

GENDER EFFECTS OF GAGNE'S INSTRUCTIONAL STRATEGY ON PERFORMANCE IN ALGEBRA AMONG SENIOR SECONDARY SCHOOL STUDENTS IN KATSINA STATE NIGERIA

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Abstract

This study investigated Gender effects of Gagne's Instructional Strategy on performance in Algebra among senior secondary schools students in Katsina State, Nigeria. The research adopted pretest, post-test quasi experimental research design. The population consists of 69,932 SS II students from twelve (12) education zones. 382 students were sampled from four (4) zones out of the 12 education zones in Katsina State using multi-stage cluster sampling technique. Algebraic Performance Test (APT) was used as instrument for data collection with a reliability coefficient of 0.69 obtained using Pearson Product Moment Correlation Coefficient (PPMC). Two research questions were answered and two null hypotheses tested at 0.05 level of significance. The research questions were answered using mean and standard deviation while the hypotheses were tested using independent t-test. The findings revealed that a significant mean scores performance difference was found between students taught Algebra using GIS ($M=34.07$, $SD=8.78$) and those taught using conventional method ($M=30.42$, $SD=11.47$) $t(380)=3.46$. The results also found significant mean performance difference between male and female students taught Algebraic concepts using GIS. The study recommended that GIS should be encouraged by the ministry of education to be adopted by secondary school mathematics teachers.

Keywords: Gender Effects, Gagne's Instructional Strategy, Performance, Algebra, Senior Secondary School students.

Introduction

There is no development, if there is no education while there is no nation that can achieve scientific or technological advancement without proper foundation in school mathematics. Gan (2018) stated that mathematics is an essential intermediate by which and with which science expresses, formulates and communicates itself. He stressed that Mathematics has now turned out to be more than simple calculations; it has become a powerful tool for practical science like engineering, industry and others to mention but a few. It has entered into the development of technology and a great variety of many inventions. Mathematics has many branches among which is Algebra, Trigonometry, geometry, statistics and so on (NPE, 2013).

Usman (2015) define algebra as an aspect of mathematics which involves the use of letter and numbers to resolve mathematical problem. Algebra is a specialized version of arithmetic that uses variables to stand for unspecified numbers. Its major aim is to solve equations with systems of equations such as quadratic formula and elimination (for resolving groups of equations in matrix form). Although, algebra is considered as one of the most important aspect

of school mathematics that function as a gate keeper to future educational and employment opportunities (Silver, 2017). For students to understand and possess the mathematical skills of problem solving, communication, reasoning and making connections that are necessary in human daily living they need algebra. This is so because algebra is the language through which most of the mathematics is communicated (Iji, Abakpa&Takor, 2015). It was on this note that Effiom (2024) sees algebra as a branch of mathematics where arithmetic operation and formal manipulations are applied to abstract symbols rather than specific numbers.

It is worth noting that various studies have been carried out according to Abdulraheem, (2012), Bilesanmi-Awoderu, (2012) and Akpokiniovo, (2022) related to instructional approaches, learning environment interaction pattern, curriculum evaluation and implementation in teaching and learning. In Nigeria, among the above issue, inappropriate method of teaching used by mathematics teachers still poses a serious concern. Bilesanmi-Awoderu (2012) asserted that poor instructional approach adopted by teachers is majorly responsible for poor achievement scores of the students. To him most teachers are on the habit of using conventional method of teaching and most times rote learning occurred where the student solely depends on memorization of concepts rather than complete understanding of the subject content and concepts. This could have strong effects on student's performance.

Bell (2015) views performance as an accomplishment or outcome that indicates the attainment on a given skill or a body of knowledge a student has accomplished in institutional activities. Mohammed and Waheed (2015), view performance as the assessment of how much students have learned, the extent to which students have acquired certain information or mastered skills usually due to prior information or training. Tang, Tsai and Huang (2020) stated that performance improves when student-centric teaching method like Gagne's Instructional Strategy

(GIS) is efficiently utilized which also helps in diagnosing student learning difficulties and provides the teacher with ways of improving learning effectiveness. Performance is commonly measured by examination or continuous assessments but there is no general agreement on how it is best tested or which aspect is more appropriate. For a good performance in Mathematics, the method or strategy used is of paramount importance as such the choice of strategies that would hopefully improve student performance such as Gagne's instructional strategy is of paramount importance.

