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Information Communication Technology (ICT)-Based Instructional Software and Its Effectiveness in Teaching High School Geometry

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ABSTRACTS

The study aimed at developing and testing an ICT-based instructional software called UBDGEOMESYS, to facilitate students' learning of selected topics in Mathematics. It is a researcher-created program that uses a language known as Microsoft Visual Basic. The respondents of the study included 2 groups of second-year Special class students of Koronadal National Comprehensive High School (KNCHS). Data for analyses were the scores from tests administered before and after the instruction. Validity and reliability activities were done to ensure the quality of the tool. The evaluation showed that the ICT-based material was of good quality along with its content, technical and instructional value. The analysis also indicated that the learning achievement of students exposed to the instructional software (R2 = 0.284) was reasonably higher than those who utilized the traditional way (R2=0.05).

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1. INTRODUCTION

Mathematics is the mainframe and backbone of civilization. It determines the lifecycle of man and one of its branches is Geometry. It was considered for its complexity in the twenty-first century, where the evolution of technologies became the decay of past, present, and future gadgets. The invention of the computer as man's best friend machine becomes the basic needs in daily life and it makes work easier in respect of time and place. The continuity of civilization in the modern world where mathematics and machines, which are dual have progressively advanced due to the major help of education. Education responds to the development of human nature as it continues to cater to the challenges in the effectiveness and usefulness in the habitat of a human being. Today our world becomes complicated and the only answer is to become free from ignorance through education, where philosophies mold and glow at the highest peak. Mathematics education is the major translation of numbers into the real world that enables technological processes to become the weapons of industrialization of civilization (Squier & Jenkins, 2003).

The usefulness of instructional materials and the fluidity of language that fit students' interest have a great impact on the students' achievement and performances. The language of computers known as ICT has a major role in teaching and learning mathematics. The intervention of something to do in the classroom instructions makes students understand and keeps learning in a better position. This motivated and challenged the researcher in the creation of ICT- instructional materials for youth-oriented language that enable students to learn a lot about mathematics, especially Geometry. ICT in teaching and learning Geometry makes this researcher develop a computer system. An ICT instructional tool enhances the visualization and interactive capacity of students. However, the increase of ICT tools and Multimedia computer programs in enhancing student learning available in the market still is not suited to Filipino students. This researcher developed the computer program names: instructional software, encoded, programmed, and execute in microsoft visual studio version 2010. instructional software as an ICT tool in teaching selected topics in Geometry will determine its effectiveness in the achievement of students. The innovation in teaching and learning Geometry may propel new industries in education like an electronic blackboard.

The development of modern society is based on the peripherals of the computer's system. In this field where the civilization of mankind arises from the tip of mechanical machines into superpower machines. Computers affect every aspect of human life, mostly in the part of education, through a toddler's development going to the adult's life, computers stray on his basic necessity. Information communication technology (ICT) integration in the teaching and learning process has been overdue since the computer has been discovered. Before the COVID 19 pandemic hit the education, system there's called Computer-Aided Instruction (CAI), Computer–Assisted Learning (CAL), and now the proponent faces it is a new name called Information Communication Technology (ICT). ICT in education has been flex as effective in the teaching and learning process for both teachers and learners in different field of disciplines.

Historically, ICT-based is already part and parcel of education, since pre-Covid 19 pandemic era, the gap now is widening as this new normal education hit the hierarchy of the education system from preschool to university level where no face-to-face instruction happened. According to Flor (2008) that there are four major policy gaps in the implementation of ICT particularly in the Department of Education:

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(i) An Expanded Definition of ICT. Taking a cue from UN agencies, the ICT for education in the Philippines should adopt an expanded liberal definition of ICT inclusive of both low-end and high-end technologies, digital and analog devices.
(ii) An Appropriate Use Policy - With the adoption of the above definition, what logically follows is an Appropriate Use Policy that sets efficient and effective utilization guidelines for ICTs with due consideration given to technological, ethical, proprietary, and humanistic issues. The Policy should be considerate of the primary, secondary, and higher-order impact of specific technologies to be employed on individual stakeholder groups as well as communities. The use of technology should be guided by practicality, cost-effectiveness, and sustainability.
(iii) Donor Coordination and Harmonization -With the variety and diversity of ICT for education initiatives and donors, with their attendant interests, donor coordination and harmonization policy may be in order. This policy begins with the tacit agreement that one unified framework should be adopted and that ICT initiatives in the education sector should be guided and situated accordingly by and within this framework. Lastly the fourth gap
(iv) Public-Private Sector Financing - A policy on public-private sector partnerships for the ICT4E movement should be enforced. The private sector should be sensitized to the fact that supporting ICT4E would pump prime the ICT industry.

Tomaro (2018) discussed fully integrating ICT in education in the case of the Philippines such as added training for teachers, provision of computer infrastructures, integration of ICT in the curriculum in a strategized manner, and lastly strong leadership. Integrating Information and Communication Technology (ICT) into teaching and learning has become a great concern for many educators in developing countries like the Philippines and must be used, taught in meaningful ways, with its rapid development, educators should find ways to integrate technology in the learning process. Further, he elaborated that ICT should not drive education, rather, educational goals and needs must drive its use in schools, and targeting holistic growth for learners is a crucial factor in realizing the need to develop ICT curriculum standards for K-12 schools in the Philippines. Preclaro-Ongtengco (2019) and Plowman and Stephen (2003) cited that ICT should have a different format of presenting text, but rather considered it with instructional design in mind and an initial review of an existing digital enhancement of the lesson plans, a digital (animated) version of each lesson was created to help increase interest and attention of its young viewers. Further, she discussed that what was missing however from this innovation was the instructional design component that directs the use of ICT towards creating a more engaging learning environment. Due to this proponent's creative mind, the UBDGEOMESYS has developed' a combination of Understand by Design (UBD) strategy and Geometry lessons a second-year mathematics subject in the Basic Education Curriculum (BEC), the academic year 2013-2014. This UBDGEOMESYS is an ICT-based instructional software that enhances interaction and students' learning activities. Lee (2018) and Hou *et al.* (2020) cited that modern society has evolved to extent that computer technology has become part of various fields, creating new and superior value to society. He reiterates that education on computer literacy, including the ability to design and build software, is now becoming a universal education that must be acquired by everyone, regardless of the field of study

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2. METHODS

This is developmental and experimental research. The creation of the instructional software by the author itself using a window-based programming language called Visual Basic version 6.0. The content of the instructional software is in UBD (Understand by Design) format that is used in (BEC) Basic Education Curriculum. The developed instructional software called UBDGEOMESYS focuses on the second-year mathematics lessons as the main contained knowledge. The following five main topics are (i) Ration and proportion; (ii) Proportional segment; (iii) Proportional segment; (iv) basic similarity theorem in triangles; and (v) similarity in right triangles. The author created the instructional software that is not purely text, simply read and solved by the users (respondents) instead there are interactive features embedded in the UBDGEOMESYS. The UBDGEOMESYS as an ICT-based teaching strategy is compared to the chalk and talk methods/ traditional approach in the same subject and lessons. Survey and Pre-Post-test quasi-experimental designs are the main statistical data to be used and gathered between the ICT and non-ICT teaching strategies.

There are fifty validated multiple-choice questions made by the author which are composed of 10 questions per topic, a topic of five with a total number of fifty objective type tests. Further, these fifty objective type tests, particularly a multiple-choice type was used as the main data for the pre and post-test designs in determining the effectiveness of UBDGEOMESYS in teaching selected topics in high school geometry. In the comparison of the results with the traditional way of teaching, this study also gets the data from the control group. The data gathered is analyzed using the SPSS software to determine the descriptive and inferential results of the study.

3. RESULTS AND DISCUSSION

This section presents the analysis and interprets the data generated from the study. Tabular, graphical information, and regression analysis are presented to reveal significant points useful in pursuing the main concern of this study – to answer the research questions by testing the hypothesis earlier formulated.

