

ASSESSMENT OF GENDER DIFFERENCES IN ACADEMIC ACHIEVEMENT AND RETENTION IN MATHEMATICS AMONG SENIOR SECONDARY STUDENTS IN NIGERIA

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Abstract

This paper assessed gender differences in academic achievement and retention in mathematics among senior secondary students in Nigeria. The paper sought to review literature on gender differences in senior secondary students' academic achievement and retention in mathematics in Nigeria. It also sought to provide an insight as to why the differences exist and also proffered solutions on how best mathematics teachers can overcome gender disparity in students' achievement and retention in mathematics. Theory of chunking and the capacity of short term memory and Test-Operate-Test-Exits (TOTE) theory were used to explain why learning could be temporary and how best to make it permanent to enhance academic achievement and retention in mathematics. The paper discussed gender issues in students learning of mathematics to include factors shaping students' learning. Gender stereotype threat theory was used to explain that members of a negatively stereotyped group will perform when that stereotype is made salient for the task at hand. Empirical reports on the effect of gender on students' achievement and retention in mathematics were reviewed. The study concluded that there is more evidence that gender does not determine students' fate in terms of academic achievement and retention in mathematics as most innovative teaching strategies and approaches proved not to be gender sensitive. Such strategies and approaches were recommended to be identified and used by mathematics teachers.

Key words: Academic Achievement, Gender, Retention and Test-Operate-Test-Exits

Introduction

Academic achievement refers to the scholastic position of a learner at a given point in his or her study life which portrays and indicates the individual's intellectual abilities in a particular area of study. It is a score measured in percentage or a grade indicated by the use of an alphabet which signifies individual's intellectual capability in their subject area of study. Egbe (2015) sees academic achievement as a current performance of students in any area of study which

indicates the level of attainment of previous learning. Achievement could also be seen as something done successfully, typically through efforts and skills (Hornby, 2015). Apart from being an indicator of previous learning, academic achievement according to Ityavzua, Ofoegbu, Muhammad and Jimin (2019) serves as a predictor of future academic success in a particular subject area and as an indicator of the level of academic success and to an extent, development of a nation. In Nigeria, the level of students' academic achievement at the senior secondary school level is determined through their performance in external examinations conducted by examination bodies like the West African Examinations' Council (WAEC), National Examinations' Council (NECO) and National Business and Technical Examination Board (NABTEB). Records from these examination bodies indicate that students' academic achievement in mathematics in Nigeria is low, particularly in mathematics. For instance, Alabi (2019) reported that only 26% of candidates that registered for WAEC in 2019 attained a credit pass in mathematics. This report is confirmed by WAEC (2019).

Many factors are attributed to the low academic achievement of students in mathematics in Nigeria. Perrin-Glorian (2003) attributed this low academic achievement in mathematics to lack of mathematics laboratory in senior secondary schools. Kurumeh (2008) links the low achievement of students in mathematics to incompetent mathematics teachers, lack of mathematics teachers in senior secondary schools, psychological fear of the subject, negative attitude of students in mathematics, large number of students in one classroom, lack of students' interest in mathematics as well as lack of mathematics laboratory. Omenka (2010) ascribed the low students' academic achievement in mathematics to poor instructional methods adopted by teachers while Chianson-Akaa, Jimin, Abubakar and Iordye (2017) attributed it to students' dependency on external locus control.

Closely related to academic achievement of students is retention. Achievement is measured in collaboration with retention. Retention simply means the amount of knowledge learnt or acquired and kept. It also refers to the skill maintained or consistent manifested problem-solving behaviours (Iji, 2010). What is retained constitutes what is known as retention. In this regards, the concept of retention could be defined as the ability of the learner to keep the content of a learned task and to be able to retrieve it, remember, recall or reproduce the acquired knowledge or some part of the knowledge after an extended period of time. Retention according to Hornby (2015) is the ability to remember experiences and things learnt by the individual learners. Similarly, Kundu and Tutoo (2002) see retention as the preservation of the mind. It therefore means that the amount of knowledge learnt or acquired and kept, skill maintained or problem-solving behaviours manifested consistently. Thus, retention of mathematical knowledge is the ability of a learner to keep and remember as well as recall or reproduce the acquired knowledge of mathematics or some part of the knowledge after a period of time. To improve students' achievement level in mathematics implies to improve the level at which they retain the concept of mathematics learnt.

