International Journal of Multidisciplinary Approach and Studies

ISSN NO:: 2348 – 537X

An ADDIE Model Analysis on the Engineering of Contextualized Intervention Materials (CIMs) and Students' Achievement in Mathematics

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ABSTRACT

The study aimed to engineer Contextualized Intervention Materials (CIMs) leading to the determination of students' achievement and construction of a learning intervention model in Mathematics at Saint Columban College-Senior High School, Pagadian City, Philippines. Following the stages of the ADDIE model by Branch (2009), this study assessed the least-mastered skills and competencies of Grade 11 STEM Learners in Mathematics; developed Contextualized Intervention Materials (CIMs) on the selected topics of a Mathematics course (Precalculus) in the STEM strand; validated the developed Contextualized Intervention Materials (CIMs) by the teacher-experts and student validators; tested the effectiveness of the developed Contextualized Intervention Materials (CIMs) to selected STEM Learners; and constructed a learning intervention model to enhance the poor achievement of STEM Learners in Mathematics. Qualitative data for improving and modifying the CIMs were collected using interviews. There were four themes that emerged based on the collective views, comments, and suggestions of teacher-experts and student validators, namely: self-learning management and responsibility, contextualized instruction, the applicability of intervention materials to real-life situations, and flexibility of the instructional delivery while quantitative data were analyzed using descriptive and inferential measures. The developed CIMs were rated "excellent" by the teacher-experts and "more than adequate" by the student-validators. This implied that the teacher-experts considered the SIMs as teacher support materials that can be used to master the competencies in Mathematics of the STEM strand and learning enhancers as evaluated by the student-validators. Results also signify that the use of intervention materials increases students' achievement significantly higher than the traditional learning materials.With its effectivity, an independent samples t-test was utilized with a p-value of 0.00 indicating that there was a significant difference between the scores of the students from the control and experimental group in favor of the Contextualized Intervention Materials. The "chess game pieces" model as a learning intervention model for learning mathematics is proposed in this study based on the data gathered from Assess (Analysis) to Test (Implementation) phases.It is recommended that teachers may develop more CIMs to address the learners' poor achievement in mathematics and make use of the modelas a guide for learning motivation and improvement.

KEYWORDS: *ADDIE Model;least-masteredskills and competencies;Contextualized Intervention Materials; students' achievement;Mathematics*

I. INTRODUCTION

The Philippine academic system is currently investigating novel and imaginative techniques to engage diverse groups of learners in the constantly changing 21st-century educational scene. Education is extremely important in every person's life in the modern, fiercely competitive global society. Learners are given the necessary skills, mindset, and information for continual lifelong learning through educational programs and interventions (Bryant, 2006).

Mathematical methods pervade literally every field of human endeavor and play a fundamental role in the economic development of a country. In our journey toward scientific and technological advancement, we need nothing short of good performance in Mathematics at all levels of schooling (Luzano&Ubalde,2023). Unfortunately, the performance of students in Mathematics at the end of secondary education has not improved in the past decade (Saclao, 2015).

After the K–12 programs were put into place, the spiral approach in the mathematics curriculum became difficult to teach and extremely problematic. After a year of implementing the spiral approach in the teaching of mathematics, Javier (2013) found that of the four areas—learners' competency, teaching competency, assessment tools, and instructional materials—the learner's competency and the materials provided to them are the least managed.

According to Orhun (2015), tackling mathematics problems presented difficulties and difficulties for many students. Disappointments and challenges came in many different forms during the learners' transitory path through mastering mathematics. In essence, he concluded that students' inability to develop conceptual understanding of mathematics abilities led to serious errors being made. Due to the rule on mechanical application in math tasks, learners committed several mistakes as a result. Due to the fact that learning processes in mathematics are technically connected and procedural, these errors happen.

Educational facility deficiencies, inadequate materials, large class sizes, subpar instruction, and a uniform curriculum pose serious threats to the education system. The current academic landscape grapples with controversies such as classroom shortages and insufficient funding for essential mathematics resources (Luzano, 2020). These issues disrupt the teaching and learning process, hindering both. Many students struggle to cope, resulting in poor performance (Pang-an, et al., 2022). Effective teaching aims to deliver practical instruction, fostering active learning. Teachers must take action, like providing tailored materials, to combat these challenges and ensure a successful education process (Weselby, 2014).

Flexible learning thrives on teachers taking the initiative to create and use tailored instructional materials, bridging learning gaps, and achieving educational goals (Aranzo, et al., 2023). Having ample, well-designed materials that cater to diverse students' learning styles, personalities, and stress-coping mechanisms enhances math teaching productivity (Luzano, 2023). Therefore, Math teachers must comprehend their learners holistically, crafting personalized materials to address individual needs for improved math comprehension (Dacumos, 2015).

The development of instructional and intervention materials plays a crucial role in the teaching-learning process, fostering a dynamic exchange between educators and students

(Casanova, et al., 2023). Well-prepared materials enhance teaching and learning, making them more engaging and effective (Olawale, 2013). The Department of Education (DepEd) has addressed declining math performance by implementing interventions outlined in DepEd Order No. 39, s. 2012. One of these interventions is the use of intervention materials, designed to bridge learning gaps and boost students' academic achievement by aligning with their comprehension levels (Romorosa, et al., 2023).

The Strategic Intervention Material (SIM), as utilized by DepEd, serves to reinforce and re-teach less mastered Mathematics concepts and skills. This material assists students in mastering competency-based skills not fully developed in regular classrooms, promoting independent and successful learning, especially for non-performing students (Bunagan, 2012). Assessments within intervention materials encompass diverse techniques, enabling students to showcase their learning through tasks and real-life applications. Intervention materials are designed to provide the necessary support for students to make progress in their subjects, aligning with the principles of flexible learning (Drucker, 2006).

Hence, to address the cited educational predicaments, this paper would like to engineer Contextualized Intervention Materials (CIMs), determine students' achievement, and construct a learning intervention model in Mathematics to enhance the poor achievement of STEM Learners.

OBJECTIVES

The general objective of this study is to engineer Contextualized Intervention Materials (CIMs) leading to the determination of students' achievement and construction of a learning intervention model in Mathematics at Saint Columban College-Senior High School, Pagadian City, Philippines.

