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Improving Secondary School Students' Achievement in Circle Geometry using Blended Learning

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Abstract: This study was designed to determine how students' achievement in Circle geometry can be improved using blended learning. This study employed a quasi-experimental research design involving non-equivalent control group design. The area of the study was Bamenda III Council area of the North West region of Cameroon. The sample for this study consisted of ninety five (95) form four students from two private college composed using multi-stage sampling procedure. Through purposive sampling technique, Bamenda III Council Area was selected for this study because of the availability of private schools with computer laboratories and internet facilities in this area. Purposive sampling technique was used to select two private schools from Bamenda III Council area that shared common characteristics in terms of availability of internet facilities and computers in the schools and willingness of the school authorities to allow for the conduct of such an experiment. In each school, one class in a stream of classes at the same level was drawn through simple random sampling technique. Simple balloting was employed to draw the students in each school. The research instrument was Circle Geometry Achievement Test (CGAT) developed by the researchers. The internal consistency of CGAT was determined using Kuder Richardson, K.R. 20 and the calculated index was found to be 0.79. Students in both groups were pretested and post-tested. Scores from these instruments were analyzed using means and standard deviation to answer research questions and analysis of covariance (ANCOVA) to test the hypotheses. Some of the major findings from the analysis were: (i) Blended Learning improved students' achievement in Circle geometry. (ii) Blended Learning favoured the female students in terms of achievement. Based on the findings, recommendations were made towards better achievement of students in Circle geometry particularly and Mathematics in general. It was recommended among others that secondary and primary school mathematics teachers should adopt Blended Learning as a teaching strategy. Another recommendation was that curriculum planners should incorporate Blended Learning into curriculum design during review of curricular contents.

Keywords: Blended learning, Circle geometry, achievement, gender, secondary schools, students.

Introduction

Mathematics is considered as a key subject in the educational system of each nation and at all stages of education. This is because of its significance in the technological development and advancement of the world economies. According to Awofala (2012) mathematics is the backbone of technological breakthrough. This makes it the key to other sciences such as physics, chemistry, and more (Agwagah & Nwoye, 2012). It is, therefore, considered as the backbone for any meaningful scientific endeavour. For any nation to advance in science and technology, conscious efforts must be deployed towards empowering the youths with the necessary

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mathematics skills. As per the curriculum, mathematics has been made a compulsory subject in secondary schools and every student in secondary school, is compel to register for the course at the ordinary level certificate examination in the English sub system of education in Cameroon. It follows also at the tertiary level of education that one must get at least a credit pass in mathematics to be able to meet up with the admission requirements for all courses in science, engineering, technology and social science in most universities in Cameroon. Despite the significant value attached to mathematics, Elekwa (2010) concerted that many students display poor attitude towards mathematics which is reflected in the lack of interest, even when students are conscious of the need of mathematics to forge ahead in all academic pursuits and in daily life. Students do not deploy any effort in learning mathematics rather, they spend most of their precious time on social media platforms engaged in unproductive activities.

Literature Review

Analysis of the Cameroon GCE examination results for the years 2018 and 2019 (CGCEB 2018, 2019 results) showed that 47.54% and 55.375% respectively of the thousands of students who sat for the ordinary level examinations in mathematics failed with a U grade. This poor performance prompted these researchers to engage in blended teaching and learning of mathematics with a focus on geometry.

Students' poor performance in topics like Circle geometry contributed tremendously to the poor results at the certificate examination. Many candidates attempted the questions on Circle geometry but the answers provided indicated lack of mastery of the content and concept. Some researchers have blamed the low achievement in mathematics to stem from the use of inappropriate teaching strategies which might result to students' loss of interest and retention of mathematical concepts and facts (Agomuoh & Ifeanacho, 2013). According to Olunloye (2010), this awful tendency of consistent failure in mathematics is a great misfortune to the nation. Hence, concerted efforts to enhance achievement in the subject have preoccupied researchers and all stakeholders in education. According to Uhumuavbi & Umoren cited in Ihendinihu (2013) some factors such as attitude of students; lack of instructional resources (Yara & Otieno, 2010); techniques employed in instruction (Olulonye, 2010) among others are contributing to the lamentable state of mathematics achievement. There is need to consider instructional strategies that can meet the needs of the contemporary society given that all spheres of life are drifting towards a digital and technological setting.

