EFFECT OF 7E LEARNING MODEL ON STUDENTS' CONCEPTUAL UNDERSTANDING OF ALGEBRA IN KOGI EAST, NIGERIA

[1]Alfred Sule, [2]Benjamin Iortswam Imoko and [3]Martha Mimi Chianson-Akaa

[1]Postgraduate Student, Department of Science and Mathematics Education, Benue State University, Makurdi

[2 & 3]Department of Science and Mathematics Education, Benue State University, Makurdi

Alfredsule24@gmail.com, searchhbk@yahoo.com

Abstract

This study examined effect of 7E learning cycle model on students' conceptual understanding, in algebra at senior secondary school level in Kogi East Senatorial District, Nigeria. The quasi-experimental research design of non-equivalent pre-test and post-test type was used. The population of the study was all the 15,360 senior secondary II students from the 147 co-educational secondary schools in Kogi East Senatorial District for the 2022/2023 academic session comprising 8,232 male and 7,128 female students. Multi-stage sampling technique was employed to select a sample of 220 SS II students. Six intact classes constituted the sample. The instrument used for data collection was a Two–Tier Algebra Diagnostic Test (TTADT) developed by the researchers. Two research questions were generated and two hypotheses were formulated. Mean and standard deviation were used to answer the research questions and Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings revealed that there was statistically significant difference between the mean conceptual understanding of students taught using 7E learning cycle model and traditional discussion method ($F = 119.244$, $P = 0.000 < 0.05$). The findings also revealed that there was no significant different between the mean conceptual understanding scores of male and female students taught using 7E learning cycle model ($F = 0.881$, $P = 0.350 > 0.05$). Based on the findings of this study, it was recommended among others, that teachers should adopt 7E learning cycle model in teaching algebra in senior secondary school in Kogi East Senatorial District, Nigeria as it has potential of improving students' conceptual understanding irrespective of gender in mathematics particularly in algebra.

Key Words: 7E learning cycle model, conceptual understanding, algebra and gender.

Introduction

Mathematics remains a service provider for all disciplines and it contributes immensely in deciding directions of activities in all major human activities such as economy, banking, market transactions, industrial functions, researches, leadership, legal jurisprudence, engineering and others. Without the use of numbers and mathematical knowledge, we cannot resolve many issues in our daily lives. Being a cook or a farmer or a carpenter or a mechanic or a shopkeeper or a scientist or a musician or a magician, everyone needs mathematics in his/her day-to-day life activities. There are times that measurements, rates, wages, tenders, discounts, claims, supplies, jobs, stocks, contracts, taxes, money exchange, consumption among others, all involve concepts of mathematics. Thus, mathematics has become the companion of man and his helper since the beginning of human existence on earth. When man, first wanted to answer questions such as “how many?” He first discovered mathematics. Then Algebra was invented to facilitate calculations, measurement, analysis and engineering (Mahtab, 2018).

Nigeria, as a country realized the usefulness of mathematics in nation building and everyday living and made it one of the core subjects in the primary and secondary school curricular. However, a credit pass in mathematics is one of the prerequisite requirements to secure admission into tertiary institutions in Nigeria to study almost all courses (Kurumeh & Onah, 2013).

Conceptual understanding of students in mathematics is one of the major issues in mathematics education. Conceptual understanding refers to the notion that a student is not just taught how to do mathematics but also the reason behind it (Soyke, 2016). Students are encouraged to see the larger framework that underlies all mathematics and to think fluidly so that they are able to apply their mathematical knowledge to a wide variety of problems. Soyke (2016) explains that if a student had been given a conceptual foundation for 5 x 3 = 15, such student would know that multiplication represent repeated addition and that 5 x 3 is the same as 5 added 3 times which will result to 15. If the student should be able to relate to this illustration, such student can probably see how developing conceptual understanding can improve academic performance and interest in mathematics.

