Effects of Teacher- Directed and Self-Paced Instructional Strategies on Achievement in Trigonometry among Secondary School Students in Ekiti State

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Abstract
This study was designed to determine the efficacies of teacher-directed and self-paced instructional strategies on students' achievement in trigonometry. Three research questions were posed and three hypotheses were formulated and tested at 0.05 level of significance. Pretest-posttest control group quasi-experimental design was employed for the study. The Population of the study comprising of 3680 SS II students from coeducational public secondary schools in Ekiti State was used for the study. A Sample size of 177 consisting of ninety-nine (99) males and seventy-eight (78) females was used for the study. Purposive sampling technique was used for the study. Trigonometry Achievement Test (TAT) was used as instruments for data collected for the study. The two instruments were subjected to face validation. The trial testing was carried out using 40 respondents and the reliability coefficient of 0.86 was obtained for TAT using K-R20. Data were collected and analyzed using mean and standard deviation to answer the research questions and ANCOVA was used to test the hypotheses at 0.05 level of significance. The findings also showed that mean achievement scores of students taught using teacher-directed instructional strategy have higher than those taught with self-paced instructional strategy in trigonometry. There was no significant influence of gender on students' achievement in trigonometry. There was no significant interaction effect of instructional strategies and gender on Students' achievement in trigonometry. Based on the findings, it was recommended that mathematics teachers should adopt teacher-directed and self-paced instructional strategies to enhance students' achievement in mathematics.

Keywords: Teacher-directed instructional strategy, Self-paced instructional strategy, Gender, students' achievement

Introduction

Trigonometry is concerned with the length and angle of a triangle. Trigonometry is an area of mathematics that cuts across other topics such as algebraic, geometric, and calculus (Kargas & Stephens, 2014). Trigonometry requires a complex intellectual task, and therefore demands greater emphasis for secondary school students (Charry, 2015). Trigonometry has the following sub-topics: trigonometric ratio of special angles, trigonometric identity, trigonometric graphing and trigonometric function in the senior secondary school curriculum, according to Nigerian Educational Research and Development Council (NERDC) 2012). Knowledge of trigonometry is important to many fields of studies like Newtonian physics, architecture, surveying, and many branches of engineering. Trigonometry is an area of mathematics that student ts find difficult and abstract compared with the other topics of mathematics (Usman & Hussaini, 2017). Candidates' areas of weaknesses have been stressed by external examination bodies involving geometry, trigonometry, longitude and latitude for core and elective Mathematics in West Africa Examination Council (WAEC) Resume; 2014, 2015, 2016, 2017).

A Teacher-directed instructional strategy is concerned with cognitive learning related to concept, proposition, strategies, and operations. Siegfried Engelmann propounded it in 1964 (Moore, 2012). Teacher-directed instructional strategy was described as a strategy in which the instructor directly presents the material to be learned, for instance, through lectures, explanations, textbooks, and educational videos (Orhun, 2013). As all instruction centers on students, Orhun (2015) suggested that teacher-directed instructional strategy replace the misnomer teacher-centered method properly to describe instruction where teacher's direct student learning and activities. Teacher-directed instruction is characterized by relatively simple and precise materials tailored to specific learning objectives, planned (and sometimes scripted) prompting procedures, provision of high-quality reinforcement for responding, and multiple trials conducted during brief teaching periods.

Self-paced instructional strategy stimulates maximum interaction to enhance efficient decision-making among students in learning. The self-paced learning strategy emerged from Montessori (1870 – 1952) method whereby students learn at their own pace with little or no interventions from the teacher (Cronin, & McCabe, 2018). The strategy facilitates the development of critical thinking through conversation, arbitration and clarification of basic content or ideas. With self-paced instructional strategy, students enjoy the liberty to advance their ideas and to benefit from the ideas and views of others. Self-paced instruction strategy is a self-regulation strategy that students can use to manage themselves as learners and direct their behavior while teaching (Greene, 2018).

Researches on gender differences in cognitive processes, intellectual abilities, area of interest, stereotypical perceptions of every-day behaviours and the ability to perform various tasks cannot be overemphasis. The differences in the scholastic achievements of boys and girls are generally attributed to biological causes and culture and stereotypes. Findings from literature revealed a series of factors that are causing gender differences in mathematics achievement in general which are teacher, student and parent related. Nwoke, Ngozi, Duru, and Maria (2018) stressed that teachers should use innovative strategies in teaching mathematics to reduce gender disparity in learning mathematics. Abdu-Raheem (2017) findings showed that male students achieved better than females in mathematics generally. This was in support of Awofala,(2011) that found significant gender achievement difference in favour of male students of mathematics.

