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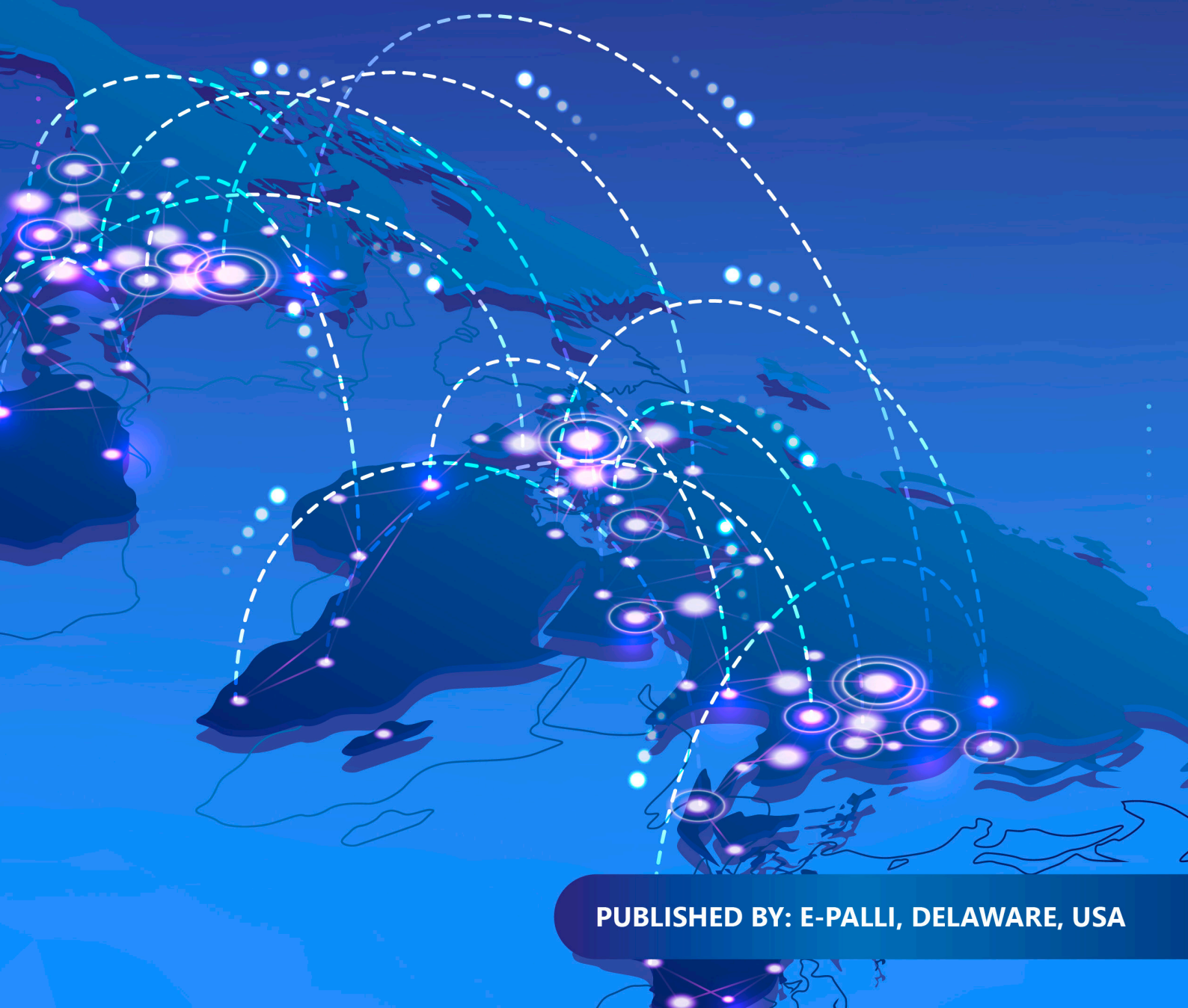

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Modular Development in Mathematics in the Modern World

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Development, Instructional Module, Mathematics in the Modern World.

