Development and Production of Computer Generated Instructional Materials for College Geometry

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Abstract. Printed materials such as worktext and textbooks are considered the best instrument in improving transfer of learning since these materials can simulate a human facilitator to teach efficiently and effectively. This study aimed to develop and produce a computer generated instructional materials (CGIM) in College Geometry. The first phase of the study is assessment. It involved eighty-three (83) Bachelor of Elementary Education students. This research utilized an 80-item researcher-made test. Statistical tools employed were percentage, mean, standard deviation, and t-test for one sample. The second phase is development and production using document analysis methods. The result of the first phase shows that students have significantly low competencies in all the topics of College Geometry compared to the passing mean set by the PRC for teachers. The researchers developed a CGIM, specifically, the worktext paired with multimedia presentation. The parts were objectives, learning concepts, exercises, evaluation, and performance task. The topics included were logic and reasoning, geometry of shapes and size, angles and perpendiculars, triangle congruence, quadrilaterals, similarity, circles, and plane coordinate geometry. Every topic has corresponding subtopics. It is recommended that the CGIM will be used in Mathematics classes to improve students’ achievement, habits of mind, and problem solving skills.

1. Introduction
Mathematics is a skill subject that requires active doing and practice. Unlike other academic subjects, students cannot excel or even become skilled at math by just listening to their instructor and reading math textbook. Consequently, to learn math, students should be given simple drills and exercises. From these, they will keep on practicing until such time that they have mastered the basics and eventually they can be given complex and abstract exercise.

However, reports have shown that many college students do not know their multiplication tables. He said it is not an idle question because of alarming frequency College professors who have noted with shock and dismay how ill prepared their incoming students are. He further added that focus should not be on how much mathematics is taught before graduation, but rather how solid the foundations of mathematics are [2].

In addition, majority of Filipino high school graduates may not have the necessary skills to succeed in college. Many high school graduates today cannot meet the academic standards of leading colleges and universities nor possess the right skills and abilities that will help them progress in college. He further said that many high schools students are ill prepared for college. Thus, when they go to the college or university of their choice, they tend to have a "culture shock". He also pointed that many high school graduates lack the skills in fundamental subjects such as Math and English [3].

In this connection, national and international researchers are interested to resolve this existing problem. One of which is the use of Computer Generated Instructional Materials. In today's generation, Mathematics teaching is no longer limited to the use of chalk and chalkboard in the classroom. Instead, many approaches could be used in bringing up to the students the content that the teachers want to convey. In addition to that, teachers were required to follow minimum essentials as to content but they were free to use any method of presenting the content to the learners.
Teachers use a variety of materials to be able to cope up with the demands of time and also to cope up with the demands of fast changing society. This will also enable the learners to understand what technology brings and what they can offer to the betterment of teaching especially with the help of modern gadgets and smart phones.

The studies have found that the perception of Math and Physics majors towards the adoption of Computer-Assisted Instruction in teaching Mathematics according to gender seems to be comparable which is described as favorable for which it can be an effective tool in teaching mathematics [4]. In addition, technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning [5].

The researchers believe that computer generated instructional materials (CGIM) is one of the best educational techniques because it addresses more than one sense simultaneously, as it addresses the senses of sight & hearing. Thus, this study was conducted to develop computer generated instructional materials to improve students’ mathematics achievement, habits of mind, and problem solving skills in college geometry.

2. Research Objectives
This study aimed to develop and produce a computer generated instructional materials in teaching College Geometry.

Specifically, this study sought to answer the following questions:

1. What is the mathematics competency of the students in College Geometry?
2. What are the least mastered competencies of the students in College Geometry?
3. Is the sample mean in College Geometry competencies significantly different from the passing mean of 75%?
4. What CGIM can be developed and produced for College Geometry?
5. What process can be used for the development and production of CGIM for College Geometry?

3. Research Design
This research used design research. The main goal of design research was to research into the process of design. But it was expanded into a broader sense and it now includes research embed in the process of designing as well as the context of designing and research based design practices.

4. Participants
The participants of this study were the 83 third year Bachelor of Elementary Education major in General Education students of West Visayas State University – College of Education for the 2nd semester of AY 2016-2017.

5. Instruments
The instrument for this study was a researcher-made 80-item multiple choices questions. Three validators who are faculty of West Visayas State University – Integrated Laboratory School and College of Arts and Sciences, validated the test. Revisions and improvements of the instruments were based on the validation. In addition, the test also underwent reliability test using the KR 20 formula and revealed a reliability coefficient of 0.7015 indicating that the test is reliable.

