EFFECTIVENESS OF ICT MEDIATED COGNITIVE APPRENTICESHIP MODEL ON ACHIEVEMENT IN MATHEMATICS OF UPPER PRIMARY SCHOOL STUDENTS IN FIJI

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Abstract

This study aimed to examine the effectiveness of ICT mediated Cognitive Apprenticeship model on Achievement in Mathematics of upper primary school students in Fiji. For achieving this purpose, the researcher used a pre-test and post-test experimental method using a 2x3 factorial design. The study consisted sample of 80 students classified into three different type of learning styles as audio (A), visual (V) and kinesthetic (K) learners. The learning style inventory (LSI) was used to categorise the students in three different types of learning styles. The experimental group of 40 students were subjected to the lessons arranged with the ICT mediated Cognitive Apprentice model of instructions (powerful Mathematics software called GeoGebra), while the control group of 40 students were submitted to the conventional teaching instructions. The Students' achievement in mathematics was measured using pre-test and post-test after treatment using the Achievement Test in Mathematics (ATM)which was prepared by the researcher and validated by experts and piloted in another school so that proper item analysis could be done and final version of test prepared for final testing. The data collected after five weeks of the application upon analysis showed that there was a high positive significant difference in the treatment effect between the two group in the scores of Mathematics basically in geometry. Independent samples t-tests results showed that there was a significant difference in mean mathematical achievement between the group taught with ICT-mediated Cognitive Apprenticeship model and the group with conventional instruction. These findings of the study revealed that the use of ICT mediated Cognitive apprenticeship model (GeoGebra enhanced the students' performance in achievement in mathematics when compared to the conventional teaching instructions.

Keywords: - *ICT mediated, Cognitive Apprenticeship, GeoGebra, Geometry, Conventional instruction, Achievement*

I. INTRODUCTION

The majority of time spent on Mathematics classes are on formally developing a concept and little time spent on establishing an intuitive basis for the idea. ICT can be a useful tool in changing the way we think about mathematics and the way mathematics is taught to students.

A computer is a powerful tool in teaching and learning mathematics, in particular in understanding the mathematical concepts, as many authors noted it (Hohenwarter & Jones, 2007; Guyer, 2008). Mathematics is a discipline in which students and youngsters get knowledge and experience about life. They improve their

ability of logical thinking and reasoning. Some analyses have been conducted and have shown that students lack Mathematical and Critical Thinking skills and also have low attainment scores.

Although steps have been taken to improve the overall achievement level of students, Mathematics is still an area of weakness across the nation in Fiji. Students across the country are showing weakness related to their knowledge of geometry in mathematics. Thus this subject demands the use of various aids and innovative methods of teaching.

A lot of mathematics software have been developed to aid teaching and learning including GeoGebra, Geometer's Sketchpad in mathematics. Several studies have been carried out on GeoGebra software to study various aspects of education. GeoGebra has become a tool that can help teachers to design useful instructional lessons. Although technology has proven to improve the efficiency of learning. Li (2007) cited that more than seventy-five per cent of the students commented that GeoGebra is found to be a beneficial technology for learning. Technology allows easy access to information and other cutting-edge research to make learning more accessible and enjoyable. Until now, GeoGebra is not used in teaching mathematics in Fiji, primary schools.

According to Hohenwarter &Jones (2007), GeoGebra is a computer program (software) for mathematics, especially for learning geometry and algebra. Abramovich (2013) states that GeoGebra as a free online software application for the study of geometry, algebra and calculus at all grade levels and different learning styles.

Moreover, Dynamic mathematical software programs enable students to make connections quickly and meaningfully, which would be very difficult to reach, if not impossible at all, without such dynamic tools. Low achieving students are usually less successfully visualising mathematical concepts compared to the high achieving classmates. Thus ICT mediation using the Cognitive Apprenticeship model can be utilised as a tool for improvement to reduce the high demands. Several studies have provided that ICT integration or intervention significantly improves the scores of the students in their Achievement in Mathematics, and also their Problem Solving and Critical Thinking skills (Ghefaili 2003; Lijojke& Ibo 2013; Kaur, 2012; Calder, 2011; Chrysanthou, 2008; Patil, 2011; Wang Bonk, 2001). It is also evident through the findings in different research that ICT mediated instructions with Cognitive apprenticeship model are more meaningful and productive than conventional classroom instruction on its own.

