

Original Article

Alignment of General Mathematics Curriculum to the PISA 2022 Mathematics Framework

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Abstract: The Philippine government developed the K–12 curriculum with the intention of providing students with the ability to compete on a global scale and to develop in a holistic manner. It is the goal of the program to produce people that are capable, employable, involved, accountable, and patriotic towards their country. This study aimed to examine the alignment of the general mathematics curriculum with the 2022 mathematics literacy framework of the Programmed for International Student Assessment (PISA). The study would help in developing the curriculum to obtain possible indicators of the effectiveness of the educational reform introduced in the country in making the Filipino learners globally competitive. The study employed document analysis, the researcher reviewed the alignment of two official documents accessible online, the 2022 General mathematics curriculum and the 2022 PISA mathematics literacy framework. Three mathematics education experts validated the researcher’s analysis. The results affirmed that the General Mathematics Curriculum meets to a certain extent the cognitive processes, content demands, context, and 21st century skills emphasized in PISA mathematics. However, there appears to be a gap in the contextualization of mathematics and the integration of all important 21st century skills. The curriculum also lacks consistent emphasis on applying mathematics in different contexts particularly in scientific contexts and on integrating some 21st century skills like research and inquiry and information use. The study provided recommendations in addressing the gaps to inform needed updating in the general mathematics curriculum not only meeting the expectations of PISA but most importantly meeting the international standards of quality educational program.

Keywords: International assessment, Curriculum Alignment, curriculum, PISA

1. INTRODUCTION

The K–12 curriculum was introduced in the Philippines in 2013 with the goal of giving students global competitiveness and holistic development. The program's objective is to generate capable, employable, involved, accountable, and patriotic citizens. The K–12 curriculum, particularly the mathematics curriculum, has undergone considerable revisions. In the Philippines, the K–12 program transition has created difficulties for educators and learners alike. In order to make the curriculum more manageable, the skills have been lowered and the emphasis has shifted to understanding for mastery. To overcome competency gaps and achieve international benchmarks, however, ongoing curriculum improvement, pertinent intervention programs, and support systems from many education stakeholders are still required [1]. Six (6) years after the implementation of the K to 12 program, the results of studies and

performance tests revealed the poor Mathematics performance of students. The performance of the students in Algebra and Trigonometry in which results showed that students who took the two subjects were not able to meet the required criteria. Similar results are found among proficiency of grade 9 students in which performance is at the beginning level [2]. In the higher learning level, the achievements of students in Mathematics courses such as General Mathematics and Probability and Statistics is at a poor level. Furthermore, the study of Refugio revealed that the challenges in teaching emerged due to time constraints and plenty of competencies to be achieved even though teachers were pedagogically and technologically equipped to teach the course, still it is not enough [3]. The Department of Education's Test (NAT) results show the National Performance by subject area. The distribution of Grade 12 test takers according to their mathematical proficiency level, while no Grade 12 is below the proficient level. A significant portion of test takers were classified as low and non-proficient levels. In order to determine and draw conclusions from the 2018 NAT Grade 12 scores, every academic area was documented [4]. More so, the Third International Mathematics and Science Study (TIMSS) 2019 data revealed that Filipino students' poor mathematical performance, only scored 297 in mathematics and 249 in science, which are "significantly lower" than any other participating country [5]. Recently, Program for International Student Assessment (PISA) released the result on 2022 examination. It indicated that the Philippines' average 2022 results in mathematics, reading and science were almost the same as in , changing by just single digits. The Organization for Economic Co-operation and Development (OECD) explained that the gap between the highest-scoring students (10% with the highest scores) and the weakest students (10% with the lowest scores) narrowed in mathematics. Thus, low-achievers in Mathematics became stronger, while performance did not change significantly amongst high-achievers. More so, 16% of Filipino students attained at least Level 2 proficiency in mathematics, which is significantly less than the Organization for Economic Co-operation and Development (OECD) average at 69%. Still, the PISA 2022 result demonstrated a potential area of concern, scoring below 361 points, indicating the urgent need for educational improvement [6][7]. With this problem faced by the Mathematics education in the Philippines, there is a need to dig out possible causes and provide solutions [8], if not, preventive measures for such. In this study, the alignment of the General Mathematics curriculum of and the Mathematics Framework of PISA was given with utmost attention [9]. Specifically, it will answer the research question, what is the extent of alignment of the PISA 2022 Mathematics Assessment Framework in General Mathematics Curriculum? It is hoped that this analysis will inform the DepEd of the level of preparedness of the Filipino students when Philippines participates in PISA 2025 or in any other international assessment [10]. More so, this will also help in developing the curriculum to obtain possible indicators of the effectiveness of the educational reform introduced in the country in making the Filipino citizens globally competitive[11].

