

**EFFECTS OF DESIGN THINKING STRATEGY ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND INTEREST IN ALGEBRA IN ABIA STATE**

**Assoc. Prof. Nneji, Samuel Onyinyechi**

Department of Mathematics/Computer Education  
Enugu State University of Science and Technology (ESUT)  
Phone No. 08101262105  
Email: [nneji.samuel@esut.edu.ng](mailto:nneji.samuel@esut.edu.ng)

**Ukachukwu Chinedum Miracle**

Department of Mathematics/Computer Education  
Enugu State University of Science and Technology (ESUT)  
Phone No. 08134587437  
Email: [iamkachukwuchinedum@gmail.com](mailto:iamkachukwuchinedum@gmail.com)

**Abstract**

The main purpose of this study was to investigate the effect of design thinking strategy on secondary school students' achievement and interest in algebra in Abia State. Quasi-experimental design was adopted for the study. It was guided by four research questions and six hypotheses. This study was conducted in Aba Education Zone of Abia State. Population for the study consisted of 72,113 senior secondary school students in the 187 registered public and private secondary schools in Aba education zone of Abia state as at the time of the study. A sample of 414 senior secondary school students was used for the study. The sample consisted of two 229 public schools' students and 185 private schools' students. Also the sample is composed of 210 students in the experimental group and 204 students in the control group. The instruments for data collection were Algebra Achievement Test (ALAT) and Algebra Interest Inventory (ALII). The instruments were constructed by the researcher and validated by three research experts. The validated copies of the instruments were subjected to test of stability and internal consistency. The Kuder-Richardson 20 (KR-20) formula and Cronbach's Alpha method were used to calculate the reliability coefficients for ALAT and ALII respectively. ALAT and ALII yielded reliability coefficients of 0.89 and 0.72 respectively. Mean and standard deviation were used to answer the research questions while test of hypotheses was done using Analysis of Covariance (ANCOVA) at 0.05 level of significance. Major findings of the study revealed that students taught with design thinking strategy (experimental group) elicited higher achievement than students not taught with design thinking strategy (control group) and students taught with design thinking strategy (experimental group) arose more interest than students not taught with design thinking strategy (control group). It was recommended among other things that mathematics teachers should be trained on regular basis through conferences, workshops and seminars on how to use design thinking strategy in teaching effectively. Useful suggestions for further researches were also made.

**Keywords:** Mathematics, Design Thinking Strategy, Algebra, Achievement, Interest.

**Introduction**

The five main national goals of Nigeria is to build; a free and democratic society; a just and egalitarian society; a united, strong and self reliant nation; a great and dynamic economy; and a land full of bright opportunities for all citizens (Federal Republic of Nigeria (FRN), 2019). From the foregoing, it is clear that the Nigerian nation believes that education is an instrument “par excellence” for achieving national development as it (education) fosters the worth and development of the individual, for each individual’s sake and for the general development of the society.

The rapid socio-economic development of a nation has a strong positive relationship with the caliber of human capital, developed through functional education, in that country (Clauss, 2021). In the philosophy of mathematics education it is expressed that mathematics can facilitate, precise and logical reasoning in her learners. This will then equip the learners for creativity and productivity. In the Nigerian formal educational system, mathematics is studied at all levels; primary, secondary and tertiary. In recognition of its importance, mathematics is made compulsory at the primary and secondary school levels. At least a credit pass in mathematics is also a sine qua non for gaining admission to study most courses in the nation’s various tertiary institutions.

Unfortunately, research evidences such as Ohanusi (2017), Derbuck and Kpakor (2015) as well as Kuntu and Pedro (2016) submitted that this all important subject is dreaded, hated, feared and massively failed by students especially at secondary school level. Secondary school mathematics curriculum covers so many topics such as geometry, trigonometry, algebra, statistics and commercial arithmetic. Ajom and Agbenyi (2018) hinted that Algebra consists over 46 percent of secondary school mathematics curriculum content in Nigeria. Algebra is one of the main branches of pure mathematics. It is concerned with the study of the rules of operations and relations, and the constructions and concepts arising from them, including terms, polynomials and equations. Secondary education algebra mainly introduces the concepts of variables representing numbers. Statements based on these variables are manipulated using the rules of operations that apply to numbers.