Therefore visual representation of mathematical concepts like geometry is more crucial for low achieving individuals (Moyer-Pakenham, Ulmer&Anderson, 2012). There exist studies in the literature involving dynamic mathematics software in mathematics education of other countries except for Fiji where a substantial increase in students success was observed. (Gutierrez & Boero, 2006; Martin-Caraballo&Tenrio-Villalon, 2015).

However, few studies are examining the relationship between ICT mediated model and teaching geometry, and there is no study on this topic involving year eight students of primary schools. Therefore, the present study aimed to observe the effectiveness of ICT mediated (GeoGebra) Cognitive apprenticeship model on achievement in mathematics of upper primary school students in Fiji.

II. PURPOSE OF THIS STUDY

The purpose of this study was to determine the effects of dynamic mathematics software GeoGebra using the Cognitive Apprenticeship model on upper primary school student's achievement in mathematics. The research on Cognitive Apprenticeship is still fragmented, with bits and pieces situated in different subfields

of educational research such as teacher education, adult education, school education and multimedia-based education. Knowing about the increasing importance of new technologies for everyday life, several educational organisations have started to develop technology-related standards (Lawless and Pellegrino, 2007, p. 576), trying to foster the integration of new technology into teaching and learning. For example, the National Council of Teachers of Mathematics (NCTM 2000), which is the world's most significant association of mathematics teachers (Wikipedia, 2016), declared technology as one of their six principles for school mathematics. The review of the above studies revealed that there is not even one experimental study conducted in the area of Cognitive Apprenticeship model on teaching. This influenced the investigator to select the Cognitive Apprenticeship model as the treatment variable for the present study.

The reviewed studies inspired the investigator to test the Effectiveness ICT Mediated Cognitive Apprenticeship model on Achievement in Mathematics of upper primary school students in Fiji.

DEFINITIONS

Cognitive Apprenticeship Model (CAM)

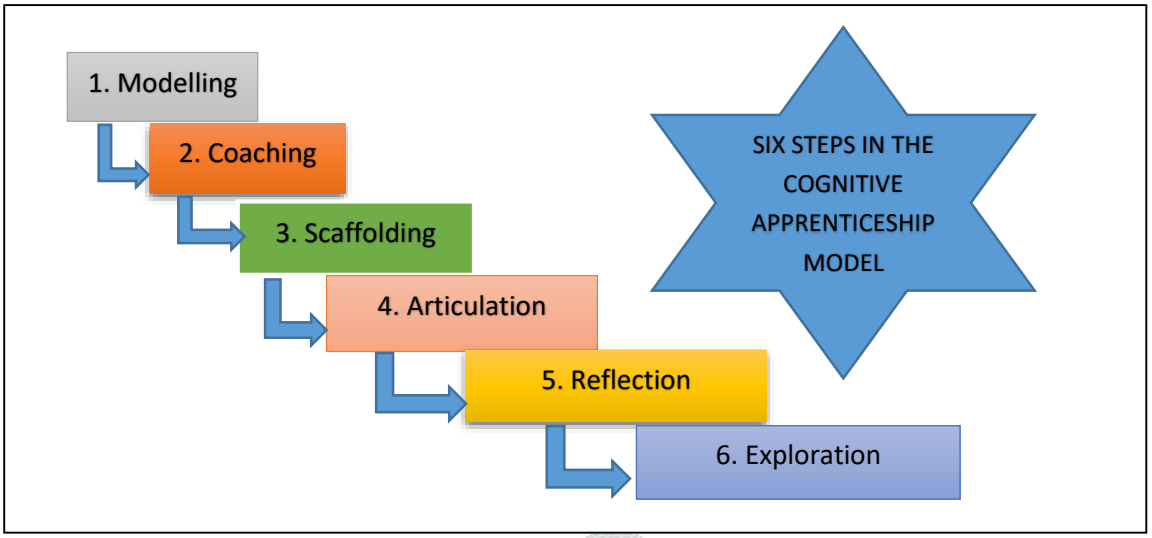
Cognitive Apprenticeship model is an instructional design developed by Collins and Brown (1989). The emphasis of this model is on the teaching of cognitive skills rather than physical skills and learning that occurs through interaction and often involves a group of novices, students, who serve as resources for each other in exploring the new domain and aiding and challenging one another with an experienced instructor. Cognitive apprenticeship (Collins, &Newman, 1989) is an instructional model that utilises the underlying principles of traditional apprenticeship learning. Instructional methods for Cognitive Apprenticeship model include modelling, coaching scaffolding, articulation, reflection and exploration.

