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Integrating Mathematical Modeling of Real-Life Problems: A Contextualized Approach to Developing Instructional Material in Basic Calculus

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Abstracts: This study focuses on the creation of contextualized educational materials for senior high school basic calculus that integrates mathematical modeling with real-life problems. The research follows the ADDIE model employing only three stages: analysis, design, and development (ADD). In the analysis phase, the researcher determines the level of modeling competency, self-efficacy, and appreciation of the learners using the Assessment of the Modeling Skills (RAMS), Indices for Mathematical Modeling Self-Efficacy Scale (IMMSES), and the Indices for the Level of Appreciation of Mathematical Modeling (ILAMM) respectively. The results from the previous phase were considered in designing and developing contextualized instructional material that aligned with the concepts of didactical situations and mathematical modeling. Quantitative data analysis includes descriptive statistics to determine the level of modeling competency, self-efficacy, and appreciation of the learners and the assessment of the teachers on the mathematical modeling activities. This study also reveals that the learner's lack of prior knowledge in algebra and trigonometry contributed to the difficulty in solving real-life problems in Basic Calculus. Moreover, teaching materials are limited only on problem-solving and formative assessment. With this, the researchers designed and developed instructional materials that incorporate a variety of resources, including problem scenarios, data sets, visualizations, and technology tools, to facilitate students' exploration and analysis of the modeled problems. Ultimately, it aims to enhance students' understanding and engagement by providing them with meaningful and practical applications of the subject matter.

Keywords: Mathematical Modeling, Self-Efficacy, Modeling Competency, Contextualized Instructional Material, Real-life Problem, Differentiation, Calculus.

1. INTRODUCTION

Mathematics is the way of settling in the mind and the habit of reasoning and it is an expression of the human mind that reflects the active well completive reasons and desires for aesthetic perfection. Mathematics is interpreted, explained, and used in different situations to generate logic, intuition, constructivism, analytical, formulation, and generalization of judicial power.

According to Poudel (2015), Mathematics is concerned with the development and implementation of an appropriate Mathematics curriculum and all issues associated with teaching and learning mathematics in keeping with the concept of lifelong learning. Mathematics education is directly concerned with classroom teachers, learners, curriculum, school, and contemporary society. Today's world expects mathematics teachers to raise individuals who are able to create effective solutions in cases of real problems and use mathematics effectively in their daily lives. Thus, they will enjoy mathematics instated of being scared of it and comprehend and appreciate the importance and power of mathematics (Arseven, 2015). The main reason why mathematics is the most comprehensive education area of the world is that mathematics could be used in various ways in areas and topics that are not related to it. In the process of modeling, the components are as follows:

Defining the Problem Statement. Real-world problems can be broad and complex. It's important to refine the conceptual idea into a concise problem statement that will indicate exactly what the output of your model will be.

Making Assumptions. Early in your work, it may seem that a problem is too complex to make any progress. That is why it is necessary to make assumptions to help simplify the problem and sharpen the focus. During this process you reduce the number of factors affecting your model, thereby deciding which factors are most important.

Defining Variables. What are the primary factors influencing the phenomenon you are trying to understand? Can you list those factors as quantifiable variables with specified units? You may need to distinguish between independent variables, dependent variables, and model parameters. In understanding these ideas better, you will be able both to define model inputs and to create mathematical relationships, which ultimately establish the model itself.

Getting a Solution. What can you learn from your model? Does it answer the question you originally asked? Determining a solution may involve pencil-and-paper calculations, evaluating a function, running simulations, or solving an equation, depending on the type of model you developed. It might be helpful to use software or some other computational technology.

Analysis and Model Assessment. In the end, one must step back and analyze the results to assess the quality of the model. What are the strengths and weaknesses of the model? Are there certain situations when the model doesn't work? How sensitive is the model if you alter the assumptions or change model parameter values? Is it possible to make (or at least point out) possible improvements?

Reporting the Results Your model might be awesome, but no one will ever know unless you are able to explain how to use or implement it. You may be asked to provide unbiased results or to be an advocate for a particular stakeholder, so pay attention to your point of view. Include your results in a summary or abstract at the beginning of your report.