ABSTRACT

The study aimed to develop an instructional module on CHED mandated topics in Mathematics in the Modern World in order to address new trend to fit in in the new normal. A developmental research design was utilized in the conduct of the investigation. The findings revealed that the CHED mandated topics in Mathematics in the Modern World included the core topics, namely: Mathematics in our World; Mathematical Language and Symbols; Problem Solving and Reasoning; and Data Management. These topics were properly placed in the different lessons of the instructional module. The panel of experts assessed the instructional module to be "excellent". Usefulness and objectives of the module were highly rated as "excellent" while the presentation of the module received a "very good" rating. The developed instructional module was found to be valid in terms of objectives, content, format and language, presentation and usefulness based on the experts' assessment. It is then suggested that the proposed instructional module be used by the Mathematics teachers from other colleges and universities to increase its reliability and usability.

INTRODUCTION

Education plays an important role in moulding the youth to be an efficient and competent individuals in their future professions. It serves as a key to open a door of success in the future and unlock many opportunities in life. It illuminates a person's mind and thinking and facilitates quality learning to help people of any age group, cast, creed, religion and region achieve their aspirations in life. If the world changes over time, so as the education system (Torio, 2015).

The rapid changes and increased complexity of today's society display new challenges and put new higher demands on the education system. Over the years there has been generally a growing awareness of the necessity to develop and improve the preparation of students for productive functioning in the continually changing and highly demanding environment. In the country, the implementation of the K-12 program of the Department of Education is the first step of the government to address the demand of improving the education system. The reason behind of the Department of Education's (DepEd) Enhanced K to 12 Basic Education Program is to enhance the quality of basic education in the Philippines. It is an educational reform in which a vision is grounded on human development, where a graduate holds understanding of the world around him and achieved success through enhanced curriculum.

In consideration of the College Readiness Standards (CHED Memorandum No. 20, Series 2013), the Enhanced Basic Education Curriculum through K-12 has integrated General Education (GE) courses in the high school core courses of higher education programs which resulted to the revision of the current GE curriculum (CHED Memorandum No. 59 Series 1996). The new GE curriculum targets to expose undergraduate students to diverse domains of knowledge and ways of understanding social and natural realities, understanding development process, intellectual competencies and civic capacities.

Aside from the K-12 program that puts the whole educational system at a new phase since 2013, this year 2020, the country is facing a new challenge that tests the national social-political, economic, and even then educational sector. In the time of COVID-19 pandemic, the global education system is in the practice of transforming and adapting to the new normal of providing a conventional teaching-learning process of classroom human interaction and centers in the usage of either on-line platform or through instructional modules. In schools and other universities that use module as a platform for learning acquisition among students, teachers do need proper training on how to come up with effective instructional module that serves as a bridge for the teaching-learning process especially that the country is currently facing a crisis due to the pandemic. Since face-to-face classes is no longer advisable for the School Year 2020-2021, alternative approach for the traditional set-up of classes must be practiced for the continuous delivery of learning to the students. Instructional module is one of the effective ways to use especially on areas that have poor internet connection and where students cannot afford to provide gadgets such as computer, laptops, or even tablets for on-line classes. As the teachers received proper training for constructing modules, it would be easy for them to relay all essential learning students need to acquire with taking consideration of their health.

For the past 2 years of teaching tertiary mathematics, the researcher strongly believes that developing mathematical understanding does not merely mean getting high scores in different assessments such as quizzes and tests or being able to solve drills in mathematics books; rather, it is manifested in the students' ability to relate and

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communicate to previously acquired knowledge and be able to identify its practical purpose. Faced with such a challenge, the researcher has the purpose of developing instructional module that can benefit both the researcher and the students. The instructional module consists of selected topics in Mathematics in the Modern World. With this, the researcher hopes that the developed instructional module can be used in teaching the concepts of Mathematics in the Modern World under the new curriculum. It is with great hope that the module can be used to the upcoming first year students of the University.

Objectives

The researcher aims to develop instructional module on CHED mandated topics in Mathematics in the Modern World with the end-view of coming up with a resource material in teaching the course.

