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Development and Validation of Learning Package in Precalculus

GALANGCO, Jeffrey[1]; RIBOROSO, Rhosechelle[2]; DOMONDON, Christian [3]

[1] 0009-0003-9062-3702; University of Northern Philippines. Vigan City, Ilocos Sur, Philippines. jeffrey.galangco@unp.edu.ph.
[2] 0000-0002-1711-400X; University of Northern Philippines. Vigan City, Ilocos Sur, Philippines. rhosechelle.riboroso@unp.edu.ph.
[3] 0000-0001-7333-1423; University of Northern Philippines. Vigan City, Ilocos Sur, Philippines. christian.domondon@unp.edu.ph.

A B S T R A C T

The development of instructional materials is seen as a vital educational goal for addressing the needs of all students and ensuring quality education. As educational paradigms evolve, there is a growing emphasis on creating resources that engage, empower, and cater to the individualized learning of students. The study endeavored to develop and evaluate Modules in Precalculus for Grade 11 STEM students. The study employed the research and development (R&D) design and descriptive research method, utilizing the evaluation rating sheet for print resources adopted from the Department of Education. The passed-not-passed method was used to determine the extent of validity of the developed modules. Five experts in the field of mathematics and language evaluated the learning material, and the data were analyzed using frequency count, mean, and summation. The newly developed learning material in Precalculus wraps up eleven (11) modules. The presentation of the topics embraces the 5E instructional model in achieving the targeted learning outcomes grounded on the Most Essential Learning Competencies (MELCs). As a result, the Modules in Precalculus for Grade 11 STEM students exhibited remarkable substance and met the standards and requirements of the evaluation process. The developed modules augment the existing learning resources used for teaching the subject in Senior High School.

RESUME

El desarrollo de materiales didácticos se considera un objetivo educativo fundamental para atender las necesidades de todos los estudiantes y garantizar una educación de calidad. A medida que los paradigmas educativos evolucionan, se pone un énfasis creciente en crear recursos que involucren, empoderen y se adapten al aprendizaje individualizado de los estudiantes. El estudio se propuso desarrollar y evaluar módulos en Precálculo para estudiantes de Grado 11 del STEM. El estudio empleó el diseño de investigación y desarrollo (I+D) y el método de investigación descriptivo, utilizando la hoja de evaluación de recursos impresos adoptada del Departamento de Educación. Se utilizó el método de aprobado-no aprobado para determinar el grado de validez de los módulos desarrollados. Cinco expertos en el campo de matemáticas y lenguaje evaluaron el material de aprendizaje, y los datos se analizaron mediante el conteo de frecuencia, media y suma. El material de aprendizaje recientemente desarrollado en Precálculo comprende once (11) módulos. La presentación de los temas sigue el modelo instruccional 5E para alcanzar los resultados de aprendizaje específicos, basados en las Competencias de Aprendizaje Esenciales (MELCs). Como resultado, los Módulos en Precálculo para estudiantes de Grado 11 STEM demostraron una notable solidez y cumplieron con los estándares y requisitos del proceso de evaluación. Los módulos desarrollados complementan los recursos de aprendizaje existentes utilizados para la enseñanza de la materia en la Educación Secundaria Superior.

RESUMO

O desenvolvimento de materiais instrucionais é visto como uma meta educacional vital para atender às necessidades de todos os alunos e garantir uma educação de qualidade. À medida que os paradigmas educacionais evoluem, há uma ênfase crescente na criação de recursos que envolvam, capacitem e atendam ao aprendizado individualizado dos alunos. O estudo se esforçou para desenvolver e avaliar módulos em précálculo para alunos STEM do 11º ano. O estudo empregou o design de pesquisa e desenvolvimento (P&D) e o método de pesquisa descritiva, utilizando a folha de classificação de avaliação para recursos impressos adotada pelo Departamento de Educação. O método aprovado-não aprovado foi usado para determinar a extensão da validade dos módulos desenvolvidos. Cinco especialistas na área de matemática e linguagem avaliaram o material de aprendizagem, e os dados foram analisados usando contagem de frequência, média e soma. O material de aprendizagem recém-desenvolvido em pré-cálculo envolve onze (11) módulos. A apresentação dos tópicos abrange o modelo instrucional 5E para atingir os resultados de aprendizagem almejados com base nas Competências de Aprendizagem Mais Essenciais (MELCs). Como resultado, os Módulos em Pré-cálculo para alunos STEM do 11º ano exibiram substância notável e atenderam aos padrões e requisitos do processo de avaliação. Os módulos desenvolvidos aumentam os recursos de aprendizagem existentes usados para ensinar a disciplina no Ensino Médio.

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Introduction

Great changes have come about in the Philippine educational system as the implementation of the K-12 Program shapes it. The educational restructure is the addition of two years in Basic Education, referred to as Senior High School. The SHS program is the last level in all basic education programs and is intended to prepare graduates for tertiary education, middle-level skills development, entrepreneurship, and employment (Rin & Domondon, 2021).

The relevance of Science, Technology, Engineering, and Mathematics (STEM) has been recognized as support for a nation's innovation capacity and as a determinant to economic growth. Indeed, STEM Education prepares students to bring knowledge and skills (Paguirigan & Paguirigan, 2023), preparing them to be critical thinkers, problem solvers, and innovators of tomorrow (Montgomery & Fernández-Cárdenas, 2018). However, despite implementing the K-12 program, certain trends and travails exist. Correspondingly, significant problems still exist within the STEM Mathematics Curriculum, particularly in the learner's knowledge, mastery, proficiency level, and insufficient instructional materials, mathematical tools, and physical equipment.

Mathematics teachers have also observed that most students have a negative view of mathematics (Rabanal & Domondon, 2023). Often, one can see students uninterested in the subject, and in turn, they keep on complaining that mathematics is such a very difficult subject. Such attitude is often reflected during mathematics tests wherein most students had passing or below passing scores (Moranda, 2015). Research also indicates that negative attitudes towards mathematics in senior high school students significantly impact their proficiency in the subject (Cerbito, 2020).

