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# EFFECTIVITY OF MODULES IN PRE-CALCULUS AND BASIC CALCULUS

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## Abstract

The development of modules in Pre- Calculus and Post Calculus subjects is the focusing area of this study. It is searching for the consideration of validity level of the developed modules with regard to format, content, demonstration, organization, and accuracy, readability leve, and the latest information.

The descriptive-developmental method of research was utilized in conducting the study. After drafting the module, validation was made by the expert validators and upon integrating the comments and suggestions a second validation was made by the same validators.

After incorporating the comments and suggestions in the second validation by the validators and the level of readability, a final copy of the module was done. The output is a developed modules in Pre-Calculus and Basic Calculus subjects.

The validity for the developed modules count on format, demonstration, content, organization, accuracy and updated information. The comments and suggestions of the evaluators mean that the modules have still rooms for improvement.

**Keywords:** Basic Calculus, module, Pre-Calculus, validity

## INTRODUCTION

### Situation Analysis

Mathematics educators all over the world continuously struggle towards upgrading the quality of mathematics learning, with emphasis being placed on elevating learners' positive attitude towards the subject. School administrators continuously exert great effort in searching for and utilizing better methods, strategies, techniques and instructional materials to propel better students' performance in mathematics in particular and better school performance in mathematics in general. This significant

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move of schools to effect better instruction to students in order to enhance their mathematics performance is dependent on mathematics teachers who are the purveyors of basic knowledge and skills in the subject.

An institution of learning must deliver instruction with utmost efficiency for the satisfaction of its stakeholders especially the students. Albay (2013) cited that the institutional performance of any educational institution in terms of effectiveness and efficiency is greatly determined by its stakeholders, especially the quality of its human capital and the consistent delivery of good governance practices by school administrators. When the roles and functions of students, the faculty members and school administrators from top level to middle level are properly performed and executed with utmost consistency, this will directly lead to the attainment of the institution's maximum performance efficiency.

The school is an institutional learning on which the teacher gives the utmost

potential knowledge to the learners. The main agenda of the school is to give good, if not the best education to its students. If you are looking for a feasible development then education is the key instrument of transformation that enhances people's transformation scope of their vision into reality. Laurie, Tarumi, Mckeown, and Hopkins (2016) pointed out that education for sustainable development helps prepare students for a sustainable future by ensuring that they are environmentally responsible, globally aware, economically astute, socially responsible, and technologically proficient citizens who are capable of coping with the emerging challenges and opportunities we are facing now.

In the classroom, so many factors need to consider for student's performance. Certain studies and researches on students' performance in mathematics proved that students are declining in terms of their performance in the subject. According to Jamil, Mastura and Imam (2013) the performance of Filipino students in the 2003 Trends in International Mathematics and Science Study (TIMSS) in which the Filipino second year high school students ranked 41st in math out of 46 participants, stuck at the bottom while struggling at a passing level locally. Students' performance in the National Achievement Test (NAT) was even more discouraging. According to Kiwanuka (2015) many factors are connected with mathematics achievement: society, families, schools, teachers, peers and individual abilities. In order to attain the national goals related to scientific literacy, it is necessary to determine what factors influence achievement of students in mathematics. In short, there is a need to analyze all related research, make appropriate policies and develop effective educational methods to improve science and mathematics education.

In order to promote greater student achievement and meet increased expectations, Mathematics teacher will need a battery of instructional materials to fulfil students' needs. Students will more likely see the value of the lesson if the instructional materials

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and student-assigned tasks reflect the worth of the content. The choice of instructional materials and its meaningful presentation may explicitly or implicitly give relevance to the students' lives; thus, promoting motivation (Effiong & Igiri, 2015).

According to Andaya (2014), curriculum, instructional strategies, math teacher competency, school context, and facilities are some significant factors in teaching and learning mathematics. The mathematics curriculum contains specific subject matter and instructional design principles to enable students to develop logical and mathematical skills needed to understand fundamental mathematical concepts. Designing an instruction based on a curriculum that is in harmony with instructional design can scaffold students learning and promote their achievement in mathematics. Instructional strategies and methods are important for the achievement of the students. Learning situations ought to be selected and implemented in a way that allows students to apply higher order of operations.

Lim (2016) mentioned that different instructional techniques and strategies have been deployed to enhance the teaching-learning process in a mathematics class. One of the best methods in making the students understand mathematical concepts is the problem solving. Learning mathematics using this method in particular enhances the critical thinking skills of the learners. However, this is so much affected by the ability of the teacher to systematically present the concepts for easier understanding. This method can be done in different ways, such as conducting lecture or using prepared modules.

In educational system Modular instruction is one of the newest revolution. A series of activities are accommodated in this modular approach, the teaching instructions directed to the beginners for each of this to start with, performances, conclusions, and description.

Guido (2014) stated as an enclosed module, free unit of a arranged learning activities series drafted student's help bring off exact precised objectives. At this own rate, beginner is able to take measers and go for necessary reclaimation.

Padmapriya (2015) mentioned the following components of a module, necessary pre-requisite skills, the statement of purpose, educational objectives, examine entry behaviour, transaction of instruments, pretest and posttest, criterion test.

Guido (2014) indicated that modules highlighted application and inquiry of hypothesis and methodologies and gives solid provided convictions. The active students acknowledged engagement and a wait to meet presonal interest areas and broaden more individualized instruction in both school and home to help teachers.

It makes the starters movable with his own rate by selecting own learning mode, and vivid topics, percieve his weaknesses, and strength with necessary recovery. Preferably, objective,pre-test, triumph catagory, educational activities, a post test, reformative education and/or boosting are included in modules.

It is a promise by Modular instruction for more structured multitude education with more effective distinctive instruction offer at a time when a teacher faced the problem of

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fabricating large group learning at the same time. It is the technique of self-instruction that includes the show-case of instructional materials for illustrative apprehension and skills. The of modular education's purpose and priciples have advantages for both instructors and students, and a juxtaposition are present among the conventional and modular approach. As per Present verification suggestion the education modular meets the call for today's more education and the content for students.

Suparman (2014) as mentioned by Telaumbanua, Sinaga, Mukhtar, and Surya (2017) attested that module helps students learn independently because the module contains the complete learning content and the module has its own self-explanatory power and the module is also developed according to the characteristics of the students. It can attract students 'attention and increase students' interest in learning math.

Sadiq and Zamir (2014) found out that modular teaching is more successful learning process as in comparison to ordinary teaching strategies. Because student get own pace for learning in modular approach. It is free self-learning style where immediate response, augmentation is provided to implement exercise, that prompt the students and create interest in them. The chances of students' participation maximized due to modular approach help in classroom in respect to complete the given tasks at the spot. Therefore the students feel free to learn in their own style.

Lim (2016) in his study on "Effectiveness of Modular Instruction in Word Problem Solving of BEED Students", come into the conclusion that Modules' utilization in word problem solving specifically in Math teaching, It is an effective teaching approach sense that it helped the subjects of the leaning Mathmatics concepts without revising in keeping up with the pacing of the teacher. The teaching modules utilization in these particular Maths concepts was very helpful for the development of the respondents in their individual learning study habits. The modular approached subjects performance are comparatively better than the exposed to traditional lecture method subjects.

Bautista (2014) mentioned that methods and teaching strategies are basic tools for teachers in imparting knowledge to the students. Hott, Isbell and Montani (2014) also emphasized that the strategies that can help student improve their mathematical vocabulary include preteach vocabulary wherein teachers use both ilustrated and material depiction to highlight the math vocabulary meaning, reminiscential techniques for students help in the improvement of their memory of new information and key word approach to visualize a visor as the key word for Search, Translate, Answer and Review (STAR).

Various instructional strategies are necessary to achieve maximum outcome of teaching-learning process as Boonen (2016) emphasized that student who have finished the word problems task for both mental representation skills and reading perception skills, along with completing reading comprehension skills should be given

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more prominent role during word problem solving instruction in Realistic Math Education (RME).

Tarnate (2011) mentioned that a successful teaching-learning can be achieved, when the instructional materials are well-established, well-assembled and well-introduced. Instructional materials play a key role in the changes that move toward inquiry-centered and standard-based instruction. These are materials that are used to aid in the transfer of transformation from one another.

Constructive teaching of any subject will not only bracing students' subject interest but also boost their examination achievement. To achieve constructive teaching and learning method, there is the utilization need for instructional materials (Nwike, 2013).

Tominez, Dela Cruz, and Gabatino (2013) stated that appropriate instructional materials introduced to the students must meet the requirements of learning mathematics in order to sustain their interest, participate actively in class discussion and improve their mathematical ability.

Igbo and Omeje (2014) attested that the use of teacher-made instructional materials was highly useful in enhancing the learning-disabled children's performance in the classroom for they attract the student's attention and motivate them to contribute on different taught topic discussions, use illustration thorugh materials and strore the information for long-term memory in that process for further application.

Adebule and Ayoola (2015) found out that the the learner performance in the Mathmatics teaching will be encouraged in great amount by the use of instructional materials. They also attest that students will perform better in Mathmatics by the use of instructional materials provided they are authorized to interact or engaged successfully in the process of teaching learning.

According to Adipo (2015), the impact of instructional materials have seen in the achievement on geometry; algebra and money activities during teaching and learning. On Geometry achievement , Geo board as an instructional material has a big impact in comparison to mathematical symbols in learning mathematics.

As cited by Ogaga, Wallace, and Egbodo (2016), it is generally agreed that instructional material and their usage have profound influence on student academic performance and achievement. Failures of teachers to use appropriate techniques and the lack of instructional materials were some of the factors of students' low achievement. Students are not given the chance to use their own skills in discovering answers in their own way or method.

Abadi, Pujiastuti, and Assaat (2017) emphasized that Mathematics teachers should learn the art of developing instructional materials which are meant to minimize flaws and reinforce existing skills to achieve proficiency. Mathematics teaching becomes

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more healthy and effective if it considers the difference as well as the creation of a Mathematics-rich environment where learners are immersed into.

Effectiveness of instructional materials in promoting students' academic performance in teaching and learning is indisputable. It provides much needed sensory experiences needed by the learners for an effective and meaningful behavioral change. Ajoke (2017) pointed out that instructional materials are meant to improve the quality of education for effective academic performance of students in schools. The performance of the students on the intended learning outcomes provide the validation–loop on the success of the interaction and instruction.

