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Development and evaluation of computer aided instructional materials (CAIM) in teaching selected topics in mathematics 7

Michel C Callao
Department of Education, Assumption College of Nabunturan, Nabunturan, Davao de Oro, Philippines

Abstract
The purpose of the study was to examine the effect of the developed computer aided instructional materials (CAIM) to the academic performance of the students in Grade 7 Mathematics compared to the traditional teaching procedures. The respondents for the assessment and evaluation of the research materials were the Mathematics teachers and ICT experts of Cebolin High School-Annex and selected Mathematics teachers form adjacent schools. There were five Math teachers, and two ICT experts serving as assessors and evaluators of the research materials. Math teachers validated the content, instructional and technical quality of the CAIM while the ICT experts validated the technical quality of the CAIM. Grade 7 was a heterogeneous section composed of 30 students with 16 males and 14 females. The section was divided randomly into two groups to compose the experimental group and the control group, with 8 males and 7 females for each group. Both groups were selected due to their equivalent academic standing and proximity of class time schedule. The Mathematics class of the experimental group employed the CAIM as an intervention while the control group used the traditional teaching method using the Self-learning Modules in Grade 7 Mathematics. Four (4) Modules namely, Module 1: Lesson on approximating the measures on quantities involving length, weight or mass, rate, time, and angle and temperature, Module 2: Lessons on solving problems involving conversion of units from Metric system to English system and vice versa, as well as converting the units to its similar units, Module 3: Lessons in Translating English terms and phrases into its equivalent mathematical phrases and sentences and vice versa, and Module 4: Lessons on illustrating and differentiating related terms used in algebraic expressions and evaluating these expressions when given values of the variables were covered for the duration of the research and both groups were given pretests prior to the use of every module. The administration of the posttest to both control and experimental groups were given at the end of each module. Based on the findings of the study, it concluded that the performance of the students in the experimental group who utilized the CAIM within the context of teaching-learning instruction was higher and more improved compared to the students taught in Self-learning modules.

Keywords: Computer Aided Instructional Materials, academic performance, content, instructional, technical, control, experimental

Introduction

The influx of modern technology has brought dramatic and tremendous changes in education process and information dissemination. Almost all public high schools nationwide had adopted and integrated Information and Communication Technology (ICT) in the teaching and learning process and Agusan del Sur secondary schools were of no exception.

Using technology in providing instructional materials play a crucial part in enriching and enhancing the learning of the students. Technology, in the classroom setting, can be distinguished into two types namely; low and high technology. Low technology refers to the commonly used devices in the classroom such as flashcards, posters, and blackboards. On the other hand, high technology pertains to the use of modern equipment like the computers, computer-aided Instructions and televisions.

Computer-Assisted Instructional Material (CAIM) is a term to describe how computers are used as instruments in education. It is applied in the teaching-learning situation involving direct instructional interaction between the students and the computers. The teacher who has the responsibility of all instructions in the classroom, arranges the learning environment through careful selection of instructional materials based on the learning needs of the students and to the recent learning topic being discussed. The teacher also ensures that each student has the necessary knowledge, skills, attitude to engage in a particular activity, monitors and supplements the learning activities, evaluates learning outputs, and, follows up with activities which stimulate retention and transfer of learning (Forcier, 2005) [4].

In the local setting, a number of private schools in urban communities have already been using computers in their classrooms as part of their curriculum. However, most of these schools use computer only as a tool or tutee mode of computer application in processing data. In search for related literature, the researcher found out that few studies have been conducted and reported with regard to the effectiveness of computers in the learning process of Filipino students, particularly in the secondary level. Moreover, locally developed instructional software were not also available for use.

An interesting area for employing CAI programs is in the field of Mathematics. Mathematics as an abstract subject, students have difficulty in understanding most of the mathematical concepts in it and sometimes find the subject boring when taught in traditional method. With more interactive CAI programs, however, learning Mathematics can become more interesting and entertaining.