Algebra do not only deal with properties of numbers but also reveals how those properties can be applied in solving day to day practical life problems. Hence, good skills and competences in algebra is a great asset to any secondary school student because it is a tool for developing critical and logical thinking that can facilitate the learning of other branches of mathematics and even

other science subjects. Indeed algebra deserves much attention given its importance. Any study based on algebra is to say the least worthwhile. This study therefore aimed at finding out ways to help students achieve higher, develop higher interest and retained more in this vital branch of mathematics. Researchers have made case for the use of innovative teaching methods to improve students' achievement and interest in mathematics. Such methods include, laboratory, discovery, delay formalization, learner autonomy, self-regulated, learning and design thinking strategy. The study sought to determine the effect of design thinking on secondary school student's achievement and interest in algebra with regard to their schools' ownership. Hence, two major sets of variables were involved in the study. They were dependent, and independent variables.

The dependent variable include students' achievement and interest in algebra. The independent variables include design thinking strategies and school ownership. AL-Gazir (2020) defined achievement as the process of bringing out or accomplishing something through effort, skill or course. Bell and Thompson (2019) averred that academic achievement generally suggests an achievement relating to education and scholarship. Tenty and Awe (2018) added that academic achievement depicts student's performance on a standard of measurement such as performance test, skill test, analytical thinking test, etc. Academic achievement can therefore be described as the gain in knowledge of students as result of taking part in a learning activity or programme.

Academic achievement, according to Kuntu and Pedro (2016) is a result-oriented construct that encapsulates the extent of performance of a describe task. Academic achievement refers to the consistency of a student's test or evaluation results as compared to those of other students at the same level (Ginga, Muhammed and Usman, 2019). More specifically, academic achievement in this study refers to achievement in secondary school algebra. This achievement was measured using Algebra Achievement Test (ALAT). The ALAT was used to measure the students' gain in knowledge as a result of been taught algebra with design thinking strategy. Students' achievement in algebra cannot be discussed fully in isolation with students' interest in Algebra.

Interest is described as a motivational force that involves the focused allocation of extra attention, leading to deeper processing, better comprehension, and longer recall (Abdullahi and Umeano, 2020). Derbuck and Kpakor (2015) defined interest as the feeling of wanting to know about something or someone, a quality exciting curiosity or holding the attention of someone. It is also disposition, attitude, and feelings of an individual towards an activity which shows behaviourally, the extent the person like to participate in an activity. AL-Gazir (2020) averred that interest is

indispensable for learning and many hold the view that there can be no real education without interest. Interest engages the attention, concern and curiosity of the individual. Interest is therefore a major factor in teaching and learning of mathematics especially at secondary school level where the vibrant and curious youngsters need to be directed to have the right kind of attitude and inward state of mind towards mathematics. In this study, students' interest in Algebra strictly refers to students' disposition, attitude and feeling towards algebra. This behavioral trait is measured herein with Algebra Interest Inventory (ALII) which indicates the extent to which the students give attention and like to participate in algebraic activities. This work to re-examine this critical, if not the premier determinant of the success and quality of any learning outcome.