Gagne's Instructional Strategy (GIS) enhances teachers' phase of activity required to be utilized to execute instruction. Every phase details a kind of information which improves skills acquisition and knowledge assimilation. At the completion of a particular phase, the learning objective should be achieved and the retention of skills and knowledge or abilities which they are being taught should be gained (Agboghoroma, Bebenimibo&Akpokiniovo, 2022). Nwaobi (2017) attested that Gagne's hierarchical learning strategy significantly improves mathematics students' performance. Gagne's model was developed suitable for planning the teaching process as a technology intensive process that follows a synthesis of behavioral and cognitive psychology. The model consists of nine steps as thus; to gain attention, Inform learners of objectives, Stimulate recall of prior learning, present the content, Provide learning guidance, Elicit performance (practice), Provide feedback, Assess performance and Enhance retention and transfer. Gagne (1987) in Pala (2014) views learning as both a product and a process. Thus,

this paper investigates the effects of GIS on students' academic performance in Algebra in senior secondary schools, Katsina State.

Statement of the Problem

Poor students' academic performance in Mathematics has been under watch for more than a decade; despite the huge investment of several stakeholders in mathematics, the performance of the students in senior secondary school certificate examinations (SSCE) has long been a matter of concerned individuals, institutions and organizations. Many reasons have been noted for this poor performance of students' in mathematics among which is instructional strategy used by mathematics teachers (Alhaji and Abdullahi, 2020; Agboghroma, Bebenimibo&Akpokiniovo, 2022). For this reason, there is need to test the use of other teaching strategies like GIS beside the conventional talk and chalk method that have been tested and proved to improve students' academic performance in different settings and locations. It is against this knowledge gap, this paper investigates the effects of GIS on mathematics students' academic performance in Algebra in senior secondary schools in Katsina State of Nigeria.

Objectives of the Study

The objectives of this study were to:

1. Find out the effect of Gagne's Instructional Strategy on the academic performance of senior secondary school students in Algebra.
2. Investigate the effect of Gagne's Instructional Strategy on performance among male and female senior secondary school students' in Algebra.

Research Questions

In view of the nature of this research topic, the following questions were raised:

1. What is the difference between the mean scores performance of students taught algebraic concepts using Gagne's Instructional Strategy and those taught using conventional method?
2. What is the difference between performances mean scores of male and female students taught algebraic concepts using Gagne's Instructional Strategy?

Null Hypotheses

The following research hypotheses were formulated and tested at 0.05 level of significance:

Ho₁: There is no significant difference between performances mean scores of students taught algebraic concepts using Gagne's Instructional Strategy and those taught using conventional method.

Ho₂: There is no significant difference between performances mean scores of male and female students taught algebraic concepts using Gagne's Instructional Strategy.

Research Methodology

The study employed a quasi-experimental research design involving pre-test and posttest. The design would be adopted because it is not possible to have a complete randomization of the subjects as this would disrupt school organization. In this design, the researchers used pre-test to determine the homogeneity of the groups while post-test was used to determine the effect of the treatments applied. The total number of SSS II students that served as

population sample was 69,932 out of which 39,988 were males and 29,944 were females with an average age of 16 years.

A multistage cluster sampling technique was employed where four (4) out of the 12 education zones in Katsina State were randomly selected (Dutsinma, Katsina, Malumfashi and Rimi. By the simple random process, one (1) Local Government Area (LGA) among the LGAs in each selected education zone was sampled. By the same process, two (2) Senior secondary schools out of schools in each LGA from the sampled zones were selected. One intact class among classes from each of the eight (8) selected schools with a total number of 382 SS II students (192 males and 190 females) were selected in the same manner. Out of the eight intact classes used for the study, four form the experimental group (N=180) while four form the control group (N=202).

Algebraic Performance Test (APT) containing 20 items was used to collect required data for the study. The instrument was subjected to assessment by experts and was field tested with a reliability coefficient of 0.69 using test retest method and Pearson Product Moment Correlation Statistics on a sample of 40 SSII students in a school that was not part of the study. APT was administered as a pretest to both experimental and control group before the commencement of the lesson. The result showed that the two groups were homogenous before the commencement of the experimental study. The experimental group was taught by the researchers using Gagne's Instructional Strategy. The researcher taught the experimental group, the selected concept in algebra using GIS for four weeks and the control group using conventional method for four weeks. At the end of the eight weeks teaching session, the researcher's post test was administered to the subjects. The answer scripts collected from the two groups were marked, scored in percentage. Mean and standard deviation were used to analyze data to answer research questions while independent t-test was used to test the null hypothesis at $\alpha \leq 0.05$ level of significance.

Presentation of Results

The data obtained from the study were analyzed using version 20 of the Statistical Packages for Social Sciences (SPSS) as follow:

Ho₁: There is no significant difference between performances mean scores of students taught algebraic concepts using Gagne's Instructional Strategy and those taught using conventional method.