The researcher intended to develop and evaluate Computer-Assisted Instructional Material (CAIM) for topics in Mathematics unto which the students find difficulty to

comprehend. This study prepares a CAIM to provide in-depth instruction concerning the most essential learning competencies in Mathematics 7 as identified by the Department of Education. The product hopes to help students understand the concepts embodied in the different topics and adopts the theory of constructivism in the development of CAIM to encourage the learning process where the students are actively involved.

Methods

Research Design

The study was a quasi-experimental control group design type of research. The design aimed to establish a cause-and-effect relationship between the independent and dependent variables (Lauren, 2020) [7]. The quasi-experimental design was used because unlike the true experimental design, it does not require randomization One section of students was divided into two groups -experimental and control group- unto which the members were randomly assigned. The design was chosen because it allows the researcher to compare groups, and the use of increasingly sophisticated programs providing greater statistical control for what has become to evaluate the outcomes of the social work programs and policies (Thyer, 2002) [11].

The design used for this study is shown in the diagram below,

O1 x O2

O3 O4

Where
O1 refers to the pretest administered to the experimental group.
O3 refers to the pretest administered to the control group.
O2 refers to the posttest administered to the experimental group.
O4 refers to the posttest administered to the control group.
X refers to the experimental treatment.
---------- refers to the non-equivalent non-random assignment of groups.

Both groups were given the same pretests before discussing each selected modular classes specifies for the assigned periods. After which, the intervention was conducted to the experimental group using the CAIM developed while the control group used the prescribed modular learning method in Mathematics 7 as provided by the Department of Education. The administration of posttests to both experimental and control groups were conducted after each module was completed.

Respondents and subjects of the study

The respondents for the assessment and evaluation of the research materials were the Mathematics teachers and ICT experts of Cebolin High School-Annex and selected Mathematics teachers from adjacent schools. There were five Mathematics teachers, and two ICT experts serving as assessors and evaluators of the research materials. Mathematics teachers validated the content, instructional and some aspects of the technical quality of the CAIM while the ICT experts validated solely the technical quality of the CAIM.

The subjects of the study were the Grade 7 students of Cebolin High School-Annex currently enrolled for the academic year 2020-2021 under the K to 12 Program. Cebolin High School-Annex had a total of 120 students from Grade 7 to Grade 10 with only one section per year level. Grade 7 was a heterogeneous section composed of 30 students with 16 males and 14 females. The section was divided randomly into two groups to compose experimental group and control group, with 8 males and 7 females each. Table 1 shows the distribution of the students in the study.

Research instruments

The questionnaire administered in the pretests and posttests were derived and adopted from the Deped Grade 7 Mathematics Self-Learning Modules as provided by the Central Office. Table of Specifications (TOS) for each lesson were prepared to identify the complexity of the test questions. The questionnaire adopted the Likert system with 15 items multiple choice format with four choices for each item.
The questionnaire has three parts, namely, content quality, instructional quality and technical quality. Each indicator has 5 sub indicators which will be rated by 5 as highest and 1 as lowest.

Validity and reliability of the research instrument

The pretest and posttest questionnaire for each module were derived from the standardized Grade 7 Self-Learning Module duly approved by the Department of Education. Table of Specifications (TOS) for each module was also prepared to identify the degree of complexity of each question. The questionnaire was tested using the separate group of thirty (30) students, not part of the control and experimental groups for the purpose of item analysis. The results were collated, organized and analyzed with the help of authorities for improvement. The improved instruments were then used as final instruments for the administration as prescribed in the gathering of data procedures.

Research procedures

The research procedure for the conduct of the study consisted of three phases, Preliminary phase, Experimental Phase, and Post-Experimental Phase.

Preliminary phase

The required materials were organized for the testing and plan of action to be formulated. Firstly, the researcher designed a sample of a questionnaire or the pretest exam with reference to the DepEd Grade 7 Self-Learning Modules and made an initial assessment to a separate students composed of 30 students not included in the study and were of higher level. The selected students became the subjects for the validation, item analysis and reliability determination. Secondly, the researcher requested permissions from the Office of the Department of Education of Agusan del Sur and the District In-charge of Cebolin High School-Annex and other schools affected to conduct the research. Once granted, letter of requests were forwarded to the teachers who were the respondents of the study and to the concerned schools for the use of the selected students as subjects of the study. Thirdly, the CAIM were constructed for every specified module based on DepEd Self-Learning Modules. The researcher made a breakdown of lessons/ subtopics to be used in the CAIM.

