



Development and Validation of Problem-Solving Activities Utilizing Foreign Mathematics Techniques

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Abstract - This study development and validation of problem-solving activities utilizing foreign mathematics technique using the Analysis, Design, Development, Implementation, and Evaluation of Instructional Model and was subjected to evaluation by 16 Mathematics teachers and 6 experts from across PHINMA-Araullo University Campus namely: PHINMA-Araullo San Jose campus, PHINMA-Araullo South Campus, and PHINMA-Araullo Main Campus. The scope of the supplementary learning material was based on PHINMA Education Network Syllabi used in the development of previous and existing modules. The modules consist of the following parts: Learning Objectives, Connect, Coach, Activities, Check, and Conclude. Teachers and expert respondents described the supplementary learning material to have objective that is specific, measurable, attainable, realistic, and time-bounded. Additionally, the developed problem-solving activities described by teacher and expert respondent to have objectives that are aligned with the course syllabus. In terms of format, the developed problem-solving activities were described to contain comprehension aids that are gender-free and contain comprehension aids like pictures, table, and the like that help contribute to better understanding of the topic. Lastly, as to evaluation, the teacher and expert respondents described the material as being very satisfactory in providing self-pacing activities and containing evaluation that are parallel to the learning objectives. Both teacher and expert respondents have suggested that the developed supplementary learning material could provide more problem-solving activities to check students' capabilities in solving problems using the mathematics technique integrated on the lesson. The expert respondents also suggested to integrate technology like Mathematics software in problem-solving. As conclusion, the development and validation of problem-solving activities in Mathematics in the Modern World is made possible using the Analysis, Design, Development, Implementation, and Evaluation Instructional Model. The teacher and expert respondents' evaluation of the supplementary learning material is very commendable with overall verbal description of "Very Satisfactory" in areas like objectives, content, format, and evaluation. Furthermore, the suggestions from teacher and expert respondents focused on adding more problem-solving activities using the integrated technique and integrating technology in problem-solving. As to recommendations, it was recommended that teachers handling Mathematics in the Modern World should be encouraged to develop supplementary learning activities using other instructional model and other authentic assessment.

Also, some of the minor suggestions provided by the teachers and expert respondents from this study should be considered.

Key Words: Problem-solving activities, Foreign Mathematics Technique, Supplementary Materials, Mathematics in Modern World

1. INTRODUCTION

Mathematics is a tool to make our life easier and better. Students must realize and appreciate the use of the mathematics and its relevance to life. But as we see nowadays that in spite of being useful of the subject Mathematics, we see that students do not give much attention to learn or to understand that subject. In learning Mathematics, students must not depend from their teacher alone. It should be a combination of both classrooms learning and out of the classroom learning.

In the dynamic and rapidly changing landscape of modern education, the quest to enhance students' retention of mathematical concepts has taken center stage. Mathematics, often considered a foundational subject, plays a crucial role in the development of critical thinking, problem-solving skills, and overall academic success. However, it is not uncommon for students to struggle with retaining mathematical knowledge over time. This challenge has prompted educators and researchers to explore innovative approaches to enhancing students' comprehension and retention.

The development of problem-solving activities using foreign mathematics techniques has gained prominence as a pedagogical strategy that holds immense potential for addressing the retention crisis in mathematics education. This solution is particularly pertinent in an age characterized by information overload, digital distractions, and ever-evolving curricula. The integration of problem-solving activities using foreign mathematics techniques, ranging from interactive online resources to personalized learning tools, has the power to captivate students' interest and facilitate deeper engagement with mathematical concepts. By honing in on the intersection of modern teaching methodologies and technology, this exploration aims to uncover the transformative impact that well-designed supplementary materials can have on students' ability to remember, apply, and appreciate mathematics.



This pursuit is not only academically relevant but also aligns with the broader objectives of education in the modern world. The development of problem-solving activities using foreign mathematics techniques in enhancing students' retention of mathematics not only seeks to boost academic achievement but also fosters lifelong learners who are equipped to navigate the complexities of an increasingly quantitative and data-driven society.