In order to test the null hypothesis one, the data generated via Algebraic Performance Test (APT) were subjected to independent sample t-test statistic and the results presented in Table 1.

Table 1: Summary of Independent t-test Statistics on the significant difference between the Mean Performance Scores of Experimental and Control Groups

Variable	Groups	N	Mean	Std. D	M. df	D.f	t	P
Performance	Experimental	180	34.07	8.787	3.65	384	3.456	0.00
	Control	202	30.42	11.47				

Significant at $P \leq 0.05$ level of significance

Results in Table 1 show that the mean scores of students in Experimental Group was 34.07 and that of Control Group was 30.42 with difference of 3.65 and standard deviations of 8.79 and 11.47 respectively. The calculated p-value of 0.00 is less than the adopted 0.05 alpha level of significance ($P = 0.00 < 0.05$). The null hypothesis H_{01} was therefore rejected. This implies that there is significant difference between the mean academic performance scores of experimental and control group in favor of the experimental group.

H₀₂: There is no significant difference between performances mean scores of male and female students taught algebraic concepts using Gagne's Instructional Strategy.

In order to test the null hypothesis two, the data generated via Algebraic Performance Test (APT) were subjected to independent t-test statistic and the results presented in Table 2.

Table 2: Summary of independent t-test Statistics on the significant differences between the Mean Performance Scores of Male and Female Students in Experimental Group.

Group	Variable	Gender	N	Mean	Std. D	M. df	D.f	t	P
Experiment	Performance	Male	85	36.12	7.52	7.95	178	5.647	0.00
		Female	95	28.17	10.99				

Significant at $P \leq 0.05$ level of significance

Results in Table 2 show that the mean scores of male students was 36.12 and that of female students was 28.17 with difference of 7.95 and standard deviations of 7.52 and 10.99 respectively. The calculated P-value of 0.00 is less than the adopted 0.05 alpha level of significance ($P = 0.00 < 0.05$). The null hypothesis H_{02} was therefore rejected. This implies that there is significant difference between the mean academic performance scores of male and female students taught algebraic concepts using Gagne's Instructional Strategy in favor of the male students.

Discussion

The result of the t-test analysis in Table 1 indicated significant differences between the mean performance scores of students in experimental group taught algebra using Gagne's Instructional Strategy and those in Control group who were taught using the conventional method. This shows that the treatment given to experimental group made them to excel in their performance higher than the control group. This finding is in support of the findings of Tang, Tsai and Huang (2020), who concludes that Gagne learning hierarchy and inherited coding approach provided a method of building mathematical skills and also diagnosing students learning problems and enhanced performance. The findings were also in agreement with the findings of Kasinath and Flosy (2022) which concluded that a study on effectiveness of instructional strategies based on Gagne's instructional design has positive impact in improving thinking skills and academic performance of secondary school mathematics students. The result of this study disagree with that of Maede (2023) who found that Students taught using Gagne's learning hierarchy recorded low academic achievement than those taught using Bybee Instructional model. The reason to this could be probably due difference in level of students taught and subject area.

The result of independent sample t-test analysis in Table 2 showed significant differences between the mean performance score between male and female students in experimental group exposed to Gagne's Instructional Strategy as treatment in favour of male students, meaning that the P value was less than 0.05 alpha level. This result indicates inability of Gagne's Instructional Strategy in bridging the gender gap between male and female students in the teaching/learning of algebra. The result of this study differs with that of Salmon (2005), who found that female students perform better than their male counterparts in problem solving. This result is also not in conformity with the findings of Hausmann, Chi and Roy (2014) who concluded that the target Gagne's Task Model, being an activity-oriented model, also enhanced better performance among male students compared with female students.

Conclusion

It was concluded based on the findings of this study that Gagne's instructional strategy has the capability of improving and enhancing students' performance in algebra but was found to be gender insensitive as it was not able to bridge the performance gap between male and female students in algebra.

Recommendations

The results of this study gave rise to the following recommendations:

1. Ministry of Education in the three tiers of governments in Nigeria should encourage the use of Gagne's instructional strategy in teaching mathematics in secondary schools to improve the teaching of algebra.
2. Teachers of mathematics in secondary schools should adopt Gagne's instructional strategy in teaching to enhance students' performance in mathematics most especially in algebra.
3. Gagne's instructional strategy should be included in mathematics pedagogy of teacher training institutions to ensure training of pre-service mathematics teacher on the use of the strategy.

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