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Enhancing Teaching and Learning of Mathematics: Adoption of Blended Learning pedagogy in University of Uyo

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Abstract: ***The emergence of web-based technologies have diversified the pedagogical approaches of tertiary institutions. The web is shifting from being a medium, in which information was transmitted and consumed into being a platform, in which content is created, shared, modified and passes along amongst learners and instructors. This study investigated the effect of blended learning in undergraduate students' achievement in pre-algebra course as compared to, purely online and offline/face-to-face learning. The study adopted a completely randomized experimental design, conducted with 90 undergraduate students of the University of Uyo Foundation Programme (i.e., Joint University Preliminary Examination Board, JUPEB). The instrument: Pre-algebra Achievement Test (PAT), created as HTML files were uploaded to webCT. It was administered to the three experimental units. Data collected were analyzed using SPSS. The study revealed that using blended learning, improves students' learning outcome in pre-algebra. Also, gender does not have any statistically significant effect on students' achievement in pre-algebra toward the use of blended learning. The study could contribute toward enhancing the institutions' e-readiness, and as a proactive prospect of blended learning courses in Mathematics Education. The research could be of immense benefit to learners, lecturers, learning technologist, and other stakeholders including curriculum designers, such as head of departments, faculty members and e-learning coordinators in the institution.***

Keywords: Blended learning, mathematics, web CT

1. Introduction

ICT has open up new horizons for progress together with challenges and opportunities in higher educational deliveries. This emerging ICT have increasingly diversified the instructional pedagogy and curriculum design models of tertiary education in Nigeria. Tertiary institutions in Nigeria have begun globalization of their instructional dimensions and approaches through the delivery of open and distance learning platforms. Open and distance learning reflects both the fact that all or most of the teaching is conducted by someone removed in time and space from the learners, and the mission aims to include greater dimensions of openness and flexibility, whether in terms of access, curriculum or other elements of structure [22-17]. The synchronicity per se is facilitated through web-based technologies such as virtual learning environment (VLE). [10] noted that the web is shifting from being a medium in which information was transmitted and consumed into a platform, in which content is created, shared, repurposed, and passed along as connective knowledge in networks. This connective knowledge is realized through the development of web-based techniques such as math wiki tools, e-learning 2.0, Web2.0, webCT, webALT, MOODLE and/or blackboard learning platforms[3]. Nevertheless, course materials are produced and altered by students in collaboration; sometimes with lecturers, who take the role of moderators, mentors and mediators in the process of teaching and learning[14]. Thus, knowledge does not only reside in the mind of an individual, but also in distributed manner across a network and learning is the act of recognizing patterns shaped by these complex networks [19]. It's imperative to adopt and examine such technological based tools on learners' learning outcome, and its effectiveness and efficiency on mathematics instructional deliverables.

1.1 Perspectives of online learning and blended learning

In this context, e-learning is synonymous to online learning which overlaps with a broader category of distance learning; as one of the fastest growing trends in educational use of technology [23]. [2] reported e-learning as: an innovative approach for delivering electronically mediated, well-designed, student-directed interactive learning environment for everyone, regardless of time and place, using either the internet or digital technology in collaboration by the principles of instructional design. Online learning can be defined as a technology-enabled pedagogy that facilitates an interactive learning environment for all teaching and learning stakeholders (students, tutors and course designers) where a continuous means of knowledge improvement is possible [6].

[16] highlighted the focus of online learning to entail the following:

1.0 Increasing the availability of learning experience for learners who cannot or choose not to attend conventional face-to-face courses.
1.0 Assessing and disseminating instructional content more cost-effectively.
2.0 Enabling instructors to handle more students while monitoring learning outcome quality that is equivalent to face-to-face instruction

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Also, online learning has incorporated more advanced materials and resources that enabled learner's control of their learning experiences and effective content design features such as:

1.0 Adequately meeting the needs capabilities and possibilities of the students.
2.0 An adapted structure for it correct understanding and assimilation
3.0 Interactivity with the learners.