2. MATERIALS AND METHODS

This study is qualitative-descriptive research that uses content analysis to describe the alignment of the General Mathematics Curriculum to the PISA 2022 Mathematics Framework. The analysis uses the official documents of OECD and DipEd. In doing the document analysis or curriculum mapping, three teachers in General Mathematics with the position of Master Teachers and with 6-10 years of teaching experience were selected. Two independent Master teachers did the mapping and reported analyses in a matrix form. A third teacher-a master teacher in mathematics, an expert in the field was engaged to check and validate the work of the two other teachers. The study undergoes three phases: Phase 1- The pre-document analysis, Phase 2- The Actual document analysis, and Phase 3- The post-document analysis. Phase 1-Pre-document analysis includes collection of the targeted official documents from OECD and DepEd, websites were utilized for other identified the components for analysis, and prepared the tool for document analysis. Actual document analysis refers to the mapping of the common features of the two official documents. Finally, Post-data analysis includes the validation and finalization of the

document analysis and the identification of gaps in the General Mathematics Curriculum based on the PISA frameworks and how to address them. As the data are primarily qualitative with the mapping of the common information in both documents, the researcher conducted a simple frequency count with equivalent percentages to the common features of the two documents analyzed. In addition, the researcher provided actual quotations to illustrate the explicit alignment between the documents analyzed.

3. RESULTS & DISCUSSIONS

Table 01. Alignment of the PISA 2022 Mathematical Reasoning Processes with the General Mathematics Curriculum

	Reasoning Processes in PISA 2022 Mathematics Literacy Framework	General Mathematics Performance Standard
1	Understanding quantity, number systems and their algebraic properties	/
2	Appreciating the power of abstraction and symbolic representation	/
3	Seeing mathematical structures and their regularities	/
4	Recognizing functional relationships between quantities	/
5	Using mathematical modelling as a lens onto the real world (e.g., those arising in the physical, biological, social, economic and behavioral sciences); and	x
6	Understanding variation as the heart of statistics.	x

Table 01 shows the results of the alignment of the core competencies (i.e., reasoning and problem-solving) in the PISA 2022 Mathematics Framework vis-à-vis the program outcomes, performance indicators, and courses set in General mathematics curriculum.

Table 02: Alignment of the PISA 2021 Mathematics Formulating Processes with the General Mathematics Curriculum

	Formulating Processes in PISA 2022 Mathematics Literacy Framework	General Mathematics Performance Standard
1	Selecting an appropriate model from a list	/
2	Identifying the mathematical aspects of a problem situated in a real - life context and identifying the significant variables	/
3	Recognizing mathematical structure (including regularities, relationships, and patterns) in problems or situations	X
4	Simplifying a situation or problem in order to make it amenable to mathematical analysis	/
5	Identifying constraints and assumptions behind any mathematical modelling and simplifications gleaned from the context	X
6	Representing a situation mathematically, using appropriate variables, symbols, diagrams, and standard models;	/
7	Representing a problem in a different way, including organizing it according to mathematical concepts and making appropriate assumptions;	X
8	Understanding and explaining the relationships between the context - specific language of a problem and the symbolic and formal language needed to represent it mathematically;	/

9	Translating a problem into mathematical language or a representation;	/
10	Recognizing aspects of a problem that correspond with known problems or mathematical concepts, facts or procedures;	/
11	Using technology (such as a spreadsheet or the list facility on a graphing calculator) to portray a mathematical relationship inherent in a contextualized problem; and	X
12	Creating an ordered series of (step - by - step) instructions for solving problems.	/

Table 02 shows the PISA 2022 formulating processes expected of a mathematically literate learner covered in General Mathematics Curriculum standard performance.