Effaodi and Zakari (2011) conducted a study on students’ conceptual understanding of mathematics and found that, the students’ level of conceptual understanding of mathematics was poor regardless of gender. Onah (2019) also indicated that students have only partial knowledge of geometric concept without conceptual understanding (underlying reasoning). Gender is an important variable in the school system. Gender refers to the condition of being male or female. Gender is analytic concept that describes sociological roles, cultural responsibilities and expectations of men and women in a given society or cultural setting. Eze (2013) explained that gender described the personality traits, attitudes, behaviour, values, relative, power, influence, roles and expectation that society ascribes to the two sexes on differential basis. Therefore, gender is a psychological term and a cultural construct developed by society to differentiate between the roles, behaviour, mental and emotional attributes of males and females (Eugen & Eze, 2016). Ezeudu and Obi (2013) state that teachers encourage gender stereotype by giving different treatment to males and females in class. Teachers go further to give different career guidance to males and females. However, it is expected that learning experiences offered to students in schools should not discriminate against males and females. There is need to see both male and female students given equal access to education especially in mathematics.

The 7E learning cycle model involves conducting learning through a cycle of seven stages of learning activities. The stages include: Elicitation, engagement, exploration, explanation, elaboration, evaluation and extension. Each stage of the learning is aimed at achieving an objective in the learners (Eisenkraft, 2013). 7E learning cycle model as a pedagogical approach is based on constructivism where learners construct their own knowledge (Sharma, 2018). The curriculum of science education at the school level demands that highly successful 5E learning cycle model should be expanded to a 7E learning model. Such a change in the 5E model is not suggested to add complexity but to ensure the facilitators do not to omit crucial components for learning.

According to Amini and Usmeldi (2019), 7E learning cycle model requires students to be able to convey ideas to solutions to problems. The 7E learning cycle model can help optimize communication skills, especially at the exploration stage because at that stage, students discuss in groups. The conceptual explanation stage encourages students to explain abstract concepts. Communication is done using language as a link between experience and logic. During the phase of explanation, the teacher can express algebraic terms from the concepts obtained when students cannot explain it. At this stage student are confident about the materials they have learned. Elaboration stage of 7E learning cycle model familiarizes students with working on deepening knowledge of the subject matter. The Elaboration stage can develop communication skills too.

The 7E learning cycle model is considerably effective, enabling students to actively participate in lessons and helping them to conduct researches, promote exchange of ideas and communication, and improving problem–solving skills (Ozmen, 2014). A 7E learning cycle model moves children through a scientific investigation by encouraging them first to explore materials, then construct a concept, and finally apply or extend the concept to other situations.

The 7E learning cycle model is an extension of the 5E learning cycle model. The model differs from the 5E learning cycle in two ways. The engagement element is expanded into elicitation and engagement. This places a greater emphasis on prior experience and eliciting tacit knowledge that can be used as a foundation for learning. Elaboration and evaluation are expanded into elaboration, evaluation and extension. This aims to differentiate between the two types of "elaboration" in the 5E cycle model. The elaboration phase of the 7E learning cycle model is limited to elaborating on the current situation (e.g intruding/changing parameters), while the post–evaluation extension phase involves transferring newly acquired skills and knowledge to new situations within the domain (Amini & Usmeldi, 2019). The 7E learning cycle model is a series of seven planned interconnected phases in which the learner goes through various scientific investigations by exploring teaching materials, building the concept after arriving at a certain conclusion and finally applying the concept or a principle in a novice situation.

The 7E learning cycle model is a learner-centered model. This model consists of stages of activities organized in such a way that students can master the competencies that must be achieved in learning by playing an active role. The advantages of 7E learning cycle model as stated by Filtri (2018) includes: stimulating students to remember subject matters, motivating students to be more effective and increasing students' curiosity, training students to learn to do through experienced activities, training students to convey verbally the concepts they have learned, providing opportunities for students to think, search, find and explain examples of the application of the concepts they have learned and providing opportunity for students to interact with themselves and share ideas together during discussion.

Discussion method is a teaching method in which both teacher and students actively contribute to the instructional process through classroom dialogue. Sam (2016) defined discussion method as teaching method where teacher and students actively partake in the learning process. A good discussion method of teaching increases student's interests and engagement. Lessons mixed with discussions can help maintain students focus. As they discuss their answers, they get different perspectives on the topic. Good questions answered can make students think to and make connections between concepts or ideas.

Conceptual understanding refers to an integrated and functional grasp of mathematical ideas. Students with conceptual understanding know more than isolated facts and methods (Meyer, 2018). They understand why a mathematical idea is important and the kinds of contexts in which it is useful. They have organized their knowledge into a coherent whole, which enables them to learn new ideas by connecting those ideas to what they already know. Meyer (2018) also maintains that conceptual understanding also supports retention. Because facts and methods learned with understanding are connected, they are easier to remember and use, and they can be reconstructed when forgotten. Soyke (2016) maintains that conceptual understanding refers to the notion that a student is not just taught how to do mathematics but also the why behind it.

