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Improving Least Mastered Mathematical Skills among Tertiary Education Students in Mathematics in the Modern World Through Strategic Intervention Materials

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ABSTRACT

This study aims to develop a SIM (Strategic Intervention Material) using problem-based learning or approach in improving least mastered mathematical skills of tertiary education students in Mathematics in the Modern World. This study also aims to prove that using SIM in teaching is more effective than the traditional way of teaching. This study made use of True Experimental Design. A total of 95 students of Camarines Sur Polytechnic Colleges who were enrolled in Mathematics in the Modern World served as the respondents of the study. Percentage, mean and t-tests were used as tools in the Analysis of data. T-test for Dependent Samples was used to determine the significant difference between the pre-test and post-test results of the students in Logic. T-Test for Independent Samples was used to determine the significant difference between the post-test results of the two-group of respondents in Logic. It was found out that there was a significant difference between the pre-test and post test results of the students in Logic. Also, there was a significant difference between the post-test results of the two groups of respondents in Logic. After using SIM to teach the lesson, it can be concluded that the experimental group's students performed significantly better. Thus, it was better and more effective to teach using SIM. It was also suggested that SIM be used as an instructional material or strategy for teaching Mathematics in the Modern World.

Keywords: Strategic Intervention Materials; Mathematics in the Modern World; Mathematical Skills; Problem-based Learning

BACKGROUND OF THE STUDY

Mathematics is fundamentally linked to various scientific, technological, and industrial fields, making it a crucial part of education and societal development. Despite its significance, many students develop an aversion to mathematics, which hinders their learning and performance. Historical data from international assessments indicate a consistent decline in the mathematics competency of Filipino students, which is alarming given the increasing demand for technological skills in the global marketplace, as noted by Amirali (2010).

Recent studies highlight the deteriorating mathematics performance among Filipino students, with rankings dropping significantly in both international assessments and global competitiveness reports. For instance, the Philippines' poor performance in the Trends in Mathematics and Science Study (TIMSS) and

the Global Competitiveness Report, as outlined by Villaver (2014), underscores the critical need for effective educational strategies and interventions.

The introduction of 'Mathematics in the Modern World' as a core course in the new General Education Curriculum by the Commission on Higher Education (CHED) aims to address these challenges by connecting students' prior knowledge to new mathematical concepts. However, there remains a gap in effectively teaching this course to enhance students' understanding and application of mathematics in real-world scenarios, as Garcia (2022) discusses.

Strategic intervention materials, such as instructional modules, offer a way to enhance learning by linking theoretical knowledge to practical applications. This approach allows students to learn at their own pace and encourages problem-solving skills critical for mastering mathematics, as Herrero (2022) emphasizes.

A study by Herrero (2022) identified a gap in students' analytical skills essential for understanding and solving complex mathematical problems. This indicates a need for intervention materials that not only address basic numeracy skills but also enhance analytical and problem-solving abilities.

Research on SIMs suggests their effectiveness in improving student performance in mathematics. For instance, studies have shown that SIMs can significantly enhance students' understanding and retention of complex topics such as fractions, a crucial area often utilized in higher mathematics (Suarez et al., 2020).

The integration of digital and electronic resources, such as Electronic Strategic Intervention Materials (ESIM), has been found to improve the learning experience and outcomes, especially in remote or online settings, as detailed by Dandan (2022). This highlights the potential for technology-enhanced SIMs to address learning gaps in mathematics education effectively.

Teachers' experiences with SIMs reveal several challenges, including time constraints, budget limitations, and lack of adequate training. However, teachers also report significant benefits from using SIMs, such as improved student performance and enhanced teaching satisfaction, as observed by Payot et al. (2022).

Assessing students' proficiency levels is crucial for identifying areas needing improvement and for tailoring intervention materials effectively. Studies like that of Abuda et al. (2019) emphasize the importance of using innovative instructional strategies, such as QRSIM, to target least mastered competencies in mathematics.

Building on the current research, there is a clear need to develop further and validate intervention materials that address specific gaps in students' mathematical knowledge and skills. The potential of SIMs to enhance critical thinking and problem-solving skills should be explored further to prepare students for complex real-world challenges, as suggested by Lestari et al. (2023).