In a classroom setting the teacher is expected to ensure that transfer of learning is attained. This is stressed in the theory of configuration based on the Gestalt theory of learning. It holds that the transfer of acquired patterns of response to a new experience depends upon the insight of the learners into the total situation to enable him to use those patterns. The teacher therefore is expected to guide the students by developing tools such as modules and other instructional materials that are very much useful in helping the students develop their critical thinking. It has to select and provide appropriate learning experience whereby the learners can discover relationship between elements in various situations and understand them as a whole in an organized and unified pattern (Aguirre and de Cadiz, 2013).

In her study on Mathematics Manipulative: Making the Abstract Tangible, Cope (2015) mentioned that educators of Mathematics can utilize manipulatives to model multiple representations of math concept, that includes tangible (concrete), photographic (static visual), and intangible (dynamic electronic) illustrations.
Great challenge is therefore placed upon the hands of the mathematics teachers in the enhancement of teaching and learning Mathmatics in schools. The researcher is a mathematics instructor who desires to contribute to the improvement of mathematics instruction.
K-12 curriculum program started its implementation in the School Year 2015-2016. On this program, the general education (GE) subjects usually in the tertiary level such as Algebra, Analytic Geometry, and Basic Calculus for Mathematics were transferred to the Senior High School (SHS) program particularly to the Science, Technology, Engineering, and Mathematics (STEM) strand. The secondary schools were not fully prepared for the SHS curriculum much more with that there are no enough instructional materials such as modules particularly to the Pre and Basic Calculus subjects. Through this, the researcher as tertiary level Mathematics instructor for several years aimed to develop modules which can help facilitate the teaching of Pre-Calculus and Basic Calculus subjects. The developed modules in Pre-Calculus and Basic Calculus as an instructional material use for students who will be working on their own in the study of theories and concepts on Calculus subjects. The topics in the modules use simple

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language and within the students' comprehension level, following procedural and interactive processes. The given exercises that were provided are contextualized and localized in order to understand the lessons better. According to Rolka and Remshagen (2015) as mentioned by Garin (2017) learning is considered beneficial for student success.

The Grade 11 students who are enrolled in STEM would benefit from the developed modules. They will be the pioneer learners and considered primary users of the modular approach. The modules may not only be used by the researcher alone but would serve as an instructional aid/tool for all Mathematics teachers handling the same subject.

## Framework of the Study

This study is anchored in three learning theories: Thorndike's Connectionism Theory, Bandura and Wallace's Social Learning Theory and Bruner's Theory of Learning. Below is the figure that shows the outerplay of the theories used in this study.

The model shows the theories and concepts in the development of the modules in Pre-Calculus and Basic Calculus. The central ring in the model is the developed modules in Pre-Calculus and Basic Calculus. The four outer rings are the theories and concepts that help support the development of modules as indicated by the arrows. The circular lines connecting the four outer rings indicate the strong bond that exists between and among the theories and concepts.

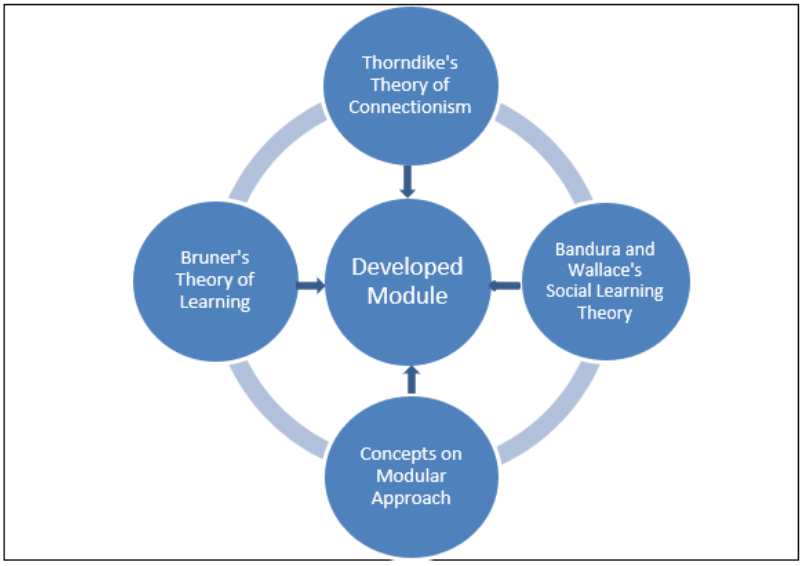


Fig. 1. Theories and Concepts in Developing the Modules

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## Stimulus-Response Theory or Connectionism

On the basis of the stimuli and responses alliance the theory is presented. There is a corresponding response for every stimulus, and the stimulus and the response link is called the S-R (Bond, 2012). The feature of the developed modules include warm-up exercises on the introductory part which will serve as the stimulus. Likewise, the activity to be accomplished by the students in the later part of the lesson will serve as the responses. These activities would developed the thinking skills and aimed to build the independence of the students as they individually perform or answer the activities, hence creates the theory of connectionism.

In order to make connectionism theory more efficient, Thorndike developed three principal laws of learning. The law of exercies, the law of readness and the law of effect are included here. When an organism is ready to act, it refers to the law of readiness. It is the preparatory set on the part of the organism to learn. The actions here are satisfying and inactions are annoying (Park, 2014). The reverses may also be true that if when an organism is not ready to act, the action is annoying and inaction is satisfying. Thus, the developed modules which contain activities makes the learning of the students dependent upon their readiness to act which at the end strengthen their understanding which will lead to mastery of learning.

The law of exercise states that exercise or practice reinforces learning. This gives importance on drill, repetition, and review. Retention is the result. Often recitation of a poem if fully comprehended results to mastery (Villanueva, 2014).
In this developed modules, the students are given different mathematical tasks or activities to improve their ability. Answering the different activities given help them gain a mastery on the subject matter.
The law of effect states that learning becomes strengthened when it gives contentment to the learner. It is debilitated if it gives exasperation to the learner (Maheshwari, 2012). The implication is that the teacher should make learning sessions as interesting as possible.

The activities given after the presentation of the lesson such as examples, exercises, and concept check were provided which are basically based in each topic. These are all adapted to the capabilities of the students which are designed to reinforce learning and would better lead to a sound understanding of the core points of the subject. Moreover, these activities provided are appropriate to the level of the students' knowledge and background in Mathematics subject, thus, expect them to work independently on the given task resulting to the improvement of their learning skills.

Since learning may be done outside the classroom, the modules are provided to serve as a learning opportunity to increase the learning abilities of the students even in the

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absence of a teacher and may take in any place which they deemed learning is appropriate
to undertake.
In addition, as a way to strengthen learning is giving praises based on the correctness or appropriateness of responses. This can be done through giving words of recognition such as excellent, very good among others. These praises have been identified to influence behavior towards the attainment of excellence.
The developed modules can respond well to the theory of Connectionism of Thorndike as strengthened by the laws of learning. The lessons and sequence of activities are in order in which they are reliably designed by expert validators in the field of Mathematics to ensure meaningful and attain maximum learning.

**Theory of Social Learning**

This theory, according to Kendra (2017) psychologist named Albert Bandura proposed a social learning theory which suggests that observation, imitation, and modeling play a primary role in this process. Bandura's theory combines elements from behavioral theories, which suggest that all behaviors are learned through conditioning, and cognitive theories, which take into account psychological influences such as attention and memory.

The developed modules go through content validity, design, organization, presentation, precision and latest information to assure that it can catch student attraction in Pre-Calculus and Basic Calculus as it features emoticons and illustrative devices. Learning the modules is self-facing; hence, retention of learned materials is expected. Formula for solving problems and the solving procedures are placed at constant pacing so that motoric reproduction is done with ease. Practice exercises are given at the last part of the lesson as reinforcement activities; hence, students can assess their performance.

**Bruner's Theory of Learning**

In this theory, learners undergo the processes of acquisition, transformation, and

evaluation. Acquisition is the process of obtaining and assimilating with understanding new information better than a previously learned one. Transformation is the process of manipulating or utilizing the information gained to remove a difficulty or to solve a problem to which it is suited; while evaluation is the process of finding out whether the information acquired is appropriately utilized (Rhalmi, 2016).

Warm-up activities are given to connect previous lesson to new lesson. After discussing the new lesson, another exercises are given in order to determine the students' level of understanding.

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According to Bruner, Any learning situation and for learning to take place: clear conceptulization, readiness, freedom and inspiration are the four basic concerns (David, 2017).

Understanding the basic and logical relationships between and among the components of a subject and even with other subjects is a prerequisite to learning. Without understanding, no learning takes place (Stephens, 2015). The module is specially designed to provide the learners the most explicit information that they need. One reading is enough to get the message being provided. Learners can proceed from one lesson to the other without having difficulty of understanding concepts since the lessons are arranged from the most basic to the most complex ones.

Learning is a precondition of readiness. At the begining level the learner need to be provided learning affair and subject matter. Therefore, the teacher need to have a true recognition of prior student proficiency. Where to start instruction, teachers need consideration about students must have learned in previous courses or workshops as well as the subject matter from their personal experiences (Bhagavathula, 2016). However, readiness would take longer period. Hence, the teacher must discard the lesson level of clarity to the learners' level of perception. Therefore receiving directives will be easy for the learner.

The module sequence of activities demonstrate specific lessons, hence, the learner are expected to acquire maximum understanding. In this study, the developed modules is prepared to be a learner-friendly that is why the learning designs and the working activities used are simple that is within students' comprehension level and follows procedural processess that makes understandable and learnable. The activities started from the basic concepts leading to a higher level of learning, thus, provides gradual development of the learners acquisition of skills. It can also be taken home, and students can continuously go through whenever they wanted to read.

The learning theories of Bruner, Thorndike and Bandura meet the individual learning preparation and socialization needs of the students. With the students' knowledge on the three learning theories, they are trained that whenever there is a stimulus, appropriate responses are expected from them, thus, required the readiness which would make them satisfied only if there is a sufficient understanding of what they have acquired

along basic information and knowledge of concepts leading to knowledge transformation and evaluation.