Research has shown that students tend to perform poorly in Precalculus (Jaudinez, 2019; Estonanto, 2017; Sonnert & Sadler, 2014; Nepaya, 2019; Spotts & Gutierrez de Blume, 2020; Collins, 2019; Bhagi, 2020; Mosina, 2015). This has been linked to low self-confidence (Galangco, 2023) and anxiety (Estonanto, 2017; Riboroso, Llagas & Taan, 2018; Taban & Cajindos, 2018; Cadorna, Garnace et al., 2023), negative attitudes (Llagas, 2021), fear of problem-solving, poor comprehension, lack of understanding of the problems, procedural mistakes, and the difficulty of the material (Taban and Cadorna, 2019; Domondon, Pardo & Rin, 2022). Additionally, the subject's complexity (Cadorna, Taban & Gavino, 2016), lack of mastery of basic skills, stigma, and the use of confusing or error-filled textbooks (Jaudinez, 2019) have also been cited as contributing factors.

To improve the students' performance in Precalculus, students were engaged in Moore method (Cooper, Bailey & Briggs, 2015), Project SKEW- Students' Know-how in accessing Educational Websites (Nepaya, 2019), research-based curriculum (Golnabi & Murray, 2019), retaking prerequisite courses (Feldman, Bullock & Callahan, 2012), using technology- oriented

and applied project-based curriculum (Mosina, 2015) such as the use of computer software program (Babaali & Gonzalez, 2015), and flipped classrooms (Spotts & Gutierrez de Blume, 2020; Collins, 2019).

Similarly, the low performance of students in content and procedural knowledge, computational skills, visualization, problem-solving, and other skills and processes in mathematics, has been attributed to students' lack of mastery of the fundamental skills, too many lessons and competencies, and lack of mathematical tools (Luzano, 2024). This could even be aggravated when teachers continue using books and other user-unfriendly and erroneous resources (Jaudinez, 2019).

Teachers on the other hand face significant difficulties in teaching precalculus subjects when teaching is shifted to an online modality (Cirillo et al., 2020). To address these challenges, they have implemented several strategies: flipping their math classrooms (Fulton, 2012; Collins, 2019; Spotts & Gutierrez de Blume, 2020), altering instructional practices (Williams et al., 2022; Cooper, Bailey & Briggs, 2015; Domondon et al., 2024; Rini et al., 2024; Varvaruk et al., 2024), redesigning courses (Jones & Lanaghan, 2021; Ong Jr., 2024), and utilizing technology (Babaali & Gonzalez, 2015; Canaria et al., 2024).

Jaudinez (2019) highlighted that the strict formalism in calculus can create challenges in both teaching and learning the subject. Calculus heavily depends on formal definitions and proofs, which is why it's important to make these concepts more relatable and in-depth when teaching (Bressoud et al., 2016; El Gaidi & Ekholm, 2015). This approach can help spark students' interest in the subject. As a result, Precalculus lessons become more meaningful, realistic, and engaging for students. Moreover, promoting group work and peer mentoring in calculus classes can enhance collaboration among students.

Tan-Espinar and Ballado (2017) emphasized that effective mathematics teaching involves knowing what students already understand and what they need to learn, while motivating and guiding them to learn well. To achieve this, teachers must not only grasp their students' learning needs in math but also recognize their individuality. They should also be adept at selecting and using different teaching methods and materials to enhance learning.

With the emerging problems in implementing the curriculum, mathematics teachers must do immediate solutions to lessen the unfavorable consequences of the problems and issues. Possible solutions to many education challenges must be anchored with engaging learning materials and yield results. At this stage, it's crucial for mathematics instruction to ensure that teachers have the right resources to help develop students' cognitive learning skills.

Jaudinez (2019) noted that performance-based assessment activities should aim to improve students' math skills, helping them understand the significance of mathematics in shaping our civilization. Additionally, with the technological advancements of the 21st century, various online resources can also be utilized effectively.

Correspondingly, one way to maintain the student's interest is to provide them with learning activities facilitated by utilizing instructional material like modules enhanced by performance-based assessment activities. Maile and Cooper (2018) describe a learning module as a structured set of instructions aimed at helping learners master specific knowledge or skills. A self-directed learning module can be either digital or print-based. For example, digital lessons available through a school's learning management system (LMS) are considered self-directed learning modules. Before the rise of digital learning, a similar tool called a Learning Activity Packet (LAP) was a paper-based version of this self-paced learning method.

To address the problems, particularly the need for instructional materials (Cadorna, Riboroso et al., 2023) catering a large number of students, offering individualized learning experience (Camara, 2016), and improving the teaching-learning process (Limon & Vallente, 2016) such as modules (Limon & Vallente, 2016; Tolentino et al., 2020; Auditor & Naval, 2014) to improve the student's performance and help them with their difficulties in Precalculus, the researchers provoke to develop modules in Precalculus that would aid mathematics teachers and students for an effective and better mathematics education. The learning module that will be developed could be used by the STEM students in the Senior High School as a learning modality whether the content exists in a print or digital form.

The researchers believe that the modules they developed will be valuable in supporting individualized learning and complementing traditional teaching, offering students additional, in-depth training. According to Shahbazi and Irani (2016), modules can serve as self-directed learning tools tailored to the needs of students. For teachers, this also provides a practical way to move toward more flexible learning approaches. Moreover, it would help reinforce students' independent learning, allow flexible learning, accommodate students' abilities, and promote motivation and a positive attitude. Students would be more engaged in learning Precalculus as they find their interest and make the learning relevant, authentic, and valuable to their lives.

Objectives of the Study

The study developed and validated a learning package in Precalculus for STEM students grounded on the Most Essential Learning Competencies as prescribed by the Department of Education.

Specifically, it sought to: (1) determine the availability and adequacy of learning materials in Precalculus; (2) describe the Learning Package in Precalculus; and (3) determine the extent of validity of the developed learning package in terms of content, format, presentation, and organization, and accuracy and up-to-datedness of information.