Specifically, it seeks to answer the following questions:

1. What are the CHED mandated topics in Mathematics in the Modern World?
2. What is the experts' assessment on the instructional module on CHED mandated topics in Mathematics in the Modern World in terms of the following:
   2.1 objectives;
   2.2 content;
   2.3 format and language;
   2.4 presentation; and
   2.5 usefulness/usability

LITERATURE REVIEW

The Commission on Higher Education of the Philippines, abbreviated as CHED, covers both public and private higher education institutions as well as degree-granting programs in all post-secondary educational institutions in the country (CHED, 2021). CHED is mandated to affiliate with Department of Education and other institutions for teacher training and education which includes the attainment of quality standards of the curricula of teacher education institutions. The purpose of the affiliation is to guarantee that the teachers of the next generation, as prime molders of young minds, are ready to teach the new educational system to young Filipinos.

Recently, there are several major reform programs that have been initiated at both the basic and tertiary levels. One of the reform programs is the addition of two years to basic education, through Republic Act 10533, enacted in 2013. It was implemented starting the Academic Year 2016-2017 which there is additional of new Grades 11 and 12, comprising senior high school for all students. As to the addition of two years to high school, CHED has also issued CMO 20, s. 2013: The New General Education Curriculum (CMO 20 s. 2013, 2013). The CMO 20 comes up with a new set of required and elective inter-disciplinary courses with a liberal education perspective. It aims to give the student a holistic development not only of intellectual competencies but also personal and civic competencies which focus on wide-ranging understandings of fundamental aspect of knowledge. It intends to produce a graduate student who appreciates his role in the community and cares about the problems that affect the society. It means that the goal of GE courses is not only limited on intellectual aspect but also on the values of the students to recognize the fundamental humanity of all.

The following are the eight core courses in the new general education curriculum: (1) Understanding the Self, (2) Readings in Philippine History, (3) The Contemporary World, (4) Mathematics in the Modern World, (5) Purposive Communication, (6) Art Appreciation, (7) Science, Technology and Society and (8) Ethics (CMO 20 s. 2013, 2013). While there are three courses for elective and 1 subject on the Life and Works of Rizal as mandated by law. According to CHED, in every course, there are samples or suggested course syllabi can be used as guides and public and private higher education may adopt the sample or suggested course syllabi in the teaching and delivery of the content.

Mathematics in the Modern World is one of the general education subjects under the new curriculum in the Philippines. It is a 3-unit subject which is part of the 36 general education curriculum. This subject replaced the old general education mathematics subject which had been used in the Philippines since 1996. It covers from the introduction to the nature of mathematics as an exploration of patterns and as an application of inductive and deductive reasoning.

The course outline of the Mathematics in the Modern World is divided into two sections, namely: A. Mandatory topics and B. Optional topics applicable to the specific program or discipline. The first four chapters discuss the required lessons identified in the course syllabus while the remaining chapters are elective ones. It is important to note that the first four chapters, namely The Nature of mathematics, Mathematical Language and Symbols, Problem Solving and Reasoning, and the Data Management (Statistical Tool) are the non-negotiable topics, and together with one or two from elective ones, depending on the need of the students make up the whole course (KWF-Mathematics-in-the-Modern-World, 2016). It aims to expose students to the nature of math and its usefulness in the development of the society. The topics and concepts in Mathematics in the Modern World are not repetition of what were learned from high school algebra, but rather it is an exploration of the nature of mathematics.

These topics are very useful to the students in their daily lives and by studying the topics it would help them to go beyond the typical interpretation of mathematics as simply a bunch of formulas, but as a source of aesthetics in patterns of nature, for instance, and a rich language itself governed by logic and reasoning.

Instructional module is a self-instructional material which consists of self-directed learning activity packets that attempts to individualize learning by allowing a student to achieve mastery of the content at their own pace and proceed to another topic as long as they understand the

previous topic. Module can be used as a supplementary material to the students who missed their lessons in school and improves their mastery of the content as they review the topics (Torrefranca, 2017). Lim (2016) claimed that modules develop learning and grading strategies, improve classroom management techniques and use existing educational resources through establishing realistic obtainable learning goals. Modules used in a classroom setting is considered as self-pacing because a student can progress through the learning tasks at his own bound. In the study done by Rizaldo, et. al., (2007) they concluded that using modular strategy in teaching makes the students performed well in class.