The modules contain a set of activities. Students are provided to determine and measure the preparedness and their mastery in a particular topic. They are considered instructional exercises that would provide greater learning acquisition and could reinforce mastery learning. Indeed, the modules sum up the learning theories and specifically applied the effect of each learning theory in the illustrative example provided

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in the module. In addition, the exercises provide directly related learning opportunities for the student's self-assessment.

It is important for an individual learner's development to be an independent learner (Mullings 2015). As the teacher won't be with the learner always, he ought to be trained independent and self-sufficient in solving problems. He must be able to search for needed information, determine his error and correct his errors by himself. The developed modules are a self-kit instructional material. It is expected that the students will undergo learning without the close and frequent supervision of the teacher. Students are given chances of learning the concepts in Pre-Calculus and Basic Calculus, try out solving the problem exercises, and check by themselves if their works are correct or not. With this, the students independent learning or student-centered learning is exercised and that their cognitive skills is independently developed.

According to Nardo and Hufana (2014), the independant study encourages through the used modules.

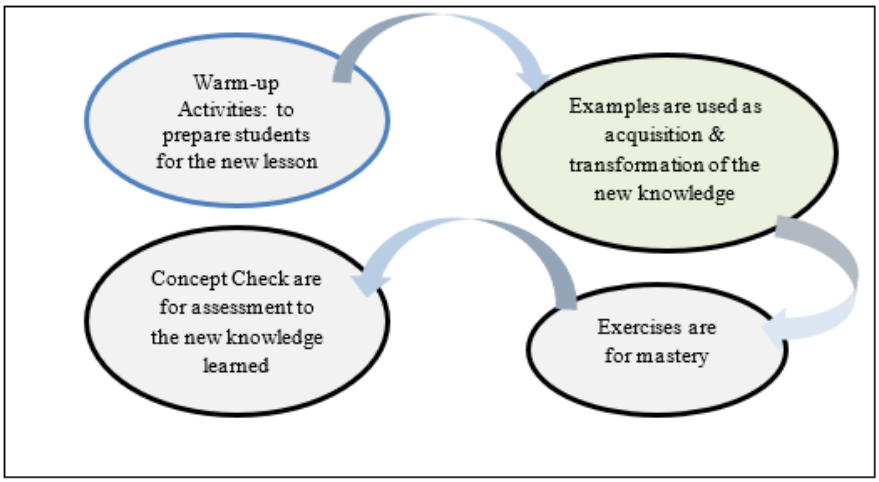


Fig. 2. Model of the Modules

It determines infromation rehearsal and practice for the students. To gain command over concepts, the progression following the examination of activities from easy to hard. The exercise arrangements are structured the difficulty level that the learners can perform. Another module using benefit for education of a better self-study or skills learning accession among students. The module engages the students in learning presented concepts. They develop a sense of responsibility in task completion provided in the module. The learners intiates further with independent learning skills with little or no assistance from the teacher.

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Learning is more effective if the learner is motivated. Posamentier (2013) believe that intrinsic motivation is more desirable than extrinsic motivation. Intrinsic motivation comes from within the individual learner. He may have a desire to learn because of its worth. Extrinsic motivation comes from outside the individual in the forms of rewards and punishments (Warmuth, 2014). While it is true that students will only work on assignments that are required for them to do, there is always that difficulty of motivating them to take extra reading on their lessons. Students who love mathematics find mathematics a fun-filled lesson; hence, the developed modules in Pre-Calculus and Basic Calculus will be an essential instructional material for them since the exercises are at their capability level, the learning instructions are clear and solving the problems are enjoyable with the use of the different or instructional aids or technologies.

Instructional materials are essential and significant tools needed for teaching and

learning of school subjects to promote teachers' efficiency and improve students'

performance. They make learning more interesting, practical, realistic and appealing. They also enable both the teachers and students to partcipate actively and effectively in lesson sessions. They give room for acquisition of skills and knowledge and development of self- confidence and self- actualization (Olayinka, 2016).

Various instructional practices, teaching methods, strategies and techniques have

been put into play during the teaching and learning processes with the aim to assess the effectiveness of enhancing learners' mathematics performance (Dochy, de Rijdt, & Dyck, 2014). Added to these efforts is the development of varied instructional materials such as modules as aids in facilitating comprehension and prompt subject concepts and skills. The module as an instructional material is an indispensable tool in the learning process. It provides learners' opportunities for advance learning. In most instances, the modules fills in the gap between the teacher and the learner that arises during class discussion due to the former's lapses in the instructional delivery process.

Rajasekar and Charles (2014) define module as a self-instructional package form

and considered as relatively recent occurance. It facilitates the learner to have a control

over his learning and recieves greater learning responsibility. Module is a unit of work in a course of instruction that is virtually self-contained and a method of teaching that is based on the building up skills and knowledge in discrete units. Module should include an introduction to the topic and instructions or suggestions about how the various components

of the module are to be used.

The use of the modular approach whereby a teacher uses a module as an

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instructional material has been found effective in teaching. Alabaso (2012) and Chamberlain (2017), stated that the use of developed and validated modules is more effective compare to the traditional teaching method. Modules serve as the line of communication between the teacher and the learner when the latter is at home. The teacher
makes use of the module as a supplement to traditional instruction which can produce an educationally significant improvement in students' examination achievement. Thus, the modules is an important tool in the teaching-learning processes but the lack of it or its limited number of copies is a serious problem on the part of the teacher. Development and validation of modules in Mathematics aim to remedy the problem on lack of instructional materials that would facilitate the teaching and learning of Mathematics concepts and skills.
In the study of Sadiq and Zamir (2013), found out that modular teaching is more successful learning process as in comparison to ordinary teaching strategies. Because student get own pace for learning in modular approach. It is free self-learning style where immediate response, augmentation is provided to implement exercise, that prompt the students and create interest in them. The chances of students' participation maximized due to modular approach help in classroom in respect to complete the given tasks at the spot. Therefore the students feel free to learn in their own style.

One important characteristic of a modules in mathematics is its ability to use specific mathematical terms and make mathematical symbols and notations related on the interest and on the level of the learners. In other words, the learner can easily understand and see the concept of mathematics in the course he is currently taking up. In this manner, his acceptance of the relevance of the subject in pursuing his line of interest will likely improve; thus, becoming more positive towards Mathematics.
Damilig (2014) cited that the theory of connectionism of Thorndike which comprises the Law of Exercise, Law of Effectm, and Law of Readness is found to be significant in learning Mathematics especially through modular instruction. The modules will ask the students to revisit the lesson if their performance showed that they have not fully achieved the competence level required. It is clear that practice leads to improvement only when it is followed by positive feedback or reward. She also claimed in her study that the constructed module in College Algebra is a valid instrument that helps improve the performance of the students.

Imbug, Matanluk, Mohammad, and Kiflee (2013) mentioned that the use of Module contributed high level thinking skills among students. It enabled students to achieve better performance in examinations, particularly on the essay form. They also found out that the use of module enabled students to conquer problems while learning such as, concentration, skills in critical, lack of interest, and creative thinking. Learning problem could be overcome by providing a conducive learning environment based on

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problem solving, pairs working, brainstorming, and the concept construction of maps.

According to Sejpal (2013), teacher must consider learners' self- differences That entail the adoption planning of the most significant techniques of teaching in order to help the individual growth and his/her own pace development.
He found out in his study that efficacious and latest utilization of modules. The technology based stratgy utilization in the current educational field. The modular approach he attested to provide more flexibility to learners as well as the distance teaching mode.
The modules must meet the requirements of the topics to be learned in order to sustain the interest of the students and to encourage them to participate actively in class discussion. The modules must be based on the K-12 Grade 11 Senior High School Mathematics Curriculum Guide. The subject has been divided into two semesters. For the first semester the Pre-Calculus topics are discussed and the Basic Calculus for the second semester (K to 12, 2013).

The modules prepared and developed are Pre-Calculus: Analytic geometry, Series and Mathematical Induction, and Trigonometry. For the Basic Calculus, the topics are: Limit and Continuity, Derivatives, and Integration. The competencies that were indicated in the K12 Grade 11 Mathematics curriculum guide were considered and incorporated in the modules.

In developing modules, certain procedure is followed in order to come up with good validated modules. The study followed the input-process-output (IPO) model. The input of the study includes the analysis on the K-12 Mathematics curriculum, CHED policies on general education courses specifically on the Mathematics subjects, and the Grade 11 Mathematics curriculum for Pre-Calculus and Basic Calculus. The process is the module development such as organizing, planning, drafting the modules, validation of the modules, analysis on the validity of readability, revision, and final packaging of the modules. The output includes the modules in Pre-Calculus and Basic Calculus.
Planning in developing a module is a procedure that ensures a very good output. It is a function that involves setting objectives and determining a course of action for achieving those objectives. It requires that the person or the planner be aware of environmental conditions confronting the project and then forecasting future conditions. Hence, students' capability and background, school curriculum, competencies of students on their previous Mathematics subjects, and Mathematics curriculum must be considered in planning for the development of a modules. It also requires that the planner must be a good decision maker.
Planning and organizing are functions that involve developing objective structure and allocating available resources to ensure the accomplishment of objectives. The structure of the objectives of the module is the framework within which effort is collaborated. The structure is usually based on and represented by objectives within the content of the modules.

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After the planning and organizing phase, drafting of the modules was done. To ensure its comprehensibility, simple use of symbols, language, units of measurement, notation systems, visual styles, graphical presentation and page layout are considered. To ensure its clarity, an accepted standards and specifications that transcends language barrier makes the technical concepts simple.

In order to determine if the modules meet the needs of its users, validation was undertaken. To validate is to give official sanction, confirmation, or approval of the subject being validated. Validation of the developed modules in Pre-Calculus and Basic Calculus was done by the experts in mathematics. They are Mathematics faculty in the tertiary teaching level the subject for at least five years.

A readability test was done to determine the wordsc complications and modules sentence structure and if it is readable or all-inclusive to the target base users.

After the validation from the experts a revision of the copy was done and after the esblishment of the readability of the modules a final draft was accomplished.

The paradigm of the study on the next page shows that the K-12 Mathematics curriculum and Curriculum guide for Pre-Calculus and Basic Calculus are basis/guide in the development of the modules. The initial stage in the module development is planning which is followed by the significant stages leading to the final packaging the modules, then, the output is the modules in Pre-Calculus and Basic Calculus.