Stillman, et.al (2013) that modeling from a broad perspective, have two categories of pedagogical aims that must be captured in teaching methods that underpin an adequate modeling pedagogy. Firstly, modeling itself is treated as an objective and secondly, modeling is treated as a means to mathematical knowledge construction. For the first aim, the teacher needs to set an appropriate situation so that students realize the necessity of solving a real-world problem, assist students' abstraction processes, and show students the necessity of controlling for various assumptions. For the second aim, three teaching principles are suggested: (1) expanding and clarifying real-world situations satisfying a ready-made model, (2) expanding and integrating mathematical knowledge by setting up a concrete situation so that students can consider it, and 3) refining and clarifying the developed mathematical methods by treating instances of the same contexts repeatedly.

An important characteristic of mathematical modeling is that students not only make choices about how to narrow the focus of a problem but also are empowered to choose a mathematical approach. In the early grades, making and implementing decisions about how to use mathematics to get a solution might happen in a group setting. Some young children might benefit from use of visual representations to help them recognize a pattern or trend while others might recognize the pattern s something familiar to them (GAIMME, p.29, 2016).

In contrast to word problems, we often use the phrase "a solution" (as opposed to "the solution") when we talk about modeling problems. This is because people who look at the same modeling problem may have different perspectives on its resolution and can certainly come up with different, valid alternative solutions. It is worth noting that word problems can actually be thought of as former modeling problems. That is to say, someone has already determined a simple model and provided you with all the relevant pieces of information. This is very different from a modeling problem, in which you must decide what's important and how to piece it all together. Mathematical modeling questions allow you to research real-world problems, using your discoveries to create new knowledge. Your creativity and how you think about this problem are both highly valuable in finding a solution to a modeling question. This is part of what makes modeling so interesting and fun (Bliss, Fowler, and Galluzz, 2014).

Relating mathematics concept to its context in the real – world is now the demand (Gainsburg, 2008; Jurdak, 2006) which allows learning transfer through contextual teaching and learning approach (Boaler, 1993; Mahendra, 2016; Mulyono & Lestari, 2016; Nabila & Widjajanti, 2020). Context is directly related to everyday life (Supiyati, Hanum, & Jailani, 2019). Mathematizing culture and environment which it is assumed to motivate students to recognize mathematics as part of everyday life aims to enhance the student's ability, deepen their understanding of all forms of mathematics, and to make meaningful mathematical connections (Alangui, 2017; Muhtadi, Sukirwan, Warsito, & Prahmana, 2017; Rosita, 2016). Albeit, contextualization consumes much time for preparation with the unavailability of the local materials and difficulty in pedagogy. Not all topics are applicable and students' differences pose a challenge to contextualization, however, contextualization still increases the learning engagement wherein students have better retention of concepts and conceptual understanding (Madrazo & Dio 2020). These researches are supported by Constructivist theory. It is an important part that must be understood in contextual learning, because in contextual learning students actively construct their own understanding rather than as a process in which ideas are transferred to the student teacher. Contextual learning, Bruner's theory is a theory that is important. This is because the experience of the child will try to adjust or reorganize the structures of ideas in order to achieve a balance in his mind. This is in line with the essence of contextual learning, the students participate actively discover and transform complex information into other situations (Surya & Putri 2017).

The learning module contains summaries of material, and training, and covers how students build knowledge (Hamdunah, Yunita, Zulkardi, & Muhafzan, 2016). It is an instructional material used to ease, encourage, improve, and promote teaching and learning activities to improve and facilitate effective processes of instruction (Matarazzo, Durik, & Delaney, 2010; Fradd, Lee, Sutman, & Saxton, 2001). Learning module offers new approaches and learning opportunities that enhance students' knowledge and helps them overcome deficiencies (Gordon & Nicholas, 2013). Teachers should be aware of the prerequisite topics so that intervention could be done to address students' least mastered competencies (Herrera & Dio, 2016). Learning modules develop mathematical skills (Setyani, Putri, Ferdianto, & Fauji, 2020), and improve students' abilities and affect their learning motivation (Saifiyah, Ferdianto, & Setiyani, 2017). Nevertheless, contextualized learning modules are effective to bridge learning gaps independently as they supplement and complement the teacher's verbal explanations in making a learning experience. Contextualized learning modules can also clarify, vitalize, emphasize the instruction, and enhance learning in the process of transmitting knowledge, ideas, skills, and attitude (Oladejo, Olosunde, Ojebisi, & Isola, 2011). Hence, contextualized learning modules are user – friendly where students can learn on their own (Lai & Hwang, 2016) and are widely accepted by the present educational systems to have a positive effect on learning (Hendriana, Prahmana, & Hidayat, 2019). This connotes that contextualized learning modules eventually promote independent learning.