Mathematics instruction, from the elementary school to the university level, is frequently disappointing as far as promoting students' understanding of mathematics is concerned (Adeniji & Kajuru, 2016). The authors maintain that students are often able to carry out mathematical operations by giving ready methodologies for solving various problems, and by writing down procedural equations without any difficulties. They are also able to provide key examples when presented with formulas. However, sometimes they lack deep understanding behind the façade of knowledge.

According to Sam-Kayode & Salman (2016), a misconception is a wrong perception about a concept contrary to the current understanding of natural science. The authors maintain that these misconceptions may not be in agreement with our understanding of science. They might nevertheless have varying degrees of logic and truth. Similarly, a misconception is the result of a lack of understanding or in many cases misconception of a rule invented by learners to explain the patterns they see around them (Mohyuddin & Khalil, 2016). Furthermore, the theories learners construct from their experience which they use in making sense of the world are however, incomplete half-truths and are called misconceptions (Mohyuddin & Khalil, 2016).

Students' misconceptions have considerable influence on students' learning of fundamentals of a discipline (e.g. mathematics). This is because they (misconceptions) are a problem for two reasons. They interfere with learning when students use them to interpret new experiences. Students become emotionally and intellectually attached to their misconceptions, because they have actively constructed them and found meaning in them. They therefore, find it difficult to accept new concepts which are unfamiliar to their misconceptions (Mohyuddin & Khalil, 2016). Students' existing ideas are often strongly held and resistant to traditional teachings (Taslidere, 2013). This suggests that they are deeply rooted. Students may undergo instruction in a particular mathematics and science topic, do reasonably well in a test on the topic and yet, do not change their original ideas pertaining to the topic even if these ideas are in conflict with the mathematics or science concepts they were taught.

When students' existing knowledge prevails, the new concepts taught are rejected or there may be misinterpretations of the new concepts to fit or even support the existing knowledge. Misconception may arise when students are presented with concepts in too few contexts or when concepts presented are beyond their developmental (cognition) level. Thus, research findings on students' misconceptions have shown that misconceptions are deeply rooted and likely to remain after instruction in the students' cognitive structure, or even to resurface some weeks after students have displayed some initial understanding immediately following instruction. Students cling to their erroneous beliefs tenaciously because, they have spent considerable time and energy constructing their naive theories, and they have an emotional and intellectual attachment to them.

Oliver (2018) observes that some misconceptions may arise from failure to integrate knowledge from different topics. It may also arise from concept interference that comprises situations where the correct application of a concept by students is hindered by their misuse of another concept that they have learned. This occurs when students do not have an adequate conceptual framework to know which concept to apply in a situation. Oliver maintains further that conception interference may also be due to set effect. This is a situation where certain knowledge or conceptions are brought to mind due to strong ties with certain features of a given situation through previous experience.

Teachers can unwittingly pass their own alternative conceptions or misconceptions to their students in the way they teach. For instance, using imprecise terminology can also cause confusion (Kirbulut & Geban, 2014). Some times when teachers have the same alternative conceptions or misconceptions as their students, they think that there is nothing wrong with their students' conceptions. Another source of misconceptions in students is textbooks. Teachers should realize that textbooks also can contain errors or misleading or conflicting illustrations and statements which can give rise to misconceptions (Kaltakci & Eryilmaz, 2012). For instance, the procedure for finding LCM of two or more numbers found in most textbooks is based on misconception. As such, textbooks should not be regarded as infallible. Thus, Kaltakci and Eryilmaz (2012) hold that identifying and understanding nature and sources of students' conceptions will advance the design of suitable instructional strategies. It will also equip the teachers with knowledge and skills of methods of diagnosing conceptions held by students before and after instruction, thereby monitoring adequately students' learning problems. Since students' misconceptions of concept taught in class are strongly held by learners and are stable cognitive structures; and since misconceptions differ from experts' conception, it is important to know what prior knowledge students bring to the learning environment in order to help them to construct the right new (expert) knowledge. Literature is replete with studies on the effectiveness of 7E learning cycle model on students' interest in mathematics. However, studies on effect of 7E learning cycle model on students' interest in algebra are still scarce particularly in the study area. Against this backdrop therefore, this research work investigated effect of 7E learning cycle model on secondary school students' conceptual understanding of algebra in Kogi East Education Zone, Kogi State, Nigeria.