Marasigan (2019) recommended in her study, to develop a self-instructional module to be used as a learning material in the university. Developing instructional materials in mathematics and other areas of the subject is a must for all the teachers. The module should be according to the level of understanding of specific students. The learning material should be subjected to readability test in order to find out if is appropriate to the level of the knowledge of the students. The teacher should assess first the students to know if the learning material is not difficult for them at the same time they learn a lot from it. Though, there are some teachers who do not put an effort for their students because it will take up their time, but it is important that teachers should make sure that their students develop skills and knowledge from the lessons. Effectiveness of the learning materials can be achieved if the teachers make their own instructional modules because they are the ones who are experts in the subject matter. The teachers have control over instruction and ensure that their teaching strategies are aligned with the learning objectives. They also make sure that the objectives and learning outcomes are met by the students. If objectives are met, it means that the strategy is effective and can be used to future classes.

METHODS

The study utilized the developmental research design. According to Richey and Klein (2007), a developmental research design is a systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet criteria of internal consistency and effectiveness. Developmental research is particularly important in the field of instructional technology. In order to establish an empirical basis for producing self-instructional module in the subject Mathematics in the Modern World, the researcher used the ADDIE (Analysis, Design, Development, Implement, Evaluate) Model in developing the instructional module on the different lessons under the subject. Through this model, the production of the content was organized and streamlined.

The respondents were the experts (10 Mathematics teachers).

In gathering the needed data, an evaluation rating scale answered by the experts were utilized. The yielded results were treated by appropriate statistical measures.

RESULTS AND DISCUSSION

This chapter presents, analyzes and interprets the data taken from the gathered results. The collected data were tabulated, discussed and interpreted using appropriate statistical tools. Implications of the findings were based on the statistical analysis of the results.

CHED Mandated Topics in Mathematics in the Modern World

Mathematics in the Modern World is a 3-unit general education course offered to first year college students as their subject in mathematics. Table 1 presents the CHED mandated topics in Mathematics in the Modern World.

As shown in the table, the Commission on Higher Education mandated the inclusion of four key topics, namely: Mathematics in our World; Mathematical language and Symbols; Problem Solving and Reasoning; and Data Management. The four topics were considered as the core of the course and were accommodated in the instructional module. There were also elective topics which the Math teacher can choose from depending on the specific program or discipline he dealt with, to wit: Geometric Designs, Codes, Linear Programming, Mathematics of Finance, Apportionment and Voting, Logic, The Mathematics of Graphs and Mathematical System.

Table 1: CHED Mandated Topics in the Mathematics in the Modern World

Mandated Topics	Sections in the Module
A. Mathematics in our World	Lesson 1
B. Mathematical Language	Lesson 2
C. Problem Solving and Reasoning	Lesson 3
D. Data Management	Lesson 4
E. Select 1 or 2 Topics (depending to a specific program or discipline) Geometric Designs Codes Linear Programming Mathematics of Finance Apportionment and Voting Logic The Mathematics of Graphs Mathematical System	

The core topics are described as follows:

Mathematics in the World advances mathematics as a useful way to think about nature and the world. It covers the lessons ranging from patterns and numbers, to the Fibonacci sequence and the application of these tools in exploring natural phenomena in the environment;

Mathematical Language and Symbols likens the mathematics to language, as it is a body of knowledge governed by symbols, syntax, and rules. Key lessons

such as expressions vs. sentences, the concept of sets, functions, relations, and binary operations and elementary logic are discussed in this topic;

Problem Solving and Reasoning further explores the use of reasoning in problem solving, with lessons on inductive and deductive reasoning, the concept of intuition, proof, and certainty, Polya's 4-step problem solving, and recreational mathematical problems, among others are included; and

Data Management exposes students to statistical tools derived from mathematics useful in processing and managing numerical data in describing or predicting values. Basics such as data gathering and organizing, interpreting, central tendency measures, probabilities, and linear regression and correlation, among others, are covered in this topic.