Specifically, this study aims to:

a. Assess the least-mastered skills and competencies of Grade 11 STEM Learners in Mathematics;
b. Develop Contextualized Intervention Materials (CIMs) on the selected topics of a Mathematics course (Precalculus) in the STEM strand;
c. Validate the developed Contextualized Intervention Materials (CIMs) by the teacher-experts and student validators;
d. Test the effectiveness of the developed Contextualized Intervention Materials (CIMs) to selected STEM Learners; and
e. Construct a learning intervention model to enhance the poor achievement of STEM Learners in Mathematics.

FRAMEWORK

This developmental study is anchored on the theories of Vygotsky's Scaffolding (1978) and Contextualized Teaching and Learning (2017).

Vygotsky scaffolding is a theory that focuses on a student's ability to learn information through the help of a more informed individual or made-easy learning materials. When used effectively, scaffolding can help a student learn content they wouldn't have been able to process on their own. Scaffolding explicated that learning is dependent on teacher's or peer's support.It is a method of teaching that helps learners understand educational content by working with an educator or with enhanced self-learning material. The educators or students teaching the learners scaffold the material in smaller chunks so the learner can expand their understanding of the material more than they would on their own.

Furthermore, it is the manner of guiding and assisting students in order to address difficulties in certain disciplines, hencevery vibrant in the conduct of the study. The development of self-learning intervention material is one of the many aids in addressing least-learned skills and competencies in conceptual and practical understanding in Mathematics (Cooper, 2005).

Contextualized Teaching and Learning (CTL) theoryaims to increase mastery of the learning competencies by utilizing the context that isfamiliar to the students. Through this theory, it can guarantee the quality of education that can satisfy the needs of the students and it can improve the fundamental training of educational programs. The learning competencies can easily be mastered because the contexts are culturally rooted, responsive, and personalizedto the nature of the learning styles and preferences of the learners (Nuqui, 2017).

According to Utech (2008), contextualizing the presentation of topics helps students learn skills by learning them using authentic contexts in which students must use those skills in the realworld. As stated, the contextualized curriculum is effective both for community-based and workplace arenas. In education, lesson plans and teachers' guides must be in alignment with the curriculum and classroom realities. This method helps teachers to adapt and contextualize their pedagogy and to have a directive line in presenting the lessons fitted to the learning capacities of the students. This also intends to assist teachers in arranging and managing their courses andlessons, as well as ensuring that learning objectives and learners' needs are met.

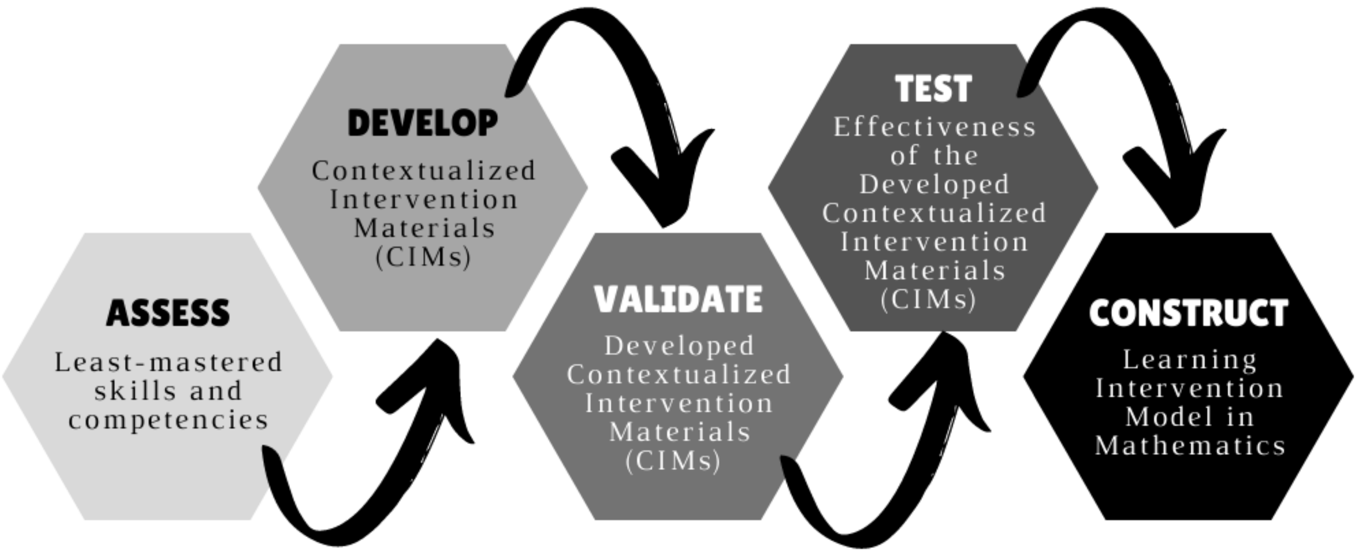

Figure 1. Schematic Diagram of the Study

II. METHODOLOGY

Research Design

This study made use of the developmental research design. For the development and validation of Contextualized Intervention Materials (CIMs), a mixed-method analysis was used, such as descriptive measures for validation and thematic analysis for qualitative findings. In investigating the impact of the intervention materials, a quasi-experimental design was utilized. Data analysis and synthesis in a developmental study are comparable to the other research projects. There are likely to be descriptive data presentations and qualitative data analyses using data from surveys and observations. Traditional quantitative data analysis techniques are used as well to test and validate well the learning materials developed (Richey, Klein, & Nelson, 2004).

Calderon (2012) explained in his book entitled Methods of Research and Thesis Writing that developmental research is a purposive process of gathering, analyzing, classifying, and tabulating data on prevailing conditions, practices, beliefs, processes, trends, and cause-effect relationships and then making an adequate and accurate interpretation about such data with or without the aid of statistical methods. This method was used in determining the curricular validity of the Contextualized Intervention Materials (CIMs).

Research Locale

This study was conducted at Saint Columban College-Senior High School, Pagadian City, Zamboanga del Sur.

