

Development and Validation of Instructional Material in Basic Calculus

Alfred P. Pantaleon
College of Graduate Studies,
Ilocos Sur Polytechnic State College
Sta. Maria, Ilocos Sur, Philippines

Abstract:- Basic Calculus is one of the most significant topics in pure mathematics, and students commonly fail to grasp its concepts. Thus, the development of teaching materials in Basic Calculus is essential to enhance the performance of the students to make learning more interactive. This study evaluated the learning skills of Grade 12 STEM students at Ilocos Sur Polytechnic State College in Basic Calculus particularly in Differentiation part, which led to the creation of a Developed Instructional Material. It made use of the descriptive research design involving correlational and developmental methods with a two-part questionnaire as the data gathering tool. The 36 student-respondents were chosen using the total enumeration technique. Weighted mean and Spearman correlation were utilized to analyze the data. According to the findings, the respondents' level of technology-assisted resources at home is relatively low. In addition, in terms of content, style, and instructions, the developed instructional material in Basic Calculus has a Very Acceptable degree of acceptability. Furthermore, the adequacy of technology-assisted resources had no effect on the level of acceptability of the developed instructional material in terms of content and style. Only the student-respondents' level of acceptability of instructions, on the other hand, showed a positive correlation. Finally, the developed instructional material is deemed to be very valid. The developed instructional material in basic Calculus may be used as an instructional material and that further studies can be conducted to continuously explore possible pedagogical interventions.

Keywords:- *Developed Instructional Material, Technology-Assisted Resources, Acceptability of Instructional Material, Validated Material.*

I. INTRODUCTION

Mathematics is one of the subjects that plays a significant role in everyday life. Math is used in a variety of everyday tasks. Mathematics serves as a foundation for other disciplines such as natural science and social science. Because of the importance of mathematics, it is usually taught in any educational institution and at each grade level with a substantially larger share of the lesson hour than other disciplines.

Calculus is a field of mathematics that studies how things change and provides a framework for modelling systems as well as a method for deducing the models' predictions [1]. It is one of the disciplines required for any STEM program in the K to 12 Education Curriculum in the

Philippines. However, students in the subject had been having recurring issues. Students struggle to master new concepts, resulting in a high failure rate in the course.

In the SHS STEM Curriculum, Calculus is subdivided into two. The Pre-Calculus that focuses on the introduction of calculus and the Basic Calculus that tackles the various concepts of calculus. Basic Calculus comprises three components in the STEM track: Functions, Limits and Continuity, Differentiation, and Integration. Each unit is made up of lessons that bring together learning competencies that are related. Each lesson is further subdivided into sub-lessons that focus on one or two teaching and learning competencies. [2]

The learning approach in basic calculus has always been based on a concept, theorem, and algorithm. But these concepts are difficult to understand without further discussions. For two pandemic years, Department of Education and Commission on Higher Education are doing its best to distinguish the effective modality to be implemented in every school. These include different learning delivery modalities that the department will look into such as Online Learning, Modular Distance Learning, Blended Learning, Radio-Based Instruction, and TV-Based Instruction.

Modular instructions are one of the learning resources produced at Ilocos Sur Polytechnic State College (ISPSC). It includes mathematics training for high school to college students in the hopes of supplementing other types of learning. However, there are some concepts or lessons that students do not fully comprehend, particularly in mathematics.

According to an interview with teachers at the ISPSC-Laboratory High School who taught Basic Calculus, this subject is one of the most significant topics in pure mathematics, and students commonly fail to grasp its concepts. All of the teachers who taught the subject noticed that the Differentiation unit, which includes five topics such as implicit differentiation, derivatives of trigonometric and exponential functions, derivatives of logarithmic and inverse functions, and the application of derivatives, was the most difficult for students.

Some of these issues included students' failure to learn, inability to apply knowledge obtained, low student engagement, unwillingness to practice problem sets or employ formula, and the subject's inherent complexity [3]. Despite of these difficulties, the students were expected to

apply their skills in calculus to their future field of specialization.

The development of teaching materials needs to be varied with other media to reduce the negative effects so that learning Basic Calculus can be more interesting, and the students' understanding on the concepts can be more powerful. One variation is to utilize information and communication technology development, such as utilizing the video application. This technology allows developers to do many things, including the development of teaching materials using multimedia that are contextual, actual, factual, innovative, and attractive. [4].