3.1. Descriptive Perceptions (Overall Perceptions for Qualities (Content, Technical & Instructional) Of Ubdgeomesys By the Respondents and ICT Teachers)

Table 1 shows the overall perceptions of the UBDGEOMESYS's three qualities, namely: content, technical, and instructional. Their overall weighted mean is 4.05. The UBDGEOMESYS was rated as “very good” which means that the integration of ICT is “very agreeable” to the experimental group. Among the three qualities, only the technical quality had a lower rating to means that the computer laboratories should update their software and hardware components.

Table 1. Overall perceptions of the UBDGEOMESYS.

Quality Components	Mean	Interpretation
Content quality	4.13	*Very good*
Technical Quality	3.77	*Very good*
Instructional Quality	4.24	*Excellent*
Overall mean	4.05	*Very good*

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Table 2 presented the perceptions of content quality in the UBDGEOMESYS. It has nine properties which earned the mean of 4.13 and the interpretation of "very good". Among the nine properties, numbers 1, 4, and 9 have "excellent" descriptions. The flow of lessons in the UBDGEOMESYS received the most attention from the respondents, to show that they liked the content. The UBDGEOMESYS created vibrant, well-diversified, and substantial topics which translated into simplified and relevant lessons as perceived by respondents.

Table 2. Perceptions for content quality of the developed UBDGEOMESYS by the respondents.

No	Content	Mean	Interpretation
1	The content is scientifically adequate and accurate.	4.33	*Excellent*
2	It emphasizes active learning.	4.18	*Very good*
3	It is well organized.	4.18	*Very good*
4	It is relevant to learning objectives.	4.36	*Excellent*
5	It reaches powerful ideas.	4.18	*Very good*
6	It evaluates student learning as stated in the objectives.	3.67	*Very good*
7	It allows the development of multiple intelligences	3.67	*Very good*
8	The topics are interesting.	4.15	*Very good*
9	The content is free of ethnic, gender, and other stereotypes	4.46	*Excellent*
	MEAN	4.13	*Very good*

Table 3 revealed that all respondents rated the technical quality of UBDGEOMESYS as "very good". The nine properties earned the average weighted mean of 3.77. Among the nine properties, numbers 4 and 7 had a lower value of weighted mean and received "good" descriptions. Only number 6 received an "excellent" description. However, it also shows the poor quality of the sounds and the capacity of the computer to run, indicating that the problems are more on the computer peripherals. The computers in the computer laboratory are not complete in terms of accessories like the speaker, and, the models are old.

Table 3. Perceptions of the technical quality of the developed UBDGEOMESYS by the respondents.

No	Technical	Mean	Interpretation
1	The system is easy to navigate.	3.82	*Very good*
2	It allows the learner to control the pace of learning.	4.15	*Very good*
3	It is well organized.	3.67	*Very good*
4	The sounds are clear.	3.23	*Good*
5	The layout and design are attractive.	4.33	*Excellent*
6	The user support materials are comprehensive and directive.	4.00	*Very good*
7	Runs quickly, with minimum waiting.	3.00	*Good*
8	Intended users can easily and independently use the system.	4.00	*Very good*
9	The system is aesthetically pleasing.	3.70	*Very good*
	Mean	3.77	*Very good*

Table 4 shows that the assessment on instructional quality had an "excellent" description and the nine properties earned the average weighted mean of 4.24. Among the nine properties, numbers 2, 3, 4, 5, 7, and 8 had "excellent" descriptions. The interactions between the students and the lessons on the computers created a relevant value in teaching and learning as experienced by respondents. The interactive UBDGEOMESYS which caters to the

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needs of the students in the teaching and learning of the five topics described the respondents' response as "strongly agree" indicating that the UBDGEOMESYS is needed in current styles of the learning process.

Table 4. Perceptions for instructional quality of the developed UBDGEOMESYS by the respondents.