Statement of the Problem

Majority students in Nigeria view mathematics especially algebra as problematic and abstract. This may be because they have difficulty in understanding and assimilating the concept of algebra. The results of students in mathematics in May/June WAEC from 2015 – 2022 revealed the persistent failure and loss of interest in the subject by Nigerian students. If this failure is allowed to fester, the growth of the nation's economy and desire for producing future professional scientists and technologist will be hindered.

Mathematics as it is being taught in school especially algebra is abstract to the students, making them to learn mostly by rote memorization which has persistently results in mass failure. The widely used instructional strategy seem to be the conventional method which is characterized by a predominance of teachers' tasks with little or no active involvement of students in the process generating misconceptions. Lessons that required practice are mostly taught through teacher demonstration. Students' participation is thus limited to listening, answering and asking questions and writing notes as the lesson progresses.

Some researchers have found that in mathematics, males have better interest than females, but other researchers, there is no gender difference in students' interest in mathematics. Although many educators have advocated the use of innovative strategies which include problem-solving and constructivist approaches in teaching mathematics especially algebra but there is no work available to the best of the researcher's knowledge which has investigated the effect of the 7E learning cycle model in teaching and learning algebra in the study area. Based on this gap, the problem of this study put in question form is: would 7E learning cycle model improve students' interest in algebra?

Purpose of the Study

The purpose of this study was to investigate the effect of 7E learning cycle model on students' conceptual understanding of algebra in senior secondary schools. Specifically, the study compared:

1. Conceptual understanding of students when taught algebra using 7E learning cycle model and discussion method.
2. Conceptual understanding of male and female students when taught algebra using 7E learning cycle model.

Research Questions

The following research questions were raised and guided the study:

1. What is the difference between the mean conceptual understanding scores of students taught algebra using 7E learning cycle model and those taught using discussion method?
2. What is the difference between mean conceptual understanding scores of male and female students when taught algebra using 7E learning cycle model?

Hypotheses

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

Ho$_1$. There is no significant difference between the mean conceptual understanding scores of students taught algebra using 7E learning cycle model and those taught using discussion method.

Ho$_2$. There is no significant difference between mean conceptual understanding scores of male and female students when taught algebra using 7E learning cycle model.

Research Method

This study adopted the quasi-experimental design of non-equivalent pre-test and post-test type. The design was used because the study involved experimental and control groups and the use of intact classes. The population of the study was all the 15,360 senior secondary II students from the 147 co-educational secondary schools in Kogi East Senatorial District for the 2022/2023 academic session. The population according to Kogi State Ministry of Education, Lokoja in 2022, was made up of 8,232 male and 7,128 female students. The sample of this study was 220 SS II students spread across six intact classes. The researchers adopted multi-stage sampling procedure. The sample of 220 students consisted of 115 students in the 7E learning cycle model group and 105 students in the discussion group. Out of 115 students in 7E learning cycle model group, 51 were males while 64 were females. The instrument used for the study was a Two- Tier Algebra Diagnostic Test (TTADT) cycle II developed by the researchers The development process of TTADT cycle II to measure conceptual understanding of students in algebra was done following a similar approach by Treagust (2006) model as cited in Cheong, Treagust, Kyeleve and Hiew (2010). The difference was in the interviews. The open- ended questions generated the misconceptions through students' answers and the justification supplied to each item. There were three main stages in the procedure of preparation of TTADT cycle II: defining the content area by identification of propositional content knowledge statements of the topics; obtaining information about students' algebra concepts by having students' provide free response answers and reason for their answers; and developing TTADT cycle II which were all done in cyclic pattern. Each test item in the instrument consisted of a stem followed by a two-tier multiple choice question. The first tier is the conventional multiple choice content questions with four possible options (one correct answer and three distracters) related to students' misconception in addition to the mathematically correct answer. The second tier question contained multiple choice set of reasons students gave that was associated with the answer to each item that was scored correct. When both the correct choice (answer) and reasons are correct, it was full credit (2). Getting part one correct attracted a partial credit (1). But if a student failed part one and got part two correct, such a student was not given any credit because it clearly showed that such a student guessed the answer.

