

Development and Content Validation of Modular Textbook on Mathematics in the Modern World at Sorsogon State University, Sorsogon, Philippines

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Abstract

Modular textbooks are widely recognized as a valuable resource for teaching mathematics in schools and colleges. This descriptive-developmental research aimed to provide a research-based modular textbooks for course Mathematics in the Modern World. Difficulties encountered in mathematics by 100 Grade 11 students from three public secondary schools in Magallanes, Sorsogon were identified along with the prescribed topics and competencies by CHED as inputs on the development of the textbook. As a result, the developed textbook is consisting of 21 modules since 7 units of 3 lessons and each module is divided into 10 parts. Modules related to proofs, logic and functions as the top 3 difficult key concepts were given more emphasis in terms of examples and activities to be included. Five experts who are teachers that have experienced teaching MMW have evaluated the textbook in terms of design, format, and OBE alignment. It was found out that the textbook is very satisfactory with a weighted mean of 4.29 as assessed by the evaluators through the use of adopted instrument. With these findings, researchers and educators should consider developing modular textbooks that are tailored to the needs and interests of students, with a focus on enhancing their problem-solving skills and critical thinking abilities. The modular textbook should be extensively validated before they are used in classrooms, and that the validation process should be ongoing, with regular reevaluation and revision of the textbooks to ensure that they remain relevant and effective.

Keywords: development, content validation, modular textbook, Mathematics in the Modern World

INTRODUCTION

Mathematics is a fundamental subject that plays a crucial role in our daily lives. It is not only essential for scientific and technological advancements but also for decision-making, problem-solving, and critical thinking. In today's modern world, where technology and innovation are rapidly evolving, it is imperative to have a comprehensive and up-to-date textbook on mathematics that caters to the needs of learners [1]. The purpose of this study is to develop and validate a textbook on Mathematics in the Modern World. This textbook aims to provide learners with a solid foundation in mathematics while incorporating real-world applications and examples that are relevant to the modern era. By doing so, it is expected that learners will develop a deeper understanding and appreciation for the subject, leading to improved performance and engagement.

Mathematics Education in the Modern World

Mathematics education has undergone significant changes over the years, particularly in response to the demands of the modern world [2]. Traditional approaches to teaching mathematics, which focused primarily on rote memorization and procedural knowledge, have been replaced by more student-centered and inquiry-based methods [3]. This shift aims to develop students' critical thinking skills, problem-solving abilities,

and mathematical reasoning. According to the study conducted by [4], mathematics education should be focused on helping students make connections between mathematical concepts and their real-world applications. This approach not only enhances students' understanding of the subject but also promotes their ability to apply mathematical knowledge in practical situations.

The Role of Textbooks in Mathematics Education

Textbooks play a vital role in mathematics education as they serve as a primary resource for both teachers and students [5]. A well-designed textbook can provide a structured and organized approach to learning, presenting mathematical concepts in a clear and concise manner. It can also offer a variety of exercises and examples that allow students to practice and apply their knowledge. However, the effectiveness of a textbook depends on its content, relevance, and alignment with the curriculum [6]. Outdated or poorly designed textbooks can hinder students' learning and engagement, leading to a lack of interest and motivation in the subject [7]. Therefore, it is crucial to develop textbooks that are not only comprehensive but also up-to-date and relevant to the modern world.

Development of the Textbook on Mathematics in the Modern World

The development of the textbook on Mathematics in the Modern World should follow a systematic and rigorous process to ensure its quality and effectiveness. The first step should involve conducting a thorough review of existing textbooks and related literature to identify the gaps and shortcomings in current materials. This review may also help in determining the key topics and concepts that should be included in the textbook [8]. Once the content framework is established, a team of experts in mathematics education may be assembled to develop the textbook. These experts may include mathematics educators, curriculum specialists, and subject matter experts who have a deep understanding of the modern world and its mathematical applications [9]. The team will work collaboratively to create a comprehensive and engaging textbook that aligns with the curriculum standards and addresses the needs of learners.

Content Validation of the Textbook

After the initial development phase, the textbook should undergo a rigorous content validation process to ensure its accuracy, relevance, and effectiveness. This process should involve seeking feedback and input from a diverse group of stakeholders, including mathematics educators, students, and experts in the field [10]. Their insights and suggestions should be used to refine and improve the content of the textbook. The content validation process should also include pilot testing the textbook in a select group of schools or classrooms. This will allow for the identification of any potential issues or areas for improvement before the textbook is finalized [11]. The feedback from the pilot testing will be carefully analyzed and incorporated into the final version of the textbook.