Research Participants

The participants of this study were the ten (10) teacher-experts who validated the content and presentation of the CIMs. They are both private and public-school teachers who are holders of Master and Doctorate degrees with specialization in Mathematics and have been teaching in the large schools in Pagadian City. All of them are teaching Mathematics for at least three years and have attended various training in Mathematics instruction and instructional designing and the ten (10) student-validators who are STEM strand enrollees of Saint Columban College-Senior High School.

The participants for the quasi-experimental setup were the two STEM sections with 35 students each, a total of 70 STEM learners. One group was assigned as the experimental group that had used the CIMs while the other group was the control group that was given traditional work exercises/assignments.

Sampling Techniques

The researcher used the purposive-expert sampling technique in the selection of the ten (10) teacher-experts who were involved in the validation of the content of the CIMs and the ten (10) student-validators who were enrolled in the STEM strand.

The participants of the quasi-experimental setup were chosen using the matching technique. The students' average grades in the First Quarter in Mathematics (Precalculus) were calculated and collected. The two groups were divided according to the following techniques. The top students were distributed to both groups. This was also done to the students who had low averages. This means that both the groups had almost the same participants. The average of the grades was calculated using MS Excel. The results were the basis of distribution. The control group has 35 students and another 35 for the experimental group.

Data Analysis

The study involved the following activities which were done properly to generate the necessary data, sending a letter to the principal where teacher-experts for CIM validation according to their availability and convenience; securing approval from the Division Schools Superintendent of Pagadian City, to the president of Saint Columban College and asking for official permission from the principal of the Senior High School Department to look for teachers and students purposively to validate and be tested for the Contextualized Intervention Materials (CIMs).

Upon meeting the validators, they were informed and oriented on the concept of the CIM as attached to the validation sheet. Then, the rationale of the material had been discussed with them by the researcher aside from that it is attached to the validation sheet for them to have a basis for rating and validating the Contextualized Intervention Materials (CIMs).

This study followed certain procedures in the engineering of Contextualized Intervention Materials (CIMs) to address the least-learned skills and competencies of the STEM students. The following steps were undertaken in the engineering of the CIMs as prescribed by Saclao (2015): (1) Developing CIM rationale; (2) Deciding on aims and learning outcomes; (3) Thinking about the content and format; (4) Exploring learning and teaching strategies and the appropriate learner support; and (5) Planning validation strategy.

The instrument used in the study was the evaluation instrument for the validation of the Contextualized Intervention Materials (CIMs). The instrument used to validate the developed learning materials was a five-point rating scale adapted from a study byNivera (2006). The modified tool was then revised, mainly through the researcher's preferences to suit the needs of the study. The validation was based on the following criteria: (1) Design; (2) Clarity of directions used; (3) Readability; (4) Importance of the content; (5) Appropriateness of activities; (6) Ease of task completion; (7) Opportunities for active learning; and (8) Usefulness in meeting learner's needs.

The validation sheet was made up of the following: (1) directions on how the learning materials will be validated; (2) the series of statements as the basis for the validation of the CIM; (3) section for general comments and suggestions for the improvement of the CIM; and (4) the participant's name for both content and student validators.

To determine both the numerical and descriptive equivalent of the validation of the developed Contextualized Intervention Materials (CIMs),the researcher adopted the instrument made use by Nivera as cited in Saclao, 2015.

Table 1. Numerical and Descriptive Equivalence of CIMs Validation

Hypothetical Mean Range	Descriptive Equivalent Content-Validators	Descriptive Equivalent Student-Validators
4.21-5.00	Excellent	More Than Adequate
3.40-4.20	Above Average	Adequate
2.61-3.40	Average	Partially Adequate

1.81-2.60	Below Average	Inadequate
1.00-1.80	Needs Improvement	Extremely Inadequate

Thematic analysis was utilized in the presentation and interpretation of the gathered responses, comments, and suggestions from the teacher-experts and student-validators.

In investigating the impact of Contextualized Intervention Materials (CIMs) on the students' achievement in Mathematics of STEM learners, the t-test for independent means was used to determine if there was a significant difference in the gain score from the pretest to posttest in each group of the two Mathematics classes. For each class, learning will be considered to have taken place if the achievement of the students in the posttest was greater than that of the pretest. That is, if the difference between the pretest scores and posttest scores was found significant. Data collected were collated, processed, and analyzed statistically using frequency distribution, mean and standard deviation. These were calculated using the SPSS.

A 40-item multiple-choice type of test was prepared by the researcher as pretest and posttest for investigating the impact of CIMs on students' achievement in Mathematics of STEM learners. The parallel tests were made after making a table of specifications. The constructed test items were validated by the subject matter experts. Minor changes and reliability testing have been made based on the comments and suggestions of the subject matter experts.

On the other hand, the given table below was used to calculate the percentage equivalent of the scores and descriptive equivalent gathered by the learners.

Table 2. Mastery/Achievement Descriptive Equivalence

Percentage Score	Descriptive Equivalent
96-100	Mastered
86-95	Closely Approaching Mastery
66-85	Moving Toward Mastery
35-65	Average Mastery
15-34	Low Mastery
5-14	Very Low Mastery
0-4	Absolutely No Mastery

The Learning Intervention Model was framed and crafted based on the results from Assess Phase (Analyze) to the Test Phase (Implementation) of the ADDIE and Modified Model.

Ethical Considerations

This research endeavor involved various personalities and information which were treated with utmost upright consideration. As in every research effort, there is a need to enormously consider ethical practices because the value of any research does not only come from the volume and intensity of information it provides but also from the ethical consideration it requires.

III. RESULTS AND DISCUSSIONS

The study was guided by the steps of the instructional design model, specifically by the ADDIE model. ADDIE model is an instructional design method and framework for designing and developing educational learning materials which stands for Analyze, Design, Develop, Implement, and Evaluate. The model indicated below has been modified and customized as basis for the analysis of the results.