Learning in general is centered on one's memory, if one remembers nothing from his experience; it means that one has not learnt. To enhance retention, Miller provided two theoretical ideas that are fundamental to cognitive psychology and the information processing framework. Miller (1956) developed the theory of chunking and the capacity of short term memory. Miller observed that, short-term memory could only hold 5-9 chunks of information (seven plus or minus

two), chunk is any meaningful unit. The concept of chunking and the limited capacity of short term memory became a basic element of all subsequent theories of memory. The second theory propounded by Miller, Galanter and Pribram (1960) was Test-Operate-Test-Exit (TOTE). The theorists suggested that the stimulus-response should be replaced by TOTE as the basic unit of behaviour. Test-Operate-Test-Exit is a learning process where the goal of a learning task is tested to see if it has been achieved and if not an operation will be performed to ensure that the goal is achieved. The cycle of test-operate will be repeated (rehearsed) until the goal and the level of retention or retrieval of mathematical knowledge is ensured or attained. The implication of this theory to mathematics is that learners should do a thorough practice or rehearsal to ensure or enhance retention of mathematical knowledge and skill.

Achievement and retention are closely related on the basis that both reflect the level of academic success in a subject area in a given time after a previous learning or an academic activity. Education itself is defined as causing a permanent change in one's behaviour. This is suggestive that education is supposed to be permanent and the only way this could be done is for learners to be able to retain what is learnt. Achievement that cannot be retained would be meaningless and only used for the purpose of passing examinations that comes immediately after learning. Retention is therefore the justification that achievement can be stored, retrieved, reproduced and used in future, a characteristic which is necessary for the general purpose of education. Gender has remained a reoccurring decimal in any academic discussion on students' achievement and retention in mathematics. Gender is a construct used to differentiate male from female. Mberekpe (2013) defined gender as a cultural difference between male and female which has been determined by biological division. Gender differences have been under contention to be a source of disparity in students' academic achievement in mathematics. There is general belief that gender has effect on students' academics activities in mathematics. This belief holds that male students perform better than their female counterpart in mathematics. This general belief, according to Badmus (2002), makes some people to consider or regard mathematics as male subject or course. This ideology and belief which has no empirical proof usually constrain girls from performing well in mathematics. This is because it usually makes female students to feel that mathematics is meant for male students and not for female students. The belief has also made female students to prefer enrolment in non-mathematics related courses in the tertiary institutions of learning leaving their male counterparts to mathematics related courses. This paper therefore seeks to assess gender differences in academic achievement and retention in mathematics among senior secondary school students in Nigeria and reported by various research works on the subject.

Statement of the Problem

Many stakeholders in mathematics are worried about students' underperforming in mathematics in both internal and external conducted examinations. It is a fact that the achievement of any student is dependent on how much the student can retain from previous knowledge. Some research works have suggested that gender is a factor in determining students' achievement and retention in mathematics (Kurumeh & Onah, 2013; Adigun et al, 2015), though many others disagree with this position (Ajai & Imoko, 2015; Paulette, Joris & Jelte, 2018). The latter group are of the opinion that instructional resources are not gender sensitive. It is against this background

that this work was set up to examine if gender differences in academic achievement and retention in mathematics among senior secondary students in Nigeria.

Gender Issues in Students' Academic Achievement and Retention in Mathematics

Gender is one of the variables that have engaged the attention and interest of many researchers in the recent times. Researchers in mathematics education have been interested in finding out gender influence on students' academic achievement in various aspects of mathematics. Gender has been identified by many researchers such as Badmus (2002) and Kurumeh and Onah (2013) as an important variable associated with students' achievement and retention in mathematics in secondary schools. In investigating the influence of gender on students' achievement and retention in mathematics, many research findings have verified the effect of gender with numerous findings providing evidence for both sides of the divide. An analysing of reports suggests that gender effect in mathematics is rather dependent on the instructional path taken by the teacher. While some learning experiences have proven to be supportive of both boys and girls, some have been found to favour the boys more than their female counterparts.

The expectation of the National Policy on Education (FRN, 2013) and every mathematics teacher is that the teaching process should cater for both male and female students equally. However, Obodo (2004) opined that parents encourage sex stereotyping between their children by encouraging different activities for male and female children. According to the Obodo (2004), some of the activities have advantages and disadvantages for learning mathematics. Obodo (2004). Explained that parents permits and encourages male children to explore their environment more by indulging in different form of plays given that advantages through ethnomathematics. The author illustrated that while male children are permitted to perform play activities like constructing play houses which will familiarize them with mathematical concepts like shapes and exposes them to more rigorous activities because they are expected to be braver and stronger than females. On the other hand, female children permitted to undertake fewer play activities and pamper to be soft, fragile and encouraged to leave strenuous activities to boys. This makes the boys to have more experiences for the mathematics teachers to build on in mathematics lessons. For instance, a pack of card is a common mathematical teaching aid. However, few female students know what it is but most boys play card game. The card game alone can be used to explain probability, set theory, inequalities, mensuration, and numerical operations. The teacher will struggle to carry female students along when illustrating problems involving cards. More so, the game is mathematical in nature and helps build the numeracy of the players which are usually the male folks. This explains why male students achieve significantly higher than females.