Furthermore, enhancing interactive learning experience in online approach with multimedia, (i.e., video lectures, power point slides presentation, animations and/or games) could be extended to learners interactivity with the teacher as mediator in the learning process. In addition, learning styles of each learner tends to be different and hence, a simple mode of instructional delivery may not provide sufficient choices, engagement, social contact, relevance and context needed to facilitate effective learning achievement and performance. An attempt to accommodate these challenges is what leads to hybrid or blended learning or blended e-learning. According to Singh (2003) [20] blended mixes various event-based activities, including face-to-face classroom, live e-learning, and self-paced learning. This often is a mixed of conventional instruction-led training, synchronous online conference or training, asynchronous self-paced learning [11].Blended learning is a mixture of conventional face-to-face learning and online learning adopted to foster active learning, interactivity, and collaborative learning experience; as learners strive to understand, develop knowledge and creativity in the learning process.

2. Related Work

Research meta-analyses have shown studies involving blended learning, online learning as compared to face-to-face (conventional approach) in the teaching and learning of mathematics. It provides mixed evidence regarding whether blended learning is more or less effective than conventional approach with regards to mathematics achievement scores. In recent experimental and quasi-experimental studies contrasting blends of online and face-to-face with conventional face-to-face classes, blended instruction has been more effective, providing a rationale for the effort required to design and implement blended approaches. A project on BL strategy was used in teaching mathematics undergraduate courses. The result showed that there was an improvement in the students' performance in mathematics[13]. Instruction combining online and face-to-face elements has a large advantage relative to purely face-to-face instruction than did purely online instructions [16]. The effect size was larger for studies in which the online instruction was collaborated or instructor-directed than those studies where online and face-to-face learning worked independently. The mean effect size in studies comparing blended with face-to-face instruction was $\eta^2 = 0.35$, p = 0.001. This effect size is larger than that for studies comparing purely online and purely face-to-face conditions, which had an average effect size of $\eta^2 = 0.05$,p = 0.46 [16].

On the other hand, Rossi (2001) [17] reported that in a linear algebra course, students went to a learning resource centre to use online interactive tutorials and/or get help from peer tutors. The online interactive tutorials provide well design content, as well as opportunities to practice quizzes and test. Each unit ended with an electronically graded quiz, and optional lectures. There was no significant difference in students' grades as compared to previous semesters before the redesign. In a similar study [9] reported that the average score on the achievement test for the experimental group(blended learning) was slightly higher than that of the control group (conventional face-to-face learning), but insignificant result with a small effect size($\eta^2 = 0.01$), indicating that blended learning did not significantly affect achievement test scores.

Furthermore, attitude towards computer has been found to influence not only the acceptance of computer in classroom, but also future behavior, such as using a computer as professional tools. On this notes, studies have shown that the use of computer in education has a potential of changing students attitude positively towards mathematics and computer [15]. Also, [12] envisaged that the blend serves to introduce students to the diverse environment and experiences comprising of professional practices.

3. Statement of the Problem

In the teaching and learning of mathematics we encounter problems that are difficult to solve in a face-to-face teaching framework for the beginners. They may lack the interest, motivation and positive attitude, some are not intended to specialize in it, and thus, they pay little or no attention to understanding basic mathematics concepts [1]. Therefore, utilizing blended learning approach could improves learners interest and gives learner control of their learning task as well as increasing the number of students offering mathematics courses. Blended learning facilitates active learning and interactivity between learners and the mediator in the learning environment. Also, the use of blended learning helps to diversify the instructional delivery in mathematics curriculum, as well as, exploring the benefits of web-based technologies in mathematics education.

4. Purpose of the Study

The purpose of this study was to investigate the effect of Blended learning (BL) approach which combines the conventional classroom learning, peer tutorial with well design e-learning tool (WebCT) and web-based learning on students' achievement scores in pre-algebra. It will investigate the effect of the moderator variable (gender) towards utilizing blended learning as compared to purely online and purely offline (conventional face-to-face) learning of the concepts of pre-algebra in the university of uyo.

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5. Research Questions

The following research questions guided the study;

1. Does supplementing face-to-face instruction with online instruction enhances learning and achievement scores in pre-algebra?
2. How does the effectiveness of blended learning compare with that of purely online and offline learning (face-to-face) learning in pre-algebra?
3. What condition influences the effectiveness of blended learning approach in pre-algebra?
4. Does gender have effect towards the utilization of blended learning approach in pre-algebra?