Table 3. Analysis Model of the Study

Original ADDIE Model	Modified Model
✓ Analysis	✓ Assess
✓ Design	✓ Develop
✓ Development	
✓ Implementation	✓ Validate
	✓ Test
✓ Evaluation	✓ Construct

Assess Phase (Analysis)

This phaseincludes analyzing, planning, and conceptualization of the Contextualized Intervention Materials (CIMs) developed. Grade 12 STEM students were assessed. Based on the Final examination in Pre-Calculusgiven to them, the results revealed that most of the Grade 12 STEM students got very low scores in the examination having a Mean Percentage Score (MPS) of 51.45 out of a 360-item test with 248 takers.

The policy of the sectioning of the STEM strand of Saint Columban College-Senior High School is also one of the reasons why this study has been conceptualized because the department has followed the "first come, first served" basis upon enrolment which determines also the section where the students will be placed regardless of their general average in the junior high school. As to its outcome, it created a heterogeneous group of students in the classroom, where above average, average, and below-average students can be found resulting in low-quality learning. And the most affected by the set-up based on observation were the students who were low performers in Mathematics, in the same way, brilliant learners depreciate their interest in the class.

The other baseline data that the researcher obtained every start of every academic year revealed that indeed the STEM students, find Trigonometry, particularly in solving right triangles, oblique triangles, and angles in unit circle as the most difficult topics to deal with in the second quarter of Pre-Calculus under the K to 12 Curriculum. Providing interventions for the students were the plans of the researcher.

To give additional background, the learners are just utilizing learning tools available were some exercises only taken from the reference book. Now, the learning materials which to be offered to the students were upgraded learning materials called Contextualized Intervention Materials (CIMs). Based on other data sources, the assessment done before was not as comprehensive, scientific, and with real-life applications as these materials are concerned for. Findings before were not put into writing as compared to the present study where every single detail and every action taken by the researcher were properly documented to fully capture the need of the students.

The subject matter is very important because for a STEM student to proceed to the next higher level of Mathematics learning there is a need to master first these skills and competencies. Bayer (2014) believes that it is only through constant practice one can succeed in learning Mathematics. Hence, numerous activities are provided in the CIMs for further life-long learning.

With the aforementioned problems, issues, and predicaments, the researcher was able to find a cure and select the topics and the learning competencies that were not mastered by the students. Hence, the researcher came up with the idea of engineering Contextualized Intervention Materials (CIMs) to address the area of least-mastered skills and competencies of STEM learners. The preparation of materials, determination of the format to be used, and other pertinent aspects in the engineering of the CIM were established in this phase.

Develop Phase (Design & Development)

In the development stage, this focuses on the design and development of the learning materials in which the least-learned competencies were made as bases. The following steps were undertaken in the development of the CIM according to Saclao (2015): (1) Developing CIM rationale; (2) Deciding on aims and learning outcomes; (3) Thinking about the content and format; (4) Exploring learning and teaching strategies and the appropriate learner support; and (5) Planning validation strategy.

According to Ramsden (2002), developing intervention should be holistic since even the best designed instructional materials, with very well-defined learning outcomes, can fail if the approaches, organizations, and delivery are not well-crafted.

With these CIMs, the researcher has maintained the printing of colorful pictures, icons, and cover pages to catch students' interest. It was a common observation, that when a learning material to be used by students is thick or voluminous, they lose interest in reading it, so, to avoid such a problem to arise, the learning materials were subdivided into three packets entitled "The Right Try (CIM No. 1), The Oblique Attempt (CIM No. 2), and The Ultimate Shot (CIM No.3). These Contextualized Learning Materials (CIMs) have the following features:

a. What the CIM is all about. It gives a preview of what students will learn.

b. What you are expected to learn. It presents the focus skills and mentions the learning competencies and subtasks.

c. How to learn from this CIM. This contains some tips on how to use these learning materials and mentions the skills one learner has to possess while answering these Contextualized Intervention Materials (CIMs).

d. Guide Card. This provides the topic under focus and the skills the learner should master. It introduces the activities the students have to perform.

e. Activity Card. This defines the task/s that the learner should undertake in order to develop the skill. It provides enough examples and work-out solutions. If the learners will have difficulty in answering the exercises, they can always refer to an example for help.

f. Assessment Card. This helps the learner measure the mastery of the skill upon completion of the task/s. The result of the assessment also gives the teacher information on the knowledge/skills the learner failed to understand so that the teacher could revise or improve the materials to further develop/enhance the identified skills.

g. Enrichment Card. This extends learning providing additional concepts and exercises for further application of knowledge/skills. This will challenge the learner to think creatively and develop higher-order thinking skills.

h. Reference Card. This provides additional content and emphasizes important facts or details relevant to the concept in focus. It also provides a list of resources or books the learner may refer to for further reading.

i. Answer Card. The answers in the CIMs are listed down in this section and are found at the last page of these learning materials.

Table 4.Blueprint of the Contextualized Intervention Materials (CIMs)

Quarter	Competencies	Topics	CIM No.	Title
2	Determine the missing lengths of the sides and measures of the angles of right triangles.	Right Triangles	1	The Right Try
2	Determine the missing lengths of the sides and measures of the angles of oblique triangles.	Oblique Triangles	2	The Oblique Attempt
2	Illustrate the unit circle and the relationship between the linear and angular measures of a central angle in a unit circle.	Angles in a Unit Circle	3	The Ultimate Shot

The first drafts of the CIM went through informal validation. Each developed CIM was presented and consulted to STEM students in order for the researcher to pre-assess each of the materials. Subsequently, they were presented to the adviser and colleagues for some corrections. After which, the insights of the CIM experts and validators were sought in order to determine the strong and weak points of the developed CIMs. Comments and suggestions were considered for the improvement.

The highlights of the engineered Contextualized Intervention Materials (CIMs) are shown below.

Validate Phase (Implementation)

In this phase, the validation and evaluation of the developed CIMs are scrutinized and validated. The validation of the content and technical quality of the developed CIMs was based on: (1) design; (2) clarity of directions used; (3) readability; (4) importance of the content; (5) appropriateness of activities; (6) ease of the task completion; (7) opportunities for active learning; and (8) usefulness in meeting the learners' needs. Part of the validation was the comments and suggestions as to further improvements on the different parts or cards of the CIMs made by the teacher-experts and student validators at the same time the final revision also has complied.

