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Multimedia as a Pedagogical Tool for Teaching and Learning Mathematics in Colleges of Education

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Abstract - *There is no refuting fact that in teaching and learning of mathematics in Colleges of Education, technologies such as Computers, the Internet, Electronic/smart boards, Email and smart phones, have changed the concept, beliefs, perceptions and practices of mathematics Tutors. Technology and Internet are used in enhancing the methodology of mathematics Education. Apart from the commercial importance of technology, it is seen as a pedagogical tool for effective teaching and learning. The last two decades have witnessed innovative change in the academia due to the use of technology in teaching and learning. This rapid change and development of information technology has offered a better way to discover new teaching models. Using multimedia to create a context to teach mathematics has its exceptional advantages. This paper analyzes the necessity of multimedia technology to the teaching of mathematics in Colleges of Education and will also bring out the barriers that hinder the usage of technologies in teaching mathematics. The authors are of the view that the use of multimedia and various technologies in teaching mathematics will surely motivate the learners' interest, create a better interaction and provide interactive environment for both Tutors and students to increase the teaching and learning efficiency of mathematics.*

Keywords: *Multimedia, Internet, Technology, Professional Development, Technological Pedagogical and Content Knowledge (TPACK).*

I. INTRODUCTION

Multimedia refers to computer-mediated information that is presented concurrently in more than one medium. It consists of some, but not necessarily all, of the following: text; still graphics; images; motion graphics; animations; hypermedia; video and audio (sound, music and narration). Multimedia can support multiple representations of the same piece of information in a variety of formats. This has several implications for learning (Ke, 2008).

The role of multimedia and its effectiveness have been the subject of many studies. This paper intends to shed more light to the multimedia approach of teaching mathematics. Several studies shows that computer-based multimedia can enhance learning and sustenance of materials presented during classroom lesson presentation.

II. OBJECTIVES OF THE STUDY

1. To identify the importance of multimedia-based teaching approach in teaching pre-service teachers' mathematics.
2. Identify the barriers that hinder the integration of multimedia in traditional method of teaching mathematics

III. RESEARCH QUESTIONS

1. What is the importance of using multimedia-based teaching approach in teaching pre-service teachers' mathematics?
2. Which barriers hinder the integration of multimedia in the traditional method of teaching mathematics.

IV. LITERATURE REVIEW

The Role of Multimedia in Teaching and Learning

Multimedia is a combination of more than one media elements with the aid of technology for the purpose of enhancing understanding or memorization. It supports verbal instruction with the use of static and dynamic images in the form of visualization technology for better expression and comprehension. Multimedia is characterized by

the presence of text, pictures, sound, animation, video, audio; some or all of which are organized into a coherent program.
Multimedia approach of teaching and learning is an approach of teaching in which different medium are incorporated to make teaching and learning more effective, enthusiastic, inspirational, meaningful and interesting. The term multimedia approach to teaching and learning may be referred to as the use of appropriate and carefully selected varieties of learning experiences which when presented to the learner through selected teaching strategies will reinforce the way learners will achieve predetermined objectives in an effective way (Alessi and Trollip, 2000)

Multimedia provides an array of powerful tools that may help in transforming the present isolated Tutor centered and text-bound classroom into rich student focused interactive knowledge environment (Badhani, Pathankot & Punjab, 2012). Alessi and Trollip (2000) stated that in teaching student-teachers about classroom management skills, the best medium cannot be worse but a power point presentation using LCDs or video footage depicting a well-managed classroom will promote better understanding of the concept.

Importance of ICT in Education
Different studies argue that the use of new technologies in the classroom teaching and learning process is essential for providing opportunities for students to study in an information age. Yellard (2001) argued that, to be suitable in preparing students to be productive in various workplaces, there is a need for students to be ICT inclined and therefore the traditional method of teaching needs to be upgraded to include technology. Yellard (2001) argument is supported by Grimus (2000) who stated that "by teaching ICT skills in the primary school, prepare pupils to face future development based on proper understanding" (page. 362).
According to Brandsford et al (2000), several studies have received the literature on ICT and learning and have come out that using ICT in teaching various subjects has great potential to enhance student's achievements in learning. Grabe and Grabe (2007) has stated in a study they conducted that technologies can play a pivotal role in student skills, motivation and knowledge. They claim that ICT can be used to present information to students and help them to complete learning task. It is therefore the interest of the researchers of this study to encourage Tutors at the Colleges of Education to use ICTs in their teaching and learning process most especially in the field of mathematics.