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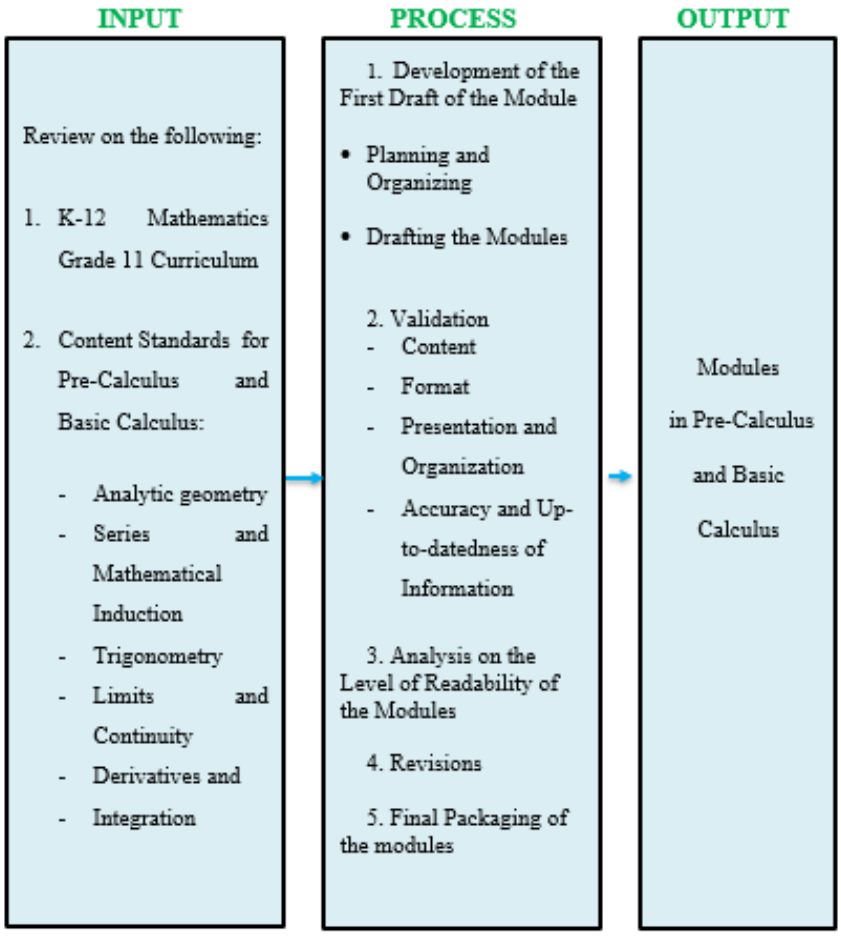


Fig. 3. Paradigm of the Study

## The Problem Statement

This study aimed for modules development in Pre-Calculus and Basic Calculus subjects for the Senior High School, STEM Strand. Exclusively the solutions to the following questions:

1. What is the validity level of the developed modules in Pre-Calculus and Basic Calculus in terms of:

1.1 Content

1.2 Format

1.3 Demonstration and organization

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1.4 Precision and updated information?

2. What is the readability developed modules level?

**Definition of Terms**

The following terms are defined operationally and conceptually for better understanding of the content of the study.

*Precision and latest information* refer to the correctness and preciseness of the statement and information in the modules.

*Calculus* is a mathematics division that considers the estimation of instantaneous rates of change and the summation of infinitely many small factors to consider some whole ( Berggren, 2017). In this study, the two parts considered are the Pre-Calculus and the Basic Calculus. *Pre-Calculus* refers to the topics or subjects pre-requisite to the topics discussed in the Calculus subjects. The topics include conic section, the system of quadratic equation, mathematical induction, binomial theorem, and trigonometry. *Basic Calculus* refers to the topics/subjects taken as pre-requisites for many courses in Mathematics, Statistics, Engineering, Pharmacy, etc. (Fischer, 2015). In this study, the following topics are considered; limit and continuity, the differential and integral calculus.

*Content validity* refers to whether the instrument adequately covers all the content

that it should with respect to the variable (Heale & Twycross, 2015). In this study, it covers on the domain related to the variable such as students' level of development, the objective of the subject area, the cognitive skills, the ideological prejuduces, desirable traits and values, the readers' interest, and on acctivities appropriate cautionary notes where safety and health concerns.

*Curriculum Guide* is an outline of topics to be covered in an education or training course. In this study, the topics and subtopics on Pre-Calculus and Basic Calculus were considered.

*Development of Modules* refer to the processes undertaken by the researcher in gathering pertinent information and relevant data that can be collated and utilized as a working concept in developing modules to be used in teaching Pre-Calculus and Basic Calculus subjects.

*Format* refers to the feature of the modules where it concerned with the styles on printing, illustrations, design and layouts and on paper binding.

*Mathematics Experts* pertain to the persons who are experts in the field of Mathematics. These are the teachers who are teaching Mathematics subjects in the tertiary level for more than five years.

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A *Modular Approach* is a teaching strategy used by a teacher whereby modules are used as instructional materials. It is described as self-pacing since a student completes the prescribed learning tasks at his own pace (Gonzales, 2015). In the modules, topics discussed are presented briefly and clearly and includes the detailed solution and discussion of the solution in illustrative examples.

A *Module* is an instructional material which consists of an independent unit of planned series of learning activities designed to help the students accomplish certain well-defined objectives (Paspasan, 2015). In this study, a short and simple instructional material that the topics are based from the specific goals/objectives on Pre-Calculus and Basic Calculus from the Grade 11 Mathematics Curriculum Guide.

*Presentation and organization* refers to the approach used to show logical arrangement of the content, the accuracy of the words used in order to create better understanding of the items and an insightful grasp of information.

*The complicated words* and structured sentence in a content piece measures readability. The presumption for this metric is that difficult sentences are harder to analyze and read compared to simpler ones. The level of reading usually reported and (stated as years of formal education) call for easy text reading (Nielsen, 2015). In the study it is explored that on what grading level a student can grasp and understand the modules. The *Flesch Kincaid Reading Ease Test Tool*s such as Smog, Gunning Fog Score, Coleman Liau Index, and Index, and are utilized to determine the *readability* of the modules.

*Validation* refers to the process of reviewing the module/instructional material prepared by the researcher. In this study, the process of determining The developed modules go through content validity, design, organization, presentation, precision and latest information, and readability of the modules as an instructional material will be undertaken.

*Validators* are the Mathematics experts who are teaching Mathematics subjects in the tertiary level for more than five years. They are requested to evaluate and give comments and suggestions to the developed modules.

*Validity* refers to the extent to which the test serves the purpose for what it is intended (Henne, 2014). The module validity was considered through the Mathematics experts in Pre-Calculus and Basic Calculus subjects pooled judgment.

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## METHODOLOGY

### Research Design

The descriptive-developmental research strategy is included in self employed procedure. It is descriptive in nature since it described the level of validity of the instructional modules in teaching Pre-Calculus and Basic Calculus subjects. According to Rahi (2017), a research's descriptive method focused on obtaining on current state phenomena information. This research plan to provide an absolute situations either for people or events profile.

Analysis and review of the K-12 Mathematics curriculum were made by the researcher and focused on Grade 11 Mathematics curriculum guide and the syllabi for Pre-Calculus and Basic Calculus. The study is also developmental because these curricula were used as inputs in the development of the modules. According to Mehran (2017), developmental research is a study that involves repeated observations of the same items over a period of time and comparison of two separate but equivalent longitudinal studies. In the field of instructional teaching material this type of research is vital. Where the product-development process is scrutinized, compared and explained, and the final product is assessed, there the common types of developmental research is very much involved as per the situation.

### Sources of Data

The study involved the development of modules as an instructional material in teaching Pre-Calculus and Basic Calculus subjects.

The K-12 Mathematics Curriculum and the Grade 11 Mathematics Curriculum guide for Pre-Calculus and Basic Calculus were carefully analyzed by the researcher for the conceptualization of the development of the modules. The activities were patterned and based on the activities therein, thus the researcher came out the first draft of the modules. The first draft was validated by the six Mathematics teachers in the tertiary level from the six State Universities and Colleges in Region I. These Mathematics teachers have been teaching the same field of specialization for at least five years. The validation instrument used was adopted from the *DepEd Rating Sheet for Print Supplementary Materials* as used by Garin (2017). It is along the four areas in evaluating instructional materials such as illustration, format, content and organization, and precision and latest information.

The results of the evaluation during the first validation were reviewed and analyzed by the researcher. Several corrections, comments and suggestions were given which include; improve the graphs and illustrations, highlights the defined terms, figures should be more visible, the font sizes must be consistent, and a clearer image of the

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graphs. All of these suggestions were considered and incorporated in the modules. After which, a revalidation was made and there are still comments and suggestions given by the validators such as; the modules are already consistent/patterned with the Senior High School curriculum, indentions in the writing of paragraphs, a simpler text, and a clearer illustrations of graphs. All of these suggestions were also incorporated within the modules for its improvement.

**Instrumentation and Data Collection**

The study employed the following schemes in the conduct of the study: The researcher used the questionnaire or evaluation sheet which was adopted from the *DepEd Rating Sheet for Print Supplementary Materials.* This was used to determine the validity of the developed modules in Pre-Calculus and Basic Calculus subjects. Documentary analysis was utilized to review the K-12 Mathematics curriculum and the Grade 11 Mathematics curriculum guide and Content standards in Pre-Calculus and Basic Calculus subjects. The topics in the Pre-Calculus include the Analytic Goemetry, the Series and Mathematical Induction, and the Trigonometry. In the Basic Calculus, topics included are Limits and Continuity of a Function, the Derivatives, and Integration. Analytic Goemetry covers the topics on conic sections and system of non-linear equations. Series and mathematical induction include the topics on Pascal's triangle and the binomial theorem. Trigonometry includes the topics on unit circle, circular functions, trigonometric identities, and polar coordinates.

Limits of a function includes topics on continuous and discontinuous functions and the intermediate and extreme value theorem. Derivatives of function includes slope of a tangent line, optimization and related rate problems. Integration or the antiderivative of function includes the topics in finding the area of an irregular polygons.

The presentation of topics is based on the K to 12 Grade 11 Curriculum Guide. This was also the basis on the formulation of directions leading into the attainment of objectives and the development of competencies of the students. Table 1 on the next page presents the curriculum guide in Pre-Calculus and Basic Calculus.