6. Research Hypotheses

The following null hypotheses guided the study;

1.0 There is no significant difference on students' mean achievement scores between the different instructional approaches (blended, online and face-to-face) in learning pre-algebra.
2.0 There is no significant difference on students' mean achievement scores between genders and the different instructional approaches (blended, online and face-to-face) in learning pre-algebra.
3.0 There is no significant interaction effect between gender and instructional approaches (blended, online and face-to-face) on students' achievement scores in learning pre-algebra.

7. Research Methodology / Approach

7.1 Population and Sampling

The accessible population was all undergraduate students who offered pre-algebra course in the university of Uyo foundation programme affiliated to Joint University Preliminary Examination Board (JUPEB). A completely randomized design was adopted to select a sample of 90 undergraduates with a group of 30 students to the three different experimental units.

7.2 Instrumentation

The experimenter adopted Pre-algebra Achievement Test (PAT) in mathematics. This was a 20-item multiple choice questions. The instrument was face-content validated by mathematics educators and trial tested on a sample of undergraduate students from the population excluded from the research sample. A reliability coefficient of 0.78 was established using cronbach's alpha technique, which ensures internal consistency of the items in the instrument.

7.3 Research Design

This research adopted pretest-posttest randomized experimental design. The study took effect in the first semester of 2013/2014 session and the university e-library was used, were WebCT/e-learning was enabled for some online courses including pre-algebra course in mathematics. The experimental treatment groups consisted of students in purely online and blended learning groups respectively, while the control treatment group was students in face-to-face learning group as well. The blended learning combines conventional face-to-face classroom learning, peer tutorial with well design e-learning tool (WebCT) and web-based learning (quiz tool, WebCT, calendar, e-mail, grades tools and so on). Purely online course in pre-algebra was administered to the online learning group via WebCT e-learning platform. In the experimental groups, Pre-algebra Achievement Test (PAT) was administered online via WebCT e-learning platform. The test was created as an HTML files and was uploaded to WebCT e-learning platform with the assistant of ICT experts, while the control group received offline instruction via face-to-face instruction in the classroom. In the experimental groups, students were able to see their final posttest exams scores through WebCT grades tool, while in the control group posttest exams scores were given to students at the beginning of second semester. The independent variables were the different instructional methods (i.e., online learning, blended learning, and offline/face-to-face learning) and gender, while the dependent variable was posttest exams scores and pretest scores as the covariate. The experiment lasted for twelve weeks with four hours of instructions per week across the treatment groups. SPSS was use to analyzed data gathered and ANCOVA was used to test the null hypotheses at 0.05 level of significant.

8. Results

Table1: ANCOVA result of pretest-posttest scores using the three different instructional groups in pre-algebra course

Source	*SS*	*DF*	*MS*	*F-ratio*	*Sig*
Model	2274.42[a]	7	3249.30	1932.27	.00
Pretest	105.49	1	105.49	62.73	.00
Gender	3.341	1	3.341	1.98	.162
Groups	27.90	2	13.95	8.29	.001
Gender* Groups	4.44	2	2.22	1.32	.272
Error	139.57	83	1.68		
Total	22885.00	90			

R squared = 0.994 (Adjusted R squared = 0.993)
Alpha = 0.05 level.

Table 1 shown the ANCOVA result of students pretest-posttest scores using the three instructional approaches (i.e., online, blended and offline/face-to-face learning) in pre-algebra course. The result revealed that there is statistically significant difference on students achievement scores when the three difference groups received different instructional approaches in pre-algebra course ($f = 8.289$, $p = 0.001$, $\eta^2 = 0.167$), while the effect of the pretest scores was account for the in experiment. However, gender does not have any significant effect on the students' achievement scores across the groups when using three different instructional approaches in learning pre-algebra course ($f = 1.987$, $p = 0.162$, $\eta^2 = 0.023$). Also, there is no statistically significant interact effect of gender and instructional approaches on students achievements scores ($f = 1.322$, $p = 0.272$, $\eta^2 = 0.031$).

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Table 2: Scheffé's post-hoc result of the three instructional approaches in pre-algebra course

	Groups (B)	*Mean difference(A-B)*	*sig*[b]
Online	blended	-1.30*	0.001
	offline/face-to-face	-0.417	0.652
Blended	online	1.370*	0.001
	offline/face-to-face	0.957*	0.022
Offline/face-to-face	online	0.417	0.652
	blended	-0.953*	0.022

*the mean difference is significant at the 0.05 level
b:Adjustment for multiple comparisons: Bonferroni

Table2 revealed that there is statistically significant difference in using blended learning approach as compared to other approaches (p =0.001, and p = 0.002) respectively.