The K to 12 Mathematics Curriculum Guide underscores the need for learners to learn and explore mathematics comprehensively and with much depth due to the fact that its value goes beyond the classroom and school. Little (2009) affirmed that the ability to compute, problem-solve, and apply concepts and skills in mathematics influences multiple decisions in life. Thus, it is imperative for a Mathematics teacher to engage, facilitate and encourage learners to achieve the twin goals of mathematics (critical thinking and problem-solving), especially in Senior high School being the concluding part of basic education.

2. THEORETICAL FRAMEWORK

This study is anchored to the following several key theories:

Constructivism. Constructivism is founded by three psychologists. Jean Piaget belongs to radical constructivism. His theories indicate that humans create knowledge through the interaction between their experiences and ideas. His view of constructivism is the inspiration for radical constructivism due to his idea that the individual is at the center of the knowledge creation and acquisition process. Lev Vygotsky, on the other hand, focuses on the social components of experiential learning. He suggests that one learns best through interacting with others. Through the process of working with others, learners create an environment of shared meanings with peers. By being immersed in the new environment, the learner is able to adapt subjective interpretations to become socially accepted. Vygotsky especially emphasizes that culture plays a large role in cognitive development. John Dewey straddles the two perspectives and offers numerous ideas that appeal to both. His work proclaims that learners who engage in real world activities will be able to demonstrate higher levels of knowledge through creativity and collaboration (Behling & Hart, 2008). One of Dewey's most recognized quotes is: "If you have doubts about how learning happens, engage in sustained inquiry: study, ponder, consider alternative possibilities and arrive at your belief grounded in evidence" (Reece, 2013, p. 320). The common ground that brought these psychologists together under the banner of constructivism is that all three believed that the learning process were rooted in experiences in the classroom instead of experiments in a lab.

Constructivism is a learning theory which holds that knowledge is best gained through a process of reflection and active construction in the mind (Mascolo & Fischer, 2005). Thus, knowledge is an intersubjective interpretation. The learner must consider the information being taught and - based on past experiences, personal views, and cultural background - construct an interpretation. Constructivism is split into two main camps: radical and social. The first form radical (or cognitive) constructivism proposes that the process of constructing knowledge is dependent on the individual's subjective interpretation of their active experience. The second form social constructivism affirms that human development is socially situated, and that knowledge is constructed through interaction with others. This chapter discusses the history, practice, examples in education and limitations.

Contextualization. This concept involves connecting mathematical concepts to real-life situations, making the content more relatable and applicable to students' lives. By embedding calculus principles within authentic contexts, such as engineering, physics, economics, or biology students can see the practical relevance of the subject matter, which enhances their engagement and motivation to learn. It explores the integration of contextualized approaches in teaching calculus. It discusses the benefits of connecting calculus concepts to real-world contexts, highlights challenges in implementing contextualized instruction, and provides practical strategies for incorporating contextualization in calculus classrooms. Several studies on contextualization in mathematics education have found that it improves student learning and engagement.

Self-Efficacy. According to Bandura (1997), mastery experiences are the most important and effective sources of self-efficacy beliefs. For example, if the students with higher performance in mathematical modeling get higher scores from a modeling course, they will develop positive beliefs in their capacity for this subject. However, although they have higher performance, and they get low scores, then, their belief in their ability will decrease and it will directly affect their performance.

3. METHODS

This study applied instructional design called the ADDIE model or Analysis, Design, Development, Implementation, and Evaluation. However, this study only includes 3 phases Analysis, Design, and Development (ADD). In Phase 1, the Analysis part, applied both quantitative and qualitative approaches to determine the level of student's self-efficacy and appreciation of the real-life application of differentiation through mathematical modeling. Moreover, in this phase, the least learned competencies of the students and the learning gap in understanding the different mathematical concepts through different learning resources were also determined. In phase 2, the Design of the contextualized materials corresponds to the results from the previous phase and to the learning objectives reflected in the K to 12 curricula.

Finally, Development starts the production and testing of the methodology being used in the project. In this phase, designers make use of the data collected from the two previous stages and use this information to create a program that will relay what needs to be taught to the participants. If the two previous phases required planning and brainstorming, the Development phase is all about putting it into action. This phase includes three tasks, namely drafting, production, and evaluation (educational technology.net).