Diabat and Aljallad (2020) asserted that the education and training sector has actively implemented tasks and solutions to improve support management, teaching, learning, assessment, scientific research, and the application of information and communication technology (ICT) in order to meet the demands of the rapidly developing scientific and technical revolution. Some researchers have investigated the effects of computer based instructions on students' academic achievement but very little has been on the effects of combining the computer based with the traditional instruction. Sani & Tudunkaya (2019) investigated the effects of web – based on academic performance in coordinate geometry. Also Agwagah, Arua & Abugu (2019) explored the effect of computer assisted instruction approach on students' achievement in mathematics. Also there is Computer Based Instruction with animation and Recorded Conventional Instruction Strategy (RCIS) (Ojo, 2015) among others. However, Recorded Conventional Instructional Strategy (RCIS) considered as the control in this study was designed by the researchers with the help of Information and Communication Technology (ICT) experts. RCIS is an offline instruction installed in the computer for students to watch with the direction of the teacher. Hence, blended strategy to give learners the opportunity to explore different learning possibilities for variety is the spice of life.

One important lesson that emanated from the COVID-19 pandermic is the need to promote the combination of remote "face-to-face" teaching via television and online teaching via the Internet to ensure the progress and effectiveness of students' learning (Attard and Holmes, 2020; Ho, Cheong, & Weldon, 2020; Hori and Fujii, 2021; Mukuka ; Shumba & Mulenga, 2021; Pham,

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Nguyen, Nguyen, Duong, Ho et al., 2021; Stahl, 2021). This type of strategy is referred to as blended learning. According to Al-Rimawi, & Firas (2014), this model combines the advantages of e-learning and the benefits of classroom education that is the basis of such education is to integrate the traditional learning and e-learning. Tong, Uyen & Ngan (2022) asserted that a combination of lectures with images, videos, and other learning content in the classroom will make these lessons more effective for teachers thereby making students to feel more engaged and active in acquiring knowledge and so enhance teaching and learning of geometric concepts. This therefore informs the choice of this study.

It is imperative to consider an appropriate blended teaching model depending on the aspirations of each educational facility on the basis of various factors, such as facilities, financial capabilities of the school, subject and curriculum, and more, depending on each school's capacity. Given the prevailing conditions and research needs this study chooses the flex model as the starting point of the design for the experimental lectures. This model can be appreciated differently by the students depending on the gender. A lot of studies have investigated the influence of gender (Boyte-Eckis et al., 2018; Cai et al., 2017) and educational levels (Diep et al., 2016) on online learning outcomes. Huang & Fang (2013) observed that online learning outcomes can be predicted by educational levels to a large extent and noticed that conflicts exist with regards to the influence of gender on online learning outcomes. Nistor (2013) in a study observed no significant gender differences in leaning outcomes given that while males were more stable in attitudes on the other hand females were outstanding in engagement. A study carried out by Alghamdi et al. (2020) revealed that females had stronger self-regulation than males, giving them an urge to have more significantly positive online learning outcomes than males.

Statement of the problem

Mathematics is a necessary requirement for technological and scientific development but many students have a phobia for the subject but have a flare for technology. Teachers stick to analogue teaching strategies making the teaching and learning process boring whereas there exist other strategies which can get students more actively involved in the process. Many students have smart phones, I phones and other gadgets for online communication which they mostly use for social networking. It is possible to get students engaged in active learning by giving notes, assignments and other exchanges using the online/ offline platforms alongside the face-to-face classroom interactions, but, it is not the case especially at the secondary school level in developing nations. The model of learning prescribed so far is common at the University level. How can secondary school teachers be made to exploit the potentials offered by blending online/ offline learning with the face-to-face model to improve students' achievement in mathematics?

Purpose of the Study

The purpose of this study is to determine how Blended Learning can improve students' achievement in Circle geometry.