Therefore, the researcher wants to develop a supplementary learning material in teaching-learning process that may help the students retain their knowledge in Mathematics and eventually apply skills as they perform not just problem-solving activities but also their activities or lessons in other subjects and more importantly in their everyday lives. It has the potential to improve the learner's academic performance in Mathematics in the Modern World. If this will be used appropriately, it can be of immense help to their part to understand the topics in Mathematics in the Modern World. Apart from this, the supplementary learning material was localized and contextualized by the researcher for the students to relate to the topics, and the materials on the activities/tasks were improvised to make the materials easily available. The researcher chose Mathematics in the Modern World topics because of the students' low mastery of the topics. Some of the teachers pointed out that one of the causes behind this problem is the lack of interest of the student because they see it as a tough subject because of their weak foundation. The developed mathematics activities using foreign mathematics techniques can serve as supplementary material to cope with the interest of the students in the said subject.

Review of Related Literature

This chapter presents the literature and different studies that are related to the present study.

1. Module as a Supplementary Material

As defined by Abdu-Raheem (2016[1]) instructional materials are essential and significant tools needed for teaching and learning school subjects to promote teachers' efficiency and improve students' performance. They make learning more interesting, practical, realistic, and appealing. They also enable both the teachers and students to participate actively and effectively in lesson sessions. They give room for the acquisition of skills and knowledge and the development of self-confidence and self-actualization.

Instructional materials enable both teachers and students to actively and effectively participate in lesson sessions, thereby fostering an interactive learning environment. They provide opportunities for students to acquire relevant skills, expand their knowledge base, and develop positive attitudes toward learning. By offering tangible representations of abstract concepts, instructional materials help bridge the gap between theoretical knowledge and real-world applications.

Moreover, instructional materials cater to diverse learning styles, ensuring that visual, auditory, and kinesthetic learners benefit from lessons. The incorporation of these materials into teaching strategies also promotes creativity and critical thinking, allowing students to engage with the content in a meaningful and hands-on manner. As a result, instructional materials play a crucial role in improving comprehension, retention, and overall academic achievement (Abdu-Raheem, 2016).

According to Gustiani et.al (2017[2]) these instructional materials may be printed or non-printed, and may include textbooks, technology-based materials, other educational materials, and tests. A review of middle school curriculum materials that determine how currently available learning materials align with national learning goals and pedagogical criteria rooted in the literature found that the materials covered many topics at a superficial level, focused on technical vocabulary, failed to consider students' prior knowledge, lacked coherent scientific explanations of real-world phenomena, and provide students with few opportunities to develop explanations of phenomena. High-quality instructional materials should not only align with educational standards but also support deeper learning by encouraging critical thinking, inquiry, and problem-solving skills (Kesidou & Roseman, as cited in Gustiani et al., 2017).

According to Torrefranca (2017[3]), Modular instruction is an attempt to individualize learning by allowing a student to achieve mastery of one unit of content before moving on to another. Module, as a self-instructional material, can be used as supplementary material to help students improve his/her mastery and as means to help the student catch up with the missed lessons.

A module, as a form of self-instructional material, serves as both a primary and supplementary learning tool. It can be utilized to reinforce students' mastery of subject matter by providing structured, sequential lessons tailored to individual learning needs. Additionally, modular instruction plays a crucial role in addressing learning gaps, particularly for students who may have missed lessons due to absences or other circumstances. By enabling learners to revisit concepts at their own pace, modules support independent learning, encourage self-discipline, and enhance academic performance.

Furthermore, modular instruction aligns with the principles of mastery learning, which advocate for providing students with adequate time and resources to fully grasp content before moving forward. This method not only fosters student autonomy but also allows teachers to cater to diverse learning styles and paces, making education more inclusive and effective.

According to Brown C.A., and McIlroy K., (2011[4]) as cited by J. Aguilar (2023[5]) instructional materials play a vital role in teaching and learning at various levels of education, it provides opportunities for children to broaden and deepen their knowledge by providing a variety of firsthand, developmentally appropriate experiences and by helping



children acquire symbolic knowledge through representing their experiences.