Table 03: Alignment of the PISA 2022 Mathematics Employing Processes with the General Mathematics Curriculum

	Employing Processes in PISA 2022 Mathematics Literacy Framework	General Mathematics Performance Standard
1	Perform a simple calculation,	/
2	Drawing a simple conclusion,	/
3	Selecting an appropriate strategy from a list,	/
4	Devising and implementing strategies for finding mathematical solutions;	/
5	Using mathematical tools, including technology, to help find exact or approximate solutions;	/
6	Applying mathematical facts, rules, algorithms, and structures when finding solutions;	/
7	Manipulating numbers, graphical and statistical data and information, algebraic expressions and equations, and geometric representations;	/
8	Making mathematical diagrams, graphs, and constructions and extracting mathematical information from them	/
9	Using and switching between different representations in the process of finding solutions;	/
10	Making generalizations based on the results of applying mathematical procedures to find solutions; reflecting on mathematical arguments, and explaining and justifying mathematical results; and	/
11	Evaluating the significance of observed (or proposed) patterns and regularities in data	/

Table 3 shows the PISA 2022 employing processes expected of a mathematically literate learner covered in General Mathematics Curriculum standard performance.

Table 04: Alignment of the PISA 2022 Mathematics Interpreting and Evaluating Processes with the General Mathematics Curriculum

	Interpreting and Evaluating Processes in PISA 2022 Mathematics Literacy Framework	General Mathematics Performance Standard
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1	Interpreting information presented in graphical form and or diagrams	/
2	Evaluating a mathematical outcome in terms of the context	/
3	Interpreting a mathematical result back into the real - world context	/
4	Evaluating the reasonableness of a mathematical solution in the context of a real - world problem	/
5	Understanding how the real world impacts the outcomes and calculations of a mathematical procedure or model in order to make contextual judgments about how the results should be adjusted or applied	/
6	Explaining why a mathematical result or conclusion does or does not make sense given the context of a problem	/
7	Understanding the extent and limits of mathematical concepts and mathematical solutions	X
8	Critiquing and identifying the limits of the model used to solve a problem	X
9	Using mathematical thinking and computational thinking to make predictions, to provide evidence for arguments, and to test and compare proposed solutions.	X

Table 4 shows the PISA 2022 interpreting and evaluating processes expected of a mathematically literate learner covered in General Mathematics Curriculum standard performance.

Table 05: Alignment of PISA Mathematics Literacy Content Domains with the General Mathematics Curriculum

PISA 2022 Mathematics Content Domains	PISA Topics Covered	General Mathematics Performance Standard
Quantity	Making Sense of Data, Statistics in Decision Making; Measurement; Estimation; Number and Number Sense; Numerical Trends and Patterns; Computer Simulation	<ol style="list-style-type: none"> 1. accurately construct mathematical models to represent real-life situations using Functions. 2. Appropriately apply a method of proof and disproof in real-life situations. 3. Appropriately apply a method of proof and disproof in real-life situations.
Uncertainty and Data	Counting Principles; Probability in Predicting Events; Sampling; Data Collection; and Measures of Central Tendency and Variability Conditional decision-Making	<ol style="list-style-type: none"> 1. accurately formulate and solve real-life problems involving rational functions 2. Use appropriate financial instruments involving stocks and bonds in formulating conclusions and making decisions.
Change and Relationships	Algebraic Expressions and Functions; Equations and Inequalities; Relationship between and among	<ol style="list-style-type: none"> 1. apply the concepts of inverse functions, exponential functions, and logarithmic functions to formulate and solve

	Geometrical Objects; Algebra in Growth Phenomena	real-life problems with precision and accuracy.
Space and Shape	Spatial Visualizations Measurement; and Algebra Geometric Approximations	1. accurately construct mathematical models to represent real-life situations using functions.