Specifically, this study sought to determine:

1. The mean achievement scores of students in Circle geometry when exposed to Blended learning (BL) and Recorded Conventional Instructional Strategy (RCIS).
2. The mean achievement scores of male and female students in Circle geometry.
3. The interaction effect of Instructional strategies and gender on students' achievement in Circle geometry.

Research Questions

The study was guided by the following research questions.

1. What are the mean achievement scores of students in Circle geometry when exposed to Blended learning (BL) and Recorded Conventional Instructional Strategy (RCIS)?

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2. Which gender has better mean gain in achievement when taught Circle geometry using Blended learning (BL) and Recorded Conventional Instructional Strategy (RCIS)?

Hypotheses

The following null hypotheses were formulated to guide the study and were tested at 5% probability level.

H_{o1}. There is no significant difference in the mean achievement scores of students in Circle geometry when exposed to BL and RCIS.

H_{o2}. There is no significant difference in the mean achievement scores of male and female students in Circle geometry.

H_{o3}. There is no significant interaction effect of instructional strategies and gender on students' achievement in Circle geometry.

Methodolody

This study employed a quasi-experimental research design involving non-equivalent control group design. According to Nworgu (2015) the design allows for maximum control of extraneous variables and two intact groups were randomly assigned to the treatment conditions. This study was carried out in Bamenda III Council area of the North West region of Cameroon. The sample for this study consisted of ninety five (95) form four students which was composed using multi-stage sampling procedure. Through purposive sampling technique, Bamenda III Council Area was selected for this study because of the availability of private schools with computer laboratories and internet facilities in this area. Purposive sampling technique was used to select two private schools from Bamenda III Council area that share common characteristics in terms of availability of internet facilities and computers in the schools and willingness of the school authorities to allow for the conduct of such an experiment. The researchers considered schools where computer laboratories were available with internet and a closely balanced gender classroom, because gender is a variable in this study. In each school, one class out of the stream of classes in form four were drawn through simple random sampling technique. The research instrument was Circle Geometry Achievement Test (CGAT) developed by the researchers. The internal consistency of CGAT was determined using Kuder Richardson, K.R. 20 and the calculated index was found to be 0.79. The mathematics teachers of the intact classes that were drawn for the studies were trained on the conduct of the study. After the training, the research assistants administered pretest on CGAT and the scores were collated pending posttest score. The same length of time was used for the pretest and posttest on both groups. Next was the treatment where the experimental group was taught using BL while the control group was taught using RCIS by the respective research assistants. Data collected from this experiment was used to answer research questions and hypotheses. Mean and standard deviation were used to answer the research questions. Analysis of Covariance (ANCOVA) was used to test the null hypotheses formulated for the study at 0.05 level of significance.

Results

Research Question one:

What are the mean achievement scores of students in Circle geometry when exposed to Blended learning (BL) and Recorded Conventional Instructional Strategy (RCIS)?

Table 1: **Mean and Standard Deviation of Pretest and Posttest Scores of Students Taught Circle Geometry Using BL and RCIS**

Variable		Pretest		Posttest		
Instructional strategies	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean gain
BL	46	30.59	7.32	67.48	5.59	36.89
RCIS	49	29.22	6.76	31.73	7.53	2.51

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The result presented in Table 1 shows the difference in the mean achievement scores of students in circle geometry when taught with Blended Learning (BL) and those taught with Recorded Instructional Strategy (RCIS). The result shows that the pretest mean achievement scores of students in circle geometry when taught with BL was 30.59, with a standard deviation of 7.32 while the posttest mean was 67.48 with a standard deviation of 5.59. The difference between the pretest and posttest means was 36.89. On the other hand, when taught with the RCIS, the students had a pretest mean of 29.22 with a standard deviation of 6.76 and a posttest mean of 31.73 with a standard deviation of 7.53. The difference between the pretest and posttest means was 2.51. This means that pretest results showed almost equal performance among the students. For both BL and RCIS the posttest means were greater than the pretest means, with students taught using BL having a higher mean gain than their counterparts who were taught using RCIS.

H_{01}: There is no significant difference in the mean achievement scores of students in Circle Geometry when exposed to BL and RCIS.