Educational games are getting increasingly common to use in education, both in schools and in homes of the learners [5]. At the same time, the amount of educational games on the market is increasing tremendously. Many students at this generation are hooked on certain types of online games.

Ref. [6] stated that education, computer/ video games can help develop problem solving skills and negotiation, judgement, analysis and strategic thinking, communicating skills and networking, narrative skills and transmedia navigation, non-linear thinking patterns, improved attention, vision and cognition.

The goal of this research is to develop a good learning instructional material in Basic Calculus, which can be easily accessed through mobile phones media by students from anywhere and at any time. It is an alternative medium that eases students in the institution to study Basic Calculus so that it can make students access the learning materials anytime, anywhere easily, and they can learn calculus with more flexible time and place.

A. Objectives of the Study

This study aimed to determine the level of acceptability and validity of the developed instructional material in Basic Calculus to SHS- STEM students in enhancing their mathematics performance. Specifically, it aims to answer the following questions:

- a) What is the level of adequacy of the technology-assisted resources of the students at home in terms of the following:
 - Smartphone
 - Personal Computer
 - Tablet
 - Laptop
 - Netbook
 - iPad, and
 - Ordinary Mobile Phone (Keypad, etc)
- b) What is the level of acceptability of the developed instructional material in terms:
 - Content,
 - Style, and
 - Terms of Instructions
- c) Is there a significant relationship between the technology-assisted resources and the level of

acceptability of the developed instructional material in Basic Calculus?

- d) What is the level of validity of the Developed Instructional Material in Basic Calculus?

II. METHODOLOGY

This study used the descriptive research design employing correlational and developmental approaches. The descriptive research was chosen to determine the profile of the respondents in terms of adequacy of technology- assisted resources, and their level of acceptability on the developed instructional material. In addition, the study used correlational research design to determine the significant relationship of variables. In this study in particular, the researcher looked into the relationship between the technology-assisted resources of the students and their level of acceptability of the developed instructional material in Basic Calculus. The study was conducted among the SHS- STEM Grade 12 students who were enrolled during the First Semester, Academic Year 2021-2022 at the Ilocos Sur Polytechnic State College, Santa Maria Campus. Thirty-six (36) student- respondents were selected through total enumeration technique. The study used the descriptive survey questionnaire in gathering the data needed. Modified questionnaire from the study of [7] was used and had it validated by experts. The data gathered were treated statistically using the Weighted mean and Spearman correlation.

III. RESULTS/ FINDINGS

Table 1 displays the level of adequacy of technology-assisted resources which the SHS- STEM students used in their studies.

Items	Mean	DR
Smartphone	4.67	Completely Adequate
Personal Computer	2.78	Moderately Adequate
Tablet	2.58	Partially Adequate
Laptop	3.47	Adequate
Netbook	2.42	Partially Adequate
iPad	2.28	Partially Adequate
Ordinary Mobile Phone	2.92	Moderately Adequate
Average Mean	3.02	Moderately Adequate

Table 1 : Level of Adequacy of Technology-Assisted Resources

Based on the table, it can be inferred that the level of adequacy of technology-assisted resources of the students for their studies is low described as Moderately Adequate. This shows that the students have a very limited technology resources to aid their learning experience. By implication, the result suggests that it would be difficult for the student to acquire new knowledge and develop existing competencies with the limited resources to be used in their studies. Among the listed items, smartphone followed by Laptop is the most completely adequate technology-assisted resources among the respondents. This is because of the multiple features that smartphones can provide for the

users. This is in consonance to the findings of [8] which revealed that ninety-four percent of students owned smart phones, and majority of them used like mobile by using as a computer connected to internet and a digital camera. Furthermore, tablet, Netbook, and iPad are partially adequate from the respondents. The result shows that the respondents have a limited knowledge on the functions of these technological resources, especially the iPad.

Table 2 shows the level of acceptability of the developed instructional material in terms of content among the SHS- STEM students of ISPSC, Sta. Maria Campus.