With the inclusion of the CHED mandated topics in the developed instructional module, one can say then that the instructional module contained the representative topics in Mathematics in the Modern World.

Assessment of the Experts on the Characteristics of the Instructional Module on Mathematics in the Modern World

The data on the experts' assessment on the instructional module are displayed in Table 2. The instructional module was assessed in terms of objectives, content, format and language, presentation and usefulness/ usability. And evaluation rating scale was used by the experts in determining the acceptability of the designed instructional module. Objective of the module. As depicted in the table, these were 10 items on objectives

Table 2: Mean and Standard Deviation in the Assessment of the Experts on the Characteristics of the Instructional Module on Mathematics in the Modern World

Aspects	Mean (n=4)	Desc	sd
Objective of the Module			
1. The of objectives are clearly stated.	4.75	E	0.50
2. The objectives are specific.	4.75	E	0.50
3. The objectives are measurable and attainable.	4.75	E	0.50
5. The objectives are closely related to the purpose of the module.	5.00	E	0.00
6. The objectives are relevant to the topics of each lesson of the module.	5.00	E	0.00
7. The objectives are well-planned and organized.	4.50	E	0.58
8. The objectives are well-formulated.	5.00	E	0.00
9. Each set of specific objectives leads to the achievement of its relevant general objectives.	4.50	E	0.58
10. The objectives are well-disseminated.	5.00	E	0.00
Average (Objective)	4.81	E	0.26
Content of the Module			
1. The contents are relevant to the objectives.	4.50	E	0.58
2. The contents are arranged in logical sequence of learning.	4.75	E	0.50
3. The topic(s) of each lesson is (are) fully discussed.	4.25	VG	0.96
4. The content of each lesson is simple and easy to understand.	4.75	E	0.50
5. The topics of each lesson are fully discussed.	4.50	E	0.58
6. Each topic is given equal emphasis in the lesson.	4.50	E	0.58
7. The topics are supported by illustrative examples, and the practice task are suited to the level of the students.	4.50	E	0.58
8. All activities are appropriate for their content and objectives.	4.50	E	0.58
9. All learning activities promote active participation and response.	4.50	E	0.58
10. Appropriate self-check questions and answers have been included at all necessary points.	4.75	E	0.50
Average (Content)	4.55	E	0.37
Format and Language of the Module			
1. The format/layout is well-organized making the lessons interesting.	4.50	E	0.58
2. The language used is easy to understand.	4.75	E	0.50
3. The language used is clear and concise.	4.75	E	0.50
4. The language used is motivating.	5.00	E	0.00
5. The mathematical symbols are well-defined.	4.50	E	0.58
6. The instructions given are clear, understandable and easy to follow.	4.50	E	1.00
7. All visual elements have been successfully integrated into the learning sequence.	4.75	E	0.50
8. Learning activities are shown as input-process-output cycle.	4.75	E	0.50
9. All concepts in the modules are well displayed/suggested.	4.00	VG	0.00
10. Whenever appropriate, a touch of humour has been added using cartoons, humorous comments, caricatures, and other similar aspects.	4.00	VG	0.00
Average (Format and Language)	4.55	E	0.25
Presentation of the Module			