Table 2: Analysis of Covariance (ANCOVA) of the Difference in the Mean Achievement Scores of Students in Circle Geometry When Taught With BL and RCIS

Source	Type III Sum of Squares	Df	Mean Square	F	Partial Eta Sig. Square
Corrected Model	30853.520	4	7713.380	193.571	.000 .896
Intercept	13728.621	1	13728.621	344.525	.000 .793
PretestAchi	64.077	1	64.077	1.608	.208 .018
Strategies	29942.791	1	29942.791	751.427	.000 .893
Gender	357.204	1	357.204	8.964	.004 .091
Strategies * Gender	106.508	1	106.508	2.673	.106 .029
Error	3586.312	90	39.848		
Total	262927.000	95			
Corrected Total	34439.832	94			
a. R Squared = .896 (Adjusted R Squared = .891)					

The result in Table 2 shows that an F-ratio of 751.427 with associated probability value of 0.000 was obtained with respect to the difference in the mean achievement scores of students in Circle geometry when taught with BL and RCIS. Since the associated probability (0.000) was less than 0.05 set as the benchmark for taking a decision, the null hypothesis (H_{01}) which stated that; there is no significant difference in the mean achievement scores of students in Circle geometry when taught with BL and RCIS was rejected. Therefore, inference drawn was that there was a significant difference in the mean achievement scores of students in Circle geometry when taught with BL and RCIS in favour of the experimental group. The researcher also considered the effect size, as indicated by the corresponding partial eta squared value which is .893. This value indicates how much of the variance in the dependent variable (achievement) is explained by the independent variables (instructional strategies). Converting the partial eta squared value to a percentage by multiplying by 100; it gives 89.3% percent which means 89.3% of the variation in students' achievement in Circle geometry is influenced by the independent variable. This also implies that the researcher is able to explain only 89.3% of the variance.

Research Question two:

What are the mean achievement scores of male and female students in Circle geometry?

Table 3: Mean and Standard Deviation of Pretest and Post-test Mean Achievement Scores of Male and Female Students in Circle Geometry?

Variable		Pretest		Posttest		
Gender	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean gain
Male	44	29.73	5.92	45.86	20.05	16.13
Female	51	30.02	7.92	51.78	18.07	21.76

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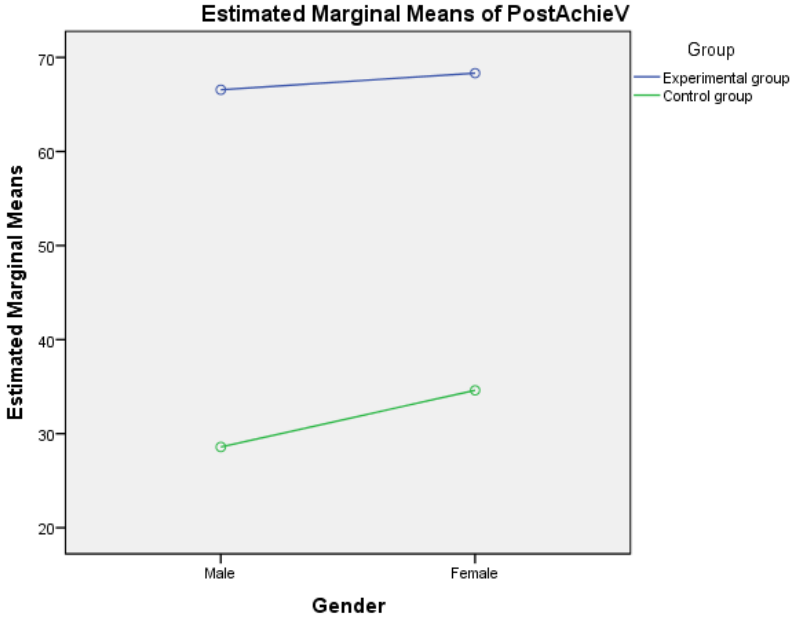
The result in Table 3 shows the difference in the mean achievement scores of male and female students in Circle geometry. The result shows that the male students had a pretest achievement mean score of 29.73 with a standard deviation of 5.92 and a posttest mean score of 45.86 with a standard deviation of 20.05. The difference between the pretest and posttest means was 16.13. On the other hand, the female students had a pretest achievement mean score of 30.02 with a standard deviation of 7.92 and a posttest mean score of 51.78 with a standard deviation of 18.07. The difference between the pretest and posttest means for the female group was 21.76. For both male and female groups, the posttest means were greater than the pretest means with female students having a slightly higher mean gain in Circle geometry than their male counterparts.