Indicators	Mean	DR
1. Content reinforces, enriches, and leads to the mastery of certain competencies for the level and subject it was intended.	4.42	Very Acceptable
2. Facts are accurate and there is clear and meaningful connection between all concepts.	4.47	Very Acceptable
3. Language is appropriate for the level of the target user specified.	4.67	Very Acceptable
4. Visuals are clear in content and detail.	4.44	Very Acceptable
5. Assessment complexity matches learning content supplied.	4.33	Very Acceptable
6. Assessment answers are accurate and comprehensive.	4.47	Very Acceptable
7. Learning activities are user friendly.	4.42	Very Acceptable
Average Mean	4.46	Very Acceptable

Table 2 : Level of Acceptability of the Developed Instructional Material in terms of Content

It can be gleaned from the table that “Language is appropriate for the level of the target user specified” recorded the greatest mean rating, while “Assessment complexity matches learning content supplied” received the lowest mean rating, both labelled as "Very Acceptable." The overall mean score in terms of the acceptability of the material along content was “Very Acceptable”. As a result, the developed instructional material is widely approved for use as an extra instructional tool in improving and developing students' performance.

The outcomes of this study corroborate with the conclusions of [7], who found that the content of instructional materials in his study is extremely satisfactory. Furthermore, this finding indicates that the instructional material was successfully used in the teaching–learning process by the respondents. Students may have been able to easily fulfill the lesson's goal without compromising their performance or the lesson's goal. Because passages and photos are localized, they were most likely able to make connections to the instructional content.

Table 3 shows the level of acceptability of the developed instructional material in terms of style among the SHS- STEM students of ISPSC, Sta. Maria Campus.

Indicators	Mean	DR
1. The grammatical structure is correct and appropriate.	4.67	Very Acceptable
2. Visuals are relevant to the topic.	4.58	Very Acceptable
3. The materials considered are of high quality.	4.53	Very Acceptable
4. Material is free of ideological, cultural, religious, radical and gender biases and prejudices.	4.61	Very Acceptable
5. Resources conform to the learner’s privacy and respect learner’s cultural beliefs etc.	4.72	Very Acceptable
6. The typographic layout is well-organized, attractive, and supports the printed modules.	4.53	Very Acceptable
7. Size of the letters is appropriate for the target audience.	4.53	Very Acceptable
Average Mean	4.60	Very Acceptable

Table 3: Level of Acceptability of the Developed Instructional Material in terms of Style

The table revealed that all of the indicators received a "Very Acceptable" rating. “Resources conform to the learner’s privacy and respect learner’s cultural beliefs etc.” received the greatest mean rating, while items “The materials considered are of high quality”, “The typographic layout is well-organized, attractive, and supports the printed modules”, and “Size of the letters is appropriate for the target audience” received the lowest mean rating, all of which were rated as "Very Acceptable." This meant that the layout of the information, as well as the size of the letters, should be improved to accommodate diverse types of learners. Overall, the developed instructional material was rated "Very Acceptable" in terms of style acceptability. This implies that the developed instructional material met or exceeded the material's quality and applicability criteria.

The results confirmed the findings of [7] that students can more effectively respond to a book when they have critical thinking skills. Students can deduce the primary idea and supporting facts, as well as the sequence of events and the overall structure of the text, as they read. In addition, students will be able to recognize literary devices and their impact on the text. Critical thinking abilities aid a student's comprehension of a material, resulting in a more enjoyable reading experience.

Table 4 shows the level of acceptability of the developed instructional material in terms of instructions among the SHS- STEM students of ISPSC, Sta. Maria Campus.

Indicators	Mean	DR
1. The purpose, process and possible outcome have been clearly stated.	4.58	Very Acceptable
2. The learning objectives have been made clear to the learners.	4.58	Very Acceptable

3. The material has accompanying feedback and evaluation form.	4.50	Very Acceptable
4. The material can be easily and independently use.	4.44	Very Acceptable
5. The material can be used without direct involvement of the developer.	4.53	Very Acceptable
6. The learning activities support the goals and objectives.	4.56	Very Acceptable
7. The instructions and prompts are helpful.	4.64	Very Acceptable
Average Mean	4.55	Very Acceptable

Table 4: Level of Acceptability of the Developed Instructional Material in terms of Instructions

The table displays that “The instructions and prompts are helpful” had the highest mean rating, followed by “The purpose, process and possible outcome have been clearly stated” and “The learning objectives have been made clear to the learners”, both of which were classified as "Very Acceptable." While “The material can be easily and independently use” received the lowest mean rating, it was nevertheless deemed "Very Acceptable." The overall mean rating in terms of instructions was "Very Acceptable." This means that the developed instructional material provides a well-defined set of instructions to help clients improve their performance. These figures are relevant to [9], as stipulated in the study of [7], instructional materials are both enjoyable and educational, and they can appeal to a variety of senses.