Table 5 presents the validation of the teacher-experts of CIM No. 1 (The Right Try). As displayed in the table, it shows that readability surmounts among the eight criteria with a weighted mean of 5.00, descriptively interpreted as excellent and appropriateness of activities, ease of task completion, and opportunities for active learning has the lowest weighted mean of 4.60, but still interpreted as excellent. All of the criteria have the highest rating manifesting the overall mean response of 4.75and interpreted as excellent. This only showed that CIM No. 1 (The Right Try) has a higher suitability level in meeting the needs of the STEM students if they can experience difficulty in their lessons about this area in Mathematics.

Various researches purport to this result. Orhun (2015) concluded that most often learners have difficulties in understanding concepts in Mathematics particularly if the material is not well-developed. This could also be one of the factors that hinder the learners' understanding of Mathematics. This problem was addressed by the result of this CIM since readability exhibits a maximum rating from the teacher-experts.

Table 5. Teacher-Experts' Validation of CIM No. 1 (The Right Try)

Criteria	Mean	Standard Deviation	Qualitative Description
1. Design of the CIM	4.80	0.65	Excellent
2. Clarity of directions used	4.80	0.65	Excellent
3. Readability	5.00	0.00	Excellent
4. Importance of the content	4.80	0.65	Excellent
5. Appropriateness of activities	4.60	0.54	Excellent
6. Ease of task completion	4.60	0.54	Excellent
7. Opportunities for active learning	4.60	0.54	Excellent
8. Usefulness of the CIM in meeting the needs of the learner	4.80	0.65	Excellent
Overall Mean	**4.75**	**0.53**	**Excellent**

Table 6 exhibits the validation of the teacher-experts of CIM No. 2 (The Oblique Attempt). As presented in the table, it shows that readability and usefulness of the CIM excel among the eight criteria with a weighted mean of 5.00, descriptively interpreted as excellent and ease of task completion has the lowest weighted mean of 4.40, but still interpreted as excellent. All of the criteria have the highest rating manifesting the overall mean response of 4.75 and interpreted as excellent. This only showed that CIM No. 2 (The Oblique Attempt) has a higher suitability level in meeting the needs of the STEM students same as CIM No. 1 if they can experience difficulty in their lessons about this area in Mathematics.

Few researches confirm this result. Dahar (2012) emphasized that the usefulness of instructional materials has a strong relationship to the academic performance of the students. Thus, the instructional materials play an important role in improving students' academic achievement. This CIM imparts a significant outcome towards developing an interest in the side of the students in learning Mathematics.

Table 6. Teacher-experts' Validation of CIM No. 2 (The Oblique Attempt)

Criteria	Mean	Standard Deviation	Qualitative Description
1. Design of the CIM	4.80	0.65	Excellent
2. Clarity of directions used	4.60	0.54	Excellent
3. Readability	5.00	0.00	Excellent
4. Importance of the content	4.80	0.65	Excellent
5. Appropriateness of activities	4.60	0.54	Excellent
6. Ease of task completion	4.40	0.42	Excellent
7. Opportunities for active learning	4.80	0.65	Excellent
8. Usefulness of the CIM in meeting the needs of the learner	5.00	0.00	Excellent
Overall Mean	**4.75**	**0.43**	**Excellent**

Table 7 presents the validation of the teacher-experts of CIM No. 3 (The Ultimate Shot). As displayed in the table, it shows that design of the CIM, readability, importance of the content, appropriateness of activities, and ease of task completion surmount among the eight criteria with a weighted mean of 5.00, descriptively interpreted as excellent and appropriateness of activities, ease of task completion, and clarity of directions used, opportunities for active learning, and usefulness of the CIM have the lowest weighted mean of 4.80, but still interpreted as excellent. All of the criteria have the highest rating manifesting the overall mean response of 4.93 and interpreted as excellent. This only showed that CIM No. 3 (The Ultimate Shot) has a higher suitability level in meeting the needs of the STEM students if they can experience difficulty in their lessons in Mathematics.

Various researches support this finding. Togon on (2011) stipulated that most often learners should find the concepts in Mathematics exciting particularly if the intervention materials are well-designed. This could also prove that learning occurs when there will be new face of the materials being used in the classroom.

Table 7. Teacher-Experts' Validation of CIM No. 3 (The Ultimate Shot)

Criteria	Mean	Standard Deviation	Qualitative Description
1. Design of the CIM	5.00	0.00	Excellent
2. Clarity of directions used	4.80	0.65	Excellent
3. Readability	5.00	0.00	Excellent
4. Importance of the content	5.00	0.00	Excellent
5. Appropriateness of activities	5.00	0.00	Excellent
6. Ease of task completion	5.00	0.00	Excellent
7. Opportunities for active learning	4.80	0.65	Excellent
8. Usefulness of the CIM in meeting the needs of the learner	4.80	0.65	Excellent
Overall Mean	**4.93**	**0.24**	**Excellent**

Table 8 presents the validation of the student-validators of CIM No. 1 (The Right Try). As gleaned in the table, it shows that appropriateness of activities and ease of task completion top among the eight criteria with a weighted mean of 4.80, descriptively interpreted as more than adequate and clarity of directions has the lowest weighted mean of 4.20, interpreted as adequate. All of the criteria have the highest rating manifesting the overall mean response of 4.58 and interpreted as more than adequate. This only showed that CIM No. 1 (The Right Try) has the potential and more than adequate to meet the needs of the STEM students if they cannot cope up directly their lessons in Mathematics.

Several researches affirm the findings of this finding. Cooper (2005) concluded that the self-learning material must be rooted on different viewpoints to accommodate the least learned skills of the students so that they will be productive in discovering their own learning upon certain concepts. Hence, this study stimulates their interest for they find the activities in this CIM easy.