Trial runs of the CAIM were tested for its effectiveness to another group of students, recorded the results and integrated necessary revisions. After the revisions, the CAIM were finalized and used for the teaching-learning intervention.

Experimental phase

The experimental phase was the introduction of the CAIM to the experimental group as an intervention. The assessed and developed CAI materials were then introduced and utilized as a means of the learning process to the selected students in the experimental group.

Post experimental phase

In this phase, the posttests were administered to both control group and experimental group at the end of each module. The post-testing of both groups marked the end of the experiment of each module. The same questionnaire was given to both students in the control and experimental groups. The results were recorded and tallied by the researcher and submitted to the statistician for analysis. The results of the statistical analysis were then interpreted, findings drawn, conclusions formulated, and recommendations submitted.

The Evaluation Phase

The evaluation form of Galarse (2008) [5] used in the study consisted of three categories namely, content quality, instructional quality, and technical quality with each category composed of 10 items.

The first category was about the accuracy of the content, educational value, clarity of the presentation and grammar. The second category included the effectiveness of the material, the degree of importance, logical sequencing and the appropriateness of the color and graphics used. The third category evaluated the choice of the colors, font backgrounds, text and navigation and the appearance of the screen.

The control and experimental groups were given the same pre-assessment test as pretests. The control group used the Grade 7 Self-Learning Materials while the experimental group were given the Computer-Assisted Instructional Material (CAM) as intervention. After which, both groups were administered posttests after each module. The results of the pretests and posttests were then organized, analyzed, evaluated, and interpreted.

Results and discussions

Table 1 shows the results of the computations and respective interpretations of the reliability of the research instruments used in the pretests and posttests.

Table 1: Reliability of the Research Instrument

Module	Topics	$\bar{x}$	SD^2	Index of Reliability	Interpretation
1	Approximating Measures	16.67	49.81	0.96	Very High Reliability
2	Solving Problems Involving Conversion of Units	14.87	28.32	0.97	Very High Reliability
3	Translating English Phrases and Sentences to Mathematical Phrases and Sentences	13.27	27.48	0.95	Very High Reliability
4	Algebraic Expressions	13.67	33.19	0.97	Very High Reliability
Weighted Mean				0.96	Very High Reliability

As shown in the table, Module 1 was 0.96 with an interpretation of Very High Reliability, Module 2 with 0.97 with an interpretation of Very High Reliability, Module 3 with 0.95 with an interpretation of Very High Reliability and Module 4 with 0.97 with an interpretation of Very High Reliability. Overall, the research instrument had a reliability index of 0.96 interpreted as Very High Reliability.

Reliability is concerned with the extent unto which a measurement of a phenomenon provides stable and consist of result (Carmines and Zeller, 2005) [3]. Reliability is also concerned with repeatability. For example, a scale or test is said to be reliable if repeat measurement made by it under constant conditions will give the same result (Moser and Kalton, 2010) [8]. Testing for reliability is important as it refers to the consistency across the parts of a measuring instrument (Huck, 2007) [6].

Table 2: Pretest/ Posttest Scores by Module

Module	Control Group			Experimental Group		
	Pretest	Posttest	MGS	Pretest	Posttest	MGS
1	3.33	7.93	4.6	3.27	10.87	7.6
2	3.6	6.93	3.33	4.20	10.73	6.53
3	3.80	5.93	2.13	4.47	9.33	4.86
4	3.93	3.93	2.47	4.73	9.80	5.07
Mean	3.665	6.798	3.133	4.168	10.183	6.015

Table 2 shows the comparative analysis by module of the pretest scores of the control and experimental groups to determine the equivalence of their academic status prior to the intervention.