This study was conducted and fixed on the two schools' divisions namely, the Division of Agusan del Norte and the Division of Butuan City. The schools were then identified based on the curricular offering in senior high school wherein the study focuses on the STEM strand.

To provide meaning and an acceptable interpretation for the data acquired, statistical procedures such as frequency count and percentage, and mean were used to analyze and interpret the quantitative data gathered. A descriptive design using a questionnaire was used in the qualitative analysis of the data. To decide whether the program was appropriate and reliable, there was an investigation done by a survey questionnaire on their reflection on the traditional and the mathematical modeling strategy to find a significant difference from the prior analysis. Frequency and Percentage Distribution were the statistical tools used to identify the number of times the data value occurs. This was used in assessing the learners' least–learned competencies in differentiation and the teacher's evaluation of the mathematical modeling activity. While mean was computed where the sum of a collection of numbers divided by the count of numbers in the collection is multiplied by 100%. This was used to determine the learners' level of mathematical modeling competency, self-efficacy, appreciation of the mathematical modeling, and the teacher's evaluation of the factors that hinder the teaching–learning process and affected the performance of the learners through their experiences and observations.

4. RESULTS

As shown in Table 1, from the competencies in unit 2 of the Basic Calculus subject in Senior High School of the Department of Education, the above-stated competencies are the least–developed competencies. Based on the result, the competency with the highest percentage is the "application of the differentiation rules in computing the derivative of algebraic, exponential, and trigonometric functions" with an overall percentage of 10.25% across the four schools. It was followed by "solving optimization problems" with 9.58%, and the lowest is "solving situational problems involving related rates" with 7.85%. However, the learners still did not meet a good performance rating as these three competencies fall into the No Mastery level. In the overall evaluation, the three competencies gained a general percentage score of 9.23% which it falls to the No Mastery level wherein these correspond to the skills of the learners that really need to be learned and developed.

Table 1. The Mean Percentage scores of the Least – learned Competencies of the Learners in Differentiation

Competencies	School A	School B	School C	School D	Overall	Remarks
solve optimization problems (STEM_BC11D-IIIg-1)	13.33%	9.00%	9.33%	6.67%	**9.58%**	**No Mastery**

apply the differentiation rules in computing the derivative of algebraic, exponential, and trigonometric functions (STEM_BC11D-IIIf-3)	11.60%	10.40%	7.50%	11.50%	**10.25%**	**No Mastery**
solve situational problems involving related rates (STEM_BC11D-IIIj-2)	8.44%	5.78%	6.67%	10.50%	**7.85%**	**No Mastery**
Mean Percentage	**11.12%**	**8.39%**	**7.83%**	**9.56%**	**9.23%**	**No Mastery**

LEGEND: 75% - 100% - Mastered; 51% - 74% - Nearly Mastered; 50% and Below - No Mastery/Least Learned Skill

A study by Nurkaeti (2018) and expounded by the study of Ereño and Benavides (2022), analyzed the problem-solving difficulties of students based on the Polya strategy which is a strategy of problem-solving that can be developed in mathematics learning.

The results showed the difficulty of mathematical problems solving of students consists of the difficulty of understanding the problem, determining the mathematical formula/concepts that are used, making connections between mathematical concepts, and reviewing the correctness of answers with questions. This happened because the problem presented is in a story problem, which is rarely studied by students. Students usually solve mathematical problems in the form of routine questions, which only require answers in the form of algorithmic calculations.

Another characteristic of the students that are analyzed is mathematical competency. Table 2 shows the assessment of the learners' level of mathematical modeling competency.

Table 2. The Mean Percentage scores on the Learner's Level of Mathematical Modeling Competency

Law of Cooling	Mean	Verbal Description	Interpretation
Attitude			
Understanding the Problem	3	Often	Moderate
Simplifying	2.25	Sometimes	Low
Mathematising	2.50	Sometimes	Low
Working Mathematically	2	Sometimes	Low
Interpreting	2	Sometimes	Low
Validating	2.75	Often	Moderate
Overall Mean	**2.42**	**Sometimes**	**Low**
Population Dynamics	**Mean**	**Verbal Description**	**Interpretation**
Attitude			
Understanding the Problem	3	Often	Moderate
Simplifying	2.50	Sometimes	Low

Mathematising	2.25	Sometimes	Low
Working Mathematically	2	Sometimes	Low
Interpreting	2.50	Sometimes	Low
Validating	2.25	Sometimes	Low
Overall Mean	**2.42**	**Sometimes**	**Low**
Grand Total Mean	**2.42**	**Sometimes**	**Low**

Based on the results, it revealed that from the first activity on the law of cooling that the overall mean is 2.42 which is a low competency level. On the other hand, in the population dynamics activity it showed an overall mean of 2.42 which also falls in the low competency level. From the two modeling activities, only the indicator about understanding the problem where the learners got a somewhat high competency level from among the indicators where it gained a mean of 3 for both the activities. The grand total mean of 2.42 got a low level of mathematical modeling competency on the learner's part.