The literature indicates a significant need for targeted intervention strategies to improve mathematical proficiency among tertiary students. By identifying the least mastered areas and utilizing strategic intervention materials effectively, educators can enhance student outcomes and better prepare them for future academic and professional challenges. This research aims to develop, implement, and assess such materials, contributing to a more robust mathematical education framework.

OBJECTIVES OF THE STUDY

This paper aims to develop strategic learning material in least mastered skills of the students in Mathematics in the Modern World. It also seeks to answer the common problems of the students in Mathematics. Specifically, this paper aims to answer the following questions:

1. What is the performance level (Pre-test) result in Mathematics in the Modern World of the students along:

a. Mathematics in Our World,
b. Mathematical Language and Symbols,
c. Problem Solving and Reasoning,
d. Data Management,
e. Logic, and
f. Mathematical System

2. What is the least mastered skill of the tertiary students in Mathematics in the Modern World?
3. Is there a significant difference between the performance level on the least mastered skills of the control and experimental group before and after the intervention?
4. Is there a significant difference between the performance level on the least mastered skills of the control and experimental group?
5. What strategic intervention material can be developed based on the result of the study?

HYPOTHESES

1. There a no significant difference between the performance level on the least mastered skills of the control and experimental group before and after the intervention.
2. There is no significant difference between the performance level on the least mastered skills of the control and experimental group.

METHODOLOGY

The focus of the study was to improve the least mastered skills among tertiary level students in Mathematics in the Modern World through Strategic Intervention Material. The study made use of "True Experimental Design". In this kind of design, it can establish a cause-and-effect relationship within a group. There is a control group that is not subjected to changes and an experimental group that will experience the changed variables.

Moreover, the researcher utilized questionnaire which cover the topics Mathematics in Our World, Mathematical Language and Symbols, Problem Solving and Reasoning, Data Management, Logic and Mathematical System as part of the syllabus in Mathematics in the Modern World mandated by the Commission on Higher Education (CHED). The test questionnaire was checked and validated by the Mathematics in the Modern World instructors and subject matter expert. The pretest and posttest were designed and administered to measure the performance level and least mastered skills of the students. The pretest and posttest both consist of a 54-item test. The controlled group and experimental group took the test twice with the same content of the test, pretest and posttest. The pretest was administered to all students, the control group and experimental group prior to the treatment. The pretest was helpful in assessing student's prior knowledge in Mathematics in the Modern World and in determining the least mastered skills of the students. A posttest was administered to measure the treatment effects. In addition, the results of the pretest and posttest scores were analyzed and categorized using the scale below:

90% and Higher – Advanced (A)
85% - 89% - Proficient (P)
80% - 84% - Approaching Proficiency (AP)
75% - 79% - Developing (D)
74% and Below – Beginning (B)

Additionally, the data in this study were treated using the following statistical tests. The mean, t-test for

paired samples (dependent samples), and t-test for independent samples. Mean is being described as the average of a set of scores or values. On the other hand, t–test for independent samples used to test the significance of difference between the posttest mean scores in the experimental and control group while t- test for paired samples (dependent samples) used to test the significance of the difference between the pretest and posttest mean scores within each of the group.

RESULTS AND DISCUSSIONS

In this section, the data gathered were precisely organized, analyzed and interpreted using the right statistical tools.

Table 1 shows the performance level or pretest result of the students in mathematics in the Modern World.

Mathematics in Our World		
Performance Level	**F**	**Percentage**
Advanced	8	8.42%
Proficient	-	-
Approaching Proficiency	46	48.42%
Developing	30	31.58%
Beginning	11	11.58%
Total	95	100.00%
Mathematical Language and Symbols		
Advanced	6	6.32%
Proficient	-	-
Approaching Proficiency	39	41.05%
Developing	37	38.95%
Beginning	13	13.68%
Total	95	100.00%
Problem Solving and Reasoning		
Advanced	10	10.53%
Proficient	-	-
Approaching Proficiency	33	34.75%
Developing	37	38.74%
Beginning	15	15.79%
Total	95	100.00%
Data Management		
Advanced	5	5.26%
Proficient	14	14.74%
Approaching Proficiency	34	35.79%
Developing	28	29.47%
Beginning	14	14.74%
Total	95	100.00%

