

EFFECT OF INQUIRY INSTRUCTIONAL STRATEGIES ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN MATHEMATICS IN OWERRI, IMO STATE

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Abstract

The study investigated the effect of inquiry instructional strategies on secondary school students' achievement in mathematics in Owerri, Imo State. The study was guided by four research questions and four null hypotheses tested at 0.05 level of significance. The population of the study was 1,456 (486 males and 970 females), SS1 Mathematics students found in all the 9 (nine) public secondary schools in Owerri municipal Local Government Area of Imo State. The sample for the study was 150 students purposively selected from the intact classes. The instrument for data collection was Students' Mathematics Achievement Test (SMAT). The instrument was trial tested and the reliability of SMAT was found to be 0.82 using Kuder-Richardson formula (KR20). Mean and standard deviation were used to answer research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Results of the study revealed among others that: There was a significant difference in the achievement scores of students taught mathematics using inquiry instructional strategy and those taught using conventional lecture strategy. There was no significant difference in the mean achievement scores of male and female students taught Mathematics using inquiry instructional strategy. It was recommended among others that mathematics teachers should be encouraged to use either guided or unguided strategies in teaching suitable *mathematics* contents as both are efficacious for improving students' achievement.

Keywords: Instructional strategies, secondary school, students' achievement, mathematics

Introduction

In today's world, where technological advancements, economic stability and scientific innovations are largely driven by mathematical proficiency, the capacity to think critically and solve complex problems has become imperative. Despite its critical importance, research worldwide demonstrated frequently poor achievements and low engagement in mathematics which often are attributed to conventional teacher-centred instructional strategy that rely on rote memorization rather than deep conceptual understanding. Based on this, educational system seeks to bridge the achievement gap, since research indicates that the implementation of active student-centred instructional strategy such as inquiry- guided or unguided and technology-enhanced techniques are essential for fostering and improving academic outcomes of students.

Secondary education, which is also known as post basic education, is the educational level that prepares students for further education at colleges, universities or higher diplomas or their equivalents (Nnamdi, 2019). It focuses on equipping students with essential life skills and preparing them for future career. Secondary education is the supply base from which tertiary institutions draw their major students for admission into their different programmes. Secondary education fosters national unity as well as provides technical knowledge and vocational skills necessary for agricultural, industrial, commerce and economic development (Iorlamen, 2017). According to Federal Republic of Nigeria (2013), the broad aim of secondary education is the preparation of the child for useful living and at secondary education level, some subjects are being offered such as English, Mathematics, Chemistry, Physics, Economics to mention but a few. These subjects are the basics for the preparation of the child's development and for higher education.

Mathematics is one of the foremost tools' men uses to interact with the environment and to solve emerging problems. It is therefore a useful and powerful subject. It is considered as knowledge indispensable to the educated man; hence, it is a key subject in the school curriculum. In many countries, attainment in mathematics is used as a sifting device (Lawal & Deneye, 2019). Most employers demand a good knowledge of elementary mathematics from graduates of our schools and colleges. Mathematics which is the focus of this study is one of the subjects offered in post-basic education schools. Mathematics is the deductive study of numbers, geometry and different dynamic constructs or structures. According to Razia and Abdul (2019), mathematics is that branch of science that utilizes numbers and signs. Numbers and signs are organized utilizing orderly numerical principles. In this research, mathematics is therefore the science of the study of

numbers, signs, shapes, figures, in-depth reasoning and its applicability in relation to solving real-life problems.