Stillman et. al. (2013) cited Redmond, Brown, and Sheehy which investigates how the discourse of the mathematics classroom impacts and enables the students to analyze mathematical contexts, synthesize strategies to mathematize these tasks, and communicate solutions and conclusions to others. Redmond, Brown, and Sheehy argue that when students engage with the discourse of their mathematics classroom in a manner that promotes the communication of ideas, they employ mathematical modeling practices that reflect the cyclical approaches to modeling employed by mathematicians.

Innovative classroom practices could bring more teachers into the fold who are able to realize the espoused potential benefits of modeling for students in allowing them to utilize mathematics as a means of "experiencing the world" (Chapman 2009). As student progress through this modeling cycle, research suggests there are specific skills students can develop. When students analyze real-world situations, students need to bridge and connect knowledge from multiple domains because it is almost impossible to just use ideas from a single topic or discipline (Lesh & Harel, 2003). The use of modeling tasks in the classroom is important in order to develop modeling abilities in students and modeling instructional and design skills for teachers. Research has provided some insight on what student thinking, teacher knowledge, and instructional components need to be considered as teachers design and enact modeling tasks within the classroom in order to promote these abilities (Buhrman 2017).

Table 3 shows learners' level of Mathematical Modeling self-efficacy. This is another student characteristic that is considered in the design of Instructional material. The mean percentage score on the level of learners' self – efficacy in mathematical modeling across five indicators with the corresponding overall mean as shown in Table 8. The highest mean is 3.42 (Competencies to understand the real problem and to set up a model on reality), followed by 3.40 (Competencies to set up a mathematical model from a real model), 3.27 (Competencies to interpret mathematical results in a real situation), 3.24 (Competencies to solve mathematical questions within this mathematical model), and 3.06 (Competencies to validate the solution). The overall mean (3.28) of all indicators is distributed equally with the verbal description "neither agree nor disagree". Most learners demonstrate this, with the mean responses indicating a moderate manifestation of their self–efficacy in doing mathematical modeling.

Table 3. The Mean Percentage scores on the Learner's Level of Mathematical Modeling Self- Efficacy

Indices for Mathematical Modeling Self-Efficacy	Mean	Interpretation

Competencies to understand the real problem and to set up a model on reality		
I could understand real life problem situation by simplifying.	3.45	Moderate
I could make assumptions to understand and interpret real life problems.	3.58	High
I could identify real-life situations differently.	3.75	High
I have difficulty in planning to solve a real-life problem.	3.23	Moderate
I could benefit from relations between variables to make estimations from given situation.	3.58	High
I have a difficulty in setting up figure, drawing or model to describe real-life situation.	2.93	Moderate
Overall Mean	**3.42**	**Moderate**
Competencies to set up a mathematical model from a real model		
I have difficulty in establishing relationships between mathematical models (formula or graphics) and mathematical materials ((unit cubes, geometrical strips, etc.).	3.38	Moderate
I could not decide on relevant information to set up a mathematical model.	3.05	Moderate
I could see mathematical relationships in real-life situations.	3.68	High
I could reflect on mathematical model in depth.	3.05	Moderate
I could use different materials to set up a mathematical model.	3.58	High
I could choose appropriate mathematical notations (graphic, function, etc.) to set up a mathematical model.	3.65	High
Overall Mean	**3.40**	**Moderate**