Another factor that could be responsible for disparity between male and female students' achievement and retention at senior secondary school level is the African and Nigerian mentality of the general role of a woman in the family and society. The expectation is that, women should not go all out to acquire active professions like engineering or architecture, but rather should go for less involving paper and pen professions that will be stress free. This makes female students to wish avoiding mathematics and science generally. Since mathematics may not be a core for their preferred profession, female students seems to just accept whatever mathematics throws at them with the hope of leaving it one day as such hardly put in their best it the subject.

According to Adigun et al (2015), the importance of examining performance in relation to gender is based primarily on the socio-cultural differences between girls and boys. Some vocations and professions have been regarded as men's (engineering, arts and crafts, agriculture etc.) while others as women's (catering, typing, nursing etc.). In fact, parents assign task like car washing, grass cutting, bulbs fixing, climbing ladders to fix or remove things etc. to the boys. On the other hand, chores like dishes washing, cooking, cleaning and so on are assigned to the girls. In a nutshell, what are regarded as complex and difficult tasks are allocated to boys whereas girls are expected to handle the relatively easy and less demanding tasks. As a result of this way of thinking the larger society has tended to see girls as a weaker sex". Consequently, an average Nigerian girl may go to school with these fixed stereotypes.

Fox, Brody and Tobin (2005) also support the notion that culture plays a big role in preparing boys and girls differently for mathematics. According to the authors, girls are always expected to display more mature behaviour, not embarrass themselves, and this is a serious hindrance in mathematics. Mathematics cannot be efficiently understood unless students speak out regardless of whether they are right or ridiculously wrong. This is a very important tool in learning and understanding anything but more so mathematics. Girls who are shy to participate in class are deprived of learning and have to spend more and more time studying to figure things on their own. Nejad and Khani (2014) opine that the degree of intellectual simulation in mathematics that students receive from learning situations is rooted in gender stereotypes which may be responsible for observable gender differences in mathematics. Nejad and Khani adds that girls right from primary to secondary school level underestimate their abilities in mathematics which is as a result of gender stereotypical environment in which children are groomed. Zhu (2007) argued that girls are often marginalized and given subordinate status in the mathematics class. Zhu is of the notion that teachers holds the perception that girls' performances in mathematics are dependent on rote learning, hard work and perseverance rather than natural talent, flexibility and risk taking which are the learning styles of boys.

Despite the above, Paulette, Joris and Jelte (2018) stereotype threat theory predicts that members of a negatively stereotyped group will perform when that stereotype is made salient or relevant for the task at hand. This theory brings in the mathematics teacher to the fore. It is therefore, regardless of what position both boys and girls are before the mathematics lesson, the role of the teacher to carry every member of the class along and up to speed. The selection of the learning experience determined how the students are going to learn and perform. Teaching experiences that are motivating and appealing to both sexes will close the presumed gap existing between them while those that will thrust the advantage to one sex will tilt the results in favour of the advantaged sex. Supporting the latest argument, Ajai and Imoko (2015) maintain that performance is a function of orientation not gender, thus male and female students are capable of competing and collaborating in mathematics. Methods of teaching that permit some level of collaboration among students could witness a higher correlation in students' achievement and retention in mathematics while those that depends solely on students' entry knowledge could give the advantage to a particular gender, and in most cases, the boys.

Reports on Effect of Gender on Students' Achievement and Retention in Mathematics

Some research findings in Nigeria have rejected the idea of gender difference in ability of students in mathematics. Reports in consonance with the above include a study conducted by Ajayi and Angura (2017) worked to improve senior secondary students' retention in electrolysis using Collaborative Concept Mapping Instructional Strategy (CCMIS) in Ado-Kola Local Government Area, Taraba State. The researcher found that there was significant difference in the mean retention scores between students taught electrolysis using CCMIS and discussion method in favour of students exposed to CCMIS. Also no significant difference was notice between male and female students' retention scores in the retention test.

Another study on the influence of gender on students' achievements in mathematics was conducted by Gambari, Shittu, Daramola and James (2016). The study investigated the effects of video type instructional packages on the students' achievement and gender in mathematics among senior secondary schools in Minna, Nigeria. After exposing the students to three different treatments, results from the study revealed that the effect of the treatments was significant and there was no significant effect of gender on the mean achievement score of students in the three experimental groups however, gender had significant effect in the controlled group.

Obi, Agwagah and Agah (2014) investigated the effects of Origami Instructional Approach on JS I students' retention in geometry in Enugu State and results holds that the use of Origami in teaching geometry to junior secondary school students enhanced their retention in geometry. The study also revealed that the use of Origami had no significant effect on male and female students' retention.