In conclusion, the development and content validation of a textbook on Mathematics in the Modern World is essential to provide learners with a comprehensive and up-to-date resource that meets their needs. By incorporating real-world applications and examples, this textbook aims to enhance students' understanding and appreciation of mathematics. The systematic and rigorous process of development and content validation will ensure the quality and effectiveness of the textbook, ultimately benefiting both teachers and students in their mathematics education.

OBJECTIVES OF THE STUDY

This study aimed to develop and validate modular textbook on Mathematics in the Modern World. Specifically, it aimed to:

1. Determine the difficulties encountered by the senior high school students in Mathematics subjects at selected secondary schools.
2. Determine the topics and competencies on prescribed by the course syllabi made by the CHED Technical Panel of General Education
3. Develop textbooks on Mathematics in the Modern World based on the identified difficulties and prescribed topics and competencies
4. Validate the developed textbook in terms of its content as perceived by the experts.

METHODOLOGY

This study employed the descriptive developmental design since modular textbook was developed based on the identified difficulties of the senior high school students in Mathematics and the result of content validation by the experts. Specifically, ADDIE model of instructional design was utilized in which started with the analysis of the difficulties encountered by the senior high school students as well as the topics and competencies to be included. 100 Grade 11 students under STEM and GAS strands were randomly selected from three public secondary schools in Magallanes, Sorsogon and were surveyed through checklist questionnaire. Regarding the topics and competencies on Mathematics in the Modern World, CHED Memorandum No. 20, series of 2013 including the course syllabus used for Mathematics in the Modern World in Sorsogon State University were carefully analyzed. The module to be developed was divided into 10 parts. To validate its content in terms of its design, format, and OBE alignment, five experts who were Mathematics instructors from the four campuses of Sorsogon State University and have already taught Mathematics in the Modern World. Its validity was measured through the use of indicators and rated using a 5-point Likert scale. Descriptive statistics such as frequency count and ranking and weighted mean were used.

RESULTS AND DISCUSSION

Difficulties Encountered by the Students in Mathematics

Table 1 shows the top 10 difficulties met by the Grade 11 students in Mathematics, particularly in the subject General Mathematics. The top three key concepts that were found difficult by the students were proof, logic, and functions. This finding implies that strategic interventions may be conducted to lessen those difficulties such as innovation on instructional materials being used, conduct of remedial instruction and integration of enrichment activities. This may be brought by the shifting of instruction from face-to-face to modular or online in which the students were learning in their own pace most of the time. The identified difficult key concepts were found similar on the study conducted by [12] in which teacher-respondents have difficulties on teaching such topics. With this, teacher's knowledge may be considered one of the factors why students also found it difficult.

Table 1. Top 10 key concepts in Mathematics that were difficult by the student-respondents

Key Concepts	Weighted Mean	Standard Deviation	Rank
A. Functions	2.42	0.65	9
B. Rational Functions	2.61	0.86	4
C. Inverse Functions	2.57	0.77	6
D. Exponential Functions	2.65	0.81	3
E. Logarithmic Functions	2.58	0.76	5
F. Simple Interest & Compound Interest	2.28	0.66	10
G. Simple and General Annuities	2.55	0.78	7
H. Stocks and Bonds	2.57	0.75	6
I. Business and Consumer Loan	2.50	0.80	8
J. Propositional Logic, Syllogism, Fallacies	2.74	0.90	2
K. Proof & Disproof	3.34	1.12	1

Topics and Competencies Prescribed by CHED for MMW

The inclusion and implementation of General Education Curriculum is anchored on CHED Memorandum No. 20, series of 2013. One of the GEC subjects offered in all undergraduate programs is the Mathematics in the Modern World. According to the memorandum, MMW course deals with the nature of mathematics, appreciation of its practical, intellectual, and aesthetic dimensions, and application of mathematical tools in daily life. As shown in Table 2, there are eight competencies that should be developed by the students in terms of knowledge, skills, and values. Key concepts in MMW are divided into ten units

of lesson. On the study by [13], it was given emphasis that topics and competencies to be included in an instructional material should be carefully selected and aligned with the existing curriculum and learning needs of the students.