No	Instructional	Mean	Interpretation
1	It provides appropriate feedback on the accuracy of students' answers.	4.18	*Very Good*
2	It is of high educational value.	4.28	*Excellent*
3	It is a good supplement to the curriculum.	4.33	*Excellent*
4	It addresses the needs and concerns of students	4.23	*Excellent*
5	The instructional material facilities collaborative and interactive learning.	4.36	*Excellent*
6	It integrates students' previous experiences.	3.95	*Very good*
7	The test items are constructed appropriately to the level of the lessons.	4.23	*Excellent*
8	It reflects the current trend in Mathematics education.	4.46	*Excellent*
9	The graphics, and colors, used are appropriate for instructional objectives.	4.15	*Very good*
	MEAN	4.24	*Excellent*

3.2. Graphical Perceptions

The results for the graphical perceptions are shown in **Table 5**. Through the summary results of graphical perceptions. There is enough evidence to claim that the students in the ICT-based approach performed better in the post-test with their main gain score of 19.06. It implies that ICT based approach was better prepared and got higher scores in the post-test compared to their pre-test. Using the UBDGEOMESYS was effective in students' achievement. The mean gain score difference of 19.06 reveals that the scores of the ICT-based approach in the post-test were higher than those in the pre-test. The UBDGEOMESYS as researchers' masterpiece and innovative teaching strategy in teaching geometry was proven to be effective in students' achievement. The immersion of students in ICT activities like computer programs, education software, and courseware particularly in a core subject area like math is revealed to cause high standards of achievement and creates homogenous results. Moreover, in Non-ICT-based approach, showed that the students in the non lCT group performed better in the post-test with the main gain score of 10.55. It implies that the control group was better prepared and got a higher score in the post-test compared to the pre-test. After the treatment, using the traditional method was more effective in students' achievement. In summary, ICT based approach gain a mean score of 8.51 from non-ICT based approach (chalk and talk method) in teaching high school geometry with five selected topics: (i) ratio and proportion; (ii) proportional segment; (iii) proportional theorem; (iv) basic similarity theorem in a triangle; and (v) similarity in right triangles.

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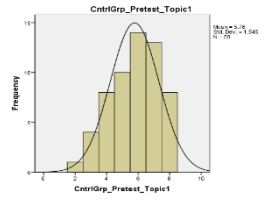
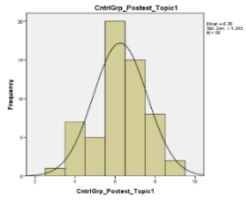
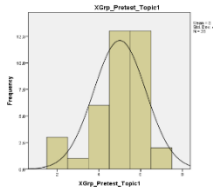
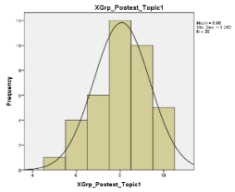
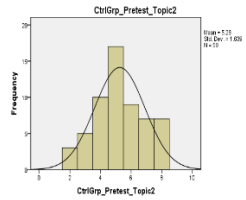
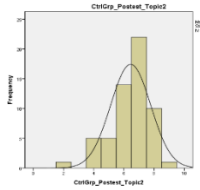
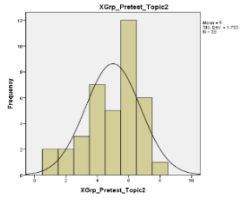
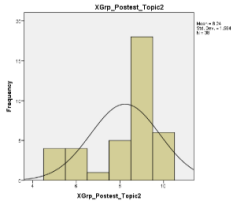
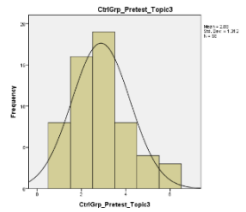
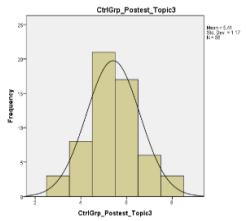
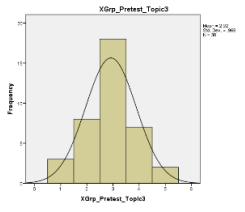
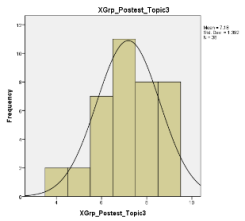
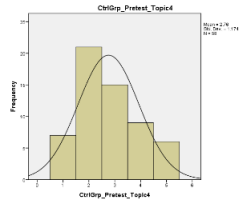
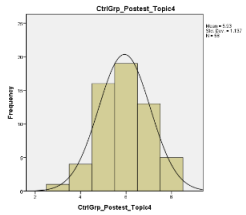
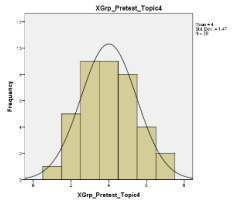
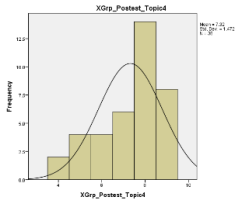
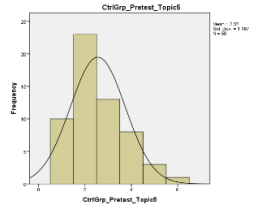
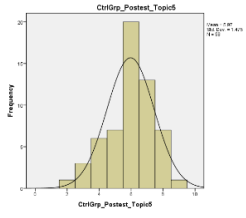
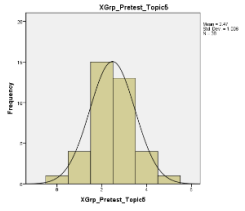
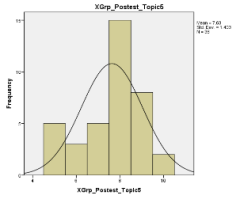
Table 5. Graphical perceptions.