The instrument was subjected to three experts' judgment to ascertain their face validity. Two of these experts were from Mathematics Education Unit, Department of Science and Mathematics Education in Benue State University, Makurdi and the other one was from Measurement and Evaluation unit in the same Benue State University, Makurdi. Their observations and suggestions were used to improve the quality of items in the instrument. The instrument was trial tested on 25 students of one of the co-educational secondary schools in Kogi East. The school was not among the schools that were selected for the study. The reliability coefficient of TTADT was calculated using Pearson product moment correlation coefficient and it yielded reliability coefficient of 0.71. This reliability coefficient is enough to guarantee the use of the instrument for data collection in the study. This is supported by Metha and Makhosi (2014) who posits that an instrument with a reliability coefficient of 0.55-0.99 is sufficiently reliable for research purpose.

There were a total of six teachers from the six schools under study as research assistants. The researcher organized a five-day uniform training programme for all the Research Assistants in various groups. Three of these teachers were for the experimental group and the other three for the control group. These six teachers were trained by the researcher on how to go about the study. Before the treatment, the TTADT was administered to the experimental and control groups as pre-test. Two days were used for pre-testing of students in the experimental group and in the control group. The treatment lasted for four (4) weeks and it commenced in week one. During the period, students in the experimental group were exposed to 7E learning cycle model and those in the control group were exposed to discussion method. Two lessons were taught every week. The contents that were taught were linear inequalities and algebraic fractions. In the presentation of the lesson under experimental group, the teacher first and foremost elicited students' prior knowledge and this was done in a variety of ways, such as quick quizzes and post-it notes. This helped the teacher to identify students' misconceptions or test material that the teacher visited previously that was needed to understand the lesson. The next stage was the "Engagement" stage. In this stage, the teacher presented new tasks to the students so that they could apply their prior knowledge to solve it.

During the exploration stage, students were given opportunities to work together to solve the given problem. At this stage, the teacher grouped the students into 3 – 5 members in a group in order to share idea and tackle the given problem. The teacher served as a facilitator, helping students by asking questions and observing. At the explanation stage of the lesson, the teacher used what students had discussed to help build the concept/knowledge further. This involved checking and asking questions on students' findings. In the elaboration stage, students were persuaded to use the knowledge gained to solve similar and more difficult problems. This was where students formalize their idea with teacher's comments and apply their learning to more difficult tasks. The evaluation section was the section where the teacher evaluated the learning that had occurred. It involved questioning or quick low stage quizzing to establish understanding of the concept. The extension stage was where students were encouraged to apply the knowledge acquired to solve real life problems. Student made connections not just in the subject or idea studied in the class but also beyond it. Students in the control group were exposed to traditional discussion method particularly teacher-student-centered discussion method. In this discussion method, the teacher asked the students to express their opinion on the topic at hand. The teacher harmonizes students' opinions with his/her own opinion and discusses the topic with the students.

The schools for experimental groups were far from those of the control groups to avoid students and class interaction. After the completion of the lessons, post- TTADT was administered to the two groups to measure students' conceptual understanding of algebra. The study adopted partial credit model in scoring TTADT. In this model, a student received a score of 2 marks if he/she responded correctly to the first tier (content choice) and correctly to the second tier (reasoning part). It signifies full conceptual understanding of algebraic concepts. Correct answer to the content part and wrong reason attracted a score of 1 mark. It signifies partial understanding (misconception). Wrong answer and correct reason or wrong answer and wrong reason earned 0 marks. It signifies no conceptual understanding or lack of knowledge. This is because if a student is assumed to progress from knowing to explanation, the student whose answer to first tier is incorrect but has correct explanation should not exist on the progression path. This pattern of response is attributed to guessing. This method of analysis was used and was recommended by Peterson and Treagust (1989) as cited by Uyulgan, Akkuzu and Alpat (2014).

The data obtained was subjected to analysis according to the research questions and hypotheses. Research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The advantage of using ANCOVA lies in its ability to take care of any existing initial differences of the sampled students.

Results

Research Question One

What is the difference between the mean conceptual understanding scores of students taught algebra using 7E learning cycle model and those taught using discussion method?

Table 1: Mean Scores and Standard Deviation in Algebra of Conceptual Understanding of Students in 7E Learning Cycle Model and Discussion Method.