Stone, Zuby and Bill (2021), Mbunda (2019) and AL-Gazir (2020) in their separate works observed that problems of students' achievement and interest in mathematics cannot be solved effectively without considerable attention to teaching methods in use. Perhaps the most popular method of teaching in secondary school today is the expository or lecture method. Major attribute of expository method is that the teacher stands in front of the class and gives out his message to a listening class. It is usually described as a teacher-centered approach. In most cases, students are passive in expository or lecture classes. Ayuba (2018) stated that though a good number of today's educators and professors are products of the expository method yet the much desired impact has not been achieved at least in mathematics education as the achievement of students taught with expository method is generally poor. Hence, the search for instructional methods that promotes active learning increases daily. Making case for active learning in mathematics classroom Bell and Thompson (2019) noted that learning is not a spectator sports. Students do not learn much just listening to teachers, memorizing prepackaged assignments, and spitting out answers. They must talk about what they are learning, write reflectively about it, relate it to past experience, and apply it to their daily lives. They must make what they learn part of themselves. Bell and Thumpson, thus, recommended the use of Design Thinking Strategy for teaching algebra to secondary school students.

Design thinking refers to creative strategies designers use during the process of designing. It is also an approach to resolve issues outside of professional design practice, such as in business and social contexts. Design thinking is a method for practical, creative resolution of problems. According to Zest (2018) design thinking process is iterative, flexible and focused on collaboration between designers and users, with an emphasis on bringing ideas to life based on how real users

think, feel and behave. Design Thinking tackles complex problems by; empathizing, defining, ideating prototyping and testing. Design thinking encourages divergent thinking to ideate many solutions (possible or impossible) and then uses convergent thinking to prefer and realize the best resolution. Unlike analytical thinking, design thinking includes "building up" ideas, with few, or no, limits on breadth during a "brainstorming" phase. This helps reduce fear of failure in the participant(s) and encourages input and participation from a wide variety of sources in the ideation phases, (Tenty and Awe, 2018).

Many research evidences that investigated the effect of design thinking strategies on public and private secondary schools students' achievement and interest in mathematics submitted conflicting findings. Marcellio and Haroldi (2021), Kofi (2019), Ojim and Nyim (2017) and Adejumo (2015) reported that public schools' student achieved higher and showed more interest in mathematics than counterparts in private schools' who received the same treatment. On the other hand, Eze and Ogbodo (2021), Kim et al (2020), Ayuba (2018) and Michelle (2022) all reported that private schools students out-performed their public schools counterpart. This study therefore sought to determine the effect of design thinking strategies on students' achievement and interest in algebra with regard to their schools' ownership.

### **Purpose of the Study**

The purpose of this study was to investigate the effect of design thinking strategy on senior secondary school students' achievement and interest in algebra. Specifically, the study sought to determine students';

- i. achievement in algebra
- ii. interest in algebra

### **Research Questions**

The following research questions guided the study.

1. What are the mean algebra achievement scores of students in the experimental and control groups in both pretest and posttest?
2. What are the mean algebra interest scores of students in the experimental and control groups in both pretest and posttest?

### **Hypotheses**

The following research hypotheses were tested at .05 level of significance.

1. There is no significant difference between the mean algebra achievement scores of the students in experimental and control groups.
2. There is no significant difference between the mean algebra interest scores of the students in experimental and control groups.

### **Methodology**

The quasi experimental research design was adopted for this study. Intact classes were used for experimental and control groups to avoid randomization of the research subjects. The study area covered Aba Education zone of Abia State. The zone is located at the southern part of Abia State.

The population for the study consisted of 72,113 senior secondary school students in the 187 registered public and private secondary schools in Aba education zone of Abia State as at the time of the study. A sample of four hundred and fourteen (414) senior secondary school students was used for the study. The sample consists of two hundred and twenty nine (229) public schools' students and one hundred and eighty five (185) private schools' students. Also the sample is composed of two hundred and ten (210) students in the experimental group and two hundred and four (204) students in the control group. The sample was drawn from twelve intact classes in the three public and three private secondary schools randomly drawn from the three Local Government Areas in Aba education zone of Abia state. Two instruments namely Algebra Achievement Test (ALAT) was used for data collection in the study. ALAT was used to collect pretest and posttest achievement scores as well as the retention scores. It is made up of Forty (40) multiple choice questions with four options each. The instrument for data collection was validated by three experts. The instrument for data collection was validated by three experts. The instrument was subjected to trial testing to ensure the reliability of the instrument. Precisely, Kuder Richardson formula 20 (KR-20) was used for ALAT. The instruments ALAT was administered to 73 senior secondary school students in Awka Education Zone, Anambra State. The students were made up of 41 students from a public secondary school and 32 students from a private secondary school. The students' scores were used to obtain the reliability co-efficient for the instruments. Mean and standard deviation were used to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