Competencies to solve mathematical questions within this mathematical model		
I have difficulty in understanding mathematical and cognitive processes in developing mathematical formulas or notations.	3.38	Moderate
I could compare mathematical models developed for different problem situations.	3.18	Moderate
I could decide on how to use mathematics in different problem situations.	3.43	Moderate
I could design mathematical models for different mathematical subjects.	3.08	Moderate
I could use a formula developed for solving a math problem in developing formulas for similar problems.	3.33	Moderate
I could demonstrate a function on a graphical model.	3.08	Moderate
Overall Mean	**3.24**	**Moderate**
Competencies to interpret mathematical results in a real situation		
I could interpret mathematical results in social and daily life.	3.55	High
I could apply the solution for a mathematical problem to the real-life situations.	3.53	High
I have difficulty in understanding mathematical formulas or graphics used in other disciplines (physics, chemistry, etc.).	3.15	Moderate
I have difficulty in interpreting mathematical formulas or graphics applied to real-life situations.	3.08	Moderate
I could generalize mathematical solutions into different real-life situations.	3.4	Moderate
I could develop formulas or graphics that enable to take actions for the future based on a given dataset.	2.93	Moderate
Overall Mean	**3.27**	**Moderate**
Competencies to validate the solution		
I could validate the model that I developed by mathematical modeling.	3.08	Moderate
I feel confident to demonstrate the accuracy of a mathematical model.	2.68	Moderate
I could critically check the solution that I obtained by mathematical modeling.	3	Moderate
I could review the modeling process after developing a solution for a mathematical problem situation.	3.15	Moderate
I could develop alternative solutions during mathematical modeling process.	3.2	Moderate
I could develop creative solutions by checking possible mistakes done during modeling process.	3.2	Moderate
I could develop problems that could be solved by mathematical formulas or graphics.	3.15	Moderate
Overall Mean	**3.06**	**Moderate**
GRAND TOTAL MEAN	**3.28**	**Moderate**

Legend: 1.00-1.49(Very Low), 1.50-2.49(Low), 2.50-3.49(Moderate), 3.50-4.49(High), 4.50-5.00(Very High)

The mean percentage score on the level of learners' self–efficacy in mathematical modeling across five indicators with the corresponding overall mean is shown in Table 3. The highest mean is 3.42 (Competencies to understand the real problem and to set up a model on reality), followed by 3.40 (Competencies to set up a mathematical model from a real model), 3.27 (Competencies to interpret mathematical results in a real situation), 3.24 (Competencies to solve mathematical questions within this mathematical model), and 3.06 (Competencies to validate the solution). The overall mean (3.28) of all indicators is distributed equally with the verbal description "neither agree nor disagree". Most learners demonstrate this, with the mean responses indicating a moderate manifestation of their self–efficacy in doing mathematical modeling. According to the results of Slamet, et.al (2021) student's mathematical self-efficacy is positively correlated with and has a significant effect on students' Mathematical understanding. The results also reveal that students with a high level of student's mathematical self-efficacy perform better in their mathematical understanding than students with medium and low student's mathematical self-efficacy. Furthermore, our findings indicate that students' mathematical self-efficacy could be the best predictor for student achievement, such as mathematical understanding.

Table 4. The Mean Percentage scores on the Learner's Level of Appreciation in the Mathematical Modeling

Indices for the Level of Appreciation of Mathematical Modeling	Mean	Interpretation
Attitude		
I am looking forward to taking more mathematics.	3.68	High
No matter how hard I try, I still do not do well in mathematics.	2.75	Moderate
Mathematics is harder for me than for most learners.	2.75	Moderate
If I had my choice, this would be my last mathematics subject.	2.5	Moderate
I am good at solving mathematical problems.	3.05	Moderate
Overall Mean	**2.95**	**Moderate**
Usefulness		
I expect to use the mathematics that I learn in this subject in my future career.	4.08	High
It is not important to know mathematics in order to get a good job.	2.45	Low
Mathematics is useful in solving everyday problems.	3.93	High
Very little of mathematics has practical use on the job.	3.13	Moderate
The content of this course will be useful in my future.	4.28	High
There is no value in studying proofs in mathematics.	1.8	Low
I already know enough mathematics to get a good job.	2.55	Moderate
Proofs are essential to the understanding of mathematics.	4.28	High
Overall Mean	**3.31**	**Moderate**
Creativeness		
Trial and error can often be used to solve a mathematics problem.	4.48	High
Learning mathematics involves mostly memorizing.	3.33	Moderate
Mathematics is a good field for creative people.	3.5	High
There is little place for originality in solving mathematics	3.15	Moderate
There are many different ways to solve most mathematics	4.33	High
New discoveries in mathematics are constantly being made.	4.18	High
Mathematics is mostly learning about numbers.	3.58	High
Overall Mean	**3.79**	**High**
GRAND TOTAL MEAN	**3.35**	Moderate

