contextualized scenarios and multi-step reasoning tasks similar to those found in PISA mathematics assessments. These tasks encourage learners to analyze information, construct mathematical models, and justify their reasoning rather than rely solely on routine procedural computation. Several studies have highlighted that exposure to PISA-like contextual problems significantly improves students' ability to apply mathematical knowledge in authentic situations and enhances their mathematical literacy skills (Iskandar et al., 2024; Aini et al., 2022). In addition, contextualized mathematical activities have been found to increase student engagement and facilitate deeper conceptual understanding of mathematical relationships in real-world contexts (Meryansumayeka et al., 2022).

4. Conclusions and Recommendation

The study successfully designed and developed a PISA-aligned mathematics workbook intended for Grade 9 students to enhance mathematical literacy, numerical reasoning, and problem-solving skills. The findings revealed that the competencies emphasized in the PISA Mathematics Framework were closely aligned with the Grade 9 Most Essential Learning Competencies (MELCs), particularly in Geometry topics such as quadrilaterals, similarity, and proportional reasoning. Through the integration of contextualized and real-world mathematical tasks, the workbook provided learners with meaningful opportunities to formulate, apply, interpret, and evaluate mathematical concepts in authentic situations. The developed workbook was found to be acceptable in terms of clarity, usefulness, engagement, and suitability for Grade 9 learners based on the evaluations of mathematics teachers and expert validators. Furthermore, the workbook demonstrated strong alignment with the principles of

mathematical literacy and contextualized learning, making it a valuable supplementary instructional material for improving students' higher-order thinking skills and preparedness for international assessments such as PISA.

Based on the findings of the study, it is recommended that mathematics teachers utilize the developed workbook as a supplementary learning material to strengthen students' mathematical literacy and real-world problem-solving abilities. Curriculum developers and instructional material writers may further develop similar PISA-aligned resources for other mathematics topics and grade levels to support the integration of contextualized learning in mathematics education. Future researchers may conduct experimental studies to determine the effectiveness of the workbook in improving students' academic performance, mathematical reasoning, and PISA-related competencies. It is also recommended that future instructional materials incorporate more collaborative and interactive activities, visual aids, and differentiated tasks to further improve student engagement and accommodate diverse learning needs. Lastly, educational institutions and curriculum planners may strengthen the integration of PISA-based competencies in classroom instruction to better prepare Filipino learners for global standards in mathematics education.

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