The Traditional Method of Teaching Mathematics
Traditional methods are based on direct instruction where students are shown on standard method of performing a task. According to Chapko and Buchko (2004), traditional teaching method is a tutor centered instruction, traditional method of teaching mathematics is where the tutor present a mathematical concept, reviews the procedures required to find the solution and allow students to practice these procedures with additional problems.
Traditional method of teaching mathematics is based on the behaviorism learning theory. Behaviorist refers to the learning theories emphasizing on changing behavior which results from learner's association of stimulus-response. It asserts that learning is a change in behavior due to experience (Ormord, 1995). Traditional method is where the tutor reviews previous materials and homework and then demonstrates low-level problem solving followed by seatwork imitating the tutor's demonstrations (Stonewater, 2005).
Most tutors agree that mathematics teaching and learning is an ongoing concept and procedures in each academic level (Lessani, Yunus & Bakar, 2017). In traditional method of teaching mathematics, the instructor is viewed as the pivot in the classroom, responsible for all actions and guaranteeing that all classroom message goes through him/her (Razia and Majid, 2019).

Pedagogical Integration of ICT in Teaching Mathematics
Many tools may be used to improve the teaching and learning of mathematics. Some commonly used tools include the calculator, geometer's sketchpad, spreadsheet and mathslab (Lolli, 2002). It is important that when tutors use these technological tools to teach, it ensures that they are used in a manner that does not replace the learners thinking ability but rather promoting it.

Tutors who use ICTs are usually enthusiastic because learners will be able to engage with the visuals provided by the software (Lolli, 2012). A study conducted by Tatar (2013) on mathematics tutors' perceptions on the use of software to teach, indicated that tutor's perception on the use of technologies and software to teach were raised after understanding the impact of technology in the teaching of mathematics.

Teaching and learning activities are extremely widespread (Olakulehin, 2007). This give the impression that, a holistic approach that focus on technology, content and pedagogy as interrelated aspects in tutor training is vital. Makrakis (2005) points out that, new and modern technologies require new tutor roles, new pedagogies, and new approaches to tutor training. However, the responsibility of preparing tutors, who are ready to integrate technologies in their teaching, lies with teacher educators and the teacher training institutions (Howland & Wedman, 2004). In equipping pre-service teachers with subject–specific expertise, teacher training courses should be able to prepare pre-service teachers the challenges of a changing world, by conveying effective teaching practices, an understanding of technology and the ability to work collaboratively with other tutors and students.

The concept of TPACK in Multimedia-Based Teaching of Mathematics

The three knowledge domains that are the basis of the TPACK framework intersect to form four unique domains as illustrated in Figure 1: Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and finally Technological Pedagogical Content Knowledge (TPACK). Each of these areas represents a knowledge set required by instructors to achieve effective technology integration into teaching (Koehler & Mishra, 2009). TPACK framework (Koehler & Mishra, 2009) is an extension of Shulman (1986) by adding technology knowledge to content and Pedagogical knowledge. According to Koehler and Mishra (2009) many tutors do not feel prepared for the use of modern technologies to present information.

The internet provides many computer-aided instructional software which mathematics tutors could use in delivering mathematics lessons (for example see www.geogebra.org/materials). Various studies have shown that integrating technologies in the teaching and learning of mathematics greatly improves the performance of students in learning mathematics (Fisher, 2010).

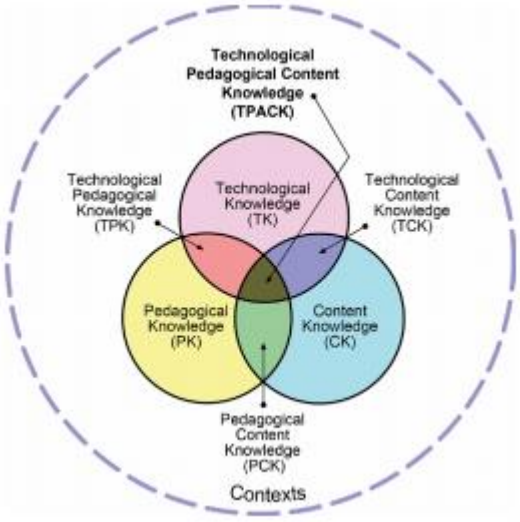

Figure 1: TPACK Framework

Barriers to Multimedia Approach in Teaching Mathematics

The integration of technology and multimedia into the teaching and learning of mathematics is a complex process and very often encounter a number of challenges. These challenges are known as barriers (Schoepp, 2005). A barrier is defined as "any condition that makes it difficult to make progress or to achieve an objective" (WordNet, 1997) as cited in Schoepp (2005, p.2).