Table 8. Student-validators' Validation of CIM No. 1 (The Right Try)

Criteria	Mean	Standard Deviation	Qualitative Description
1. Design of the CIM	4.40	0.42	More Than Adequate
2. Clarity of directions used	4.20	0.35	Adequate
3. Readability	4.60	0.54	More Than Adequate
4. Importance of the content	4.60	0.54	More Than Adequate
5. Appropriateness of activities	4.80	0.65	More Than Adequate
6. Ease of task completion	4.80	0.65	More Than Adequate
7. Opportunities for active learning	4.60	0.54	More Than Adequate
8. Usefulness of the CIM in meeting the needs of the learner	4.60	0.54	More Than Adequate
Overall Mean	**4.58**	**0.53**	**More Than Adequate**

Table 9. Student-validators' Validation of CIM No. 2 (The Oblique Attempt)

Criteria	Mean	Standard Deviation	Qualitative Description
1. Design of the CIM	4.00	0.25	Adequate
2. Clarity of directions used	4.20	0.35	Adequate
3. Readability	4.40	0.42	More Than Adequate
4. Importance of the content	5.00	0.00	More Than Adequate
5. Appropriateness of activities	4.80	0.65	More Than Adequate
6. Ease of task completion	4.60	0.54	More Than Adequate
7. Opportunities for active learning	4.80	0.65	More Than Adequate
8. Usefulness of the CIM in meeting the needs of the learner	5.00	0.00	More Than Adequate
Overall Mean	**4.60**	**0.36**	**More Than Adequate**

Table 9 presents the validation of the student-validators of CIM No. 2 (The Oblique Attempt). As exhibited in the table, it shows that importance of the content and usefulness of the CIM dominate among the eight criteria with a weighted mean of 5.00, descriptively interpreted as more than adequate and design of the CIM has the lowest weighted mean of 4.00, interpreted as adequate. All of the criteria have the highest rating manifesting the overall mean response of 4.60 and interpreted as more than adequate. This only showed that CIM No. 2 (The Oblique Attempt) has the potential and more than adequate to meet the needs of the STEM students if they cannot cope up directly their lessons in Mathematics.

Many researchers affirm the results of this outcome. Escoreal (2012) emphasized that through the use of Contextualized Intervention Material (CIM), it reduced the number of least mastered skills of the students most especially if the CIM is content-centered and has real-life applications. Gultiano (2012) posited that with the aid of the CIM, students were enhanced for they became more attached to the material as it caught their attention with its color and the made-easy way of presenting the activities.

Table 10. Student-validators' Validation of CIM No. 3 (The Ultimate Shot)

Criteria	Mean	Standard Deviation	Qualitative Description
1. Design of the CIM	5.00	0.00	More Than Adequate
2. Clarity of directions used	5.00	0.00	More Than Adequate
3. Readability	4.80	0.65	More Than Adequate
4. Importance of the content	5.00	0.00	More Than Adequate
5. Appropriateness of activities	4.80	0.65	More Than Adequate
6. Ease of task completion	5.00	0.00	More Than Adequate
7. Opportunities for active learning	5.00	0.00	More Than Adequate
8. Usefulness of the CIM in meeting the needs of the learner	5.00	0.00	More Than Adequate
Overall Mean	**4.95**	**0.16**	**More Than Adequate**

Table 10 presents the validation of the student-validators of CIM No. 3 (The Ultimate Shot). As exhibited in the table, it shows that design of the CIM, clarity of directions used, importance of the content, ease of task completion, opportunities for active learning and usefulness of the CIM dominate among the eight criteria with a weighted mean of 5.00, descriptively interpreted as more than adequate and readability and appropriateness of activities have the lowest weighted mean of 4.80, still interpreted as more than adequate. All of the criteria have the highest rating manifesting the overall mean response of 4.95 and interpreted as more than adequate. This only showed that CIM No. 3 (The Ultimate Shot) has the potential and more than adequate to meet the needs of the STEM students if they cannot cope up directly their lessons in Mathematics.

Few researches confirm the results of this result. Lagata (2012) emphasized that through the use of Contextualized Intervention Material (CIM), the learners will become more knowledgeable in identifying errors able to determine cause and effect relationships. The study of Lagata about the causal model proved that learning is the result of the diverse instructional materials being applied in the classroom.

Table 11 presents the summary of the validation of the teacher-experts and student validators of the three CIMs, which are the CIM No. 1 (The Right Try), CIM No. 2 (The Oblique Attempt), and CIM No. 3 (The Ultimate Shot). As displayed in the table, it shows that the teacher-experts validated the three materials with a grand weighted mean of 4.81, descriptively interpreted as excellent and the student-validators rated the three learning materials with a grand weighted mean of 4.71 interpreted as more than adequate. This means that the developed intervention materials have great potential in helping the learners with poor performance in Mathematics.

The result is supported by the study of Hirsch (2001) which contended that the traditional instruction of teaching Mathematics could no longer accommodate the learning needs of the 21st century learners and further argued that we need to move away from traditional instruction by implementing the intervention programs to support the new breed of learners. Due to the demand of the learners of this generation, educators should become more creative to accommodate the new thinkers and discoverers. 21^{st} century learners are very demanding in terms of the instruction and curriculum that have applied and delivered to them.

Table 11. Summary of Teacher-Experts' and Student Validators' Validation of CIMs

CIM No.	Title	Teacher-Experts	SD	QD	Student-Validators	SD	QD
1	The Right Try	4.75	0.53	Excellent	4.58	0.53	More Than Adequate
2	The Oblique Attempt	4.75	0.43	Excellent	4.60	0.36	More Than Adequate
3	The Ultimate Shot	4.93	0.24	Excellent	4.95	0.16	More Than Adequate
	Grand Mean & SD	**4.81**	**0.40**	**Excellent**	**4.71**	**0.35**	**More Than Adequate**

The overall result of the validation of the teacher-experts and student-validators of the of the three Contextualized Intervention Materials (CIMs) was highly exceptional in terms of the capacity of the materials to enhance the STEM learners with poor performance in Mathematics.