Methodology

The researchers used the research and development (R&D) design (Gustiani, 2019) and descriptive research design (Creswell & Creswell, 2018). It is developmental as it leads toward

crafting a learning package in the form of modules in Precalculus for STEM students. Moreover, it is descriptive since it describes the availability and adequacy of learning materials in Precalculus, and the validity of the developed learning package in terms of its content, format, presentation and organization, accuracy, and up-to-date information.

There were 15 senior high school mathematics teachers from 10 selected public schools in Ilocos Sur who answered the survey questionnaire on the availability and adequacy of learning materials in Precalculus. Furthermore, five of the 15 teacher respondents were randomly selected for interviews to verify the survey results. On the other hand, the developed learning package was evaluated in terms of its content, format, presentation and organization, accuracy, and up-to-date information by two language experts who are graduates of Master of Arts in Teaching English and three mathematics experts who hold Doctorate in Mathematics Education and are instructional material developers in Math.

The instrument used in gathering the data was the Evaluation Rating Sheet for Print Resources, adopted from the Department of Education- Development Learning Resource. The Passed - Not Passed method was used to determine the extent of validity of the developed learning package in Precalculus. Using this method, any material that fails in at least one of the four factors of the evaluation rating should not be recommended for use. Each item was evaluated using a 4-point Likert scale.

The flow of the study revolves around four processes, namely: (1) Planning Phase, (2) Development Phase, (3) Validation, and (4) Revision and Finalization.

Planning Phase. The researchers examined the learning materials available in Precalculus at the different big public schools in Ilocos Sur and the Most Essential Learning Competencies the Department of Education set. It also included in this phase the review of the different learning theories and the 5E Model that guided the researchers in developing the Modules.

Development Phase. After determining the topics to be modularized, the researchers crafted the modules embracing the 5E instructional model (Bybee, 2009), which was used by Paguirigan and Paguirigan (2024). In the designing process, the researchers defined the parts of the module. Each module comprises the learning competencies, opening activity/concept preview, presentation of the concepts, illustrated examples, activities, performance-based assessment activities, self-reflections, a summary of significant lessons, and objective-type assessment tests.

Validation Phase. This phase covers the evaluation of the developed learning package by experts in Mathematics, language, and module making who are at least masteral holders. The developed learning package in Precalculus was evaluated in terms of its content, format, presentation and organization, accuracy, and up-to-date information using the Evaluation Rating Sheet for Print Resources, adopted from the Department of Education- Development Learning Resource.

Revision and Finalization Phase. This phase focuses on the finalization of the material by incorporating and complying to the suggestions and recommendations of the evaluators on the developed learning package in Precalculus.

Research ethics were properly observed in the conduct of the study. Permission to gather data was asked from proper authorities and the researchers provided informed consent for the respondents, assuring their names' anonymity. There were no conflicts of interest in the study. The researchers considered privacy and confidentiality.

The data gathered in the study were treated using frequency and percentage, mean, and sum.

Results and Discussions

The study aimed to develop and validate a learning package in Precalculus. After developing and validating the material, the gathered data were analyzed, presented, and interpreted.

Availability and Adequacy of Learning Materials in Precalculus

Table 1 presents the availability and adequacy of learning materials in Precalculus used by mathematics teachers.

Table 1.
Availability and Adequacy of Learning Materials in Precalculus

Learning Materials in Precalculus	Available		Not Available		Adequate		Not Adequate	
	f	%	f	%	f	%	f	%
Textbooks	10	66.67	5	33.33	6	40.00	9	60.00
Modules	9	60.00	6	40.00	5	33.33	10	66.67
Handouts	7	46.67	8	53.33	7	46.67	8	53.33
Worktext	3	20.00	12	80.00	4	26.67	11	73.33
Study Guides	8	53.33	7	46.67	5	33.33	10	66.67
Manuals	7	46.67	8	53.33	3	20.00	12	80.00
Math Charts	2	13.33	13	86.67	2	13.33	13	86.67
Math Models	3	20.00	12	80.00	2	13.33	13	86.67
Math Kits	2	13.33	13	86.67	2	13.33	13	86.67
ICT-related Tools	10	66.67	5	33.33	7	46.67	8	53.33

The table shows the availability and adequacy of learning materials in Precalculus. Availability of information resources plays a major role in teaching and learning. For effective teaching to take place information resources must be provided and teachers must have access to various types of resources, particularly in their areas of specialization. It can be noticed that more than 50 percent of the teacher-respondents indicated that textbooks, modules, ICT-related tools, and study guides in Precalculus are available. This shows that these learning materials are close at hand and ready to use. However, 80 percent of the teacher-respondents revealed that there are no worktext and math models available in Precalculus while more than 80 percent specified that there are no available math charts and math kits.

According to the Cambridge Dictionary, adequacy means the fact of being enough or satisfactory for a particular purpose. Adequacy of learning materials in Precalculus connotes the quality of being sufficient or able to meet the needs of the teachers teaching the

subject. Even though other materials are available, their adequacy must be considered. Though more teacher-respondents indicated that there are available textbooks, modules, study guides, and ICT-related tools than those who do not have them, there are also more teacher-respondents who indicated that they are not adequate. The result shows that there is a limited number of learning materials available for every teacher and student's use as mentioned by four out of the five teacher-respondents during the interview. Furthermore, it was mentioned during the interview with the teacher-respondents that it would have been better if the available textbooks, modules, and ICT-related tools were aligned with the MELCs in Precalculus since available learning materials are not MELC-based. Four out of the five teacher-respondents who were interviewed also commented that the activities in the available textbooks and modules do not fit with the capability of the senior high school students and it was more of pure, direct problem solving, that is, unappealing and boring.

Oladejo et al. (2011) emphasized the importance of making instructional materials and being resourceful in their selection, planning, and utilization. Also, the utilization of made instructional materials promotes and enhances effective teaching-learning. Thus, teachers should be encouraged to use them in teaching. Providing adequate and relevant material resources enhances teaching and learning processes (Owoeye & Olatunde Yara, 2011; Effiong and Igiri, 2015; Okori and Jerry, 2017; Yusta, Karugu, Muthee and Tekle, 2016).