1. The topics are presented in a logical and sequential order.	5.00	E	0.00
2. The lessons are presented in a unique/original style/form.	3.50	G	0.58
3. The learning activities promote active participation and response.	4.50	E	0.58
4. The learning activities are clearly presented.	4.25	VG	0.50
5. The presentation of each lesson is attractive and interesting.	4.50	E	0.58
6. Adequate examples are given in each topic.	4.25	VG	0.96
7. The learning activities are divided into small steps/units.	4.50	E	0.58
8. The length of time needed to complete the module is adequate/sufficient.	4.50	E	0.58
9. Effective reinforcement statements have been included at necessary point.	4.25	VG	0.50
10. Continuity of learning has been ensured by the inclusion of bridge passage at all necessary point.	4.75	E	0.50
Average (Presentation)	4.40	VG	0.29
Usefulness of the Module			
1. The instructional module motivates the students to study the subject.	4.75	E	0.50
2. The instructional module helps the students master the topics at their own pace.	5.00	E	0.00
3. The instructional module allows the students to use their time wisely/efficiently.	4.75	E	0.50
4. The instructional module develops the analytical thinking and reasoning skills of the students.	4.75	E	0.50
5. The instructional module encourage independent learning for the students.	4.75	E	0.50
6. The instructional module serves as supplementary material for teachers and students.	5.00	E	0.00
7. The instructional module encourage students to develop their study habits.	5.00	E	0.00
8. The instructional module allows students to develop some values like patience, creativity, self-worth, self-confidence, etc.	4.75	E	0.50
9. The instructional module leads the students to develop positive attitude toward mathematics.	5.00	E	0.00
10. The instructional module attains the course outcome.	4.75	E	0.50
Average (Usefulness)	4.85	E	0.13
Over-all Average	4.63	E	0.25

Legend:

4.51 – 5.00	=	*Excellent (E)*
3.51 – 4.50	=	*Very Good (VG)*
2.51 – 3.50	=	*Good (G)*
1.51 – 2.50	=	*Fair (F)*
1.00 – 1.50	=	*Poor (P)*

that were rated by the experts. Their evaluation showed an over-all mean of 4.81, described as "excellent" and standard deviation of 0.26. There were four items which were rated 5.00 described as "excellent", to wit: item 5 "The objectives are closely related to the purpose of the module"; item 6 "The objectives are relevant to the topics of each lesson of the module"; item 8 "The objectives are well-formulated"; and item 10 "The objectives are well-disseminated". The obtained standard deviation scores of these items resulting to 0.00 imply that the experts shared the same rating in evaluating the objectives. They were one in their evaluation of the instructional module in terms of objective. The characteristics of the objectives as to their being relevant, purposeful, well-formulated and well-disseminated stand-out in their evaluation.

Content of the Module. Displayed in the table are 10 items describing the content of the instructional module. There were three items which showed high mean rating of 4.75 described as "excellent" and these are: item 2 "The contents are arranged in logical sequence of learning"; item 4 "The content of each lesson is simple and easy to understand"; and item 10 "Appropriate self-check questions and answers have been included at all necessary points". The items registered a standard deviation of 0.50. However, there was one item, item 3 "The topic(s) of each lesson is (are) fully discussed" which registered a mean rating of 4.25 described as "very good", and was the lowest mean rating from among the ten items. The obtained over-all mean rating of the content aspect is 4.55 described as "excellent" with a standard deviation of 0.37.

The results showed that the raters were homogeneous in their evaluation of the content aspect. They were one in considering the content of the module to be logical, understandable and verifiable since appropriate self-check questions and answers were included in all necessary parts of the module. However, more discussions should be given for topic(s) of each lesson.

Format and Language of the Module. Shown in the table are 10 items for the assessment of the format and language of the module. There were five items with high mean ratings, to wit: items 4 ($\bar{x}$=5), "The language used is motivating"; item 2 ($\bar{x}$=4.75), "The language used is easy to understand"; item 3 ($\bar{x}$=4.75), "The language used is clear and concise"; item 7 ($\bar{x}$=4.75), "All visual elements have been successfully integrated into the learning sequence"; item 8 ($\bar{x}$=4.75), "Learning activities are shown as input-process-output cycle"; all of these mean ratings were described as "excellent" and with standard deviation of 0.00 and 0.50. The experts noted the module to be motivating, understandable, clear, concise, output

oriented and the visual elements have been successfully integrated into the learning sequence. Item 9 "All concepts in the modules are well displayed/suggested" and item 10 "Whenever appropriate, a touch of humour has been added using cartoons, humorous comments, caricatures, and other similar aspects", received a mean rating of 4.0, described as "very good" which suggested that concepts should be added with a touch of humour by using cartoons, caricatures, humorous comments and other similar aspects. An over-all mean rating of 4.55 described as "excellent" with a standard deviation of 0.37 was obtained. The experts' evaluation, as the results denote, indicated that they share the same insights on the format and language of the module.