Emerging Themes from Views, Comments and Suggestions of the Teacher-Experts and Student Validators

There were four themes that emerged based on the collective views, comments, and suggestions of teacher-experts and student validators, namely: (a) Self-learning management and responsibility, (b) Contextualized Instruction, (c) Applicability of Intervention Materials to real-life situations, and (d) Flexibility of the Instructional Delivery.

a. Self-learning management and responsibility

Self-learning management and responsibility represent an essential skill and knowledge for both teachers and students to achieve a better learning experience (Wolff, Van den Bogert, Jarodzka, &Boshuizen, 2015). Self-learning management and responsibility is one of the themes that came out from the participants. According to them, the intervention materials will facilitate and motivate students to learn on their own. Through the intervention material, they commented that this will help the teachers empower the above-average learners to help below-average learners, thus, they will be responsible already on their learning, since the materials were found to be made-easy for them.

b. Contextualized instruction

Contextualized Instruction is a way to demonstrate how teachers incorporate strategies in addressing the needs, interests, and learning styles of their students (Taylor, 2015). Citing this theme, Participant 7 described that the material should focus if the intervention materials achieve their purpose of aiding learners with poor performance in Mathematics. Additionally, it was suggested also that the material will have a comprehensive context in order for learners to imagine how to get the right way to solve the problem.

c. Applicability of Intervention Materials to real-life situations

Another theme pertains to relating the concepts of the intervention materials to a real-life situation. This practice is a practical way of education in which the teacher is making the learning materials the real world for learners. This theme includes the implicit and explicit strategy of organizing and brainstorming concepts that will be integrated and incorporated in the material. Moreover, the teacher-experts are unanimously commented to integrate own experiences in the development of the materials in order to know the pulse of students in learning.

d. Flexibility of the Instructional Delivery

The construction of the intervention materials is flexible because it will be dependent on the nature of the learners you are to intervene. The flexibility of the teacher is also an essential factor in planning an intervention program. Teachers should be flexible and equipped with the knowledge of using various strategies, techniques, and approaches to cater varying groups of learners. The materials need to overcome the problems and peculiarities inside the class and make the instructional presentation fitted to the learners' needs.

Test Phase (Implementation)

To investigate the achievement of STEM learners, impact, and effectiveness of the Contextualized Intervention Materials (CIMs) that were used as intervention materials in Mathematics, a quasi-experimental design was utilized. The students' average grades in the First Quarter in Mathematics (Precalculus) during the AY 2018-2019 were used as baseline data for the comparability of the two groups (control and experimental). T-test for the independent and dependent means was the statistical tool used in this phase of the study.

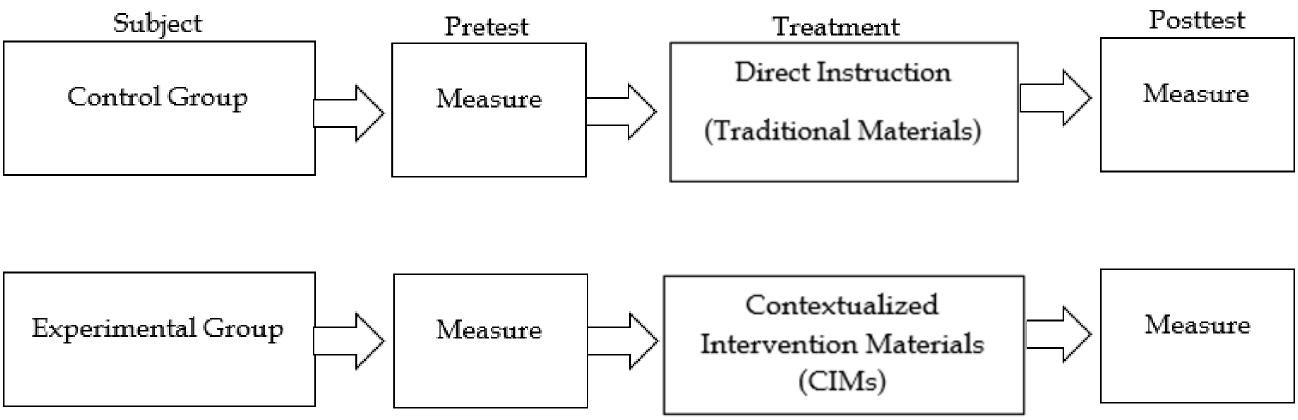

Figure 5. Quasi-experimental design model

Table 12. Mathematics Mastery/Achievement of Grade 11 STEM Learners

Level of Mastery/Achievement	Percentage Score Distribution	Experimental Group				Control Group			
		Pretest		Posttest		Pretest		Posttest	
		f	%	*f*	%	*f*	%	*f*	%
Mastered	96-100	0	0	5	14	0	0	1	3
Closely Approaching Mastery	86-95	2	6	14	40	0	0	6	17
Moving Toward Mastery	66-85	5	14	8	23	3	8	11	31
Average Mastery	35-65	15	43	5	14	10	29	5	14
Low Mastery	15-34	10	29	3	8	13	37	12	34
Very Low Mastery	5-14	3	8	0	0	9	26	0	0
Absolutely Mastery	0-4	0	0	0	0	0	0	0	0
Mean		45.20		76.70		32.30		57.59	
Level		Average Mastery		Moving Toward Mastery		Low Mastery		Average Mastery	
Standard Deviation		1.45		0.94		1.78		1.05	

Table 12 shows that the pretest results of both groups are of little difference in favor of the experimental group. Based on the achievement descriptions set by the Department of Education,the experimental group established a middle ground in achievement, and the control group with low mastery. However, their respective standard deviations indicated that the pretest scores of the students in the experimental group were more scattered compared with that of the control group. The frequency and percentage of pretest scores show that before the conduct of the study, the participants in both the experimental group and the control group least mastered the concepts in Mathematics. Pretest results indicate that the students have poor academic achievement scores.

Results signify that the use of intervention materials increases students' achievement significantly higher than the traditional learning materials. The results are in consonance with the findings of Bunagan (2012)that with the use of intervention materials in the teaching and learning process, the posttest achievement scores of the students are enhanced as compared to those using the traditional materials.