Description of the Learning Package in Precalculus

The Learning Package in Precalculus for Grade 11 Science, Technology, Engineering, and Mathematics (STEM) students was developed in response to the dearth of instructional materials in Senior High School. It is also a response to the lacking, user-unfriendly, and erroneous books and the subject's too many lessons and competencies.

The newly developed learning material is entitled "Precalculus for STEM Students: A Modular Approach." There are eleven (11) developed modules covering the three components of Precalculus, namely (1) Analytic Geometry, (2) Series and Mathematical Induction, and (3) Trigonometry, which are grounded on the Most Essential Learning Competencies. To achieve the desired learning outcomes, each learning module devours the following features, which embrace the 5E model by Bybee (2009).

Table 2.
The Features of the Modules in Precalculus Utilizing the 5E Instructional Model

5E Model	Features of the Module
Engage	Concept Gear Up
Explore	Explore It Up
Explain	Lesson Proper
Elaborate	Work It Up
	Learning Highlights
Evaluate	Self-Reflection
	Self-Check

On Concept Gear Up. This acts as a review of the key concepts that students need to grasp in order to better understand the new lesson. This can also be a sneak preview of the lesson that is to be presented.

Figure 1. *Concept Gear Up of Module 1*

Figure 1 shows a sample of the feature of the module. It presents a sneak preview of the topics discussed in Module 1; showing pictures of real-life applications of conic sections.

On Explore It Up. This is an opening activity that would allow the learners to explore the lessons they are to undertake.

Figures 2.a and 2.b show samples of the exploratory tasks for Modules 1 and 2, respectively. The learners view a video on conic sections in Module 1 and can investigate how each conic is generated. While in Module 2, the learners would investigate a parabola's features by moving the point about.

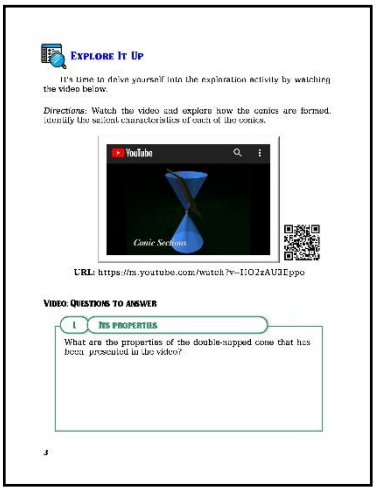


Figure 2.a. *Explore It Up of Module 1*

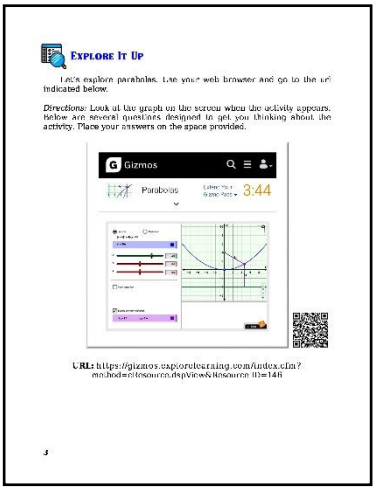


Figure 2.b. *Explore It Up of Module 2*

In this part of the module, the learners may complete lab math activities that help them utilize prior knowledge to generate new ideas, discover questions, and design and conduct preliminary investigations related to the concepts presented.

On Lesson Proper. At the end of each module, students have the opportunity to practice and apply the knowledge and skills they've learned. They are provided with exercises, activities, or challenging problems that align with the learning objectives.

The sample presentation of the lesson's instructions is shown in Figure 3.

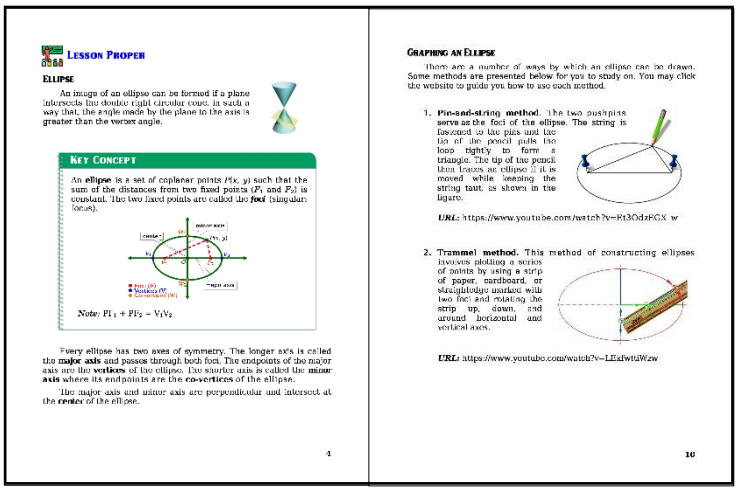


Figure 3.a. *Lesson Proper of Module 3*

Figure 3.a presents a sample portion of the lesson's instruction in Module 3. It introduces the key concepts accompanied by figures and illustrations of the covered topics. This provides visuals for the learners to better comprehend the mathematical concepts presented.