Several studies have tried to categorize the barriers that hinder multimedia usage into teaching mathematics into extrinsic and intrinsic barriers. Ertner (1993) referred to extrinsic barriers as first-order and cited access, time, support, resources, training and classified intrinsic barriers as second-order and cited attitudes, beliefs, practices and resistance as its key components. Hendren (2005 as cited in Al-Alwani, 2005) defined extrinsic barriers as pertaining to organizations rather than individuals and intrinsic barriers as pertaining to tutors, administrators and individuals.

Another categorization of barriers found in literature is stated by Becta (2004) who classified barriers into teacher-level and school-level barriers. According to Becta (2004), teacher-level barriers relate to hindrances such as lack of time, lack of confidence and resistance to change while the school-level barriers relate to things such as effective professional development training and lack of access to technological resources. Other studies look at the barriers as tutor, institution or system-level. However, since this study focuses on current and future barriers that face mathematics tutors in their teaching and learning process, our focus is on the tutor-level and school-level barriers as discussed in the next session.

Tutor-Level Barriers

Lack of Confidence

Several studies have indicated that one of the strongest barriers of using technology and multimedia approach in the teaching of mathematics is the lack of tutor's confidence (Dawes, 2001). In a survey conducted by Becta (2004) saw the issue of lack of confidence as the area that most respondents talked about. Many teachers who responded to Becta's survey argue that teachers who are skillful in using ICTs are confidence using their teaching but since most of the teachers don't have technical know-how about most ICTs, they avoid using them in teaching.

Lack of Tutor Competence

Another barrier that affects tutor's integration of technology and multimedia approach in teaching mathematics is the lack of competence. Newhouse (2002) found that most tutors lack knowledge and skills on how computers and other technological tools and software are used to present information in the classroom. Research by Pelgrum (2001) found that lack of knowledge and skills on the side of tutors is a serious obstacle to using technology and multimedia approach to teach.

Tutors' negative attitudes towards the use of technology

Research has found that tutors attitudes and resistance to change is also a barrier to technology integration and multimedia approach to teaching mathematics in most pre-service teacher training institutions. Gomez (2005) stated that most tutors resistance to change concerning the use of new technology tools has become an obstacle to the use of multimedia and the integration of technology in general into teaching and learning most especially the teaching of mathematics.

School – Level Barriers

Lack/inadequate professional development training

According to Becta (2004), providing pedagogical training for tutors at professional development sessions is better than simply training tutors on how to use ICT tools. Cox et al. (1999) argues that if tutors are convinced of the value of using technology in their teaching, their training must focus on the pedagogical issues. Results from Cox et al. (1999) research showed that after tutors had taken through professional development course in ICT, they still could not use ICTs in the classroom instead they just knew how to run a computer since the course only focused on acquiring basic ICT skills and not how to develop the pedagogical aspect of ICT.

V. Methodology

This study adopted the cross-sectional survey research design to explore technology and multimedia integration in teaching mathematics at Colleges of Education in Ghana. In a cross-sectional study design, either the entire population or a subset of a population is selected, and from these individuals, data are collected to help answer research questions of interest. In this study, eighteen (18) tutors teaching various mathematics courses at St.

Monica's College of Education, Agona S.D.A College of Education and Mampong Technical College of Education, were selected to represent the other Colleges of Education in Ghana.

Descriptive analysis was employed in analyzing responses to the PLE questionnaire. Expert tutors' responses on the five-point Likert scale were coded as (1) Strongly Disagree (2), Disagree (3), Uncertain (4), Agree, and (5) Strongly Agree. This was fed into SPSS version 27 software for processing and analysis.