Table 2. *Topics and competencies prescribed by CHed Technical Panel for General Education*

Competencies for MMW	Topics under MMW
<p>Knowledge</p> <ol style="list-style-type: none"> 1. Discuss and argue about the nature of mathematics, what it is, how it is expressed, represented, and used; 2. Use different types of reasoning to justify statements and arguments made about mathematics and mathematical concepts; 3. Discuss the language and symbols of mathematics; <p>Skills</p> <ol style="list-style-type: none"> 4. Use a variety of statistical tools to process and manage numerical data; 5. Analyze codes and coding schemes used for identification, privacy, and security purposes; 6. Use mathematics in other areas such as finance; <p>Values</p> <ol style="list-style-type: none"> 7. Appreciate the nature and uses of mathematics in everyday life; and, 8. Affirm honesty and integrity in the appreciation of mathematics to various human endeavors. 	<p>Unit 1 – Mathematics in Our World Unit 2 – Mathematical Language and Symbols Unit 3 – Problem Solving and Reasoning Unit 4 – Data Management Unit 5 – Geomtric Design Unit 6 – Mathematics of Finance Unit 7 – Mathematics of Graphs Unit 8 – Codes Unit 9 – Voting and Apportionment Unit 10 – Linear Programmng</p>

Modular Textbook Developed for MMW

A module was designed for each three lessons of the seven chapters of MMW course as shown in Table 3. The module was composed of 10 parts in which it includes the learning objectives and learning experiences. Special feature of the developed modules was the inclusion of module evaluation and sef evaluation by the students. Preliminary parts such as preface and table of contents were added to the developed modules to form the textbook which was named, “#iloveMath” as shown in Figure 1. Similarly in the research made by [14], modules in mathematics were also developed specifically using problem solving approach and catering student’s reflective thinking. The development of its modules undergone 4 stages while the present study followed the ADDIE model which is comprised of five stages.

Table 3. Subtopics for each unit of lessons and the parts of the developed modules

Sub-Topics	Parts of the Module
1.1 Patterns and Numbers in Nature and the World 1.2 The Fibonacci Sequence 1.3 Arithmetic and Geometric Progression and Series 2.1 Language of Mathematics 2.2 Sets, Functions, Relations, and Binary Operations 2.3 Elementary Logic and Formality 3.1 Inductive and Deductive Reasoning 3.2 Problem Solving with Patterns 3.3 Problem Solving Strategies 4.1 Data Gathering, Organization, Presentation and Interpretation 4.2 Measures of Central Tendency 4.3 Measures of Dispersion 5.1 Recognizing and Analyzing Geometric Shapes 5.2 Transformations 5.3 Patterns and Diagrams 6.1 Graphs and Euler Circuits 6.2 Weighted Graphs 6.3 Euler's Formula 7.1 Simple and Compound Interest 7.2 Credit Cards and Consumer Loans 7.3 Stocks, Bonds, and Mutual Funds	I. Module Title II. Overview/Introduction III. Learning Outcomes IV. Learning Experiences and Self-Assessment Activities (SAA) V. Summary/Key Points VI. SAA Answer Sheet VII. End of Module Assessment (EMA) VIII. SAA Answer Key IX. Looking Ahead X. Self and Module Evaluation



Figure 1. The developed modules for Mathematics in the Modern World

Content Validation of the Developed Modular Textbook

In Table 4, it shows that the developed modular textbook was evaluated by the experts based on three major components, namely, design, format, and OBE alignment. Along with these components, the modular textbook was rated very satisfactory with a weighted mean of 4.29. It can be implied that the modular textbook was well-designed and well-developed along with those components. [15] also conducted validation of developed modules in basic mathematics in which five experts in mathematics education were involved on the validation process. Same components were assessed to measure its validity except its OBE alignment.

Table 4. The summary of results of content validation by the experts

Component	Weighted Mean	Adjectival Rating
A. Design	4.23	Very Satisfactory
B. Format	4.34	Very Satisfactory
C. OBE Allgnment	4.29	Very Satisfactory
<i>General Weighted Mean</i>	4.29	Very Satisfactory

DISCUSSION

As reflected on the aforementioned results on the key concepts which were found difficult, it can be implied that the teachers and administrators may plan and implement interventions to lessen those difficulties and may help the students to cope with the challenges on dealing with the transition from basic education mathematics to higher education mathematics. To address this need, the present study provides a modular textbook on Mathematics in the Modern World.

CONCLUSIONS

Based from the findings, the following conclusions were drawn:

1. The top three key concepts that were found difficult by senior high school students are proof, logic, and functions.
2. There are 21 topics and 8 major competencies should be included and reflected on the modular textbook to be developed.
3. A modular textbook on MMW is developed which is consists of 21 modules, three for each unit of lesson.
4. The developed modular textbook is very satisfactory based on its design, format and OBE Alignment.

RECOMMENDATIONS

Based from the conclusions, the following recommendations were made:

1. Teachers may implement strategic interventions such as remedial instruction and enrichment activities on the identified difficulties on key concepts in Mathematics.
2. Existing textbooks on MMW may be reviewed to generate gaps that could be bridged by the present study.
3. Additional modules may be developed to cater the other optional topics such as Codes, Voting and Apportionment, and Linear Programming.

4. Modifications may be done by enriching the learning experiences and activities and contextualizing examples.

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