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Table 1. Curriculum Guide for Pre-Calculus and Basic Calculus

| CONTENT | CONTENT STANDARDS | LEARNING COMPETENCIES |
|---|---|---|
| Analytic Geometry | The learners demonstrate an understanding of …<br><br>key concepts of conic sections and system of nonlinear equations | 1. Define circle<br>2. Determine the standard form of the equation of a circle<br>3. Graph a circle in a rectangular coordinate system<br>4. Define parabola<br>5. Identify the parts of parabola<br>6. Consider the standard type of a parabola equation<br>7. Sketch the chart of a parabola<br>8. Define ellipse<br>9. Recognizing the parts of an ellipse<br>10. Consider the standard form of an ellipse identification<br>11. Sketch the ellipse diagram<br>12. Define hyperbola<br>13. Recognize the hyperbola parts<br>14. Consider the standard type of a parabola equation<br>15. Diagram a hyperbola in a rectangular coordinate system<br>16. Equation identification of the conic sections types<br>17. Find solutions for situational problems involving conic sections<br>18. Demonstrate nonlinear equations of systems<br>19. Systems solution of nonlinear identification by using substitution, elimination, and graphing |
| Series and Mathematical Induction | Key concepts of series and mathematical induction and the Binomial Theorem | 1. Illustrate a series<br>2.A series transformation from a sequence<br>3. The sigma notation utilization for a series representation<br>4. The Mathematical induction demonstration<br>5. Application of Mathematical induction for identification proof |

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| | | |
|---|---|---|
| | | 6. Illustration Pascal's triangle in the expansion of (x + y)n for small positive integral utilities<br>7. The proof of Binomial Theorem<br>8. Determine any term of (x + y)n, where n is a positive integer, without expanding<br>9. Mathematical induction and the Binomial theorem problem solution |
| Trigonometry | Key concepts of circular functions, trigonometric identities, inverse trigonometric functions, and the polar coordinate system | 1. Demonstration of a circle unit and the relationship between linear and angular measures<br>2. Transform radian measure from degree measure and vice versa<br>3. Illustrate the different circular functions<br>4. Use reference angles to find the values of a circular function<br>5. Determine the domain and range of the different circular functions<br>6. Graph the six circular functions; a.) amplitude, b.) period, c.) phase shift<br>7. Solve problems regarding circular functions<br>8. Know the identity and a conditional equation<br>9. Obtain trigonometric identification by involving sum and angles difference, the double and half angle formulas<br>10. Easy utilization of trigonometric expressions and trigonometric specification<br>11. Trigonometric specification problem solution<br>12. The illustration of domain and the inverse range of trigonometric functions<br>13. Inverse trigonometric expression calculation<br>14. Solutions Trigonometric equations<br>15. Problem solutions for involving inverse trigonometric functions<br>16. Find out points in polar coordinates<br>17. The coordination transformation from rectangular to polar systems and vice versa<br>18. Problem solutions involving polar coordinate system |
| Continuty and Limits | The beginnner illustrate an | 1. Illustrate the limit of a function using a table of values and the graph of a function |

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| | | |
|---|---|---|
| | concept of …<br><br>the basic concepts of limit and continuity of a function | 2. Distinguish between $\lim_{x\to 0} f(x)$ and *f(c)*<br>3. Illustrate the limit laws<br>4. Apply the limit laws on functions of algebra (rational, polynomial, and radical)<br>5. Logarithmic limits of computing, trigonometric, and exponential, utilizing functional value tables and functional graphs<br>6. Involving the expressions estimation limits $\frac{\sin t}{t}$, $\frac{1-\cos t}{t}$, and $\frac{e^t-1}{t}$ utilizing the table utilities<br>7. Apply these expressions in evaluating the limit of a function<br>8. Illustrate the function continuity at a number<br>9. Calculate whether it is a constant function at a number or not<br>10. Demonstrate and estimate whether a function is constant on an interval or not<br>11. Calculate discontinuity of a function<br>12. Demonstrate vivid discontinuity (hole/removable, jump/essential, and asymptotic)<br>13. Discuss the intermediate and extreme value theorem<br>14. Demonstrate the intermediate and extreme value theorem<br>15. Find solutions for involving continuity of a function |
| Derivatives | Basic concepts of derivatives | 1. The tangent line demonstration to the functional graph at a given point<br>2. The definition application of derivative of function at a given number<br>3. The derivative of a function can relate to the slope of a tangent line<br>4. The relationship consideration between the continuity and a function differentiability<br>5. Derive the rules of differentiation<br>6. Application of the rules differentiation in computing the derivative of an algebraic, exponential, and trigonometric functions<br>7. Illustrate the relative extreme values (the maxima and minima) |

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| | | |
|---|---|---|
| | | 8. Apply relative extrema of a function<br>9. Solutions to the problems' optimization<br>10. Compute functions of higher-order derivatives<br>11. Demonstrate the Chain Rule of differentiation<br>12. Problems' solution by using Chain Rule and higher-order derivatives<br>13. Illustrate implicit differentiation<br>14. Use implicit differentiation in solving logarithmic and inverse trigonometric functions<br>15. Infer problems on related rates<br>16. Solve problems involving related rates |
| Integration | Antiderivatives and Riemann Integral | 1. Demonstrate the functional antiderivative<br>2. The general calculation of antiderivative of functions radical, polynomial, , exponential, and trigonometric.<br>3. Demonstrate the functional antiderivative by utlilizing substitution rule;<br>4. Antiderivatives applications to the functions of logarithmic and inverse trigonometric<br>5. Different solutions to separable calculation by using antidifferentiation<br>6. Problems' solutions involving exponential growth and logistic growth.<br>7. Maximum region area using the Riemann sums;<br>8. Definite integral definition as Riemann sums limits<br>9. Demonstrate the Fundamental Theorem of Calculus.<br>10. Utilization of Calculus Fundamental Theorem to calculate a function of definite integral<br>11. Demonstrate the substitution rule; and<br>12. Evaluate definite integral using the rule of substitution.<br>13. Calculate the region area by using definite integral<br>14. Find solutions for involving areas of plane regions. |

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Several stages were considered in the preparation and development of the modules. It all started in the Planning Phase wherein analysis of the K-12 Mathematics curriculum in the Basic Education and the Grade 11 curriculum guide and Content standards in Pre-Calculus and Basic Calculus subjects were considered as basis in achieving the objectives of the lesson. The design phase and creation of the modules were done step-by-step. Review of the curriculum was made and served as relevant inputs in designing and developing the modules.

The analysis phase entails the details of the modules. It includes features that are based on the students' capability in understanding the topics in Calculus subjects. This was followed by the validation phase. This is a process of reviewing and scrutinizing the content of the module which was made by the validators in order to determine with the extent which the modules serve its purpose. The level of validity of the modules was rated a 1 to 4 scale on which four as the highest and one as the lowest. Along content, the modules are evaluated on topics that are within the grasp of the target learners, the materials develop higher cognitive skills, and the interestingness to the target learners. On format, it was rated on the sizes of letters, the clarity of texts, the attractiveness, and the paper used of the modules. Along presentation and organization, it was rated on the ideas smooth flow as logical, vocabulary level, the sentences length and structured paragraph. For the validity and latest information, The consideration on concepts of the topics, factual information, correctness in grammar and computation, and up to datedness of information.

The texts attribute of the modules was determine using a readability index. This is to estimate how difficult to read a texts of the modules are and to determine the texts presentation such as length of the word and sentence, syllable counts and so on give us ways for the measurement of the text complexity.

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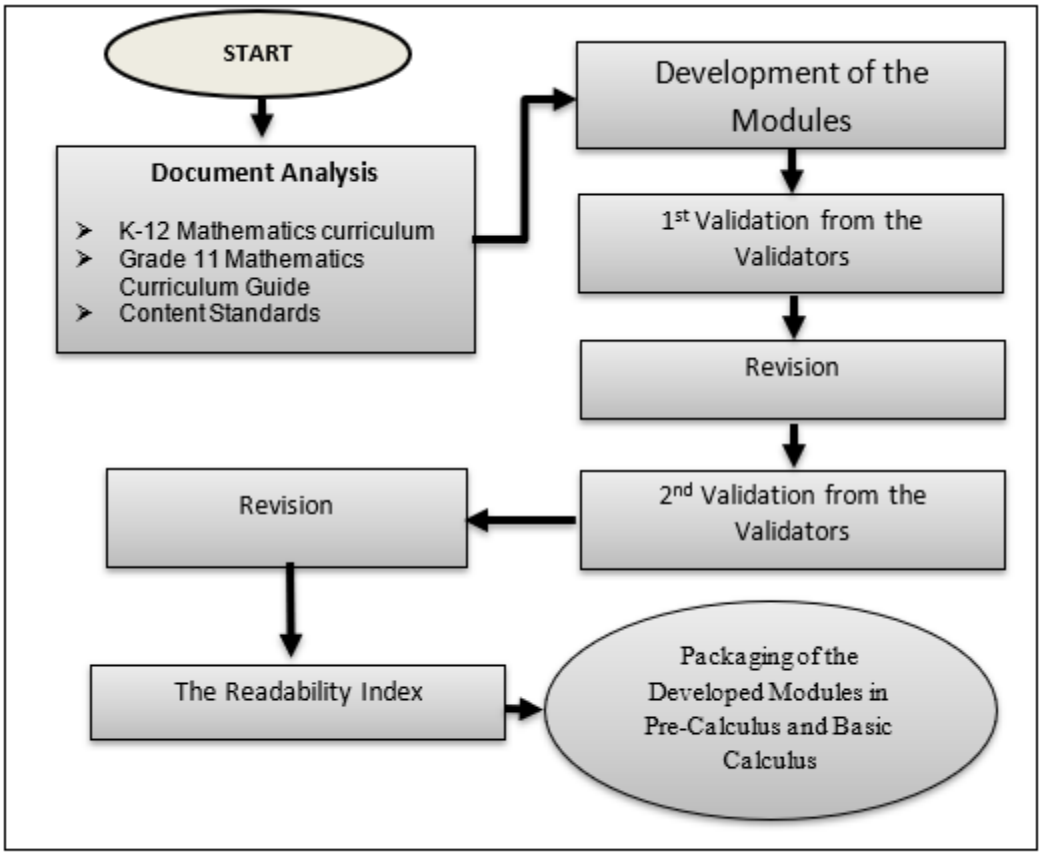


Fig. 4. Flowchart in Data Gathering

The flowchart shows the processes and procedures that were considered and undertaken. There were documents analysis made by the researcher on the K-12 Mathematics curriculum, the Grade 11 Curriculum Guide and the Content Standards. From there, the initial stage and the development of the module was made. In order to check the accuracy and appropriateness of the content, validation was made by the validators twice leading the readability index.