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ISSN NO:: 2348 – 537X

Table 13. Difference Between the Pretest and Posttest of the Control and Experimental Groupsvia Independent Samples *t*-Test

		Levene's Test for Equality of Variances		***t-test for Equality of Means***						
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Diff.**	**Std Error Diff.**	**95% Confidence Interval of the Diff.**	
									Lower	*Upper*
Pre-Test	Equal Variances Assumed	2.412	.128	-.174	68	.722	-.14555	.64570	-1.678955	1.412353
	Equal Variances Not Assumed			-.174	64.231	.722	-.14555	.64570	-1.651209	1.423512
Post-Test	Equal Variances Assumed	0.612	.345	-11.342	68	.000	-5.2333	.54391	-6.672345	-5.075654
	Equal Variances Not Assumed			-11.342	66.321	.000	-5.2333	.54391	-6.673218	-5.075407
Deviation	Equal Variances Assumed	1.205	.223	-6.812	68	.000	-5.08775	.82435	-7.234055	-4.173435
	Equal Variances Not Assumed			-6.812	64.335	.000	-5.08775	.82435	-7.234242	-4.173890

An independent sample t-test was conducted to compare the student scores and mean gain scores who used the CIM and those who are exposed to traditional materials. The table shows that scores of the control and experimental group on the pretest do not have significant differences before the CIM was used by the experimental group (p- value is 0.722). Upon using the CIM, a posttest was given to the participants. As seen in the table, the p-value of 0.000 with a t-value of -11.342 is an indication of the significant difference between the scores of the students from the control and experimental group.

This implies that the participants who used the CIM have significant higher scores than those who did not use the intervention materials. Also, there is significant difference (p-value of

0.000 and t-value of -6.812) present in the mean gain scores of the participants with regard to their pretest and posttest scores. This is an indication that the use of CIM is an effective way of improving the achievement of the students in their Mathematics subject. The results confirmed findings of Salviejo, Aranes and Espinosa (2014) that Intervention Material has motivating capabilities that demand attention and create a strong impact on the learners. It also mentioned in their earlier study that intervention materials could provide effective communication and proper instruction matched with the learning needs of the students.

Construct Phase (Evaluation)

Based on the analysis from Assess Phase (Analyze) to Test Phase (Implementation), this developmental study was able to construct a Learning Intervention Model (LIM) that helps and guides STEM learners to foster greater heights in learning Mathematics amidst difficulties that can be encountered in the future. This model is generally applicable not only in Mathematics but also for other disciplines. The chess game was utilized to be a symbolic representation of the model.

The Pawn. *Every move matters.*
The pawn is the lowest-value piece on the chessboard. They may only move one space. Pawns can only capture pieces while moving forward and diagonally, either to the left or the right.

The first move to learning is usually and typically the most challenging part of the game. We need to move, whether it is a small action to learning, it already matters if done consistently.

The Knight. *Strategize and be directed rightly.*
Knights make up the "minor pieces." A knight is worth three points, or equal to the value of three pawns. The knight must always move in an L shape: two spaces in one direction, and then one space perpendicular, or vice versa.

While we are on the road of learning, we experience getting tired, unmotivated, and disappointed. But we get to be disciplined for learning and strategize to go over for the right steps that are available in the materials.

The Bishop. *Be consistent to your goal in learning and stay on track no matter what.*
The bishop is considered a minor piece worth 3 pawns, or points. The bishop may move any number of spaces diagonally in any direction.

We are the author of our own book of learning. We decide whether we will stuck ourselves on difficulties or ride on with the different intervention materials available to bridge the complexities of poor performance in Mathematics.

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The Rook. *Be a critical thinker. Be flexible.*
The rook is considered a major piece valued at five pawns, two more than a bishop or knight and slightly less than two bishops or two knights. The rook moves through unoccupied spaces and captures an opposing piece by occupying its space.

In the changing demands of instructional delivery, we have no time to get mundane with learning. We need to empower ourselves to be critical thinker and strive to look for better approaches to learn certain concepts.

The Queen. *Chase the valuable opportunities.*
The queen is the most valuable piece in the game of chess, and a key component in countless chess strategies. The queen's moves combine the moves of the rook and bishop, making it an extremely strategically useful piece.

A pessimist learner sees only the difficulty in every opportunity but an optimist sees the opportunity in every difficulty.
Stop being the chess piece of learning; become the player of your own learning. It's our move that counts now and when we are in failing situations, that's the best opportunity to regain our first love in learning.

The King. *Be an overcomer and winner for learning.*
The king is the most important piece in chess, and chess strategy often revolves around finding ways to protect your king while threatening your opponent's. The king can move in any direction, albeit only one square at a time. The goal is to corner other's king.

Amidst difficulties in learning, if we will not give up, we can still drink fully the fountain of knowledge regardless of the subjects we are to take. By deciding to overcome the challenge, we are now then prepared to take responsibility for helping other learners.

IV. CONCLUSIONS AND RECOMMENDATIONS

This study showed that CIMs provide hope for the STEM students who generally have a bad impression and poor performance in Mathematics since it came out that they were able to rate the materials as more than adequate to meet their needs in coping with their difficulties. Aside from that, most of the students who validated the material have been attracted to the distinct design and clear instructions of the learning materials and most of them found the tasks contained in the CIM not difficult to accomplish. The validation of the teacher-experts also proved and agreed with the aforementioned observation of the students.

Based on the findings of the study, the Contextualized Intervention Materials (CIMs) made by the researcher are considered by the teacher-experts and student-validators as suitable, effective, impactful, and appropriate for the STEM learners in orderto master the learning competencies in Mathematics.

Based on the aforementioned summary and conclusions, the following recommendations were made on the basis of the results obtained from the analysis of data:

- ✓ Researchers may develop and use Contextualized Intervention Materials (CIMs) in other topics in Grade 12 STEM Mathematics to further validate the results of the study.
- ✓ Researchers may conduct similar studies on the use of Contextualized Intervention Materials (CIMs) in other disciplines to confirm the results of the study.
- ✓ The Contextualized Intervention Materials (CIMs) made by the researcher may be used by Mathematics teachers as intervention learning materials in the STEM strand.
- ✓ Teachers may use Contextualized Intervention Materials (CIMs) as remediation materials to enhance the academic achievement of low-performing students in Mathematics and other areas and as enhancement materials to further improve the cognitive skills of average and above-average type of students.
- ✓ Mathematics teachers may be provided with more seminars and workshops on the principles of CIM construction.

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