Results and Analysis

Research Question 1: *What is the importance of using multimedia-based teaching approach in teaching pre-service Tutors' mathematics?*

	N	Range	Minimum	Maximum	Sum	Mean	**Std. Deviation**
It is great way to improve student learning	18	1.00	4.00	5.00	87.00	4.8333	**.38348**
It allows students to engage with different media elements when solving mathematical problems.	18	3.00	2.00	5.00	76.00	4.2222	**.73208**
It permits Tutors to work collaboratively with students in teaching and learning a particular concept	18	1.00	4.00	5.00	84.00	4.6667	**.48507**
Allows Tutors to create and design lessons that offer learners with both cognitive and affective experiences.	18	1.00	4.00	5.00	85.00	4.7222	**.46089**
Allows Tutors to create and design teaching and learning resources rather than copying the representations created by others.	18	1.00	4.00	5.00	83.00	4.6111	**.50163**
Valid N (listwise)	18						

Table 1: Statistical analysis of the importance of multimedia-based approach in teaching pre-service Tutors' mathematics.

A total of 18 survey questionnaire were collected from the tutors teaching mathematics at the three selected Colleges of Education. The survey respondents were asked to respond to some statements on the use of multimedia in teaching mathematics at the college. To analyze the research question one, the survey instrument included the following five statements associated with the importance of using multimedia-based teaching approach in teaching pre-service Tutors' mathematics: 1) It is great way to improve student learning, 2) It allows students to engage with different media elements when solving mathematical problems, 3) It permits tutors to work collaboratively with students in teaching and learning a particular concept, 4) Allows tutors to create and design lessons that offer learners with both cognitive and affective experiences, 5) Allows tutors to create and design teaching and learning resources rather than copying the representations created by others.

The statements were rated using a 5-point Likert scale. Means and standard deviation were determined by the following values: 1 = Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree. The data collected were statistically analyzed (result shown in table 1) by using a one sample binomial test to evaluate the proportion of mathematics tutors that prefer the multimedia-based approach in teaching mathematics. From table 1, the data from respondents indicated that majority of the tutors strongly preferred the multimedia-based approach of teaching rather than traditional instructions on all five statements.

Research Question 2: *Which barriers hinder the integration of multimedia in the traditional method of teaching mathematics.*

	N	Mean	Std. Deviation
Lack of access to technology	18	4.4444	.51131
Resistance to change by teachers	18	3.5556	1.14903
Lack of time to integrate technology and multimedia	18	3.9444	.99836
Lack of training (ICT professional development)	18	4.1667	.51450
Lack of technical support	18	4.6667	.48507
Valid N	18		

Table 2: Barriers that hinder multimedia integration in teaching and learning mathematics

From table 2, the mean rating of 4.44 with standard deviation of .511 shows that 100% of the tutors agreed that lack of access to technology is a hindrance to technology integration and therefore mathematics tutors are unable to use the multimedia-based approach in teaching mathematics. The study also revealed that majority of the tutors are resistant to change from the traditional approach to the use of multimedia-based approach to teach mathematics. The result produced a mean of 3.56 which clearly shows that tutor's resistance to change is problem to integrate technology into teaching by most tutors at the College of Education.

In terms of lack of time to integrate technology and multimedia in teaching mathematics, the mean response ratings of 3.94 indicate that the tutors agreed there is no much time to permit them use technology in their teaching with the belief that integrating technology is a waste of time where completion of the course outline on time is a factor. Also, on the lack of training (professional development), the result revealed the mean rating of 4.71 which implies that most of the tutors accepted the fact that they don't receive training on how to use technology in their teaching and learning process more especially in the field of mathematics.

Finally, table 2 shows a strong agreement that tutors lack technical support to use technology and multimedia in teaching mathematics. As shown in table 2, the mean rating of 4.67 suggest that, there is no technical support from

IT experts to help tutors who have difficulty in using technology to use the few available technology in their teaching.

VI. CONCLUSION

The aim of this study was to provide information on encouraging desired improvement in the future of teaching situation to those responsible for the integration on ICT into mathematics education. The findings of this study indicates that tutors have strong desire for the integration of technology (ICT) and the use of multimedia-based approach of teaching mathematics but major barriers such as lack of access to technology, lack of ICT professional development training, low-level of competence and lack of technical support hinder the integration of ICT in the teaching of mathematics. However, we believe that the use of multimedia-based approach and the integration of technology in the teaching of mathematics has positive impact on students' performance in learning mathematics and the presence of all needed components will increase the likelihood of tutors' integration of technology in teaching and learning mathematics.

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