**Analysis of Data**

To determine the validity of the modules, an evaluation sheet or a validation questionnaire (see Appendix B on page 68) as used by Garin (2017) was utilized. The evaluation sheet was used by the validators in rating the developed modules.

The following scoring key was used on the features of the module:

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| Features of the Module | Total Score | Descriptive Rating |
|---|---|---|
| Content | below 21 | Failed |
| | 21 and above | Passed |
| Format | below 54 | Failed |
| | 54 and above | Passed |
| Presentation and Organization | below 15 | Failed |
| | 15 and above | Passed |
| Up-to-datedness of Information | below 18 | Failed |
| | 18 and above | Passed |
| Over-all | below 108 | Failed |
| | 108 and above | Passed |

As per indicator, the scoring key was:

| *Score* | *Descriptive Rating* |
|---|---|
| Below 3 | Failed (F) |
| 3 and above | Passed (P) |

The *Flesch Kincaid Reading Ease Test Tool* was used to determine the modules of *legibility*. This is a software introduced by Rudolf Flesch and Peter Kincaid of Naval Technical Training, USA on which a score on the level of readability of the text in the module will be achieved.

The following *Flesch Kincaid Reading Ease Test Tool are* used;

1. Flesch Kincaid Reading Ease
2. Score of Gunning Fog
3. SMOG Index
4. Colemann Liau Index

The following are used as scoring key for Flesh-Kincaid reading ease:

| ***Range of Score*** | ***School level*** | ***Notes*** |
|---|---|---|
| 100 – 90 | 5th grade | Read easily and an average 11-year-old student realization |
| 90 – 80 | 6th grade | conversation and reading English for consumers easily. |
| 80 – 70 | 7th grade | Easy readable. |
| 70 – 60 | 8th & 9th grade | Simple English. Realize by 13 to 15 year-old students |
| 60 – 50 | 10th to 12th | Hard reading |

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| | | |
|---|---|---|
| | grade | |
| 50 – 30 | College | Hard to read and understand |
| 30 – 0 | College graduate | Difficulty level of reading . Easily understand by university graduates |

For the Smog Index, Gunning Fog Score, and Coleman Liau Index, the following reading grade level was used:

| Score Index | Reading level by grade |
|---|---|
| 17 | College graduate |
| 16 | College senior |
| 15 | College junior |
| 14 | College sophomore |
| 13 | College freshman |
| 12 | High school senior |
| 11 | High school junior |
| 10 | High school sophomore |
| 9 | High school freshman |
| 8 | Eighth grade |
| 7 | Seventh grade |
| 6 | Sixth grade |

## RESULTS AND DISCUSSION

### Level of Validity of the Developed Modules Along Content

There are seven indicators to determine the content validity of the modules. Each indicator contains different criteria. The evaluator rated the materials from one to four, where four as the highest and one as the lowest. The modules need to have a total modal score of not lower than 21 to pass the validation criteria.

Table 2 on the next page shows that the modules have been adapted to the capabilities of the students which are designed to reinforce learning and the activities are appropriate to the level of the Grade 11 students' knowledge and background in Mathematics subjects. This is based on the modal total scores of 24 and 25 in the first and second validation, respectively, on which these values are more than 21 as the passing score.

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The suitable modules for the development of student's level. The student's accomplishment exclusive subject objective areas and for contributed intended level of grade/year; and the material is free of religious, gender, ideology, culture, and racial prejudices and biases from these criteria has a modal rating scores of four in the first and second validation.

The increased material for desirable values and traits development, material arouses interest of target reader, and adequate warning/cautionary notes are provided on topics and activities where safety and health are a concern. The modal score is three from

Table 2. Validity of the Modules along Content

| Content | 1st validation | | 2nd validation | |
|---|---|---|---|---|
| | Mode | Status | Mode | Status |
| 1. Suitable content for the level development of students. | 4 | P | 4 | P |
| 2. Exclusive objective subject area accomplishment and contributed for intended grade/year level material. | 4 | P | 4 | P |
| 3. Provide materials for the higher cognitive skills development for instance, learning by doing, innovative, critical thinking, inquiry, solving problems, etc. | 3 | P | 4 | P |
| 4. Ideological, religious, cultural, and gender biases and prejudices, racial free materials. | 4 | P | 4 | P |

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| | | | | | |
|---|---|---|---|---|---|
| 5. Material enhances the development of desirable values and traits such as: (Put a check mark only to the applicable values and traits) | | 3 | P | 3 | P |
| 5.1 | Pride in being a Filipino | ☐ | | | |
| 5.2 | Scientific attitude and reasoning | ☐ | | | |
| 5.3 | Desire for excellence | ☐ | | | |
| 5.4 | Love for country | ☐ | | | |
| 5.5 | Helpfulness/Teamwork/Cooperation | ☐ | | | |
| 5.6 | Unity | ☐ | | | |
| 5.7 | Desire to learn new things | ☐ | | | |
| 5.8 | Honesty and trustworthiness | ☐ | | | |
| 5.9 | Ability to know right from wrong | ☐ | | | |
| 5.10 | Respect | ☐ | | | |
| 5.11 | Critical and creative thinking | ☐ | | | |
| 5.12 | Productive work | ☐ | | | |
| 5.13 | Others (Please specify | ☐ | | | |
| 6. Material arouses target readers' interest | | 3 | P | 3 | P |
| 7. Safety and health concern topics are available with adequate warning/cautionary notes | | 3 | P | 3 | P |
| *Total* | | 24 | P | 25 | P |

*Legend:*

| e | Status | Per Indicator | Total |
|---|---|---|---|
| | Passed (P) | 3 and above | 21 and above |
| | Failed (F) | below 3 | below 21 |

the first and second validation which shows that the modules did not change along these criteria. The material also provides for higher cognitive skills development for instance, innovative, critical thinking, learning by doing, solving problem, inquiry etc. It has a modal score of three in the first and had improved on the second validation which

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has a modal score of four. This implies that after incorporating all the suggestions given by the validators the material has improved.

The module can be taken home and this serves as a learning opportunity to increase the learning abilities of the students even without teachers' supervision. Mullings (2015) emphasized that learner does not always have his teacher with him; he must be trained to be independent and self-sufficient in solving problems. This was affirmed by Padmapriya (2015) who said that modules can help the students to learn at their own pace and interest in their own learning for boosting confidence. This is further supported by Guido (2014), if instructional module is suitable and appropriate to the level of the students it will help the student's progress in cognitive abilities and understanding of the concepts.

Furthermore, in the preparation or designing a module one must consider the content that it is helpful in developing critical thinking of a learner, creativeness, ability to develop the skill on learning by doing and developing the problem solving skill.

**On the Values and Traits under Contents**

Table 3 shows the desirable values and traits under content of the module. It can be glossed from the table that with the help of the module, the student user developed their creativeness and critical thinking, they are encouraged to learn new things and have the desire for excellence since they can do the learning task alone. The modules develop student critical and creative thinking based from the validators rating of six and a percentage rating of 20.00. The validation of the modules got a favorable response along desire for excellence, desire to learn new things, and critical and creative thinking with a frequencies of four and a percentage ratings of 13.79. The values and traits of the modules on helpfulness, teamwork, cooperation, unity, and respect are least favored by the validators.

Imbug, Matanluk, Mohammad, and Kiflee (2013), mentioned that using module in teaching came up for students with high level skills thinking. The module enabled students for better examination accomplishments, exclusively on the essay form They also found out that the use of module enabled students to conquer problems while learning such as, concentration, skills in critical, lack of interest, and creative thinking. Learning problem could be overcome by providing a conducive learning environment based on problem solving, pairs working, brainstorming, and the concept construction of maps.

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Table 3. Desirable Values and Traits under Content of the Module

| Values and Traits | | 1st validation | | 2nd validation | |
|---|---|---|---|---|---|
| | | f | % | f | % |
| 1. | Pride in being a Filipino | 2 | 6. 90 | 2 | 6.67 |
| 2. | Scientific attitude and reasoning | 3 | 10. 34 | 3 | 10.00 |
| 3. | Desire for excellence | 4 | 13. 79 | 4 | 13.33 |
| 4. | Love for country | 2 | 6. 90 | 2 | 6.67 |
| 5. | Helpfulness/Teamwork/Cooperation | 1 | 3. 45 | 1 | 3.33 |
| 6. | Unity | 1 | 3. 45 | 1 | 3.33 |
| 7. | Desire to learn new things | 4 | 13. 79 | 4 | 13.33 |
| 8. | Honesty and trustworthiness | 2 | 6. 90 | 1 | 3.33 |
| 9. | Ability to know right from wrong | 2 | 6. 90 | 2 | 6.67 |
| 10. | Respect | 1 | 3. 45 | 1 | 3.33 |
| 11. | Critical and creative thinking | 4 | 13. 79 | 6 | 20.00 |
| 12. | Productive work | 3 | 10. 34 | 3 | 10.00 |
| | Total | 29 | 100. 00 | 30 | 100.00 |

Flynn, Babcock, and Davidson (2015) emphasized that the use of module in teaching effectively increased student understanding of complex decision making processes required of engineers. They also observed high levels of student involvement and engagement in the material throughout the module, particularly during the simulation activity.

Firdaus, Kailani, Bakar, and Bakry (2015) attested that learning modules help in developing students' critical thinking skills in mathematics to the evidence and arguments of component evaluation. Module's vivid activities can motivate a component, from which indivdual or collaborative investigation has done for non routine problem solutions. Students are responsible for solving problems with the self-evaluation method on their solution procedures. The students can share with other students to mutually evaluate the evidence and arguments in solving problems under component evaluation.