Logic		
Advanced	-	-
Proficient	-	-
Approaching Proficiency	8	8.42%
Developing	38	40.00%
Beginning	49	51.58%
Total	95	100.00%
Mathematical System		
Advanced	2	2.11%
Proficient	13	13.68%
Approaching Proficiency	19	20.00%
Developing	32	33.68%
Beginning	29	30.53%
Total	95	100.00%

Table 1. Performance Level of the students in Mathematics in the Modern World

Table 1 shows the performance level of the students in Mathematics in the Modern World. In Mathematics in Our World, there were 8 or 8.42% of the students obtained a performance level classified as advanced; 46 or 48.42% of the students had a performance level of approaching proficiency; 30 or 31.58% of the students were developing, while 11 or 11.58% were beginning. The result shows that the student's performance along Mathematics in our World was below average or developing. It implies that the students have difficulties in understanding the concepts or topics of Mathematics in Our World.

In Mathematical Language and Symbols, 6 or 6.32% of the students obtained a performance level classified as advanced, 39 or 41.05% of the students acquired a performance level of approaching proficiency; 37 or 38.95% of the students were developing, and 13 or 13.68% were beginning. The result shows that the student's performance level in Mathematical Language and Symbols was below average or developing. It implies that students were struggling to grasp the ideas or topics of mathematical language and symbols.

In the concepts of Problem Solving and Reasoning, 10 or 10.53% of the students attained a performance level classified as advanced; 33 or 34.75% of the students achieved a performance level of approaching proficiency; 37 or 38.74% of the students were developing, and 15 or 15.79% were beginning. The result shows that the student's performance level in Problem Solving and Reasoning was below average or developing. It also implies that the topics under problem solving and reasoning were difficult to understand and comprehend for the students.

In Data Management, 5 or 5.26% of the students obtained a performance level categorized as advanced; 14 or 14.74% of the students obtained a performance level classified as proficient; 34 or 35.79% of the students were classified as approaching proficiency; 28 or 29.47% of the students were developing, and 14 or 14.74% were beginning. The result shows that the student's performance level in Data Management was average or approaching proficiency. It implies that the students can understand and solve problems involving data management or statistical concepts.

In Logic, 8 or 8.42% of the students acquired a performance level categorized as approaching proficiency; 38 or 40.00% of the students obtained a performance level of developing, while 49 or 51.58% of the

students were beginning. The result shows that the student's performance level in Logic was poor or beginning. It implies the students were struggling in understanding the concept of Logic.

In Mathematical System, 2 or 2.11% of the students acquired a performance level classified as advanced; 13 or 13.68% of the students obtained a performance level categorized as proficient; 19 or 20.00% obtained a performance level of approaching proficiency; 32 or 33.68% were developing; and 29 or 30.53% of the students were classified as beginning. The results show that the student's performance level in Mathematical System were below average. It implies that the students have difficulties in understanding the concepts of Mathematical System.

The results were supported by Garcia (2022) that most of the topics covered in Mathematics in the Modern World were found to be difficult and moderately difficult. It was also revealed that the respondents have a satisfactory performance in Mathematics in the Modern World. The results were also supported by Abuda et al., (2019), that the students were unable to reach the expected level of achievement based on the pretest.

Table 2. Least Mastered Skills of the Tertiary Students in Mathematics in the Modern World

Topics	Mean	Descriptive Interpretation
Mathematics in Our World	79.39	Developing
Mathematical Language and Symbols	78.25	Developing
Problem Solving and Reasoning	78.33	Developing
Data Management	80.18	Approaching Proficiency
Logic	74.44	Beginning
Mathematical System	78.60	Developing

Table 2 shows the mean score of the students in Mathematics in the Modern World. The results show that the mean score of the students along Mathematics in Our World was 79.39 and verbally interpreted as developing. The students got 78.25 mean score along Mathematical Language and Symbols; 78.33 along Problem Solving and Reasoning; 78.60 along Mathematical System and were verbally interpreted as developing. In Data Management, the students obtained a mean score of 80.18 and verbally interpreted as approaching proficiency. It also shows that the students got a 74.44 mean score in Logic which was the lowest mean score in six chapters covered in Mathematics in the Modern World and it was verbally interpreted as beginning. This implies that the students struggled in understanding the concept of Logic. The results were supported by Herrero (2022), students have found to have basic numeracy knowledge and skills such as concepts, properties, and theoretical knowledge. However, they lack on analytical skills which was very significant in performing operations and solving word problems.