Table 06: Alignment of the General Mathematics Curriculum with the Context Requirements of PISA 2022 Mathematics Literacy Framework

Content	Performance Standard	PISA 2022 Mathematics Contexts Domain			
		Personal	Occupational	Societal	Scientific
Functions and Their Graphs	Accurately construct mathematical models to represent real-life situations using functions.	/	/	/	X
	Accurately formulate and solve real-life problems involving rational functions.	/	X	/	X
	Apply the concepts of inverse functions, exponential functions, and logarithmic functions to formulate and solve real-life problems with precision and accuracy.	X	X	/	/
Basic Business Mathematics	Investigate, analyze and solve problems involving simple and compound interests and simple and general annuities using appropriate business and financial instruments	/	/	/	X
	Use appropriate financial instruments involving stocks and bonds in formulating conclusions and making decisions.	/	/	/	X
	Decide wisely on the appropriateness of business or consumer loan and its proper utilization.	/	/	/	X
Logic	Judiciously apply logic in real-life arguments.	/	/	/	X
	Appropriately apply a method of proof and disproof in real-life situations.	/	/	/	X

Table 07: Alignment of the General Mathematics Curriculum with the 21st Century Skills in PISA 2022 Mathematics Literacy Framework

21st Century Skills in PISA 2021 Mathematics Literacy Framework	Functions and Their Graph	Basic Business Mathematics	Logic
Critical Thinking	/	/	/
Creativity	/	/	/

Research and Inquiry	X	X	X
Self-direction, initiative, and Persistence	/	/	/
Information Use	X	X	X
Systems Thinking	/	/	/
Communication	/	/	/
Reflection	/	/	/

3.1. Discussions

As shown in Table 1, four out of the six mathematics performance standard of General Mathematics curriculum could already cover the 6 PISA 2022 reasoning processes. Reasoning processes does not only require an excellent foundation on mathematics but also, it requires effective communication either in English or Filipino in oral or written form [12]. Thus, the 5th reasoning processes that need conceptualization or theory of a phenomenon, for analyzing and evaluating data, and for making predictions requires students to think critically and communicate effectively communicate in English and Filipino, both orally and in writing [13]. Moreover, the 6th reasoning process can be used on making generalization with the given set of data. Some of the competencies of General Mathematics can be incorporated with variations since it is defining around which the discipline of statistics is based [14]. In terms of performance standard in general mathematics, eight indicators captured the 12 formulating processes in the PISA 2022 mathematics framework. In the general mathematics curriculum, recognizing mathematical structure (including regularities, relationships, and patterns) in problems or situations should be embedded in the different competencies. Additionally, the use of technology in portraying mathematical relationships should also be considered [15]. In terms of performance standard in general mathematics, eleven indicators captured the 11 employing processes in the PISA 2022 mathematics framework. In the process of employing mathematical concepts, facts, procedures, and reasoning to solve problems, individuals perform the mathematical procedures needed to derive results and find a mathematical solution . And it is aligned with the competencies of the General Mathematics curriculum [16]. In terms of performance standard in general mathematics, six indicators captured the nine interpreting and evaluating processes in the PISA 2022 mathematics framework [17]. The General Mathematics Curriculum should give emphasis on learners' ability to reflect upon mathematical solutions, results, or conclusions and interpret them in the context of the real-life problem that initiated the process. This involves translating mathematical solutions or reasoning back into the context of the problem and determining whether the results are reasonable and make sense in the context of the problem [18]. On the observed gaps in the General Mathematics Curriculum relative to the PISA Mathematics Framework, there is a gap on the focus topics of PISA for every content domain. Since PISA 2022 Mathematics Framework- Content domain topics gives emphasis on growth phenomena for change and relationships, geometric approximation for space and shape, computer simulations for quantity; and conditional decision making for uncertainty and data [19]. The content of General Mathematics is aligned on the content domain of PISA in terms of Growth phenomena. Exponential Function gives emphasis on the growth and decay phenomena and it requires learners to think of data in a linear relationship and non-linear or exponential relationships like studying the spread of the disease in a flu pandemic and bacterial outbreaks. Meanwhile, the General Mathematics Mathematics curriculum needs to add competencies on the topic of geometric approximations that requires an understanding of traditional space and shape phenomena in a range of typical situations and irregularities. Also, with Computer simulation which is not included on the General Mathematics curriculum, it should also be incorporated since it is needed in complex problems in mathematics and statistics that are not quickly addressed, like budgeting, saving, experimental probability, and population distribution, where computer simulations are used as a tool for decision making. Finally,