6. Procedure
After the approval of the research proposal in the in-house review and the released of certificate to proceed, the researchers inspected the course syllabus for College Geometry. The researcher then drafted an 80-item multiple-choice test, have it validated, and pilot tested. The responses were tallied, computed, analyzed and interpreted and became the bases for the development and production of the CGIM. The researchers also discuss the content with other professors in the university for topics to be included in the CGIM. Furthermore, the researchers scanned different textbooks, worktext and surf the Internet for further references. After the preliminary preparation, the researchers drafted the content of the worktext and multimedia presentation. The draft was given to student assistants who were hired to encode the data for the worktext and multimedia presentation. It took several months for the encoding due to a lot of symbol and figures included in the CGIM. After the encoding is complete, the CGIM were printed.

7. Results and Discussion
This study has two major phases, the assessment of competencies and the development and production of the CGIM for College Geometry.
7.1. Phase One

Table 1. Mathematics Competencies of the Students in College Geometry

| Competencies                          | No of items | SD  | M   | %    | Rank |
|---------------------------------------|-------------|-----|-----|------|------|
| Reasoning and Logic                   | 5           | 1.22| 2.57| 0.51 | 4.5  |
| Geometry of Shapes and Size           | 15          | 2.04| 8.72| 0.58 | 8    |
| Angles and Perpendiculars             | 10          | 1.13| 5.16| 0.52 | 6    |
| Triangle Congruence                   | 10          | 1.40| 5.61| 0.56 | 7    |
| Quadrilaterals                        | 10          | 1.36| 5.08| 0.51 | 4.5  |
| Similarity                            | 10          | 1.23| 4.65| 0.47 | 3    |
| Circles                               | 10          | 1.23| 4.64| 0.46 | 2    |
| Plane Coordinate Geometry             | 10          | 1.36| 4.22| 0.42 | 1    |
| **Total**                             | **80**      | **7.29**| **40.65**| **0.51** |

It can be seen in Table 1 that students scored lower than 60% in all the topics covered in College Geometry. In fact the total performance of the students was 40.65 or 51%. Due to this low performance of students, the researchers were triggered to develop and produce CGIM. This decision of the researcher was supported by studies sowing that textbooks and other printed materials are still considered the best instrument in enhancing positive transfer of learning because they stimulate a good human mentor to teach efficiently and effectively. Such instructional materials enhance quality instruction and therefore guarantee quality education that can be done by providing appropriate materials that serve as the principal tool and repository of standard knowledge that schools communicate a basic instrument for organizing curricula and a basic tool for teaching and learning [6].

Table 2. t-test Result for the Difference of the College Geometry Competencies and Passing Rate of 75%

| Competencies                          | t      | df | Sig   | Mean Difference | 95% Confidence Interval of the Difference |
|---------------------------------------|--------|----|-------|-----------------|------------------------------------------|
| College Competencies                  | 42.92* | 82 | 0.000 | 34.35           | 35.9414                                  |
| Geometry                              |        |    |       |                 | 32.7574                                  |

* p < 0.001

Table 2 shows that there is a significant difference ($t = -42.92$, $p = 0.000$) in College Geometry competencies attained by the students as compared to the passing rate of 75% for teachers [7]. The result show that the students performed significantly lower which alarmed the researchers and was triggered to look for alternative to reduce if not solve this problem.

7.2. Phase Two

Developed and Produced Computer Generated Instructional Materials

Mathematics that is relevant and useful to the learners’ life is what the researchers want the learners would realize after using the worktext and viewing the multimedia presentation which the researchers have developed and produced. The goal of mathematics for the 21st century is to develop learners who are critical thinkers and problem solvers. In line with this, the researchers constructed the word problems and activities in such a way that it would trigger the learners to think critically and to become problem solvers. Also the problems were constructed vividly to resemble real-life situations. To complement the worktext, the researchers also developed and produce multimedia presentations. It is a combination of text, pictures, videos, audio and animations. This provides a 3D effect and animations that the worktext is limited into. The topics and exercises in the multimedia presentation were congruent with the worktext.
The figure above shows the process of development and production of CGIM. This model includes seven (7) steps but the researcher focused only on the first four steps for the rest was included in study 2 and 3.

1. Inspection of the Course Syllabus

The first step is inspection of the course syllabus. This step was done to search information on how important the product will be developed and produced. It was consist of literature review and action research. A literature review is undertaken to collect research findings, check what has been done in the previous study, compare and contrast the methods or process of previous researches and other information pertinent to the planned development.