**Along Format**

Table 4 on the next page shows the validity of the module along format. There are five indicators along format, namely: Demonstrations, prints, designs and layouts, paper binding, weight and size. The modules passed along these indicators as shown in the overall total modal score of 56 and 70, respectively, on which these values are higher than the passing score of 54. This shows that these features of the modules on print size, illustrations, designs and layout, paper and binding, and size and weight are big contributors or factors that would enhance the mathematical ability of the students.

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On area of prints, the font size of the letters used on the modules are appropriate to

Table 4. Validity of the Module along Format

| Format | 1st validation | | 2nd validation | |
|---|---|---|---|---|
| | Mode | Status | Mode | Status |
| 1. Prints | | | | |
| 1.1. Appropriate size of letters to the intended user | 3 | P | 4 | P |
| 1.2. Facilitate reading through spaces between letters and words | 3 | P | 4 | P |
| 1.3. Easy reading font | 3 | P | 4 | P |
| 1.4. Good quality (i.e., no broken Letter printing, even density, correct alignment, properly placed screen registration | 3 | P | 4 | P |
| Score | *12* | P | 16 | P |
| 2. Demonstrations | | | | |
| 2.1 Easily Identifiable | 3 | P | 4 | P |
| 2.2 Clarify and supplement the text | 3 | P | 4 | P |
| 2.3 Labeled or captioned properly (if applicable) | 3 | P | 4 | P |
| 2.4 colors of realistic/appropriate | 4 | P | 4 | P |
| 2.5 Alluring and appealing | 3 | P | 4 | P |
| 2.6 Culturally relevance | 3 | P | 3 | P |
| Score | *19* | P | 23 | P |
| 3. Design and Lay-out | | | | |
| 3.1Enticing and pleasing to look at | 3 | P | 4 | P |
| 3.2 Engaging (i.e. does not distract the attention of the reader | 4 | P | 4 | P |
| 3.3 Competent demonstration in text relation | 3 | P | 4 | P |
| 3.4 Amazing blending elements (e.g., illustrations and texts) | 3 | P | 4 | P |
| Score | *13* | P | 16 | P |

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| | | | | |
|---|---|---|---|---|
| 4. Binding And Paper | | | | |
| 4.1 The paper and to easy reading | 3 | P | 4 | P |
| 4 imprisheble binding to withstand frequent use | 3 | P | 4 | P |
| Score | *6* | *P* | *8* | *P* |
| 5. SM size and weight | | | | |
| 5.1 Handle easily | 3 | P | 4 | P |
| 5.2 Light relevancy | 3 | P | 3 | P |
| Score | *6* | P | 7 | P |
| *Total* | *56* | P | 70 | P |

*Legend:*

| Status | Per Indicator | Total |
|---|---|---|
| Passed (P) | 3 and above | 54 and above |
| Failed (F) | below 3 | below 54 |

the user and has a good alignment and print quality that made font readable. This is shown from the first validation with a total modal rating score of 12 and improves during the second validation with a rating score of 16. The text and font size of a module are to be considered. Path (2014) mentioned that there are vast number of parameters to consider when writing text, font size is just one of them. The writer needs to understand the target audience, the message he/she tries to communicate, and what he/she wants them to do (amongst other things) because font size impacts both accessibility and usability.

Illustrations clarify and supplement about the text. The modules has a realistic and and appropriate colors, and has a good illustrations since the total modal rating score is 19 on the first validation and 23 on the second validation. This indicates that the modules improve along illustrations during its second validation. Hott, Isbell and Montani (2014) stated that illustrative graphs and picture emphasized the meaning of Mathematics vocabulary that might improve the memory of the students for new information.

In the first validation of the modules, some of the illustrations were not properly labeled and some were not given appropriate captions as shown in the modal rating score of three but during the second validation the modal rating increased to four which shows that the modules improved in that the illustrations are properly labeled and given appropriate captions. Torrefranca (2017) emphasized that illustrations, captions, and learning activities helped the student fully understand the topics. She also found out that student enjoyed answering the practice task in each lesson as presented in the form of trivia or puzzle and enjoyed working and studying.

Nardo and Hufana (2014) also attested that sketches are useful in

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Students learning process because when students see things they learn faster that assist
In information processing.

The modules were improved from its first validation to the second validation with regard to the design and layout. The modules are attractive. They have adequate illustrations, and harmonious design. This is evident from the total modal rating score of 13 and 16 during its first and second validation, respectively. Espinar and Ballad (2016) mentioned that the use of well-designed instructional modules can be effective in improving students' knowledge and understanding.

The modules have durable binding and good quality of paper was used as shown on the total modal rating score of six during its first validation and eight on the second validation. The module is easy to handle and relatively light as shown on the second
validation with the total modal rating score of seven. These indicates that proper format on print, demonstration, paper and binding, design and layout, and the size and weight of the followed module.

**Along Presentation and Organization**

Table 5 presents the validity of the modules along presentation and organization.
The modules are well organized. The sentences length are suited to the comprehension level for the readres who are targeted. For readers' better experience and understanding, the flow of ideas are logical and smooth. And the vocabulary level is adapted to reader's experience and understanding. These were revealed on the total modal rating of 18 during its first validation and 20 on the second validation. These values are greater than the passing score of 15.

A good organization and presentation of a module is a key consideration so that a reader comprehends and understands the lessons presented. Understanding is very important since if there is no understanding there is no new knowledge acquired and

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Table 5. Validity of the Modules along Presentation and Organization

| Presentation and Organization | 1st validation | | 2nd validation | |
|---|---|---|---|---|
| | Mode | Status | Mode | Status |
| 1. Presentation is engaging, interesting, and understandable. | 3 | P | 4 | P |
| 2. There is logical and smooth flow of ideas. | 4 | P | 4 | P |
| 3. The vocabulary level that adapted to target reader's experience and understanding | 4 | P | 4 | P |
| 4. The comprehension level of the target reader needs length of the sente | 4 | P | 4 | P |
| 5. As per target reader's interest, the sentences and paragraph structures are varied | 3 | P | 4 | P |
| Total | *18* | P | 20 | P |

*Legend:*

| Status | Per Indicator | Total Score |
|---|---|---|
| Passed (P) | 3 and above | 15 and above |
| Failed (F) | below 3 | below 15 |

understanding would make the learner ready and prepare for the next lesson. Readiness is also very important in learning. Park (2014) emphasized the connectionism theory of Thorndike law of readiness, that when an organism is ready to act, action is satisfying and inaction is annoying, and the reverse that when an organism is not ready to act, action is annoying and inaction is satisfying.

The developed-modules are interesting, understandable, and engaging vivid the paragraph and sentences structures and interesting for the reader as revealed on the modal rating scores of three in the first validation and in the second validation increased to four. This indicates that after incorporating the suggestions of the validators for the

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first validation, the said modules improved that the presentation and organization of the modules have met the requirements set. The modules display includes adapted vocabulary level, a logical and smooth flow of ideas, focused readers' adapted experience and the comprehension level of the target reader conceptualizing as per the length of sentence.

**Latest and Precize Information**

The status of the module shows in Table 6 its precision and updated information. As released by the total modal score of 23 in its first and 22 in its second validation, these values are higher than the passing score of 18 this indicates that the modules passed in the validation rating scale of the validators along correctness and latest information. The developed modules have no conceptual, factual, and computational errors and has an obsolete information since the modal values on these criteria is four. Based on the validation, the modules contain some typographical errors as we see from the modal scores of three. There are also some grammatical error since the modal values decreased from four to three on the first validation to the second validation. These errors were corrected and also checked by an English

Table 6. Validity of the Module along Precision and latest Information

| Accuracy and Up-to-datedness of Information | 1st validation | | 2nd validation | |
|---|---|---|---|---|
| | Mode | Status | Mode | Status |
| 1. Notional errors | 4 | P | 4 | P |
| 2. Authentic errors | 4 | P | 4 | P |
| 3. Semantic errors | 4 | P | 3 | P |
| 4. Computational errors | 4 | P | 4 | P |
| 5. Obsolete information | 4 | P | 4 | P |
| 6. Other errors along with typographical errors (e.g., wrong captons, unsuitabl0065 or unclear , missing labels, etc.) | 3 | P | 3 | P |
| Total | 23 | P | 22 | P |

*Legend:*

| Status | Per Indicator | Total Score |
|---|---|---|
| Passed (P) | 3 and above | 18 and above |
| Failed (F) | below 3 | below 18 |

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**Summary on the Validity of the Modules**

Table 7 presents the summary of the validity of the modules along its format, content,demonstration, and organization, and precision and latest information. The developed modules passed along these features as evident from the validators-rating having an overall total modal score of 121 during the first validation and 137 on the second validation on which these values are higher than the passing score of 108. Hence, the modules are recommended to be used as an instructional material in teaching Pre-Calculus and Basic Calculus subjects. Dochy, de Rijdt, and Dyck (2014), mentioned that the development of varied instructional materials such as modules as aids in facilitating comprehension and subject prompt concepts and skills. The module fills in the
gap between the teacher and the learner that arises during class discussion. Kinney (2017) also emphasized that educational modules can play an important part in revitalizing the teaching and learning of Mathematics subjects.

Table 7. Summary Table on the Validity of the Modules

| Feature of the Modules | 1st validation | | 2nd validation | |
|---|---|---|---|---|
| | Score | Status | Score | Status |
| Content | 24 | P | 25 | P |
| Change | 56 | P | 70 | P |
| Introduction and Organization | 18 | P | 20 | P |
| Latest of Information | 23 | P | 22 | P |
| Overall | 121 | P | 137 | P |

*Legend:*

| Status | Content | Format | Presentation and Organization | Up-to-datedness of Information | Overall |
|---|---|---|---|---|---|
| Passed (P) | 21 and above | 54 and above | 15 and above | 18 and above | 108 and above |
| Failed (F) | below 21 | below 54 | below 15 | below 18 | below 108 |

Along content, the modules provide enough information to the students, so they can easily follow and understand the lesson. This is evident on the total modal score of 24 on the first validation and 25 for the second validation. On the format, the first validation has a total modal score of 56 and for the second validation the total modal score increased to 70. These scores are higher than the passing score which is 54, this implies that the developed modules follow the format of a real module.

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On presentation and organization, the modules have a total modal score of 18 on the first validation and 20 for the second validation. This shows that the modules got a passing modal score, since the passing score is 15.