conditional decision-making is needed in statistics to measure and interpret the variation characteristics of two or more variables to make predictions. The PISA Mathematics Literacy Framework gives importance on the wide variety of contexts. The context is the aspect of an individual's world in which the problems are placed. It varies from personal, to occupational, societal and scientific [20]. Problems classified in the personal context category focus on individual activities, family and peers; occupational such as job-related concerns like payroll, quality control; societal context such as problems that may involve local, national or global matters like public transport, government, policies, and scientific focuses on issues related to science and technology like weather, ecology, medicine. To understand if the General Mathematics Curriculum captures the different contexts in PISA, the different performance standards were examined [21]. The Context domain was viewed differently in the PISA Mathematics Framework and in the General Mathematics Curriculum Framework. PISA relates context to aspects of life – personal, occupational, societal, and scientific [22]. These aspects are reflected on the content topics and more specific activities in PISA. In the General Mathematics Curriculum, Context factors include beliefs, environment, language, culture, and learner's prior experience, but all these were not defined nor embedded in the content and problem-solving processes. The General Mathematics Curriculum gives emphasis on the critical thinking skills and the problem-solving skills making it parallel to the PISA 21st Century Skills [23]. The curriculum lacks competencies that focuses on research and inquiry, information use and systems thinking. Research and inquiry are highly important in the mathematics curriculum as they promote a deep understanding of mathematical concepts and foster critical thinking skills [24]. According to Ferguson that research and inquiry is important in learning mathematics since it allows students to explore, question, and make sense of information, leading to the development of new understandings. Therefore, incorporating research and inquiry into the mathematics curriculum can enhance students' mathematical abilities and attitudes towards the subject. Furthermore, in the study of Kira showed that the integration of information technology into the teaching and learning of mathematics is crucial for enhancing students' mathematical abilities and fostering a deeper understanding of the subject [25].

4. CONCLUSIONS

The analysis of the alignment of the General Mathematics Curriculum with PISA 2022 mathematics literacy framework informs the need for continuous updating of the competencies needed by the learners. The results affirmed that the General Mathematics Curriculum meets to a certain extent the cognitive processes, content demands, context, and 21st century skills emphasized in PISA mathematics. However, there appears to be a gap in the contextualization of mathematics and the integration of all important 21st century skills. This could indicate the current General Mathematics curriculum in the preparation of the learners to use mathematics in every aspect of their personal, civic, and professional lives, as part of their constructive, engaged, and reflective 21st Century citizenship may not be achieved. More so, the curriculum lacks consistent emphasis on applying mathematics in different contexts particularly in scientific contexts and on integrating some 21st century skills like research and inquiry and information use. Thus, the General Mathematics Curriculum, classroom instruction, and learning resources should aim for the development and assessment of mathematical reasoning and high-level individual and collaborative problem solving and critical thinking in personal, occupational, societal, and scientific contexts. It should also explicitly target the development of research and inquiry competencies that are emphasized in PISA since Mathematics. The identified gaps in the curriculum based on the PISA 2022 framework should be addressed for promoting equity in education and improving students' academic performance. It is essential to ensure that all students have access to high-quality instruction and equitable learning opportunities to nurture their well-being and prepare them for success in the future and further studies be done to analyze the responsiveness of the curriculum to the innovative assessment areas in PISA like creative thinking, collaborative

problem solving, and research and inquiry that are expected to be addressed for the future of our learners.

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