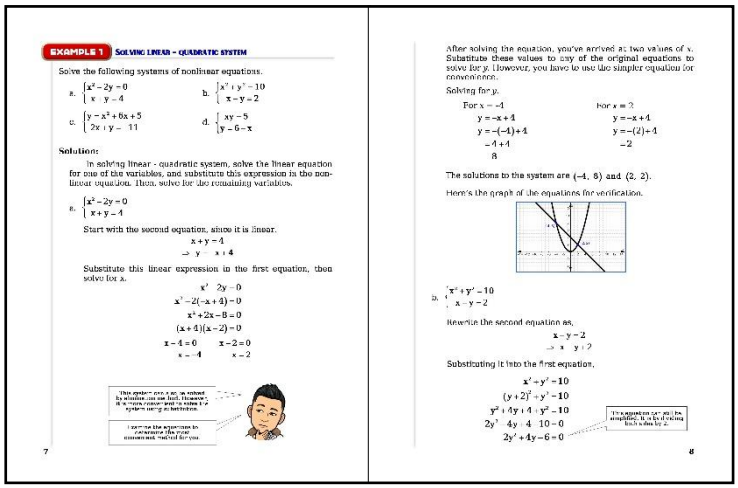
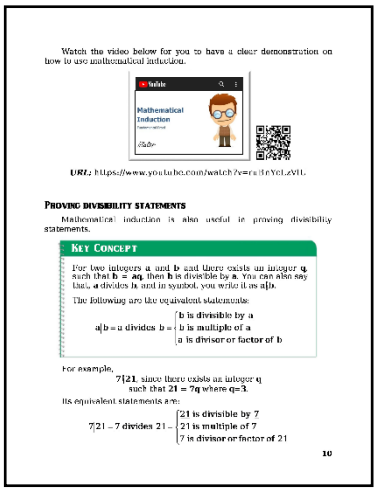


Figure 3.b. *Lesson Poper of Module 6*

Figure 3.b presents illustrated examples of the key concepts in Module 6. This would help the learners to investigate how mathematical problems are solved. The portion also provides key reminders and notes as guides in the process of solving.


Watch the video below for you to have a clear demonstration on how to use mathematical induction.

Mathematical Induction

URL: https://www.youtube.com/watch?v=rsIfrYcLzVU

PROVING DIVISIBILITY STATEMENTS

Mathematical induction is also useful in proving divisibility statements.

KEY CONCEPT

For two integers a and b and there exists an integer q such that b = aq, then b is divisible by a. You can also say that, a divides b, and in symbol, you write it as a|b.

The following are the equivalent statements:

a|b = a divides b = { b is divisible by a; b is multiple of a; a is divisor or factor of b }

For example,

7|21, since there exists an integer q such that 21 = 7q where q=3.

Its equivalent statements are:

7|21 – 7 divides 21 – { 21 is divisible by 7; 21 is multiple of 7; 7 is divisor or factor of 21 }

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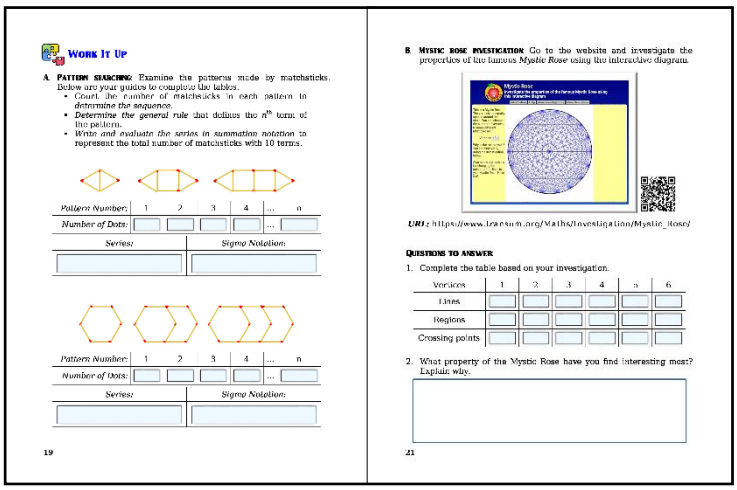
Figure 3.c. *Lesson Proper of Module 8*

In Figure 3.c, a section of the module with a video embedded in it is shown. This section would provide supplemental learning resources for the learners to have a clear demonstration and comprehensive explanation of the key concepts presented.

On Work It Up. At the end of every module, the learners are given the chance to practice and apply their knowledge and skills gained from the lesson. They are given exercises, activities, or challenging problems as reflected in the learning competencies.

Figure 4 depicts some activities that the learners are to work on. It includes exercises, mathematical games, and engaging in challenging problems.


WORK IT UP

A. **PATTERN SEARCHING**: Examine the patterns made by matchsticks. Below are your guides to complete the tables.

- Count the number of matchsticks in each pattern to *determine the sequence.*
- *Determine the general rule* that defines the n^{th} term of the pattern.
- *Write and evaluate the series in summation notation* to represent the total number of matchsticks with 10 terms.

Pattern Number:	1	2	3	4	...	n
Number of Dots:					...	

Series:	Sigma Notation:

Pattern Number:	1	2	3	4	...	n
Number of Dots:					...	

Series:	Sigma Notation:

19

B. **MYSTIC ROSE INVESTIGATION** Go to the website and investigate the properties of the famous *Mystic Rose* using the interactive diagram.

URL: https://www.texasgo.org/Maths/Investigation/Mystic_Rose/

QUESTIONS TO ANSWER

1. Complete the table based on your investigation.

Vertices	1	2	3	4	5	6
Lines						
Regions						
Crossing points						

2. What property of the Mystic Rose have you find interesting most? Explain why.

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Figure 4.a. *Work It Up Section of Module 7*

Figure 4.a presents the Work It Up section of Module 7. It is on *"Pattern Searching"* and *"Mystic Rose Investigation."* In this section of the module, the learners are provided with interesting activities that would engage them to do mathematics by themselves.

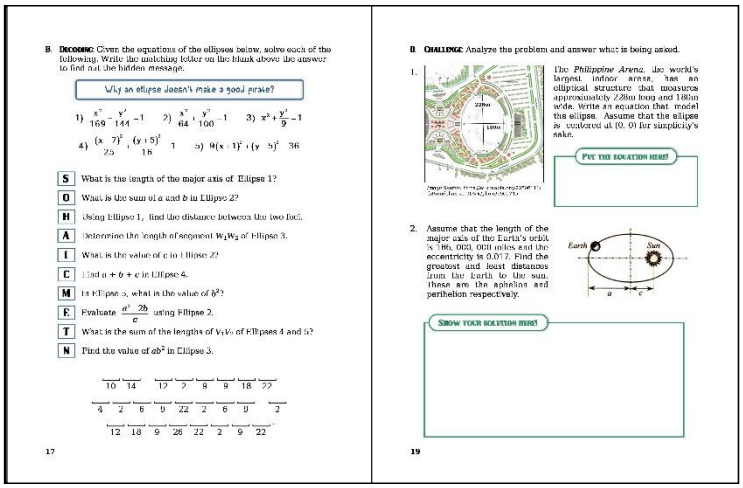

Figure 4.b. *Work It Up Section of Module 3*

Figure 4.b presents the Work It Up portion of Module 3. In this section of the module, the learners are also given mathematical games (e.g., decoding, word searching, exploratory activity, tarsia puzzle) and challenging problems. This would offer the learners the opportunity to have fun while exploring and learning mathematical concepts being covered in the module.