The module also passed on the up-to-datedness in information with a total modal score of 23 and 22 from the first and second validation, respectively, while the passing score is 18. As Samuel, Mulenga, and Mukuka (2016) mentioned in their study the secondary school teachers faced the challenges that they must get regular refresher courses/training to update themselves with new developments in Mathmatics teaching and learning.

Table 8 on the next page shows the comments and suggestions given by the validators during the first validation of the modules. The features of the module that were commented are on the figures and illustrations, words that are to be described or defined, the difficulty of the activities, and the topics on the modules should for Basic Calculus. The figures such as the colors, font size, the image and illustrations should be improved, the sources of the figures and ideas that were cited should be acknowledged, and the learning activities should be enhanced. These comments and suggestions by the validators were considered and integrated to the module, after which a revalidation was also requested to the same validators.

Table 8. Comments and Suggestions During the First Validation

| On Content:` |
|---|
| 1. In a solution the equal (=) symbol should be aligned vertically |
| 2. There should be an arrow pointing the equation of the given curve. |
| 3. Each figure should have a figure number. You may follow this format, figure 1.3.2.<br>The number one refer to chapter one, the number three refers to section 3, and the number two refers to second figure. |
| 4. Level the difficulty of the activities. If possible use at least two level of difficulty. |
| 5. Highlight words being defined or describe |
| 6. Activities are all individually done |
| 7. Give activities that measure different cognitive skills |
| 8. Simplify discussions |

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9. There are definitions of terms that are incomplete
10. Refer to Basic Calculus curriculum. Topics start at Limits.

On Format:

1. The color of the letters should be light if the background is black.
2. There are objects in the figure which are not visible because of light color used.
3. The font size that will be used in the figure should be the same or smaller as the font size of the text.
4. Font size used is not consistent.
5. Some lessons are not aligned.
6. There are terms that are not properly labeled and identified.
7. May add more graphics to attract.
8. The module is bulky.
9. Please adopt font and style in the textual presentation.
10. Use clearer image for all illustrations.
11. It is better if illustrations are enclosed in a box to separate it from the text.
12. Use black as font color for clarity purposes.
13. Observe spacing on some of the activity part of the module.
14. There should be a chapter test at the end of each module.
15. Integrate encouragement/values in the activities.
16. Give or suggest other learning resources/activities.
17. Acknowledge sources of pictures/figures.
18. Place the references after each module.
19. Try to have same font & size especially in the formula.
20. Discuss as if you are having one-on-one discussion (tutoring).

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Table 9 shows the comments and suggestions given by the validators in the second validation. The table shows that the modules were aligned with the Senior High School Curriculum Guide. Some parts are still in need of improvement by considering what is suggested and should be edited by an English critique.

Indention on each paragraph, the spacing of activities, and the uniform font and size on the text should be observed and the text must be simpler and not so decorative. A chapter test should be provided at the end of each chapter and the sources/references of the pictures and figures used in the module should be acknowledged. The module has a clear illustrative graph. All these suggestions by the validators were considered and integrated by the researcher in order to come up with a better developed-modules which can be used as an instructional materials in Pre-Calculus and Basic Calculus subjects. The texts on the

Table 9. Comments and Suggestions on the Second Validation

| | |
|---|---|
| 1. | Improve some parts as suggested |
| 2. | Congratulations for making such instructional material |
| 3. | The module is already consistent with the SHS Curriculum guide |
| 4. | Please refer to an English critique for editing. |
| 5. | Observe the uniform indention in writing paragraphs, numbered statements and writing solutions |
| 6. | Some text are not readable because they are over decorative. Make them simpler so that the text become readable. |
| 7. | Enough examples and activities for evaluation |
| 8. | Observe spacing on some of the activity part of the module |
| 9. | Sections for graphing were provided |
| 10. | Clear illustrations of graphs |
| 11. | Introduce technology in graphing equations/functions |
| 12. | There should be a chapter test at the end of each module |
| 13. | Acknowledge sources of pictures/figures |
| 14. | Place the references after each module. |
| 15. | Try to have same font & size especially in the formula |
| 16. | Discuss as if you are having one-on-one discussion (tutoring) |

modules are simple, a chapter test are available at every chaper end, the modules have a clear illustration graphs, the sources/references of pictures and figures are acknowledged and the modules were edited by an English critique.

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The modules passed the validation made by the expert-validators and the contents are easy to comprehend and understand by the intended user; hence, the modules are good supplemental instructional material in teaching Pre-Calculus and Basic Calculus subjects.

**Level of Readabilty of the Developed Modules**

The developed modules were subjected to readability testing. Readability as defined by Shen (2017), is the attempt to improve texts, to derive rules for communicating more effectively and for assessing success at communication. The two factors affecting readability are the tangible factors for instance font size, spacing, layout, typeface, extra-textual aids such as diagrams, charts, pictures, semantic mapping, etc. and the factors of the reader like their subject pre-knowledge under the discussion, , their interest, reading ability and their motivation.

The Flesch Kincaid Reading Ease tool, a software readability online utility, was used to determine the level of readability of the developed-modules. The four measures that were used from this tool are: the Gunning Fog Score, Smog Index, Flesch Kincaid Reading Ease, and the Coleman Liau Index. The Flesch Kincaid Reading Ease measures the reading difficulty of the module. The Smog Index, Gunning Fog Score, and the Coleman Liau Index was used to determine the grade level of the students who can comprehend the text.

Table 10 shows the readability statistics of the modules. The mean index on Flesch Kincaid Reading Ease is 71.7. It indicates that the modules have a descriptive rating of Fairly Easy (FE). The texts on the modules are easy to comprehend and understand by the Grade 11 student since it is within their capability level.

The mean Gunning Fog Score is 8.6 which shows that the modules are readable that even a 9th grader or a high school freshman student can read and understand it. The mean Smog Index score is 6.7 which also shows that it is readable even with the 7th grader students. The mean Coleman Liau Index, 5.9, indicates that the module is also readable for the 6th grader students.

The contents of the modules are easy to comprehend and suitable to the intended readers since it also readable to a lower grader students.

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Table 10. Readability Score of the Developed Module

| Readability Statistics | Module 1 | Module 2 | Module 3 | Module 4 | Module 5 | Module 6 | Mean Score | Grade Level |
|---|---|---|---|---|---|---|---|---|
| Flesch Kincaid Reading Ease | 71.1 | 76.4 | 73.0 | 68.0 | 70.9 | 71.3 | 71.7 | 8th or 9th |
| Gunning Fog Score | 10.2 | 6.9 | 7.3 | 8.6 | 9.9 | 8.6 | 8.6 | 9th |
| Smog Index | 7.8 | 6.1 | 5.3 | 6.3 | 7.4 | 7.0 | 6.7 | 7th |
| Coleman Liau Index | 5.7 | 3.6 | 6.2 | 6.9 | 7.6 | 5.4 | 5.9 | 6th |

*Legend:*

Flesch Kincaid Reading Ease Scoring Key:

| Range of Score | School Level Descriptive Equivalent | |
|---|---|---|
| 70 - 80 | 7th Grade | Fairly Easy (FE) |

Smog Index, Gunning Fog Score, and Coleman Liau Index scoring key:

| Score Index | Reading level by grade |
|---|---|
| 9 | High school freshman |
| 8 | Eighth grade |
| 7 | Seventh grade |
| 6 | Sixth grade |

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

### Summary

This study aimed for the studenst of Grade 11 senior high school to develop an instructional material in Pre and Basic Calculus. The instructional material which is a module was developed or designed based on the Department of Education Curriculum Guide for Grade 11 particularly to STEM students. The modules were drafted by the researcher and validated by Mathematics teachers who teach in the tertiary level and who are teaching the subjects for at least five years. The validation form or evaluation sheet of the modules was adapted from the Dep Ed Rating Sheet for Print Supplementary Materials as used by Garin (2017). The modules were validated twice

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by the validators in which the first draft of the modules was validated and comments and suggestions were given and after incorporating all the suggestions, a revalidation by the same validators was done.

Here are the salient feautres of the following study:

1. Level of Validity

The developed modules in Pre-Calculus and Basic Calculus underwent validation by six pool of experts.

1.1. In terms of content validity, the developed modules had a total sore of 24 and 25 for the first and second validation, respectively. The top three values and traits which are were found to be developed in the students when they use the modules are: crirtical and creative thinking (20.00), desire for excellence (13.33), and desire to learn new things (13.33).

1.2 . The developed modules had a total modal score of 56 (first validation) and 70 (second validation) along format which includes printing, illustrations, designs, layouts, paper and binding, and size and weight.

1.3. Along presentation and organization, the modules had a total score of 18 and 20 for the first and second validation, respectively. These scores were higher than the passing score of 15.

1.4. Along up-to-datedness of information, the modules had a total score of 23 (first validation) and 22 (second validation).

1.5. Most of the comments and suggestions of the evaluators on the improvement of the modules concern the following: the inclusion of definition of terms, the identification of degree of difficultly of the activities, and the citation of sources of the illustrations used in the modules.

2. Readability Index of the Modules

The developed modules had the following readability index: Flesch Kincaid Reading Ease, 71.7 (Grade 8 or 9); Gunning Fog, 8.6 (Grade 9), Smog, 6.7 (Grade 7), and Coleman Liau, 5.9 (Grade 6).

## Conclusions

On the basis of study findings, the following drawn conclusions are:

1. The valid modules development were along with ontent, arrangements, presentation and organization, and perfection and latest information. It also means that the modules develop desirable traits and values among students, especially Grade 11. The comments and suggestions of the evaluators mean that the modules have still rooms for improvement.

2. The developed modules can be read by students from Grade 8 to 11. Thus, the modules are easy to understand and comprehensible to the expected end-users.

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## Recommendations

On the basis of the study conclusions, the following recommendations are offered:

1. School administrators, particularly in the STEM senior high school, should encourage their teachers to use these modules as a supplementary instructional material in teaching Pre-Calculus and Basic Calculus subjects. Also, the developed modules should be used by the teachers who are teaching Pre-Calculus and Basic Calculus subjects since they contain different activities that help develop the thinking skills and mastery learning of the students.
2. The modules can be used as supplementary reference material for Grade 11 and can be used anytime for reinforcement of the mastery learning.
3. Future researchers may use these modules in the actual classroom situation to determine its effectiveness. They may enrich its content by giving or adding activities like worded problems at the end of each chapter as recommended by some of the evaluators.

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