**Results**

Research Question One: What are the mean algebra achievement scores of students in the experimental and control groups in both pretest and posttest?

**Table 1: Mean achievement scores of experimental and control groups in pretest and posttest.**

Group	n	Pretest		Posttest	
		Mean	SD	Mean	SD
Experimental	210	22.31	11.0413	71.25	5.0019
Control	204	21.84	10.5201	52.80	8.4522

From table 1 above, the pretest mean score of experimental group was 22.31 while that of control group was 21.84. These suggest that both groups were almost of equal ability at the beginning of the experiment. In the posttest experimental group had a mean of 71.25 while the control group had a mean of 52.80. Apparently, the two groups achieved higher in the posttest than the pretest indicating that learning took place. However, the posttest mean score of the experimental was higher than that of the control group. Moreso, a lower standard deviation value of 5.0019 in the posttest for experimental group indicates that there were fewer extreme scores in the experimental group than the control.

Research Question Two: What are the mean algebra interest scores of students in the experimental and control groups in both pretest and posttest?

**Table 2: Mean interest scores of Experimental and control groups in pretest and posttest.**

Group	N	Pretest		Posttest	
		Mean	SD	Mean	SD
Experimental	210	38.92	7.1203	88.42	4.2351
Control	204	39.13	7.4018	69.13	6.1024

From table 2 above, the pretest mean score of experimental group was 38.92 while that of control group was 39.13. In the posttest experimental group had an interest mean of 88.42 while the control group had an interest mean of 69.13. This result show that the two groups showed higher interest in Algebra after the treatment. However, the posttest interest mean score of the experimental was higher than that of the control group. Moreso, a lower standard deviation value of 4.2351 in the

posttest for experimental group indicates that there were fewer extreme scores in the experimental group than the control group.

### Hypothesis 1

There is no significant difference between the mean algebra achievement scores of the students in experimental and control groups.

**Table 3: ANCOVA analyses of the students' achievement scores.**

Source	Sum of Squares	DF	Mean Square	F	Sig.	Decision
Method	921.400	1	921.400	1.536	0.000	S
Ownership	98.212	1	98.212	0.149	0.340	NS
Method*Ownership	56.371	1	56.371	0.094	0.251	NS
Error	246600.000	411	600.000			
Total	247666.983	414				

From table 3, method gave an f value of 1.536 and this is significant at .000. Since .000 is less than 1.536 this mean that at .05 level of significance, the f value of 1.536 is significant. Therefore, hypothesis 1 is not accepted as stated. This indicates that there is a significant difference between the mean achievement scores of the experimental and control groups. Similarly, the sum of squares arising from methods (921.400) when compared with the sum of squares arising from error (246600.000) indicates that the observed difference in the achievement of the experimental and control groups is due to the treatment administered in the experiment.

### Hypothesis 2

There is no significant difference between the mean algebra interest scores of the students in experimental and control groups.

**Table 4: ANCOVA analyses of the students' interest scores**

Source	Sum of Squares	DF	Mean Square	F	Sig.	Decision
Method	789.450	1	789.450	1.542	0.001	S
Ownership	20.996	1	20.996	0.041	0.101	NS

Method*Ownership	5.633	1	5.633	0.011	0.121	NS
Error	210481.320	411	512.120			
Total	211297.399	414				

From table 6, method gave an f value of 1.542 and this is significant at 0.001. Since 0.001 is less than 1.542 this mean that at .05 level of significance, the f value of 1.542 is significant. Therefore, hypothesis 2 is not accepted as stated. This indicates that there is a significant difference between the mean interest scores of the experimental and control groups. Similarly, the sum of squares arising from methods (789.450) when compared with the sum of squares arising from error (210481.320) indicates that the observed difference in the interest scores of the experimental and control groups is due to the treatment administered in the experiment.