ICT

ICT is the acronym that stands for Information and Communication Technology. It includes any communication device or application, which includes radio, television, cellular phones, computer and network hardware and software, satellite systems and such as video conferencing and distance learning. CT in this particular context of study will include digital technology that is computer laptops, tablets, mobiles, the dynamic educational software that can be used to enhance the teaching and learning of mathematics.

ICT mediated CAM in this study refers to the use of ICT hardware namely networked multimedia computers and software specifically dynamic geometry software. GeoGebra was integrated into six instructional methods of the Cognitive Apprenticeship model. Based on the innovative work of Tharp (1990) and Tharp and Gallimore (1990) related to assisting in the learning process, Thus for the present study, this model will be used with the six different strategies mentioned below. The original six methods are summarised in figure 1.0 below.

Figure 1.0 Showing *the six steps involved in the Cognitive Apprenticeship Model*



Conventional Instruction (CI)

Traditional instruction of teaching defined, as the teaching method used by the regular mathematics teacher in the class, upper primary levels, in Fiji context which generally involves explanation, asking questions, giving class notes and in some instances related discussion and assignments together with some activity-based lessons.

Achievement In Mathematics

Achievement in mathematics refers to the communicative evidence of cognitive effects in the discipline of mathematics which is represented by scores obtained on the achievement test in mathematics prepared by researcher and validated by the experts.

Year Eight Students of Upper Primary School

The term upper primary in Fiji context refers to standard or years six to eight students including boys and girls within age limit 12-14 years studying in primary schools with a common Fiji syllabus. The year eight students are in the age group 12-14 years.

FIJI

Fiji officially the Republic of Fiji is an island country in Melanesia in the South Pacific Ocean about 1,100 nautical miles (2000km, 1300miles) northeast of New Zealand's north island. The closest neighbours are Vanuatu to west New Caledonia. Fiji is an archipelago of more than 330 islands of which 110 are permanently inhabited and more than 500 islets amounting to a total land area of about 18300 square kilometres.

It has two significant islands Viti Levu and Vanua Levu; an account of 87% of the population of almost 860000. Fiji has a total of 732 primary schools which includes government, non-government and individual schools. Thus in this study, one district was used from which three schools were used as the samples in this context. Fig. 2.0 below shows the map of Fiji with the identification the area in Fiji that was as the context of the study.

Figure 2.0: Map of Fiji Islands identifying the context of the study.

(Source:http://www.worldmap1.com/fiji-map.asp)

OBJECTIVES OF THE STUDY

1. To study the main and interaction effects of Instructional strategies (ICT mediated CAM) and Conventional Instruction CI)and types of learning styles(audio, visual and kinesthetic) on achievement in mathematics of year eight students of primary schools by taking intelligence as Co-variate.

HYPOTHESIS OF THE STUDY

H0(1) there is no significant difference in the main and interaction effects of instructional strategies (ICT mediated CAM and Conventional Instruction CI) and types of learning styles(audio, visual and kinesthetic) on the achievement in mathematics of year eight students of primary schools by taking intelligence as Co-variate.

III THE METHODOLOGY OF THE STUDY

In the present study, two by Three (2x3) Factorial design was utilised with Co-variate as (Intelligence). The model was structured so that every level of the one independent variable was coordinated or associated with the other. Table 1 .0 given below summarises the variables of the study used in this research.

Table 1.0 showing the variables of the study in the present study

VARIABLES OF THE STUDY FOR THIS STUDY			
INDEPENDENT VARIABLES		**DEPENDENTVARIABLES**	**COVARIATE**
ICT mediated Cognitive Apprenticeship Model (ICTMCAM)	Conventional Instruction (CI)	Achievement in Mathematics **(ATM)** (Revised Bloom's Taxonomy)	Intelligence

Population and Sample

As per the 2014 statistics in the Annual Plan, there are 732 primary schools in Fiji of which 714 are non-government, 16 as private and two as government schools. These primary schools are located in nine districts. All the students of year eight studying in 732 upper primary schools in Fiji constitute the population of this study. (Annual Report MOE (2014).

The sample of the present study consisted of 3 randomly selected schools from one of the nine districts of Fiji, namely Lautoka /Yasawa which included a total of 87 primary schools of which three schools from Lautoka were selected randomly. The three schools were chosen from the population of selected schools

that have internet and computer, laptop or tablets in schools. These three schools which followed the same primary syllabus one from each mentioned district was considered as a piloted group; two schools were used experimental group and control group. The sample consisted of students of all year eight of three randomly selected schools. The age of the students ranged from twelve to fourteen years old.