Non-ICT approach		ICT approach	
Pretest	**Post-test**	**Pretest**	**Post-test**
Proportional segment			
			
			
Proportional theorem			
			
Bas sim theorem in Tri			
			
Sim in right triangles			
			

3.3. Inferential Perceptions

The results are shown in **Figures 1** and **2**. **Figure 1** shows the regression analysis (R2 = 0.05, 0.05 significant value) of the Non-ICT base group on five topics regarding their raw scores. It shows slightly inclined in response to the effectiveness of the non-ICT group. **Figure 2** shows the regression analysis (R2 = 0.284, 0.05 significant value) of the Non-ICT base group on five

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(5) topics regarding their raw scores. The graph shows a higher inclined position compared to the non-ICT group.

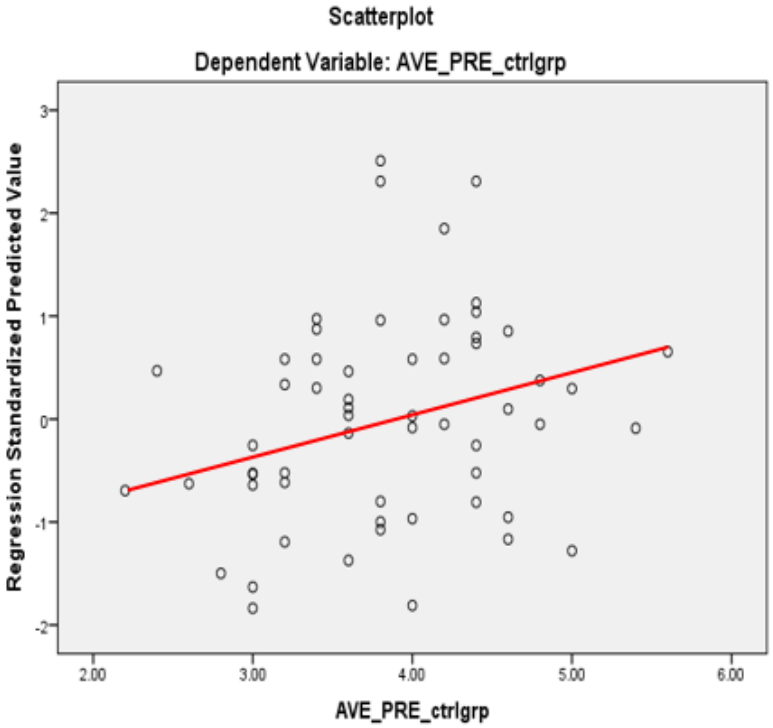

Figure 1. The regression analysis (R^2 = 0.05, 0.05 significant value) of Non-ICT base group in five (5) topics regarding their raw scores. It shows slightly inclined in response to the effectiveness of the non-ICT group.