Groups	No of Students	Pre-Test		Post-Test		Mean Gain
		$\bar{X}$	δ	$\bar{X}$	δ	
7E Learning Model	115	26.67	9.45	69.12	8.61	42.45
Discussion method	105	26.88	10.47	52.91	11.59	26.03
Mean difference		- 0.21		16.21		16.42

Table 1 shows that the mean conceptual understanding scores of students taught algebra using 7E learning cycle model was 26.67 with the standard deviation of 9.45. The students who were subjected to discussion method obtained the mean scores of 26.88 with the standard deviation of 10.47 at pre-test. After the intervention programme, the mean conceptual understanding scores of students exposed to 7E learning cycle model was 69.12 with the standard deviation of 8.61. Those taught using conventional strategy of discussion method had mean score of 52.91 with standard deviation of 11.59. The mean gain of students exposed to 7E learning model and conventional strategy were 42.85 and 26.03 respectively. The difference in the mean gain between 7E learning cycle model and discussion method groups was 16.42 in favour of 7E learning cycle model.

Research Question Two

What is the difference between mean conceptual understanding scores of male and female students when taught algebra using 7E learning cycle model?

Table 2: Mean and Standard Deviation of Conceptual Understanding in Algebra of Male and Female Students in 7E Learning Model Group.

Groups	No of Students	Pre-Test		Post-Test		Mean Gain
		$\bar{X}$	δ	$\bar{X}$	δ	

Male	51	24.88	7.71	70.18	8.66	45.30
Female	64	28.09	10.48	68.28	8.54	40.19
Mean difference		-3.21		1.90		5.11

Table 2 shows that the mean conceptual understanding scores of male and female students exposed to 7E learning cycle model were 24.88 and 28.09 with the standard deviation of 7.71 and 10.48 respectively at the pre-test. After the treatment, the mean conceptual understanding scores of male and female students were 70.18 and 68.28 with the standard deviation of 8.66 and 8.54. The difference in the mean gain was 5.11 in favour of male students.

Hypothesis One

There is no significant difference between the mean conceptual understanding scores of students taught algebra using 7E learning cycle model and those taught using discussion method.

Table 3: Result of ANCOVA in Algebra Conceptual Understanding Test of Students in 7E Learning Cycle Model and Discussion Method.

Source	**Type III sum Of Squares**	**Df**	**Mean Square**	**F**	**Sig**	**Partial Eta Squared**
Corrected Model	17655.707[a]	4	4413.927	49.429	0.000	.479
Intercept	102395.766	1	102395.766	1146.592	0.000	.842
PretestCU	342.337	1	342.337	3.833	0.052	.018
Groups	**10648.999**	**1**	**10648.999**	**119.244**	**0.000**	**.357**
Sex	2255.196	1	2255.196	25.253	0.000	.105
Group*Sex	1288.414	1	1288.414	14.427	0.000	.063
Error	19200.452	215	89.304			
Total	865879.00	220				
Corrected Total	36856.159	219				

a.R Square = .479 (Adjusted R Square = .469)

Table 3 shows that $F(1, 215) = 119.244$ and $p=0.000 < \alpha = 0.05$. Since p is less than 0.05 level of significance, the null hypothesis is rejected. This implied that there is significant difference in the mean conceptual understanding scores of students taught algebra using 7E learning cycle model and discussion method. This indicated that students taught using 7E learning cycle model benefited more than students taught using the discussion method. The partial Eta Squared of 0.357 was obtained. This meant that 35.7% of mean conceptual understanding could be accounted for by the strategy employed in teaching algebra.

Hypothesis Two

There is no significant difference between mean conceptual understanding scores of male and female students when taught algebra using 7E learning cycle model.

Table 4: Result of ANCOVA in Conceptual Understanding of Male and Female Students using 7E Learning Model Group.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	228.611[a]	2	114.306	1.557	0.215	.027
Intercept	65450.304	1	65450.304	891.598	0.000	.888
Pretest	126.665	1	126.665	1.725	0.192	.015
gender	**64.694**	**1**	**64.694**	**0.881**	**0.350**	**.008**
Error	8221.681	110	73.408			
Total	557899.00	115				
Corrected Total	8450.296	114				

a.R Square = 0.27 (Adjusted R Square = 0.10)

Table 4 reveals that the difference in conceptual understanding of male and female students taught algebra using 7E learning cycle model is not significant at 0.05 alpha level. This was indicated that $F(1, 110) = 0.991$ and $p=0.350 >$ at $= 0.05$. The null hypothesis was therefore not rejected indicating that there was no significant difference in the mean conceptual understanding scores of male and female students taught using 7E Learning cycle model. This implied that 7E learning cycle model is gender friendly. The partial Eta squared of 0.008 was obtained for gender meaning that only 0.8% of mean conceptual understanding scores could be accounted for by gender using 7E learning cycle model in algebra.