On Learning Highlights. This is the final part of the module, offering a summary that emphasizes the most important concepts covered in the lesson.

A sample of the section is presented in Figure 5.

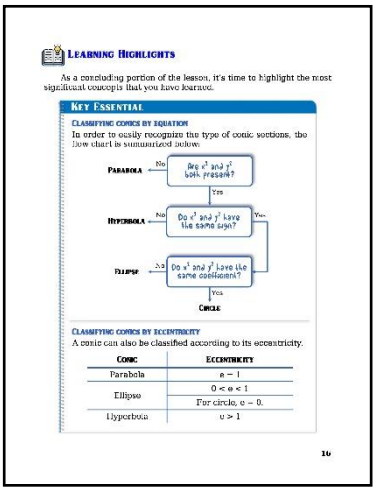

Figure 5. *Learning Highlights of Module 5*

The figure shows a sample section of the Learning Highlights that would provide the learners with a recap or synopsis of what has been covered in the module. This is for them to focus on the significant concepts presented and would improve their knowledge retention.

On Self-Reflection. In this section of the module, students are asked a reflective question to help them express what they've learned and to think critically about the knowledge they've gained from completing the module.

Figure 6 presents the sample of the Self-Reflection section of the module.

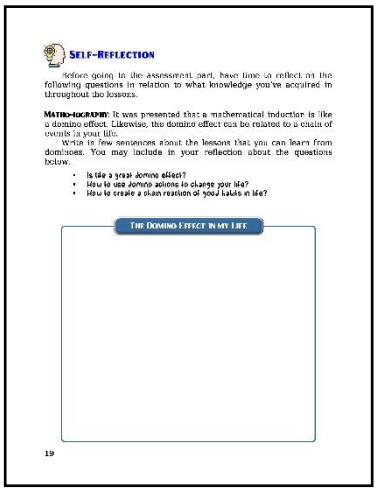

Figure 6.a. *Self-Reflection of Module 8*

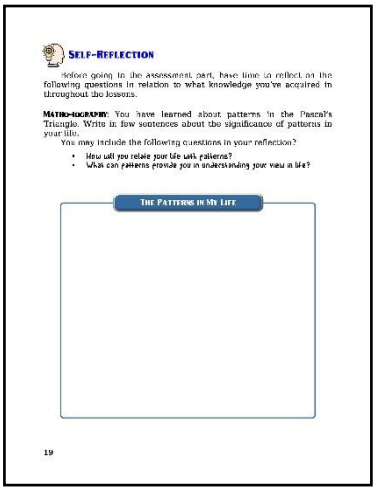

Figure 6.b. *Self-Reflection of Module 9*

The figures above show samples of the self-reflection of the module. Figure 6.a is on Module 8, which is a reflection on the *"Domino Effect,"* while Figure 6.b is on Module 9, which is a reflection related to the *"Patterns in Life."*

In this section, the learners are provided with reflective questions for them to articulate their thoughts, feelings, emotions, and actions, which are linked to the concepts being covered in the module.

On Self-Check. This section assesses the students' progress throughout the lessons in the module. They are given a 10-15-item quiz that tests the knowledge and skills they have acquired.

Figure 7 presents samples of a Self-Check section of the module.