Table 3: Comparative Analysis of the Pretests by Module

Module	Groups	N	Mean	SD	Tabular (t)	Computed (t)	Findings/ Conclusion
1	Experimental	15	3.27	0.96	1.761	0.250	Accept Ho Not Significant
	Control	15	3.33	1.39			
2	Experimental	15	4.20	0.86	1.761	1.598	Accept Ho Not Significant
	Control	15	3.60	1.29			
3	Experimental	15	4.47	0.99	1.761	1.726	Accept Ho Not Significant
	Control	15	3.80	1.08			
4	Experimental	15	4.73	1.03	1.761	1.724	Accept Ho Not Significant
	Control	15	3.93	1.09			

*t-test at 0.05 level of significance

Results of the statistical analysis using t-test at 0.05 level of significance showed that the pretest scores of both control and experimental groups were not significant in all modules. Meaning that at the start of every module, both groups were of equivalent standings academically

Results of the Null Hypothesis

Ho1. There is no significant difference between the academic performance of the students in the experimental and control groups as reflected in their pretest and posttest scores

The t-tests were used to determine the significant difference between the results of the mean gain scores of the students both control and experimental groups. In order to understand clearly the comparative result of each group, the null hypothesis was further divided into sub-hypothesis:

Ho1.1. There is no significant difference between the academic performance of the students in control group as reflected in their pretest and posttest scores.

Ho1.2. There is no significant difference between the academic performance of the students in experimental group as reflected in their pretest and posttest scores.

Ho1.1. There is no significant difference between the academic performance of the students in control group as reflected as reflected in their pretest and posttest scores.

Table 4 shows the comparative result between the pretest and posttest mean scores of the control group.

As shown in the table, the results of the statistical analysis using t-test at 0.05 level of significance showed that the pretest and posttest scores of the control group were significant in all modules. Meaning at the end of every module, students performed better after the implementation of the experiment. Therefore, the null hypothesis was rejected which implies that there was a significant difference between pretest and posttest in control group.

Table 4: Comparative Table of the Pretest and Posttest Scores in Control Group

Module		Pretest	Posttest	Computed (t)	Tabular (t)	Findings/ Conclusion
1	$\bar{x}$	3.33	7.93	9.872	1.761	Reject Ho / Significant
	SD	1.40	.88			
	N	15	15			
2	$\bar{x}$	3.60	6.93	8.919	1.761	Reject Ho / Significant
	SD	1.30	1.03			
	N	15	15			
3	$\bar{x}$	3.80	5.93	9.025	1.761	Reject Ho / Significant
	SD	5.93	.80			
	N	15	15			
4	$\bar{x}$	3.93	6.40	7.337	1.761	Reject Ho / Significant
	SD	1.10	.99			
	N	15	15			

*t-test at 0.05 level of significance

Ho 1.2. There is no significant difference between the academic performance of the students in experimental group as reflected in their pretest and posttest scores.

As shown in Table 5, the computed t-test value of 21.767 is less than the given tabular value which is 1.761 in module 1. Therefore, the null hypothesis was rejected which means that there was a significant difference between the means of pretest scores of the experimental group in module 1.

In module 2, the computed t-test value of 21.313 is less than the given tabular value which is 1.761. Therefore, the null hypothesis was rejected which implies that there was a significant difference between the means of pretest and posttest scores of the experimental group in module 2.

Table 5: Comparative Table of the Pretest and Posttest Scores in Experimental Group

Module		Pretest	Posttest	Computed (t)	Tabular (t)	Findings/ Conclusion
1	$\bar{x}$	3.27	10.87	21.767	1.761	Reject Ho / Significant
	SD	.96	1.25			
	N	15	15			
2	$\bar{x}$	4.20	10.73	21.313	1.761	Reject Ho / Significant
	SD	.86	1.03			
	N	15	15			
3	$\bar{x}$	4.47	9.33	22.605	1.761	Reject Ho / Significant
	SD	.99	.72			
	N	15	15			
4	$\bar{x}$	4.73	9.80	15.332	1.761	Reject Ho / Significant
	SD	1.03	.94			
	N	15	15			

*t-test at 0.05 level of significance

In module 3, the computed t-test value of 22.605 is less than the given tabular value which is 1.761. Therefore, the null hypothesis was rejected which implies that there was a significant difference between the means of pretest and posttest scores of the experimental group in module 3.