Students' academic achievement is an important area in teaching and learning. Academic achievement can be defined as the measure of accomplishment in a specific field of study (Abakpa, 2011). It can also be the ability of the student to study and remember facts and being able to communicate his knowledge orally or in written form even in an examination condition. According to Ali (2013), academic achievement is a measure of the degree of success in performing specific tasks in a subject or area of study by students after a learning experience. Different researchers have examined the interaction between students' academic achievement and gender. Findings on the gender difference in trigonometry achievement as well as mathematics still need more attention.

Objectives of the Study

The following objectives were formulated for the study:

1. To examine the effect of teacher-directed and self-paced instructional strategies on students' academic achievement in trigonometry.
2. Influence of gender on students' academic achievement in trigonometry.
3. interaction effect of instructional strategies and gender on students' academic achievement in trigonometry

Research Questions

The following research questions were posed for the study;

1. What is the mean score difference in academic achievement of students taught using teacher-directed instructional strategy and those taught with self-paced instructional strategy in trigonometry?
2. What is the mean score difference in academic achievement of male and female students in trigonometry?
3. What is the interaction effect of instructional strategies and gender on students' academic achievement in trigonometry?

Hypotheses

The following hypotheses were formulated to guide the study

1. There is no significant difference in the academic achievement of students taught using teacher-directed instructional strategy and self-paced instructional strategy in trigonometry.
2. There is no significant difference in the academic achievement of male and female students in trigonometry.
3. There is no significant interaction effect of instructional strategies and gender on students' academic achievement in trigonometry.

Methodology

The study employed pretest- posttest quasi experimental design. Quasi-experimental is non-equivalent control group design. The population of the study comprised 3860 of senior secondary school II students who offer mathematics in the local government areas of Ekiti South Senatorial District of Ekiti State, Nigeria. The sample size of 177 consists of 99 male and 78 female students using purposive sampling technique. The instruments that were used to collect data for the study were Trigonometry Achievement Test (TAT) and Cognitive Load Rating Scale (CLRS). To ensure the content validity, the researcher prepared a test blueprint or table of specification.

The face validity was done by two Lecturers from Measurement and Evaluation and one in Mathematics Education unit of Science Education Department, Faculty of Education, University of Nigeria Nsukka (UNN). The response of the respondents from trial testing was subjected to the reliability analysis using the Kuder-Richardson (K-R20) procedure to determine the internal consistency of TAT. While, Cronbach Alpha ∝ was used to determine the internal consistency of the Cognitive Load Rating Scale (CLRS), and the internal consistency reliability coefficients obtained for TAT and CLRS are 0.86 and 0.89 respectively. The data collected were analyzed using the following statistical tools; mean and standard deviations to provide answers to the research questions. The hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). The pre-test scores were used as covariates to the post-test scores. If the exact probability associated with the calculated value of test statistic is less than 0.05 level of significance, the null hypothesis (H_0) was rejected.

Results

Research Question 1

What are the mean achievement scores of students taught using teacher-directed instructional strategy and those taught with self-paced instructional strategy in trigonometry?

Table 1: Mean Achievement Score of Students taught using Teacher-Directed Instructional Strategy those taught with Self-Paced Instructional Strategy in Trigonometry

Instructional Strategies		Pretest		Posttest		
	N	$\bar{x}$	SD	$\bar{x}$	SD	Mean difference
Teacher-Directed	111	12.62	3.45	25.96	5.91	13.34
Self-Paced	66	12.73	2.99	20.03	3.95	7.30

Key: Number of subjects/respondents, $\bar{X}$= Mean, SD = Standard Deviation.