Additionally, instructional materials help students acquire symbolic knowledge by enabling them to represent their experiences in meaningful ways. This process of symbolic representation allows learners to connect new information with prior knowledge, thereby strengthening comprehension and retention. By integrating well-designed instructional materials into the learning environment, educators can create engaging and effective teaching strategies that cater to different learning styles and needs.

Instructional materials serve as valuable tools in promoting interactive and experiential learning. Whether in the form of printed texts, digital resources, hands-on activities, or multimedia content, these materials enhance students' cognitive development and facilitate the transition from concrete experiences to abstract thinking. As a result, instructional materials not only enrich the learning process but also contribute to the overall academic success of students

Chingos, M. and Whitehurst, G. (2012[6]) as cited by J. Aguilar (2023), Association of American Publishers School Division stated that instructional materials' means all materials that are designed for use by pupils and their teachers as a learning resource and help pupils to acquire facts, skills, or opinions or to develop cognitive processes.

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Statement of the Problem

The study developed Problem-Solving Activities Utilizing Foreign Mathematics Techniques in Mathematics in the Modern World and was subjected to evaluation. In this premise, the research unraveled the answers to the following set of questions:

1. How may the process of development of Problem-Solving Activities Utilizing Foreign Mathematics Techniques in Mathematics in the Modern World be described?
2. How do Mathematics in the Modern World teachers and experts evaluate the supplementary learning activities in terms of:
 - 2.1. objectives;
 - 2.2. content;
 - 2.3. strategy used;
 - 2.4. format; and
 - 2.5. evaluation;
3. How may the effectiveness of developed Problem-solving activities utilizing foreign mathematics techniques be described?

4. What suggestions and recommendations on further Enhancement of Problem-Solving Activities Utilizing Foreign Mathematics Techniques in Mathematics in the Modern World?

MATERIALS AND METHODS

Research Design

This study employed a descriptive method of research. According to Labaree (2016[7]), the term descriptive research refers to the type of research question, design, and data analysis that will be applied to a given topic. The research uses questions that will ultimately determine the type of approach necessary to complete an accurate assessment of the topic at hand. In this study, the descriptive method will apply in the Development and Validation of Problem-solving Activities Utilizing Foreign Mathematics Techniques in Mathematics in the Modern World.

The Analysis, Design, Development, Implementation, and Evaluation Instructional Model was used in developing Problem-solving Activities Utilizing Foreign Mathematics Techniques in Mathematics in the Modern World, which is based on prior reviews of textbooks used in Mathematics in the Modern World. The desired learning competencies in Mathematics were greatly considered. The Problem-solving Activities Utilizing Foreign Mathematics Techniques was subjected to critical evaluation by Mathematics in the Modern World teachers and experts in PHINMA-Araullo schools using a set of questionnaires.

Respondents of the Study

The evaluation of Problem-solving Activities Utilizing Foreign Mathematics Techniques in Mathematics in the Modern World was intended for evaluation of its content by the Mathematics in the Modern World teachers and expert teachers across PHINMA-Araullo University campuses. The Mathematics in the Modern World teachers evaluated the developed Problem-solving Activities Utilizing Foreign Mathematics Techniques in Mathematics in the Modern World using a set of questionnaires.

Instrumentation

A. Problem-solving Activities Utilizing Foreign Mathematics Techniques

A Supplementary Learning Material using foreign Mathematics Techniques in Mathematics in the Modern World was developed by the researcher based on prior reviews of several Mathematics textbooks and the needed learning competencies to acquire knowledge and skills. According to Naroth (2015[8]) the development of interactive mathematics activities inspired by foreign teaching methodologies indicates that hands-on activities not only engage students but also facilitate deeper comprehension of complex mathematical concepts.

B. Pre and Post Assessment Tools



In order to determine the effectiveness of the developed problem-solving activities utilizing foreign mathematics technique. The researcher conducted a pretest and posttest among the Bachelor of Science in Hospitality Management of PHINMA-Araullo University.