Presentation of the Module. The table indicated an over-all mean rating of 4.40, described as "very good" with a standard deviation of 0.29 for the presentation of the module. There were two items which obtained high mean rating, to wit: item 1 ($\bar{x}$=5), "The topics are presented in a logical and sequential order"; and item 10 ($\bar{x}$=4.75), "Continuity of learning has been ensured by the inclusion of bridge passage at all necessary point", both means were described as "excellent" with standard deviation scores of 0.00 and 0.50 respectively.

The data implied that the experts were one in their evaluation of the presentation of the instructional module of being logical/sequential and ensuring continuity of learning by providing bridge passage at necessary points. However, item 2 "The lessons are presented in a unique/original style/form" with a mean rating of 3.50 described as "good", and standard deviation of 0.58, suggested that the module be improved more to achieve uniqueness and originality in style/form.

Usefulness/Usability of the Module. As to this aspect, it registered an over-all mean rating of 4.85, described as "excellent", with a standard deviation of 0.13. The results implied that the experts homogeneously identified four items with high mean ratings of 5 and with a standard deviation of 0.00.

These items included: item 2 "The instructional module helps the students master the topics at their own pace"; item 6 "The instructional module serves as supplementary material for teachers and students"; item 7 "The instructional module encourage students to develop their study habits"; and item 9 "The instructional module leads the students to develop positive attitude toward mathematics". The experts shared the same ideas that the instructional module is useful because it helps students' in the mastery of their lesson at their own pace; in the development of their study habits, in the development of positive attitude towards Mathematics and it served as a supplemental material to teachers and students.

The experts' evaluation on the characteristics of the developed instructional module is summarized in Table 3. The characteristics of usefulness, objectives, format and language, content and presentation were arranged sequentially based on their mean rating and standard deviation.

As reflected in the table, the characteristics of usefulness

Table 4: Summary on the Experts' Assessment on the Characteristics of the Instructional Module on Mathematics in the Modern World

Aspect	Mean($\bar{x}$)	Description	sd
Usefulness/Usability	4.85	Excellent	0.13
Objectives	4.81	Excellent	0.26
Format and Language	4.55	Excellent	0.25
Content	4.55	Excellent	0.37
Presentation	4.40	Very Good	0.29
Over-all Mean	4.63	Excellent	0.25

usability and objectives were rated highly by the experts. However, the presentation of the module occupied the bottom part of the table. The data suggested that the experts considered firstly, the use of the instructional module of paramount importance in teaching – learning process.

They were one in supporting the very purpose of why the instructional module was developed and validated. Secondly, they appreciated the objective(s) found in every lesson. They are found to be valuable guides in setting the activities and deciding the methodology to be used. Thirdly, the presentation of the module has to be enhanced more. Although, this aspect was rated to be "very good", there were still items rated only "good". With this result, something should be done to improve the presentation of the module.

CONCLUSION

Based on the findings of the study, the following conclusions are considered:

1. Mathematics in the Modern World as a GE subject contains CHED Mandated Topics. However, these four topics: Mathematics in our World, Mathematical Language and Symbols, Problem Solving and Reasoning, and Data Management are considered are non-negotiable, which means that students must learn these topics regardless of the course they took. Aside from the four topics mentioned above, there are also elective topics that are given to the students based on their course.

2. The instructional module was found out to be valid in terms of its objectives, content, format and language, presentation and usefulness based on the experts' assessment. They considered the instructional module to be an excellent material in providing knowledge to the students who are taking Mathematics in the Modern World.

RECOMMENDATION

Based on the findings and conclusions:

1. It is suggested that the proposed developed instructional module be used by the Mathematics teachers from colleges and universities to increase the reliability and usability of the material.

2. Moreover, further validation and enhancement may be made on the content and presentation of the instructional module.

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