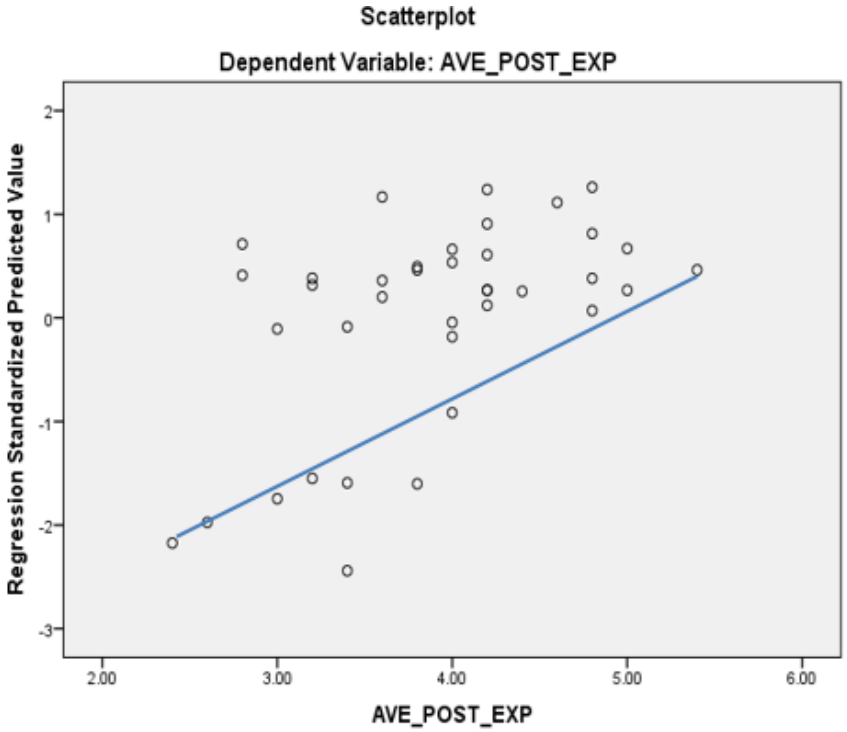

Figure 2. The regression analysis (R^2 = 0.284, 0.05 significant value) of the Non-ICT base group in five (5) topics regarding their raw scores. The graph shows a higher inclined position compared to the non-ICT group

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4. CONCLUSION

The UBDGEOMESYS was assessed as very good in its qualities for teaching selected topics in High School Geometry. After the experimental group was exposed to UBDGEOMESYS, it registered "above average" performance which is far better compared to that of the control group which garnered only an average rating. Considering all tests administered before the conduct of the study like the achievements during the second grading period in Geometry and pre-tests, the respondents exhibited comparable learning performances at the start of the experiment as confirmed by the t-test results. The summary of the finding showed no significant difference and shows that the two groups had no idea about the lessons. After the treatment, the experimental group had a higher value. The analysis also indicated that the learning achievement of students exposed to the instructional software (R2 = 0.284) was reasonably higher than those who utilized the traditional way (R2=0.05). The action-reaction of the UBDGEOMESYS triggers a big momentum in the academic performances of students and it shows that students needed a new style of teaching in the field of mathematics. The development of UBDGEOEMESYS depends on the pedagogical and philosophical values of students-teacher, teacher-school, and school –communities. The learning style of students changes due to vast development in Information and Communications Technologies (ICT). Concerning that development, teachers also need improvement and innovation in new things in teaching mathematics. The traditional approach is embedded in the human mind and taking it in gradual actions, basic routine in imparting the lessons makes students bored and not interested anymore in the subject matters. The reinvention of teaching strategy gives a new standard, a new wave in the field of education. This study is concerned with recent innovations in the methods of teaching and learning Geometry using the developed and created computer system named UBDGEOMESYS by Visual basic version 6. Further, the author suggested, a database for learners and probably a benchmark for education version 4.0 for future research.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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