C. Evaluation Checklist

The developed Problem-solving Activities Utilizing Foreign Mathematics Techniques in Mathematics in the Modern World were evaluated by the mathematics teachers across PHINMA-Araullo University Schools across all campuses using an evaluation checklist/questionnaire.

Procedures

The researcher obtained permission from the PHINMA-Araullo University heads across all campuses to evaluate the Problem-solving Activities Utilizing Foreign Mathematics Techniques. The researcher virtually and physically administered the questionnaires to the respondents to ensure that directions were properly discussed. To further validate the usefulness of the supplementary learning material in terms of realizing its ultimate objectives, the learning materials were evaluated by the mathematics teachers across all campuses of PHINMA-Araullo University using a set of questionnaires/checklists.

Statistical Treatment

Data gathered were processed, tabulated, and interpreted using the following statistical tools:

1. Frequency Counts. Frequency distribution was utilized to show the difference in assessment results before and after using the learning material. The data were tallied and counted to arrive at a frequency distribution organized into tables.
2. Percentage. Percentage was used to establish or to compare the proportion of frequencies or responses to the total number of responses.
3. T-Test. T-test was used to determine the difference of the scores before and after utilizing the supplementary learning material.

4. Weighted Mean. Weighted mean was used to determine how the teacher participants evaluated the supplementary learning material.

5. Likert Scale. The following qualitative description, including the Likert Scale was adapted to quantify the responses of each indicator.

RESULTS

This section presents the analysis and interpretation of the data gathered from the respondents of the study.

1. Teachers and Experts' Evaluation of the Contextualized Activities in Purposive Communication

Objectives	Teachers		Experts	
	WM	VD	WM	VD
1. The objectives contribute to fundamental problem-solving skills.	3.71	VS	3.67	VS
2. The objectives are specific, measurable, attainable, reliable, and time-bound.	3.79	VS	4.00	VS
3. The objectives provide self-pacing.	3.36	VS	3.67	VS
4. The objectives emphasized the mastery of the lessons for Mathematics in the Modern World.	3.64	VS	3.50	VS
5. The objectives are aligned with the course syllabus of Mathematics in the Modern World.	3.64	VS	3.67	VS
6. The objectives are clearly stated and easy to understand.	3.71	VS	3.67	VS
7. The objectives promote real-world application.	3.71	VS	3.50	VS
8. The material's objectives support independent or active learning.	3.50	VS	3.67	VS
Average Weighted Mean	3.63	VS	3.67	VS



Content				
1. The supplementary learning activities contains all basic concepts in Mathematics in the Modern World.	3.14	S	3.00	S
2. The supplementary learning activities guide the students to solve mathematical problems using foreign techniques.	3.21	S	3.00	S
3. The supplementary learning activities enable the student to develop the necessary skills in critical thinking and problem-solving.	3.21	S	3.33	VS
4. The supplementary learning materials contains follow up questions that will guide them to fully understand the lesson.	3.43	VS	3.00	S
5. The supplementary learning materials contains activities that strengthens student skills in problem solving and analyzing.	3.43	VS	3.33	VS
6. The supplementary learning activities contains illustrations that allows the student to learn the concept.	3.21	S	2.83	S
7. The supplementary learning activities reflects the course objectives.	3.43	VS	3.67	VS
Average Weighted Mean	3.30	VS	3.17	S

Strategies				
1. The strategy used in solving problems is easy to follow.	3.43	VS	3.33	VS
2. The strategy used enhanced problem-solving skills.	3.21	S	3.17	S
3. The strategy used enhance critical thinking.	3.14	S	2.83	S

4. There is contextualization included in the activity sheets.	3.00	S	3.33	VS
5. The strategy used allows the student develop the necessary skills in solving mathematical problems.	3.36	VS	3.00	S
Average Weighted Mean	3.23	S	3.13	S
Format				
1. The features of the supplementary learning materials are the same all throughout.	3.50	VS	3.67	VS
2. The lay-out of the supplementary learning material the same all throughout.	3.36	VS	3.67	VS
3. The supplementary learning materials contains comprehension aids like pictures, tables and the like.	3.29	VS	3.50	VS
4. Pictures reinforce concepts to be learned.	3.00	S	3.00	S
5. The comprehension aids are gender-free.	3.14	S	3.50	VS
6. The comprehension aids are contextualized or relatable to students' knowledge.	3.00	S	3.50	VS
Average Weighted Mean	3.21	S	3.47	VS
Evaluation				
1. The evaluation activities are parallel to the objectives of the course.	3.43	VS	3.83	VS