Tools used in the present Study:

To measure the selected variables, covariate (Intelligence Test the investigator used the following tools.

1. A standardised Group Intelligence Test (GGTI-A) by Dr DC Ahuja which was constructed an standardised.

Statistical tools and Econometric models

Achievement Test in Mathematics (ATM) was constructed by the researcher and validated by experts using selected criteria for the experiment.

Instructional Material using ICT Mediated CAM developed by the investigator for the training of students of year eight.

Learning style inventory (LSI) was constructed by the researcher and validated by experts for the experiment.

STATISTICAL TECHNIQUES USED IN THE PRESENT STUDIES.

In this present study, the data collected was analysed by using descriptive statistics and inferential statistics concerning the objectives and hypotheses.

1. Descriptive statistics: Mean Standard deviation
2. Inferential Statistics: t-test and ANCOVA, whereby Intelligence was kept as covariance

(In statistical analysis and interpretation of data, the hypothesis will be tested at 0.05 level of significance).

IV. RESULTS AND DISCUSSION

Effectiveness of ICTMCAM on Achievement in Mathematics.

To find out the Effectiveness of the ICTMCAM in Mathematics, post-test scores in Achievement Test in Mathematics(ATM) of the experimental and control groups were compared using ANCOVA by taking pretest scores in Achievement Test in Mathematics(ATM) and intelligence as the covariate. The results are presented in Table 2.0 below.

Table 2.0: ***Summary of 2x3 Factorial Design ANCOVA for the scores in Achievement Test in Mathematics (ATM) by taking Intelligence as Co-variate.***

Showing the results of *Sum of Squares, Mean Squares, Variance, Degree of freedom ratio and p-value and results*

Source Variation	Sum of Squares(SS)	Degree of freedom (df)	Mean Square(MSS)	F-ratio	p-value	Results
Instructional Strategies A	56.579	1	56.579	13.685	0.00	S*
Types of learning Style B	342.061	1	342.061	82.735	0.00	S*
(A)X(B)	8.125	1	8.125	1.965	0.163	NS

Adjusted Error	636.700	154	4.134			
Total	119006.000	160				

S* - Significant at 0.05 level

The main effect of Instructional Strategies (ICTMCAM and CI) on the scores of Achievement in Mathematics

From Table 2.0 the main effect of Instructional Strategies (ICTMCAM and CI) on the scores of Achievement in Mathematics of upper primary school students was found to be significant ($F=13.685;df=1/154;p<0.05$), for three types of learning style for two different strategies such as ICT Mediated Cognitive Apprenticeship model (ICTMCAM) and Conventional Instruction(CI).The null hypothesis (H01.1) was rejected, and the alternative hypothesis was accepted. From Table 2 it is vibrant that, the adjusted mean scores of ATM of ICTMCAM was greater than that of the students in CI in increasing scores of ATM among upper primary school students.

The above analysis indicates that ICT mediated Cognitive Apprenticeship model (ICTCAM) has a very significant effect on achievement in Mathematics when intelligence is treated as a Co-variate.

Findings of the Study

1. There is positive significant effect of ICT Mediated Cognitive Apprenticeship model (ICTCAM) on Achievement in Mathematics at the upper primary school level compared to the Conventional Instruction(CI).
2. The students of the treatment group were looking well motivated and ready to learn each day of the treatment duration of ICTMCAM treatments than the students in the CI group.

CONCLUSION

In ICT Mediated Cognitive Apprenticeship model, the teacher initially models the essential strategies, in this case, teaching geometry through GeoGebra software, allows them to try them independently, and coaches students accordingly. The steps of Cognitive apprenticeship model demands learners to articulate their reasoning or methods to solve a problem and are encouraged to reflect on and learn from others approaches. Moreover, the use of ICT-mediated Cognitive apprenticeship model in mathematics provides an adequate opportunity to each for unlocking creativity step by step through active participation and confidence in their geometric constructions. Thus ICTMCAM is very useful in developing problem-solving skills in the learners. It expands and creates a collaborative and creative climate in the classroom. Therefore there should be provision for activities enriching ICTMCAM in primary schools as well as teacher training curricula. Conclusively, this study has shown that ICTMCAM (GeoGebra Software) has a positive impact on student's achievement in the topic of Geometry. This model should be introduced to mathematics educators so that students can explore the world of mathematics on a broader scope and make the students able to think critically and creatively.

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