In module 4, the computed t-test value of 15.332 is less than the given tabular value which is 1.761. Therefore, the null hypothesis was rejected which implies that there was a significant difference between the means of pretest and posttest scores of the experimental group in module 4.

The results of the statistical analysis showed that the pretest and posttest of the experimental group were significantly different in all modules which simply implies that students performed better after the implementation of the experiment.

Table 6 shows the summary of mean results of the pretests and posttests of module 1, 2, 3, and 4.

Table 6: Summary of Pretest and Posttest Mean Scores

Modules	Pretest		Posttest	
	Control	Experimental	Control	Experimental
1	3.33	3.27	7.93	10.87
2	3.60	4.20	6.93	10.73
3	3.80	4.47	5.93	9.33
4	3.93	4.73	6.40	9.80
Average	3.67	4.17	6.80	10.18

Table 6 shows the summary of pretest and posttest mean scores of both experimental and control groups. The table implies that students in the experimental group whose instruction makes use of Computer Aided Instructional Materials (CAIM) performed better academically than the students in the control group. Moreover, the comparative results of the average scores of the experimental and control groups at 10.18 and 6.80 respectively, gave the experimental group a better achievement rating which means that they have learned more of the topics discussed.

This was supported by Roesky and Kennepohi (2008) [10] that the students from the experimental group benefitted from the use of concept cartoons in their teaching, managed to clear up misunderstandings about the topic and most importantly, the students enjoyed the learning process.

Ho2: There is no significant difference between the academic performance of the students in the experimental and control groups as reflected in their posttest scores.

Table 7 shows the result of the comparative analysis between the posttest scores of control and experimental group.

Table 7: Computation Table of the Posttest Mean Score

Module		Average		Computed (t)	Tabular (t)	Findings/ Conclusion
		Control	Experimental			
1	$\bar{x}$	7.93	10.87	11.000	1.761	Reject Ho Significant
	SD	.88	1.24			
	N	15	15			
2	$\bar{x}$	6.93	10.73	14.511	1.761	Reject Ho Significant
	SD	1.03	1.03			
	N	15	15			
3	$\bar{x}$	5.93	9.33	3.360	1.761	Reject Ho Significant
	SD	.80	.72			
	N	15	15			
4	$\bar{x}$	6.40	9.80	8.765	1.761	Reject Ho Significant
	SD	.98	.94			
	N	15	15			

The results of the statistical computation using t-test at 0.05 level of significance showed that the posttest scores of both control and experimental groups were significant in all modules. Therefore, the null hypothesis was rejected which implies that there was a significant difference between the academic performance of the students in the experimental and control groups as reflected in their posttest scores. Meaning, at the end of every module, experimental group performed better compared to control group.

The findings of the statistical analysis comparing the results of the experimental and control group is confirmed by the studies of Balm, *et al* (2008) [2] which states that the use of visual tools in learning instruction enable students to learn more meaningfully by creating a discussion environment.

Conclusions

On the basis of the results and discussions, the following conclusions are drawn:

All 30 criteria for evaluation of CAIM, which has three categories, rated favorably by the Mathematics teachers. All ten (10) criteria for evaluation of CAIM in terms of its technical quality done by the ICT facilitators showed desirable result. Mathematics teachers and ICT Facilitators had similar assessments in terms of the technical quality of CAIM.

At the beginning of experiment, both control and experimental groups were of equal academic performance standings. Level of learning in the posttest manifested a significantly differ compared to the academic result in their pretest. However, comparing their posttest mean scores of both groups revealed that the experimental group under the Computer Aided Instructional Material faired significantly better in their academic result than the control group with just only the self-learning modules used as instruction. The CAIM was observed to provide assistance to the learners. It helps the students to learn on their own by exploring the given activities on CAIM and improve their reading, comprehension and analysis.

The result confirmed the observations of Adegoke (2010) [1] that the use of improvised instructional material approach aroused the students interest consequently improving the retention of the lessons from the topics. Generally, the students under the Computer Aided Instructional Materials in the learning process appreciated the advent of computers to their way of learning the topics of Grade 7 Mathematics (Neo, 2009) [9].

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