Table 3. Test on Significant Difference between the Pretest and Posttest Scores of the Controlled Group in Logic

	Mean	N	Df	t-stat	p-value	Decision
Pretest	4.48	48	47	15.35	0.0000	Reject Ho
Posttest	6.63	48				

Table 3 shows the test on significant difference between the pretest and posttest mean scores of the controlled group in Logic. The controlled group got a 4.48 pretest mean score, 6.63 posttest mean score and a P value of 0.0000 with 47 degrees of freedom. It implies that the null hypothesis was rejected and there was a significant difference between the pretest and posttest mean score of the controlled group in Logic. The results were supported by Villonez (2018), which imply that students' achievement in any topic (mathematics) was boosted even in the absence of the integration of learning strategies.

Table 4. Test on Significant Difference between the Pretest and Posttest Scores of the Experimental Group in Logic

	Mean	N	Df	t-stat	p-value	Decision
Pretest	4.32	47	46	17.38	0.0000	Reject Ho
Posttest	7.51	47				

Table 4 shows the test on significant difference between the pretest and posttest mean scores of the experimental group in Logic. The experimental group got a 4.32 pretest mean score, 7.51 posttest mean score and a P value of 0.0000 with 47 degrees of freedom. It implies that the null hypothesis was rejected and there was a significant difference between the pretest and posttest mean score of the experimental group in Logic. The results were supported by Suarez et al., (2020), that SIM was effective in terms of improving students' performance particularly on the topic pertaining to the least mastered skills. SIM can be utilized as instructional materials during the learning process as an effective teaching tool.

Table 5. Test on Significant Difference between the Posttest Scores of the Control and Experimental Group in Logic

Groups	Mean	N	Df	t-stat	p-value	Decision
Control	6.63	48	93	5.61	0.0000	Reject Ho
Experimental	7.51	47				

The result shows that there was a significant difference between the posttest mean scores of the control group and experimental group. As evidenced by the higher mean, this suggests that students in the experimental group learnt more than those in the control group. Further, the experimental group's exposure to the strategic intervention materials provided has enabled them to master the lesson more effectively than the control group's students. The results were supported by Dandan (2022), SIM had a significant impact on learners' performance in the subject. Strategic Intervention Material (SIM) is highly acceptable and effective in improving learners' performance.

OUTPUT OF THE STUDY

The output of the study is an Strategic Intervention Material. This includes guide card, activity card, assessment card, enrichment card, reference card and answer key. All necessary or needed features are included in the SIM. This SIM was designed to help students to improve their mathematical skills in Mathematics in the Modern World particularly in Logic.

CONCLUSIONS

Based on the findings of the study, the following conclusions were drawn:

1. The performance level in Mathematics in the Modern World of the students was described as developing,
2. The least mastered skills of the tertiary students in Mathematics in the Modern World were the concept on Logic.
3. There was a significant difference between the pretest and posttest mean scores in the controlled group and experimental group on the concept of Logic.
4. There was a significant difference between the posttest mean scores between the controlled group and experimental group on the concept of Logic.
5. Strategic Intervention Material was effective in teaching the least mastered skills in Mathematics in the Modern World.

RECOMMENDATIONS

Based on the conclusions of the study, the following were suggested:

1. Since the use of Strategic Intervention Material (SIM) helps to enhance mathematical skills of the students, teachers should adopt it as a strategy or instructional material in teaching Mathematics.
2. The Commission on Higher Education must intensify their campaigns in improving their curriculum by engaging SIM in the teaching-learning process.
3. The conduct of similar studies in other areas is recommended to validate the external validity of the findings.

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