Legend: 1.00-1.49(Very Low), 1.50-2.49(Low), 2.50-3.49(Moderate), 3.50-4.49(High), 4.50-5.00(Very High)

Table 4 displays the mean score of the level of appreciation of the learners in mathematical modeling. The result reveals that the highest mean score (3.79) was for creativeness which has a high level of appreciation from its mean. Though most of the items in this indicator showed a high level, it still has "Learning mathematics involves mostly memorizing" and "There is little place for originality in solving mathematics" which gained a less or moderate level of appreciation but, overall, it is only a minimal to the overall mean of this indicator. This means that the learners recognize the value of creativeness of mathematical modeling in solving real–life problems. On the other hand, usefulness (3.31) and attitude (2.79) indicate a lesser value of appreciation. This means that the level of the learners' appreciation of the mathematical modeling activities is in the average level. For all the items across the indicators, it shows that the learners are low in terms of the "It is not important to know mathematics in order to get a good job" and "There is no value in studying proofs in mathematics" under the usefulness indicator.

Thus, most of the learners must engage more with mathematical modeling activities and the teachers as well must do some intervention that will motivate the learners to practice more of these activities for them to really appreciate it. Leonard (2012) stated that the Positive paradigm encourages learners to confront problems and act to resolve them before problems are uncontrollable. Even if there is no ideal solution, teachers can help to deal with problems more calmly which will help elaborate the negative impacts. Moreover, he inferred that 1) the levels of appreciation received by students have a positive and significant impact on the ability of positive thinking, 2) levels of appreciation received by students have a positive and significant impact on self-concept through positive thinking ability, 3) The self-concept has a positive and significant impact on students' mathematics learning achievement.

Table 5 displays the teachers' barriers or difficulties in teaching optimization and related rates. The participants' mean score was (3.11) for the instructional factors and (2.89) for the learner factors. It can be gleaned that the "High-level content and performance standards" means that it is always seen as a problem since it is also observed all the time and has a mean of 3.75. In addition, the "Learners 'lack of prior knowledge" is what teachers sometimes observed and which it gained a mean of 3.5. From these two factors, it gained a total mean of 3 which means that these were commonly observed. This indicates that the classroom setting concurrently has common struggles while the teaching and learning process is implemented. Moreover, this really affects the success of the learning process which could enable the learners to be more interested in learning mathematics so they can also highly appreciate mathematical modeling. It is also evident in the results that all of the competencies in differentiation are the least learned since there is no mastery of them. Also, the modeling competencies suggest that there is really a need to apply mathematical modeling activities.

As stated by Jaudinez (2019), Calculus is seen to be ultimately reliant on formal definitions and proofs. Thus, there's a need to contextualize and deepen the concepts in Calculus when taught (Bresoud et al., 2016; El Gaidi and Ekholm, 2015). In this manner, teaching precalculus and basic calculus lessons becomes more meaningful, realistic and profound. Further, encouraging group work and mentoring with peers among students of Calculus can harness collaboration – a key 21st-century skill where students should be equipped with. Meanwhile, Math deviation such as telling sad love story by illustrating asymptote(s) to a curve may also aid in breaking silence and in arousing the interest of students to get intrigued and thereby prepare them to learn, as what Thorndike noted in his connectionism. Another problematic situation is on the actual gap between students' prior knowledge and the mathematical foundation of Calculus which results in poor performance. To bridge such gap, conceptual and procedural knowledge should transition along with solid computational skills being enhanced through providing solved problems and examples to students.

Table 5. The Percentage scores on the Teaching Strategies used in the Classroom

Difficulties in Teaching	Mean	Interpretation
Instructional Factors		
Shorter time frame	3.3	Sometimes Observed
Time – consuming	2.75	Sometimes Observed
Lack of resources	3	Sometimes Observed
High level content and performance standards	3.75	Always Observed
Level of difficulty of the competencies	3.25	Sometimes Observed
Instructional strategies and methods	2.75	Sometimes Observed
Lack of facilities	3	Sometimes Observed
Overall Mean	**3.11**	**Sometimes Observed**
Learners Factors		
Learners' negative mentality towards mathematics	3.3	Sometimes Observed
Learners 'lack of prior knowledge	3.5	Sometimes Observed
Learners' lack of motivation/interest	3.25	Sometimes Observed
Lack of understanding	3	Sometimes Observed
Arithmetic ability	2.75	Sometimes Observed
Learning difficulties/disabilities	2	Rarely Observed
Mathematical anxiety	2.5	Rarely Observed
Overall Mean	**2.89**	**Sometimes Observed**
GRAND TOTAL MEAN	**3**	**Sometimes Observed**