Table 5 exhibits the correlation of the adequacy of technology- assisted resources of the respondents and their level of acceptability of the developed instructional material along content, style, and instructions.

	Level of Acceptability of the Developed Instructional Material		
	Content	Style	Instructions
Adequacy of Technology-Assisted Resources	0.228	0.308	0.403*

Table 5: Relationship between the adequacy of technology-assisted resources and the level of acceptability of the developed instructional material

* Correlation is significant at 0.05 level (2-tailed)

It is reflected on the table that instructions is significantly correlated to the adequacy of technology-assisted resources of the respondents at 0.05 level of significance. However, the adequacy of technology-assisted resources is determined to be insignificantly associated to content and style, which showed little correlation.

The findings showed that the adequacy of technology-assisted resources has a significant impact on the acceptability of developed instructional material in terms of instructions. This implies that the developed educational material aids students' grasp of ideas because the

information may be used simply and independently without the developer or teacher's direct involvement using the available technology- assisted resources they have at home.

This is in line with the findings of Ref. [10] that students have claimed that when multimedia presentations are used, they learn better, understand more complex concepts more easily, and retain the subject matter. Furthermore, multimedia allows students to engage in "practical" learning, improve concentration, receive personalized feedback, and gain a deeper comprehension of concepts. Privacy, collaborative and communication skills, organization, support for learning styles, and multisensory learning are all essential properties of ICT that make them suited for enabling individualized education.

A. *Validity of the Developed Instructional Material*

The table shows the result of the evaluation of the validation of the developed instructional material in basic calculus as the output of this study.

Indicators	Mean	DR
1.The learning objectives are simple, measurable, attainable, realistic and time- bound.	5.00	Very Valid
2. The activities are organized based on the sequence of the focus skills.	4.80	Very Valid
3. The activities assess students understanding of what they have learned and correct errors when appropriate.	4.80	Very Valid
4. Critical thinking abilities are developed and promoted through the exercises.	4.80	Very Valid
5. Monitor their learning and uses feedback about their progress.	5.00	Very Valid
6. Provides opportunities for students to work independently or in groups to explore answers to their own.	4.80	Very Valid
7. The strategies and activities sustain the attention and interest of the students.	4.60	Very Valid
Average Mean	4.83	Very Valid

Table 6: Level of Validity of the Developed Instructional Material

The table revealed that “The learning objectives are simple, measurable, attainable, realistic and time- bound” and “Monitor their learning and uses feedback about their progress” received the highest mean rating of "Very Valid," followed by “The activities are organized based on the sequence of the focus skills”, “The activities assess students understanding of what they have learned and correct errors when appropriate”, “Critical thinking abilities are developed and promoted through the exercises”, and “Provides opportunities for students to work independently or in groups to explore answers to their own”, all of which were still considered “Very Valid." However, as shown in the table, “The strategies and activities sustain the attention

and interest of the students” had the lowest mean rating, which still interprets to "Very Valid." This implies that before using the developed instructional material, it should be enhanced and improved by incorporating the expert – evaluators' comments and recommendations. The overall mean score of "Very Valid" indicates that the developed Basic Calculus instructional material is a viable instrument for assisting students in improving their Basic Calculus performance.

IV. CONCLUSION

Based from the data gathered and interpreted, the developed instructional material is evaluated as very valid and reliable that can help the students develop proficiency in the different learning competencies. Furthermore, the developed instructional material addresses the needs of the students in helping them improve their Basic Calculus performance. A further study along this line should be conducted not only to validate and strengthen the results and findings of this study but also to consider the interactive aspect of the material that they will produce. At the same time, they must include video presentations in the discussion part of the material.

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