Result in Table 1 showed the pretest and posttest mean achievement score of students taught using teacher-directed instructional strategy and those taught with self-paced instructional strategy in trigonometry. The result shows that the pretest mean achievement scores of students taught trigonometry using teacher-directed instructional strategy was 12.62 with a standard deviation of 3.45 while the posttest mean was 25. 96 with a standard deviation of 5.91. The mean difference between the pretest and posttest means was 13.34. Whereas, the pretest mean achievement scores of students taught trigonometry using self-paced instructional strategy was 12.73 with a standard deviation of 2.99 while the posttest mean was 20. 03 with a standard deviation of 3.95. The mean difference between the pretest and posttest means was 7.3. For both instructional strategies (teacher-directed and self-paced) the posttest mean achievements scores of the students were greater than the pretest mean scores, with students taught trigonometry using teacher-directed instructional strategy having a higher mean difference than their counterpart taught with self-paced instructional strategy. This therefore implies that teacher-directed instructional strategy appears to influence students' mean achievement when taught trigonometry than self-paced instructional strategy.

Research Question 2
What is the mean achievement score of male and female students in trigonometry?

Table 2: Pretest and posttest mean achievement scores of male and female students taught trigonometry.

Variable		Pre-test		Post-test		Mean
Gender	N	$\bar{X}$	SD	$\bar{X}$	SD	Difference
Male	99	13.05	3.59	24.66	5.56	11.61
Female	78	12.16	2.77	22.60	6.34	10.44

Key: Number of subjects/respondents, $\bar{X}$= Mean, SD = Standard Deviation.

Result in Table 2 shows the pretest and posttest scores on the influence of gender on the mean achievement scores of students' taught Trigonometry. The result shows that the pretest mean achievement scores of male students taught trigonometry was 13.05 with a standard deviation of 3.59 while the posttest mean was 24.66 with a standard deviation of 5.56. The mean difference between the pretest and posttest means was 11.61. While, the pretest mean achievement score of female students was 12.16 with a standard deviation of 2.77 and a posttest mean of 20.60 with a standard deviation of 6.34. The mean difference between the pretest and posttest means was 10.44. Both male and female students, the posttest mean achievement scores were higher than the pretest means scores, with male students having a higher mean difference than their female students' counterparts. This therefore implies that male students achievement score appear to increase when taught trigonometry than female students.

Research Question 3
What is the interaction effect of the instructional strategies and gender on the mean achievement scores of students in trigonometry?

Table 3: **Mean and Standard deviation of the interaction effect of instructional strategies and gender on the mean achievement scores of students in trigonometry.**

Variable			Pre-test		Post-test		Mean
Strategies	Gender	N	$\bar{X}$	SD	$\bar{X}$	SD	Difference
Teacher-directed	Male	65	13.08	3.63	26.62	5.36	13.54
	Female	46	11.98	3.11	25.04	6.56	13.06
Self-Paced	Male	34	13.00	3.58	20.91	3.74	7.91
	Female	32	12.84	2.23	19.09	3.99	6.25

Result in Table 3 showed the interaction effect of instructional strategies and genders on students' mean achievement scores in trigonometry. The result showed that male students taught using teacher-directed instructional strategy had a pretest mean achievement score of 13.08 with a standard deviation of 3.63 and a posttest mean of 26.62 with a standard deviation of 5.36. The difference between the pretest and posttest means for male student was 13.54. While female students taught using teacher-directed instructional strategy had a pretest mean of 11.98 with a standard deviation of 3.11 and a posttest mean of 25.04 with a standard deviation of 6.56. The difference between the pretest and posttest means for female students was 13.06. For both male and female taught using teacher-directed instructional, the posttest mean achievement scores were

greater than the pretest means with male having a slightly higher mean difference than their female counterparts. The table 4 also showed that male students taught using self-paced instructional strategy had a pretest mean achievement score of 13.00 with a standard deviation of 3.58 and a posttest mean of 20.91 with a standard deviation of 3.74. The difference between the pretest and posttest means for male student was 7.91. While female students taught using teacher-directed instructional strategy had a pretest mean of 12.84 with a standard deviation of 2.23 and a posttest mean of 19.09 with a standard deviation of 3.99. The difference between the pretest and posttest means for female students was 6.25. For both male and female students taught using self-paced instructional strategy, the posttest mean achievement scores were greater than the pretest means with male students having a slightly higher mean difference than their female counterparts. In both groups, the posttest mean achievement scores were greater than the pretest means with male students having a slightly higher mean difference in achievement scores when taught using teacher-directed instructional strategy and self-paced instructional strategy than their female counterpart.

Hypothesis 1

There is no significant difference on the mean achievement score of students taught using teacher-directed instructional strategy those taught with self-paced instructional strategy in trigonometry.