Teaching Strategy or Method	Percentage
Lecture Method	100%
Inquiry – Based Method	75%
Problem Solving	100%
Real – life Mathematical Modeling	0%
Integrating Real - world problems	50%
Practices in teaching Basic Calculus integrating Mathematical Modeling	
Teach learners using explicit instruction on a regular basis.	50%
Teach learners using multiple instructional examples.	75%
Have the learners verbalize decisions and solutions to math problem.	50%
Teach the learners to visually represent the information in the math problem.	75%

Teach learners solve problems using multiple/ heuristic strategies.	50%
Provide ongoing formative assessment data and feedback to teachers.	75%
Provide peer-assisted instruction to learners.	25%

Based on Table 6, the results reveal that based on observations and experiences, the teacher's method of teaching Basic Calculus specifically in Differentiation is through Lecture Method and Problem Solving (100%), followed by Inquiry–Based Method (75%) and Integrating Real-world Problems (50%). However, it showed that Real – Life Mathematical Modeling has never been used and applied in their day-to-day instructions (0%). It indicates that the teachers were commonly making use of the concepts of mathematics and applying it to solve related problems. Nonetheless, teachers were not really used to how should mathematical concepts be applied to solve real–life problems as they should have a connection to reality. It is also evident when they are asked how often they integrated it into their teaching and learning process, it shows that they made use of it in one to two problems.

Table 6. The Percentage scores on the Teaching Strategies used in the Classroom.

Teaching Strategy or Method	Percentage
Lecture Method	100%
Inquiry – Based Method	75%
Problem Solving	100%
Real – life Mathematical Modeling	0%
Integrating Real - world problems	50%
Practices in teaching Basic Calculus integrating Mathematical Modeling	
Teach learners using explicit instruction on a regular basis.	50%
Teach learners using multiple instructional examples.	75%
Have the learners verbalize decisions and solutions to math problems.	50%
Teach the learners to visually represent the information in the math problem.	75%
Teach learners solve problems using multiple/ heuristic strategies.	50%
Provide ongoing formative assessment data and feedback to teachers.	75%
Provide peer-assisted instruction to learners.	25%

As stated by Niss, Blum and Galbraith (2007), "Mathematical modeling competency means the ability to identify relevant questions, variables, relations or assumptions in a given real world situation, to translate this into mathematics and to interpret and validate the solution of the resulting mathematical problem in relation to the given situation.

On the other hand, the practices of the teachers in teaching Basic Calculus integrating Mathematical Modeling revealed that most of them have the following strategies, "Teach students using multiple instructional examples", "Teach the students to visually represent the information in the math problem", and "Provide ongoing formative assessment data and feedback to teachers" with (75%). While it is also common to them teaching students using "explicit instruction on a regular basis", "solve problems using multiple/ heuristic strategies", and "let the learners verbalize decisions and solutions to math problem" with (50%) and "Providing peer-assisted instruction to learners" has the lowest with (25%) only.

Contextualized Strategic Intervention Material or CSIM is a Strategic Intervention Material (SIM) that has been contextualized. The contextualization of this intervention material is in accordance to Republic Act 10533 or Enhanced Basic Education Act of 2013, which states that "the curriculum shall be contextualized and global" and "the curriculum shall be flexible enough to enable and allow schools to localize, indigenize, and enhance (the curriculum) based on their respective educational and social contexts.".

DepEd Order No. 32, s. 2014 defines contextualization as an educational process of relating the curriculum to a particular setting, situation, or area of application to make the competencies relevant, meaningful, and useful to all learners.

5. CONCLUSIONS

In conclusion, the developed contextualized instructional material focuses on the application of real–life problems through mathematical modeling. It is a series of activity worksheets and materials that allow students to process with the help of their teacher and peer in such a way that it allows them to learn and do it by themselves. The design of the worksheets was anchored on the learners' mathematical modeling competency, self–efficacy, and appreciation. Including teachers' experiences and appreciation of the real-life applications of basic calculus on the topic of differentiation. Integrating mathematical modeling in delivering competency is of great help to the senior high school curriculum.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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