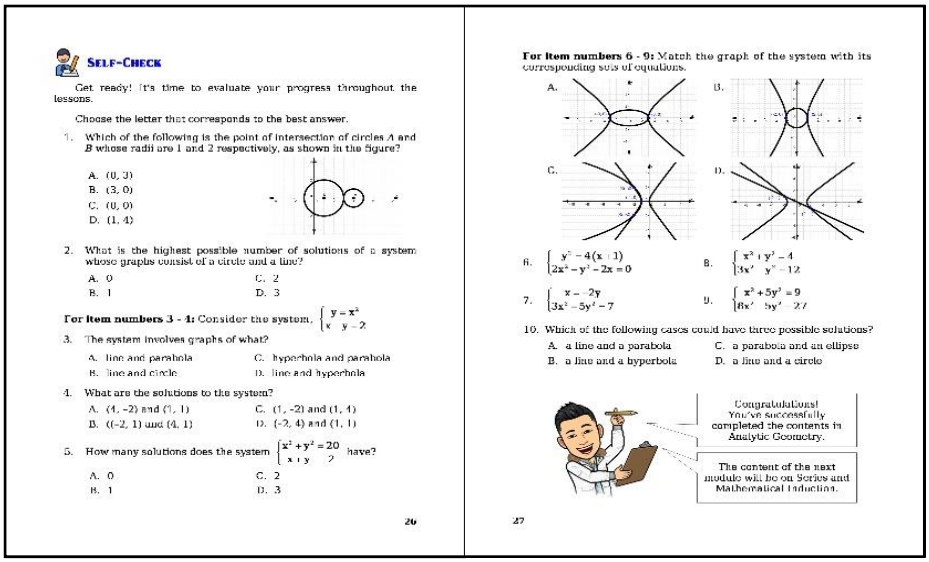

Figure 7.a. *Self-Check of Module 6*

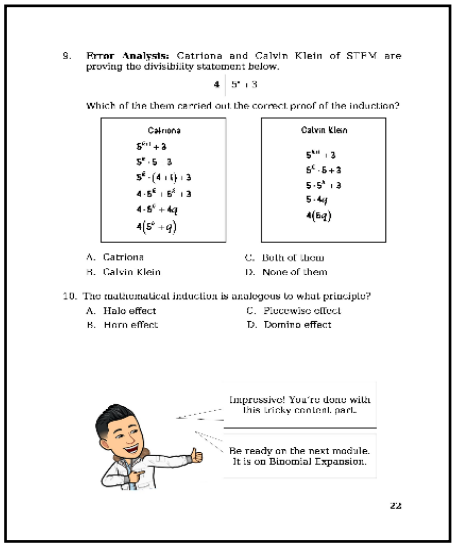

Figure 7.b. *Self-Check of Module 8*

Examples of multiple-choice tests from Modules 6 and 8 are depicted in the figures above. This is designed to check the learners' progress each time a module is completed. This would not only keep track of their learning progress but also point out where their knowledge and skill sets are strong and weak, enhancing their overall learning experience. Additionally, this would encourage students to actively participate in and take responsibility for their own learning throughout the modular learning journey.

The Extent of Validity of the Developed Modules in Precalculus

Expert validators were asked to validate the developed Modules in Precalculus for Grade 11 STEM students using the evaluation rating sheet for print resources of the Department of Education. The criteria for evaluation comprise four (4) factors which include content, format, presentation and organization, and accuracy and up-to-datedness of information on the learning material.

Mean Rating of the Developed Modules of Precalculus along Content

Table 3 presents the evaluation rating of the expert validators on the developed modules along with the content.

For the learning module to pass the content factor, the total mean score should be at least 21 points out of 28 points. As can be seen in Table 3, the developed modules scored 27.00, which shows that the developed learning material passed along content. This result indicates that the developed material is appropriate to utilize as a supplemental learning resource to the student's level of development because of its contribution to the achievement of Precalculus learning objectives or skills in terms of its content's scope, range, and depth.

Moreover, it suggests that the content might support the development of higher-order cognitive skills such as critical thinking, creativity, inquiry, and problem-solving. The rating

demonstrates that there are no ideological, cultural, religious, racial, or gender biases or prejudices in the learning modules. Additionally, it promotes the development of desirable values and traits.

Table 3.
Rating of the Developed Modules of Precalculus along Content

Indicators	Mean	DR
1. Content is suitable to the student's level of development.	4.00	Very Satisfactory
2. Material contributes to the achievement of specific objectives of the subject area and grade/year level for which it is intended.	3.80	Very Satisfactory
3. Material provides for the development of higher cognitive skills such as critical thinking, creativity, learning by doing, inquiry, problem solving, etc.	3.80	Very Satisfactory
4. Material is free of ideological, cultural, religious, racial, and gender biases and prejudices.	3.80	Very Satisfactory
5. Material enhances the development of desirable values and traits.	3.80	Very Satisfactory
6. Material has the potential to arouse interest of target reader.	3.80	Very Satisfactory
7. Adequate warning/cautionary notes are provided in topics and activities where safety and health are of concern.	4.00	Very Satisfactory
Overall Rating	**27.00**	**Passed**

Passing score: at least 21 out of a maximum of 28 points

This finding is in consonance with Selga's (2013) development of worktext in science, technology, and society, which contributes to the achievement of specific objectives of the subject, provides for the development of higher cognitive skills, is well-organized and well-designed, and it is suitable to the vocabulary level and ability of the students.

Mean Rating of the Developed Modules of Precalculus along Format

Table 4 presents the evaluation rating of the expert validators on the developed modules in format.

The term "Format" refers to five distinct indicators, namely: prints, illustrations, design and layout, paper and binding, and size and weight of resource. As reflected in Table 3, the rating of the developed material earned a score of 68.80 points. This indicates that the developed learning material in Precalculus earned the required average points and passed this criterion. The five (5) expert evaluators recognized that the letters, spaces, fonts, and printing used in the developed learning package are appropriate for high school students. Moreover, the illustrations are simple and easy to recognize, the text is explicit and supplemental, properly labeled or captioned, used appropriate colors, attractive and appealing, and culturally relevant.

In terms of the design and layout, results show that the developed material is attractive and pleasing. Likewise, the elements are satisfying, simple, and harmoniously blended. The

paper and binding, and size and weight of the material also contributed to easy reading and handling. The findings show that the physical properties of the material were well taken into account when developing the Precalculus learning package.

Table 4.
Rating of the Developed Modules of Precalculus along Format

Indicators	Mean	DR
1. *Prints*		
1.1 Size of letters is appropriate to the intended user.	4.00	Very Satisfactory
1.2 Spaces between letters and words facilitate reading.	4.00	Very Satisfactory
1.3 Font is easy to read.	4.00	Very Satisfactory
1.4 Printing is of good quality (i.e., no broken letters, even density, correct alignment, properly placed screen	3.80	Very Satisfactory
2. *Illustrations*		
2.1 Simple and easily recognizable.	3.80	Very Satisfactory
2.2 Clarify and supplement the text.	3.80	Very Satisfactory
2.3 Properly labelled or captioned (if applicable).	3.80	Very Satisfactory
2.4 Realistic / appropriate colors.	3.80	Very Satisfactory
2.5 Attractive and appealing	3.60	Very Satisfactory
2.6 Culturally relevant	3.80	Very Satisfactory
3. *Design and Layout*		
3.1 Attractive and pleasing to look at	3.60	Very Satisfactory
3.2 Simple (i.e., does not distract the attention of the reader)	3.60	Very Satisfactory
3.3 Adequate illustration in relation to text	3.80	Very Satisfactory
3.4 Harmonious blending of elements (e.g., illustrations and text)	3.80	Very Satisfactory
4. *Paper and Binding*		
4.1 Paper used contributes to easy reading	3.80	Very Satisfactory
4.2 Durable binding to withstand frequent use	3.80	Very Satisfactory
5. *Size and Weight of Resource*		
5.1 Easy to handle	4.00	Very Satisfactory
5.2 Relatively light	4.00	Very Satisfactory
Overall Rating	**68.80**	**Passed**

Passing score: at least 21 out of a maximum of 28 points

The findings of this study conforms to the claim of Abdelmohsen (2020) that the design and development facets, when used opportunely, should lead to developing an effectual module that is instructionally well-grounded and sound. Likewise, through appropriate learning support media, students can connect their knowledge with their critical thinking skills to enable them to solve problems critically (Septarini & Kholiq, 2021) through the material presented by the teacher in an attractive, simple, and straightforward manner.