Wushishi, Danjuma, and Usman (2013) in a study on effects of two modes of concept mapping instructional strategies on secondary school students' retention level in mathematics in Niger State reported that there was no significant difference in the retention level of experimental groups. Also that both experimental groups; spider and hierarchy modes of concept mapping instructional strategies, were not gender bias at retention level. Oludipe (2012) investigated the influence of gender on Junior Secondary students' academic achievement in basic science using cooperative learning teaching strategy using selected Junior Secondary Schools in three Local Government Areas of Lagos State, Nigeria. Findings of the study revealed that there was no significant difference in academic achievement of male and female students at the pretest, posttest, and delayed posttest levels respectively. Chianson, Kurumeh, and Obida (2011) investigated the effect of cooperative learning method compared with the conventional learning method in order to find out the retention level of students' in circle geometry in the three education zones in Benue State, Nigeria. The findings of the study confirmed that students who were subjected to the cooperative learning strategy were able to retain the concepts of circle geometry more than those students who were taught using the conventional learning approach and there was no significant gender effect on students' retention.

Similarly, a study to determine the effect of self and cooperative-instructional strategies on senior secondary school students' achievement in mathematics was conducted by Ifamuyiwa and Akinsola (2008) on students from selected secondary schools in Ijebu-North Local Government Area of Ogun State. The moderating effects of locus of control and gender were also investigated..

The findings of the study showed that the treatments had significant effect on students' achievement in mathematics but gender effect on students' achievement was not significant. Some research reports are of the contrary view that male students perform better than their female counterparts. For instance, Bichi, Suleiman, and Ali (2019) examined students' achievement in senior secondary school mathematics qualifying examination in Kano State. The study further investigated the influence of sex and school's nature on students' achievement in mathematics. Overall results showed that students performed below average and a significant gender difference exists in mathematics performance in favour of male students.

Bassey, Joshua, and Asim (2015) in contribution to the realization of the Millennium Development Goal (MDG) by the United Nations on the promotion of gender equity, sought to empirically verify the existence or otherwise of gender inequality in the mathematics achievement of rural male and female students in Cross River State, Nigeria. The study reported a significant gender inequality in rural schools in favour of male students. Kurumeh, Jimin and Mohammed (2012) in a study designed to enhance senior secondary students' achievement in algebra via inquiry method of teaching in Onitsha, Anambra State reported that students exposed to inquiry method of teaching significantly attained higher mean score than those in the conventional group and male students in the experimental group were found to significantly benefitted more from the treatment than the female students. In another study, Etukudo (2002) investigation on the effect of computer-assisted instruction on gender and performance of junior secondary school students in mathematics also reported that male students exposed to computer-assisted instruction attained significantly higher mean scores than the female students exposed to same instructional strategy.

Alio and Harbor-Peters (2000) in another study on the effect of Polya's problem-solving technique on secondary school students' achievement in mathematics reported that male students performed significantly better than their female counterparts in mathematics even when exposed to the same classroom situations. Also, Fan, Chen, and Matsumoto (1997) in a study on gender differences in mathematics achievement reported that gender differences were not found when total-group means were compared. However, when the high end of mathematics score distributions was examined, noteworthy gender differences favouring male students emerged. These differences became larger from the 8th grade to the 12th grade and were more prominent at more extreme score ranges. The observed gender differences for students at the high end of the mathematics score distributions are important because these students are likely to consider pursuing careers in science, mathematics, and engineering. Gender differences at the high end of the mathematics score distributions are likely to be one reason for the gender imbalance in the flow of new students into science and engineering careers.

These findings support the notion that the nurture in Nigeria tends to favour male dominance over the feminine gender. Environmental provision for male students makes them fit and able to cope with tasks requiring high intellectual challenge, computation and rigors of mathematics as compared to females.

Conclusion

In conclusion, though gender effect on students' achievement and retention may continue to be debatable, evidences are that, there are more research reports that found no significant difference in male and female students' achievement and retention in mathematics, particularly in

recent times. This study further comes to the conclusion that, even if the male child possibly gains some advantage in learning mathematics in terms of activities indulged in before coming to the mathematics class, certain teachers' innovative approaches and strategies have proven to be capable of closing the gap.

Suggestions

This study put forward the following suggestions:

1. Mathematics teachers should use instructional approaches and strategies that have been proven to be gender friendly and avoid those that have been found to be gender sensitive.
2. Mathematics teachers should be mindful of cultural stereotyping in Nigerian communities and endeavour to explain and give more examples when mathematical concepts that male students are more familiar with are to be used during mathematics lesson in order to reduce abstraction for female students.
3. Mathematics teachers should incorporate elements of cooperative learning for students. This could bridge the disparity in entry knowledge of the students during mathematics lessons.

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