Discussion of Findings

The result of this study indicated that the difference between the mean conceptual understanding scores of the two groups is statistically significant. This implies that, though students performed slightly well when discussion method was used in teaching algebra but the 7E learning cycle model group achieved higher. This is in agreement with the findings of Komikesari, Anggraini, Asiah, Dewi, Daini and Yulianto (2019) and also Habtamu and Solomon (2019) who found out that 7E learning cycle model is more effective in improving conceptual understanding and science process skills than conventional strategy. The enhanced conceptual understanding is probably because the 7E learning cycle model provides ample opportunities for students to construct their own knowledge from previous experiences when interacting and working with others. During the algebra lessons, the students worked together based on their previous experiences to solve a given task. The teacher expressed algebraic terms from the concepts obtained when students could explain it. Students' improvement in conceptual understanding when taught with 7E learning cycle model could also be due to how 7E learning cycle model provide opportunities for students to think, search, find and explain examples of applications of the concept they have learned.

The findings further revealed that there is no significant difference between the mean conceptual understanding of male and female students taught algebra using 7E learning cycle model. This is in consonance with Komikesari, Anggraini, Asiah, Dewi, Diani and Yulianto (2019) who found that there is no significant difference between male and female students' conceptual understanding in human biology when taught using 7E instructional model. The result has come out way, because in using 7E learning cycle model, shy students as well as weaker one were complemented by outspoken and more intelligent ones since they all worked together in groups.

Conclusion and Recommendations

Based on the findings of this study, it is concluded that students taught algebra with 7E learning cycle model improved in conceptual understanding than those taught using discussion method. 7E learning cycle model is also gender friendly in terms of students' conceptual understanding of algebra. That is, both male and female students benefited conceptual understanding when 7E learning cycle model was used in teaching algebra. The following recommendations were made on the basis of the findings of this study.

1. Teachers should adopt the use of 7E learning cycle model in order to enhance students' conceptual understanding of algebra.
2. Mathematical Association of Nigeria (MAN), Federal and State Ministries of Education should regularly organize workshops, seminars and symposia on how to use more effective strategies like 7E learning cycle model in teaching mathematics.
3. Both male and female students should be taught algebra using 7E learning cycle model since it has been found to be gender friendly with respect to conceptual understanding.

References

Adeniji, K.A. & Kajuru, Y.K. (2016). Analysis of misconceptions held by senior school mathematics students in algebraic equations. *Abacus*: *The journal of the Mathematical Association of Nigeria, 41(1), 136-146*

Amini, R., & Usmeldi, J. (2019). The development teaching materials use an inductive-based 7E learning cycle for elementary school students". *Journal of Physics: Conference Series,* 5(6), 4-5. *Retrieved on 4th November, 2021 from doi:10.108811742 – 6596/1521/4/042114.*

Cheong, I.P., Treagust, D., Kyeleve, I. J., & Hiew, P.Y. (2010). Evaluation of students' conceptual understanding of malaria. *International Journal of Science Education, 32(18), 2497-2519. Doi:10.10.1080/0950069/100371801 4*

Eccles, J. S., & Wang, M. T. (2015). What motivate mathematics and sciences? *International Journal of Behavioural Development, 40, 100 – 106*

Effaodi, P., & Zakaria, N. (2011). Students Procedural and conceptual understanding of mathematics. *Australian Journal of Basic and Applied Science*, 5 (7), 684-691. *Retrieved from www.researchgate.net on 17th October, 2021.*

Eisenkraft, A. (2018). Expanding 5E model. A 7E emphasizes transfer of learning and importance of eliciting prior understanding. *The Science Teacher,24(2), 17-42. Retrieved on 20th October 2021 from http://blogs. www.Edu/outreach/files/2014 /08/Eisenkraft pdf.*

Eugene, U. O., & Ezeh, D. N. (2016). Influence of gender and location on students' achievement in Chemistry bonding. *Mediterrancean Journal of Social Sciences, 7(3), 309-318*

Ezeh, D. N. (2013). Science without women: a paradox. *75th Inaugural lecture of the University of Nigeria Nsukka delivered on 30th May, 203. Nsukka: University of Nigeria Senate ceremony committee*

Ezeudu, F. O., & Obi, T. N. (2013). Effect of gender and location on students' achievement in chemistry in secondary schools in Nsukka Local Government Area of Enugu State, Nigeria. *Research on Humanities Social Science 3(15), 50-58*

Filtri. S. (2019). Improving and learning of algebra in upper basic schools using inquiry approach. *International Journal of Research in Education and Science (IJRES),* 2(3), 15-25.