Table 4: Analysis of Covariance (ANCOVA) of the Mean Achievement Score of Students taught using Teacher-directed Instructional Strategy those taught with Self-Paced Instructional Strategy in Trigonometry?

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Square	Deci
Corrected Model	2764.337[a]	4	691.084	33.571	.000	.438	
Intercept	1784.387	1	1784.387	86.681	.000	.335	
PretestAchie	1186.027	1	1186.027	57.614	.000	.251	S
Strategies	1461.430	1	1461.430	70.993	.000	.292	S
Gender	42.792	1	42.792	2.079	.151	.012	NS
Group * Gender	4.652	1	4.652	.226	.635	.001	NS
Error	3540.725	172	20.586				
Total	106156.000	177					
Corrected Total	6305.062	176					

Note: S = Significant, NS = Not Significant,

Result in Table 4 also showed that an F-ratio of 70.993 with an associated or exact probability value of 0. 000 was obtained with respect to the significance difference in the mean achievement scores of students taught trigonometry using teacher-directed instructional strategy and self-paced instructional strategy. Since the associated or exact probability value of 0.000 when compared with 0.05 set as the level of significance was found significant because it is less, null hypothesis two (H_{02}) was therefore rejected. Thus, inference drawn was that there was significant difference in the mean achievement scores of students taught trigonometry. The observed difference in the research question was probably due to chance error. Furthermore, the effect size value which is symbolically represented as η_p^2 (or partial eta squared) was 0.292. This value is

indicative that teacher-directed and self-paced instructional strategies accounted for about 29.2 percent increasing in the students' achievement scores when taught trigonometry.

Hypothesis 2
There is no significant difference in the mean achievement score of male and female students in trigonometry.

Result in Table 4 also showed that an F-ratio of 2.08 with an associated or exact probability value of 0.15 was obtained with respect to the influence gender on the mean achievement scores of students taught trigonometry. Since the associated or exact probability value of 0.15 when compared with 0.05 set as the level of significance was found not significant because it is greater, the null hypothesis three (H_{04}) was therefore not rejected. Besides, the effect size value which is symbolically represented as η_p^2 (or partial eta squared) was 0.012. This value is an indication that teacher-directed and self-paced instructional strategies accounted for about 1.2 percent increasing in the students' achievement scores when taught trigonometry. Thus, inference drawn was that there was no significant influence of gender on the mean achievement scores of students in trigonometry.

Hypothesis 3
There is no significant interaction effect of the instructional strategies and gender on the mean achievement scores of students in trigonometry.

Result in Table 4 also showed that an F-ratio of 0.226 with an associated exact probability value of 0.635 was obtained with respect to the interaction effect of instructional strategies and gender on the mean achievement scores of students in trigonometry. Given that the associated exact probability value of 0.635 when compared with 0.05 set as the level of significance was found not significant because it is greater, therefore the null hypothesis five (H_{05}) was not rejected. Hence, the conclusion drawn was that there was no significant interaction effect of instructional strategies and gender on the mean achievement scores of students in trigonometry. Besides, the η_p^2 (partial eta squared) value of 0.001 showed that only 0.1 percent variations in students' mean achievement scores in trigonometry was due to the interaction effect of instructional strategies and gender This result is further explained and supported using the interaction graph in Figure 3 which shows that there was no significant interaction effect of instructional strategies and gender on the mean achievement scores of students in trigonometry. This is evidenced in the graph because the interaction lines of instructional strategies against gender does not intercept at any point as shown below.

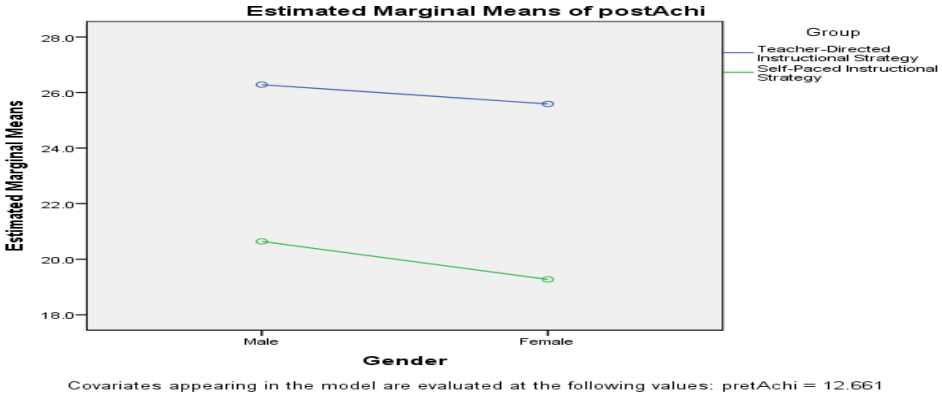

Fig. 1: Graph showing the interaction effect of instructional strategies and gender on mean achievement scores