The action research done prior to this study was entitled Effects of Computer Generated Instructional Materials (CGIM) in Students’ Performance in College Geometry. A mixed-method research was used to determine the effectiveness and benefits of CGIM in teaching College Geometry to learners. The result shows that there was an increase in the mean score of the participants after the intervention. The pretest and posttest results showed that there was an increase in the mean score of the participants from 53.89 describe as “average” to 69.04 describe as “high”. Meanwhile there was a significant difference in the result of the pretest and posttest after the intervention. The thematic analysis revealed how participants behave through CGIM and the benefits of CGIM. Also, the study proved that the use of CGIM in teaching mathematics to learners was beneficial, it helps the learners to understand and learn, at the same time the learners can see the importance of mathematics in their daily living. Hence, teachers should use CGIM in teaching mathematics in order to understand the lesson better. The learners shared their experiences through written and interview. And the benefits of the CGIM are the following: the learners (1) Motivation, (2) Confidence and (3) Academic Self-Concept have all increased. Therefore, the researcher recommends using the CGIM in teaching mathematics. The result of this action research was used as the baseline of the study and was also the bases for the selection of the topics to be included in the CGIM.

2. Planning

The next step is the planning stage for the development and production of the instructional materials. Planning is concerned with the formulation of objectives, learning concepts, activities and exercises that suit both the learners and the course content. The researcher also considers the layout/design of the worktext and the multimedia presentation as part of the planning stage. The degree of difficulty of the activities and exercises was bank in mind of the researchers while working with the worktext and the multimedia presentation.

3. Product Development

After the initial planning has been completed, the next major step is to build a preliminary form of the educational product that can be field-tested. In developing the worktext, the following steps were observed. The first step, the researcher started the draft of the contents of the worktext. The next stage, the researcher encoded the activities and exercises in the computer. The researchers also asked help from student assistant in creating figures and diagrams. After which, the
researchers answered the activities to make sure that the activities and exercises were correct and to avoid erroneous items. Finally, the after securing that the items are appropriate, the final worktext were printed.

For the multimedia presentation, selected content of the worktext were placed in the power point presentation. Videos and audio materials were also integrated in the presentation to enrich and attract students’ attention. Guidelines in preparing the power point presentation were also observed such as the font size, font color as well as the number of lines in every slide.

While developing the worktext and multimedia presentation, the researchers were also working with assessment instrument. These were Worktext Efficiency Rating Scale and Multimedia Rating Scale. The efficiency of the produced worktext and multimedia will be evaluated in terms of: (a) Physical Aspect, (b) Objectives, (c) Topics/Subject Matter, and (d) Exercises. While the multimedia will be evaluated in terms of (a) Content, (b) Physical Aspect (c) Visual Appearance, and (d) Technological Aspect.

The evaluators will evaluate the worktext using a 4-point Likert scale. The 4-point scales are: strongly disagree (1), disagree (2), agree (3), and strongly agree (4).

Furthermore, another instrument was developed; this was Worktext and Multimedia Acceptability Rating Scale. The acceptability of the produced worktext and multimedia will be determined using a 4-point Likert scale. The 4-point scales are: strongly disagree (1), disagree (2), agree (3), and strongly agree (4). These instruments will still undergo evaluation of experts.

4. The First Product
After all the things considered in planning and product development, it is time to print the worktext. This is to check if the product is usable and acceptable for use. The multimedia was also tested to meet the criteria for acceptability.

5. Mathematics Teachers Validation
The researchers decided to have the worktext validated first by the mathematics teachers. The mathematics teachers are the front liners in the classroom. Thus, they know the subject matter better than anyone else. The comments and suggestions of the mathematics teachers will be considered for the revision of the developed and produced computer generated instructional materials.

6. Expert Validation
After the incorporation of the comments and suggestions of the mathematics teachers to the first product, the researchers revised the copy of the worktext and multimedia presentation. This will be then submitted to the University’s Office of the Director of Instruction & Quality Assurance (DIQA). This office will determine further if the developed and produced instructional materials has acceptable and usable using a standard instrument.

7. Try Out
The purpose of the try out is to determine whether the developed and produced worktext could help improved students’ achievement, habits of mind, and problem solving skills. Generally, an experimental design will be used to answer this question.

8. Conclusion
1. The thrust/ mandate of State University and Colleges as an institution of higher learning was to teach (instruction), produce knowledge (research) and applies the results to the community (extension). Also faculties were encouraged to produce instructional materials (production). To meet this thrust/ mandate, the researchers developed and produced worktext paired with multimedia presentation for teaching college geometry. As the researchers work, the researchers realize that it is not easy to develop and produce an instructional material. There are so many factors that the researchers have to consider like difficulty of the items, time allotted for each item to be perform, maturity of the students, SMART objectives and the like.

2. The significantly low performance of the students in strengthen the urged of the researchers to develop and produce CGIM to help the students pass licensure examination and also become a reference material when they are already in the field of teaching.

3. In the preparation of the CGIM, the researchers read a lot of literatures to check which or what is the most appropriate process to follow in developing and producing instructional materials. The researchers found out that there is no unique process. Thus the process will depend on the researchers. The researchers will be the one to decide which of the many process is the best depending on the needs of the learners. Moreover, the process was tedious and will take a long time before the CGIM was completed. Most especially to topics symbols and figures involve.
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