Habtamu, W., & Solomonm, B. (2021). Effects of 7E instructional model with metacognitive scaffolding on students conceptual understanding in biology. *Journal of Education in Science, Environmental Health*, 7(1), 2 – 19. Retrieved on 13 November, 2022 from https://doi.org/10.2/892/jeseh.770794

Kaltakci, D., & Eryilmaz, A. (2012). *Identification of pre-service physics teachers' misconceptions and gravity concepts*. A study with a 3-tier misconception test. *Conference proceedings of the American Institute of Physics, USA, 899, 499-500. Doi: https://dx.doi.org/10.10631/1.273325 5*

Kirbulut, Z.O., & Geban, O. (2014). *Using three tier diagnostic tests to assess. Alexandra*, VA. *Retrieved from December 9, 2021 form https://www.ascd.org/pub. books/1703*.

Kogi State Ministry of Education (2022). Statistics of SS II Students' enrolment for 2022/2023 academic session.

Komikesari H., Anggraini W., Asiah N., Dewi R.S., Diani R., & Yulianto M.N. (2019). Effects of 7E learning cycle model on students conceptual understanding and science process skills on senior high school students.

Journal of Physics: Conference Series 1572 (9); 26-35. *Retrieved on 17th December, 2022 from DOI 10.1088/1742-6596/1572/1/012623*

Kurumeh, M. S., & Onah, F.O. (2013). Ethno mathematics: *A cultural way of teaching mathematics in Nigeria.* Makurdi: Azaben Press.

Metha, G., & Mokhasi, V. (2014). Item analysis of multiple – choice questions: An assessment of the assessment tool. *International Journal of Health Science and Research, 4 (7), 197 – 202*

Meyer, H.T.D. (2018). What is conceptual understanding? *The Reflective Educator, 5(2) 118-119 Retrieved 17th September, 2022 from http://www.researchgate.net*

Mohyuddin, R.G., & Khalil, U. (2016). Misconceptions of students in learning mathematics at primary level. *Bulletin of Education and Research*, 38(1), 133 – 162. *Retrieved 15th November, 2021, from https://www.pu. edu.kp/.../10muhudin% 20 and science*

Oliver, A (2018). *Handling pupils misconceptions. Retrieved 5th October, 2021 from http://www.academic.sun.acza/mathed/malati/misconception.htm*

Onah, F.O. (2019). *Measures of students' conceptual understanding and reasoning of Upper Basic School Geometry using two tier diagnostic tests in Benue State,* Nigeria. Unpublished PhD Thesis, Benue State University, Makurdi.

Ozomen, H. (2014). The effect of 7E learning cycle model on achievement of students. A meta-analysis study. *International Journal of Educational Methodology*, 4(1), 1-18. Retrieved from http://www.ijem.

Sam, M.S. (2016). Psychology dictionary: Professional reference. New York digital publisher. *Retrieved on 4th December, 2021 from www.psychologydictionay.org*.

Sam-Kayode, C.O., & Salman, M.F. (2016). Influence of subject combinations on senior school students' conceptions of geometry. *Journal of Mathematical Association of Nigeria, 40(1), 134-142*

Sharma, S. (2018). 7E Learning cycle model: A paradigm shift in instructional approach. *Shalnax International Journal of Education*, 6 (2), 13-22.

Soyke, M. (2016). *Conceptual understanding in mathematics. Retrieved 18th September, 2022 from https://www.scholar.ufs.ac.Za*

Taslidare, E. (2013). Effect of conceptual change oriented instruction on students' conceptual understanding and decreasing their misconceptions in OC electric circuits. *Creative Education, 4(4), 273-282. Doi:10.4236/ce.2013.44041*

Treagust, D. F. (2006). Diagnostic assessment in science as a means to improving teaching and retention. *Paper presented at the Universe* *symposium Assessment in Science Review* Australia18(294), 75-83.

West African Examination Council (2015-2022). Test development division. Lagos, Nigeria.