Discussion of Findings

The result from table 2 revealed that students taught using teacher-directed instructional strategy that is experimental group I had higher mean achievement score than those taught using self-paced instructional strategy in experimental group II. For each of the group of instructional strategies, the posttest scores were greater than the pre-test scores with group taught using teacher directed instructional strategy having higher mean gain. The mean achievement was strengthened by analysis of covariance which shows that there is significant difference in the mean achievement scores of students taught using teacher-directed instructional having higher mean gain compared to those taught using self-paced instructional strategy in trigonometry. This implies that teacher-directed instructional strategy enhances students' achievement than using self-paced instructional strategy. This finding is contrary to Winarno, Muthu and Ling (2017) who stated that students have difficulties in the teacher-directed instruction approach. Unlike Ahmed (2011) who shown that the attitudes of students with learning difficulties in mathematics improve when exposing to teacher-directed instructional strategy. This implies that teacher-directed instructional strategy had positive effect on students' achievement in Trigonometry.

The findings of the study revealed that mean achievement scores of male and female taught using teacher-directed instructional strategy and self-paced instructional strategy in trigonometry. The male and female students taught using teacher-directed instructional strategy had higher mean gain than their counterpart male and female students taught with self- paced instructional strategy in trigonometry. Inference drawn is that gender has no significant influence on the mean achievement scores of students in trigonometry from the analysis of covariance. This implies that using instructional strategies does not result in difference in achievement between male and female students as shown in table 5. The findings of this study are not agreeing with Nfan (2013) who found out that there was no significant difference in the mean achievement scores of the male and female students taught trigonometry via RUPSS. The findings further in agreement with, Emaikwu, and Utubakwu (2015) who found out that there is no significance difference between the mean achievement scores of male and female students taught trigonometry using problem-based learning method which is in agreement with the present study. The findings of this study

imply that male and female students benefited equally in the performance of the trigonometry content taught during the study.

The findings in table 4 indicated that the male and female students' achievement higher when taught using teacher-directed instructional strategy than their male and female counterpart. The achievement difference was further confirmed using analysis of variance which revealed that there is no significant difference interaction effect of instructional strategy and gender on students' achievement in trigonometry. This result implies that the combined effect of instructional strategies and gender on students' achievement scores in trigonometry has no significant influence on the students' achievement. This finding of the study is consistent with Nwoke, Emenyonu, and Ihekaire (2017) who revealed that there is no significant interaction between gender and Blended e-learning method oflearning on student achievement in mathematics. The findings are also in agreement with Iji, Emaikwu, and Utubakwu (2015) who found out that there is no significant interaction effect between teaching method and gender on students' performance of Trigonometry.

Conclusion

The study set out to investigate the efficacies of teacher-directed and self-paced instructional strategy on students' achievement in trigonometry. From the result of the study, there was significant difference in the mean achievement scores of students taught using teacher-directed instructional strategy and those taught with self-paced instructional in trigonometry. It was concluded that the instructional strategies have positive effect on both expertise and novice students irrespective of their gender differences in trigonometry.

Recommendations

Teachers who are already in the field should be trained in current innovative teaching-learning strategies such as conceptual teaching strategy through workshops, seminars, conferences and in-service programmes by mathematics educators, ministries and agencies in-charge of education, professional bodies such as Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN) and National Mathematical Centre (NMC) Abuja. This is to enable them update their knowledge on current teaching strategies that are found effective in teaching and learning mathematics content through research.

Classroom teaching and learning activities should be reviewed by the Nigerian Educational Research and Development Council (NERDC) and other curriculum developers to include the varieties of teaching strategies that were proved effective through research, in the teaching and learning mathematics contents. In this way teachers will be discouraged from using the conventional strategies to teaching in the classrooms.

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