**Summary of Findings**

The results presented above can be summarized thus:

1. Students taught algebra with design thinking strategy (experimental group) achieved higher than their counterparts who were not taught with design thinking strategy (control group).
2. Students taught algebra with design thinking strategy (experimental group) showed more interest than their counterparts who were not taught with design thinking strategy (control group).

**Discussion**

Research question one sought to know the mean achievement scores of the students in both experimental and control groups in both pretest and posttest. Table 1 presented the mean achievement scores and standard deviations of the students in both groups in pretest and posttest. Noteworthy is the fact that the mean pretest scores of both groups did not differ significantly. This suggests that both groups had similar entry behavior and achievement ability. Also, the wide gap between the mean pretest scores and the mean posttest scores showed that learning took place in both groups. However, the result presented in table 3 indicates that there was significant difference between the achievement of the groups. Hence, the experimental group achieved higher than the control group. Tenty and Awe (2018) defined academic achievement as the gain in knowledge of students as a result of taking part in a learning activity or program. Going by this definition, we can say, with certainty, that the achievement of the students was as a result of the treatment

administered to them. Moreso, extraneous variables were properly controlled. This implies therefore, that experimental group promoted higher achievement in algebra than the control group. Interestingly, the standard deviation for the experimental group was very small, compared to that of the control group. This implies minimal or non-existence of extreme scores in the experimental group. The mean score is therefore, a true representation of the performance of the entire class rather than the performance of a few students in the group.

According to the second item in the summary of findings, the difference between the mean interest scores of the groups was significant in favor of the experimental group. Simply put, the students who were taught algebra (experimental group) showed higher interest than their counterparts (control group) who were taught same content. This findings is a sharp contrast with. The findings of Stone et al (2021), Kofi (2019), Derbuck and Kpakor (2015), Hooke and Charles (2016) and AL-Gazir (2020). These researchers reported that the control group elicited higher interest in their separate studies. Cognitive interest is produced by seeing relationship(s) between incoming information and background knowledge. As good as this may sound, there are numerous researchers whose reports agree with the findings of this study, they include; Olureme and Ajao (2020), Ajom and Agbenyi (2018), Kwame and Damte (2018) as well as Zacky and Young (2018). All these researchers found that students taught with design thinking strategy had higher interest than students not taught with design thinking strategy. From the foregoing, both the experimental and control groups elicited emotional and cognitive interest. There must therefore, be a problem somewhere that leads to variation in findings. In trying to proffer solution Bell and Thompson (2019) advised that though play and amusement are necessary in teaching and learning, efforts should be made to ensure that play and amusement do not overshadow the intended lesson.

## **Conclusion**

Consequent upon the findings of this study, the following conclusions were reached;

1. Students taught with design thinking strategy (experimental group) elicited higher achievement than students not taught with design thinking strategy (control group).
2. Students taught with design thinking strategy (experimental group) arose more interest than students not taught with design thinking strategy (control group).

3. Interaction effect between teaching method and school ownership was insignificant.

### **Recommendations**

From the finding of this study, the following recommendations are made:

1. Design thinking strategy should be used by mathematics teachers in teaching of algebra.
2. Mathematics teachers should be trained on regular basis through conferences, workshops and seminars on how to use design thinking strategy in teaching effectively.
3. State and federal governments through their relevant agencies should develop enriched mathematical laboratories and sets to create avenue for enhanced activity and demonstrative learning.
4. Professional associations such as a Mathematical Association of Nigeria (MAN) should include design thinking strategy during their annual conferences and workshops.

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