9. Discussion

This study investigated the effect of blended learning approach on students' achievement as compared to purely online and offline/face-to-face approaches in learning pre-algebra course. The study revealed that using blended learning approach improves students' achievement scores in pre-algebra as compared to other approaches (i.e., online and offline/face-to-face learning). This could be as a result of supplementing face-to-face learning with online learning and learners have control of their interaction with additional materials, media and prompt learners' feedback. Also, students using the blended learning approach might have benefited from the mediator as more time was spent on learning the task at their own pace.[5] Reported that blended learning can support students learning more effectively than e-learning or face-to-face learning alone. In line with the findings of this study researchers envisaged that new technology and software such as computer-assisted instruction should be used in the teaching of abstract concept in mathematics [4-7]. Also, it is imperative to design blended learning, adopting the positive aspects of e-learning and face-to-face learning and avoiding some disadvantages, differences in aspects of the two approaches. On the other hand, equivalent achievement scores were obtainable between students using purely online learning and offline/face-to-face learning approaches. It could be opined that offline/face-to-face learning approach is useful and appropriate, while online learning approach is more convenient; anytime and anyplace usage, and cost-effective in delivery mathematics instruction to a large group of learners beyond the classroom. This paper contradict earlier study, [21] reported that students using e-learning (i.e., WILEY PLUS) perform modestly better, on average, than student learning the same material on conventional offline/face-to-face learning in mathematics and statistics.

Furthermore, gender does not have any significant effect on students' achievement scores between the different approaches. Thus, male and female could utilize equal opportunities provided by technology-based instruction; blended learning and online learning, and function effectively in learning mathematics. [8] Mentioned that the improvement of understanding mathematics by using interactive and personalized documents on the web could reverse bad trends, and the problems associated with recruiting girls into engineering and mathematics. ICT could help students get more information and examples to help them to understand mathematics, with better understanding in mathematics students can apply in engineering subject [21].

10. Conclusion

Emergences of web-based technologies have diversified the pedagogical approaches of tertiary institution in Nigeria. The web has shifted from being a medium, in which information was transmitted and consumed, into being a platform, in which content is created, shared, repurposed, and passes along. More course materials are produced and altered by students' collaboration and sometimes with the help of the lecturers who take the role of a mediator, mentor and/or moderator. This is realized in the development of WebCT which facilitate and promote active learning, interactivity and collaborative learning styles through open application and services. It is therefore an imperative for University of Uyo to align the instructional approaches of some mathematics courses to web-based technology and utilize blended learning approach. It is no doubt saying that students' interest and motivation are lower on pursuing career in mathematics courses, and the only way to bring a significant new group of learners to the fold is through the use of blended learning.

Emphasis on the benefit of blended learning suggested that it could improve student understanding and learning outcome on mathematics beyond the limitations of the conventional classrooms and presented lectures. Blended learning could potentially increase institutional reputation, improve the quality of teaching, and provides flexibility in students' life-long learning.

This study examined the effect of blended learning on students' achievement in mathematics as compared to purely online and entirely offline/face-to-face learning. The adoption of blended learning has improves instructional delivery in mathematics courses and students' achievement and understanding of concepts in the subject matter. It could contribute towards enhancing the institutions' e-preparedness, and as a proactive prospect of blended learning course in mathematics. The research is likely to be of immense benefit to students, lecturers, learning technologist, and other stakeholders involved in curriculum design such as, programme managers, heads of departments and e-learning coordinators in the institution.

11. Recommendation / Future scope

The institution could foster international collaboration/consortium toward developing a robust virtual learning environment (VLE) to suit the institutions' conventional curriculum design. Mathematics courses, such as, pre-algebra, and calculus that are being offered be large groups of students across the faculties of Science, Education and Engineering should be link to VLE. The ICT centre and internet facilities should have a direct link and

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networked to the Mathematics/Statistics Department, and Science Education Department, to enable technical supports within the institution. Also, further study adopting blended learning in difference faculties should be done, so as to develop e-learning in the institution.

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