H_{02}: There is no Significant Difference in the Mean Achievement Scores of Male and Female Students in Circle Geometry

The result as presented in Table 2 shows that with respect to gender an F-ratio of 8.964 with associated probability value of 0.004 was obtained with regards to the difference in the mean achievement scores of male and female students in Circle geometry. Since the associated probability (0.004) was less than 0.05 set as the benchmark for taking a decision, the null hypothesis (H_{02}) of no significant difference in the mean achievement scores of male and female students in Circle geometry was rejected. Thus, inference drawn was that there is a significant difference in the mean achievement scores of male and female students in Circle geometry in favour of the female students.

H_{03}: There is no significant interaction effect of instructional strategies and gender on students' achievement in Circle Geometry.

The result in Table 2 also indicates that an F-ratio of 2.673 with associated probability value of 0.106 was due to the interaction effect of instructional strategies and gender on students' achievement in Circle geometry. Since the associated probability (0.106) was greater than 0.05 set as the benchmark for taking a decision, the null hypothesis (H_{03}) of no significant interaction effect of instructional strategies and gender on students' achievement in Circle geometry was not rejected. Therefore, inference drawn was that there was no significant interaction effect of instructional strategies and gender on students' achievement in Circle geometry.



Covariates appearing in the model are evaluated at the following values: PreAchiev = 29.88

Discussions

Results in Table 1 showed that students in the experimental group performed better than their counterparts in the control group. The positive and higher achievement might have been as a

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result of the strategy which allows students to have a more participative involvement in the learning process that takes them through the systematic approach starting with planning, designing, implementing, reviewing and improving the BL experience for both staff and students. This finding agrees with the assertions of Attard and Holmes (2020); Ho et al. (2020); Hori and Fujii (2021); Mukuka et al (2021); Pham et al.,(2021) & Stahl (2021) on the need to promote the combination of remote "face-to-face" teaching via television and online teaching via the Internet to ensure the progress and effectiveness of students' learning.

The second null hypothesis revealed that there is a significant difference in the mean achievement scores of male and female students in Circle geometry in favour of the female students. In other words gender has a significant influence on students' achievement in Circle geometry. This is an indication that if the instructional strategies are appealing, all the students have equal chances of benefitting and achieving well irrespective of gender that many studies have reported over the years in favour of the male students. This maybe due to the exciting nature of the instructional strategy which enabled the female students to be actively involved in the lessons which resulted to higher achievement for the female students. This finding supports that of Alghamdi et al. (2020) which showed that females had stronger self-regulation than males, giving them an urge to have more significantly positive online learning outcomes than males. It disagrees with Nistor (2013) who observed no signifcant gender differences in leaning outcomes and also no signifcant gender differences in the learning satisfaction of online millennial learners was obtained by Harvey et al. (2017).

Conclusion

Based on the results obtained, it can be concluded that instructional strategies are among the key variables that can enhance achievement of students in mathematics. This finding further ascertains the role improved instructional strategies such as BL can play in students' achievement in mathematics especially in Circle geometry. This study has further validated other research findings on gender to the effect that type of instructional strategies can close gender gap in mathematics achievement as has been established with the use of BL.

Recommendations

Sequel to the findings of this study and its conclusion, the following recommendations were made:

1. Mathematics teachers should adopt BL as a teaching strategy because of its propensity to engender to enhance achievement.
2. It is recommended that curriculum planners should incorporate BL into curriculum during review of curricular contents as is the case in western countries.
3. Students should employ BL in studying Circle geometry and other topics since the study revealed improvement in achievement.
4. It is therefore so recommended for use in the schools since it does not pose any challenge in streaming of classes based on gender.

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