Mean Rating of the Developed Modules of Precalculus along Presentation and Organization

Table 5 presents the evaluation rating of the expert validators on the developed modules along with presentation and organization.

To pass the standard along presentation and organization, the developed learning package must earn at least 15 points out of a maximum of 20 points. As shown in the table, the learning package obtained an overall rating of 19.40 on presentation and organization. This result connotes that the learning package in Precalculus successfully passed the criterion of the

third factor. It denotes that the learning package exhibits highly excellent organization of topics, a smooth transition of concepts, and appropriate sentence and paragraph length. Moreover, it suggests that the material's presentation promotes engagement, supports the target user's understanding, and stimulates active rather than passive learning. Similarly, its presentations are considerably engaging, interesting, and understandable.

Table 5.

Rating of the Developed Modules of Precalculus along Presentation and Organization

Indicators	Mean	DR
1. Presentation is engaging, interesting, and	3.80	Very Satisfactory
2. There is logical and smooth flow of ideas	3.80	Very Satisfactory
3. Vocabulary level is adapted to target reader's likely experience and level of understanding	4.00	Very Satisfactory
4. Length of sentences is suited to the comprehension level of the target reader	4.00	Very Satisfactory
5. Sentences and paragraph structures are varied and interesting to the target reader	3.80	Very Satisfactory
Overall Rating	**19.40**	**Passed**

Passing score: at least 15 points out of a maximum of 20 points

The outcomes are similar to the findings in Torrefranca's (2017) study where the evaluators firmly agreed that the topics are presented logically and sequentially and are presented in a distinct and original form in the instructional modules. Likewise, these results are similar to Selga's (2013) worktext which received high marks for its presentation and organization.

Mean Rating of the Developed Modules of Precalculus along Accuracy and Up-to-Datedness of Information

Table 6 shows the evaluation rating of the expert validators on the developed modules, along with accuracy and up-to-datedness of information.

Table 6.

Rating of the Developed Modules along Accuracy and Up-to-Datedness of Information

Indicators	Mean	DR
1. Conceptual errors	4.00	Not Present
2. Factual errors	4.00	Not Present
3. Grammatical errors	4.00	Not Present
4. Computational errors	4.00	Not Present
5. Obsolete information	4.00	Not Present
6. Typographical and other minor errors (e.g., inappropriate or unclear illustrations, missing labels, wrong captions, etc.)	4.00	Not Present
Overall Rating	**24.00**	**Passed**

Passing score: at least 24 points out of a maximum of 24 points

The fourth factor considered in validating the developed learning package in Precalculus is the accuracy and up-to-datedness of information. This factor involves the

presence or absence of conceptual errors, factual errors, grammatical errors, computational errors, obsolete data, typographical and other errors that can be seen in the material.

The learning package must earn a perfect score of 24 points to pass this criterion. As reflected in the table, the learning package in Precalculus obtained 24 points along this factor. This shows that the developed learning package in Precalculus are free of conceptual, factual, grammatical, and typographical errors and that no information that could cause misunderstanding and misconception among students has been discovered to be out of date. It reveals then that the contents presented are accurate, correct, and up-to-date, which indicates that the developed modules could be used effectively as a supplemental learning resource in learning Precalculus for Grade 11 STEM students.

Summary of Ratings of the Developed Modules in Precalculus

Table 7 summarizes the expert-evaluation rating of the developed modules in Precalculus along with content, format, presentation and organization, and accuracy, and up-to-datedness of information.

Table 7.
Summary of Ratings of the Developed Learning Package in Precalculus

Factors	Rating	Remarks
Factor 1: Content	27.00	Passed
Factor 2: Format	68.80	Passed
Factor 3: Presentation and Organization	19.40	Passed
Factor 4: Accuracy and Up-to-Datedness of Information	24.00	Passed

Passing Scores:
Factor 1: at least 21 points out of a maximum of 28 points
Factor 2: at least 54 points out of a maximum of 72 points
Factor 3: at least 15 points out of a maximum of 20 points
Factor 4: at least 24 points out of a maximum of 24 points

The table reveals that the developed learning package in Precalculus passed the four evaluation criteria. Indeed, these four parameters of a print resource must be taken into account for the learning package to be a useful and complementary learning tool for learning Precalculus, which would enhance students' understanding of the subject.

However, the suggestions of the evaluators were to include QR codes for every online learning activity included in the modules and make the learning package more appealing and attractive. The researchers created QR codes and placed it on the lower right side of the activity for easier access, and used colored figures and illustrations, created a page separator for each module, and improved the cover page for the learning package in Precalculus.

Conclusions

The teacher-respondents have a wide range of learning materials, including textbooks, modules, study guides, and ICT-related tools. However, these learning materials are not adequate. The newly developed learning package covers eleven (11) modules. The topics in each module are presented using the 5E instructional model to achieve the desired learning goals,

which are grounded on the Most Essential Learning Competencies. Moreover, the developed learning package in Precalculus met the standard criteria in terms of content, format, presentation and organization, and accuracy and up-to-datedness of information Hence, it exhibited a remarkable substance and has passed the requirements of the evaluation process.

To address the scarcity and inadequacy of instructional materials in Precalculus, Mathematics teachers are urged to develop more learning resources to augment educational materials in mathematics courses in Senior High School. In addition, the developed and validated learning material is recommended as a supplemental instructional tool in teaching Precalculus for Grade 11 STEM students. Also, the developed learning package in Precalculus may be subjected to readability and acceptability tests. In addition, an experimental study may be conducted to determine its effectiveness in improving the performance of students.

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