2. The evaluation activities are varied and appropriate for college students.	3.71	VS	3.17	S
3. The evaluation activities develop students' critical thinking skills.	3.43	VS	3.00	S
4. Questions are arranged from simple to complex.	3.50	VS	3.50	VS
5. The evaluation activities provide self-pacing and feedback.	3.29	VS	3.50	VS
6. The activities cater to individual differences and multiple intelligences.	3.14	S	3.33	VS
Average Weighted Mean	3.42	VS	3.39	VS

Legend: 1.00-1.74 – Poor (P); 1.75-2.49 – Fair (F); 2.50-3.24 – Satisfactory (S); 3.25-4.00 – Very Satisfactory (VS)

DISCUSSION

The developed Problem-solving Activities Utilizing Foreign Mathematics Technique were described by teacher and expert respondents to have objective that are aligned with the syllabus and the objectives are specific, measurable, attainable, reliable, and time-bounded. In terms of the content of the supplementary learning materials both teacher and expert respondents described it as the activities reflect the lesson objectives. Meanwhile, in terms of the strategy used in the developed materials both teacher and expert respondents describe that the strategy used contributes students to developing their problem-solving skills and critical thinking skills. In terms of format, the teacher and expert respondents described it as it is the same all throughout and it contains comprehension aids like pictures, tables, and the like. Lastly, as to evaluation, the teacher and expert respondents describe the supplementary materials as the activities are parallel to the objectives of the course and the questions are arranged from simple to complex.

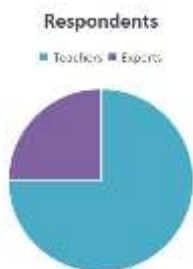


Chart -1: Distribution of Teacher and Expert Respondents

2. Significant Difference in the Pretest and Posttest Scores of the Experimental Groups

Paired Samples Statistics					
		Mean	N	t	Sig
Pair 1	Pretest	7.89	37	-7.356	.000
	Posttest	13.73	37		

Based on the computed t-value of -7.356, there was a significant difference in the pretest and posttest scores of the experimental group. The mean pretest score was 7.89 while the mean posttest score increased to 13.73, it only signifies that there is improvement in students' academic performance following the supplementary learning material. This finding strengthens the claim of Boaler (2016[9]), that fostering mathematical mindsets through creative teaching methods significantly enhances student learning. Similarly, the application of problem-solving strategies such as Polya's method (Daulay & Ruhaimah, 2019[10]) has been shown to significantly improve student performance in mathematical tasks. In addition, based on the study conducted by Ayado's (2022[11]) claim that module being mostly useful teaching unit, could help the students improve their academic performance. It also signifies that the students can focus better on course materials and on subject matter or lessons. They can easily remember the lesson because it relies on real-life experiences which the students could relate to.

3. CONCLUSIONS

1. The development and evaluation of Problem-solving Activities Utilizing Foreign Mathematics Technique is made possible using Analysis, Design, Development, Implementation, and Evaluation Instructional Model.
2. The teachers and experts' evaluation of the supplementary learning activities in Mathematics is very encouraging and commendable with some of them got overall verbal description of "Very Satisfactory" and "Satisfactory" in some areas.
3. Both groups have the same academic performance in Mathematics in the Modern World before the application of the Supplementary Learning Material; the academic performance of the students in the experimental group has improved after using the Supplementary Learning Material; the Supplementary Learning Material is useful in improving students' academic performance in Mathematics in the Modern World.
4. The suggestions from the teachers and expert respondents are focused on adding more problem-solving activities using



the technique integrated in the lesson and integrate also the use of technology in problem-solving activities using Mathematics software.

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BIOGRAPHIES (Optional not mandatory)