The value of mathematics to any developing country is not debatable and that is why the supremacy of mathematics over every other subject is extolled by the Federal Republic of Nigeria (2013), when it stated that mathematics should be made a core subject at the primary and secondary school levels. There is hardly any area of human endeavour devoid of mathematics and its application. Adeniji (2014) noted that mathematics is the foundation of any meaningful scientific endeavour and any nation that needs development in science and technology should have a strong mathematical background for its youths. Mathematics remains a service provider for all disciplines and contributes immensely in deciding directions of activities such as economy, banking, market transactions, industrial functions, research, leadership, legal jurisprudence, engineering and others too many to mention (Ugwuanyi, 2014). The development of any nation is dependent on its improved mathematics education which establishes bases for technological advancement. Thus, science is the bedrock that provides the springboard for the growth of technology, and mathematics is the gate to the science (Lawal & Deneye, 2017). The pertinent virtue of mathematics in contributing to the development of mankind calls for its improved teaching and learning. Despite its robustness and utilitarian value and emphasis placed on the teaching and learning of mathematics, major challenge still exists which gives Students' mass failure as recorded in school certificate mathematics examinations (Adu, 2016). Yakubu (2020) Stated that students' achievement in the subject has not been encouraging. In 2015-2019 about a total of 3,216,467 students enrolled for mathematics in SSCE in Owerri Education zone 1, and the results showed that about 62 percent of the students made a grade 4-6 (West African Examination Council Annual Reports 2015-2019). Also, analysis of West Africa Examination council in 2015, 2020 and 2021 revealed percentage credit pass at 41.6, 39.3 and 43.4 respectively in Imo State (Nnamdi, 2019). The poor academic achievement of students in mathematics has been a major concern generally. This low achievement in mathematics may be as a result of the conventional lecture strategies used in teaching the subject in Imo State. Conventional lecture strategies of instruction make students passive and less active during the teaching and learning process as the strategies are mostly teacher-centred.

Achievement is the sum total of students' inputs during the course of study or a programme at the end of a curriculum. It is also the learning outcomes of the students which can be measured by any form of assessment techniques to ascertain academic gain of the students. According to Unongo (2015), Academic achievement means to reach a required standard of performance, carryout successfully. To Unongo, achievement is the measure of students' acquisition of certain skills at the end of teaching and learning activities. In the context of this study, achievement refers to cognitive achievement of students which is measured in terms of passes in teacher-made tests and standardized test in mathematics. Achievement can be high or low. High achievement typically refers to a level of achievement that is significantly above average, which invariably indicates that a student has consistently excelled in his or her studies, demonstrated a deep understanding of the material, and achieved high grades or scores on tests and examinations. High achievement often reflects a strong work ethics, intellectual abilities. On the other hand, low achievement refers to a level of achievement that is below average or falls short of expectations. Low achievement suggests that a student may be struggling to grasp the material, experiencing difficulties in completing assignments or tests, failing to meet the desired standards of achievement. Low achievement can be influenced also by various factors such as lack of motivation, inadequate study skills, learning disabilities, personal issues, or external challenges. The achievement of students in mathematics in post-basic education schools in Imo State has not been encouraging (Ministry of Education, 2021). Students' achievement in mathematics could equally be influenced by gender.

Consequently, it is disheartening that research and data from National Examination bodies like West African Examination Council (WAEC) as well as National Examination Council (NECO) have shown a consistent poor achievement of students in mathematics. Some students' results in both internal and external examinations especially as it concerns mathematics are not something to write home about. Mathematics being one of the core subjects in Nigeria and beyond is expected to be embraced by students and the general public considering its valuables. However, the challenges of poor achievement in mathematics among SSI mathematics students in post basic education schools in Imo State continued to persist, and has therefore created serious worries among parents, teachers, students, government and other stake holders in the education sector.

Gender is a socio-cultural construct that assigns roles, attitudes and values considered appropriate for each sex. World Health Organization (WHO 2025) defined gender as the socially constructed characteristics

of men, women, boys, girls. It includes norms, behaviours and roles associated with being a woman, man, girl and boy as well as relationships with each other, and it varies from society to society and changes over time. Gender issues as factor or variable in this study are not yet skewed to any direction. Some research outcomes are in favour of males while others are in favour of females and sometimes no gender differences are found. Geary et al., (2023) stated that there were no significant sex differences in overall mathematics achievement among primary and secondary students. Nonetheless, Rodriguez et al (2020) observed that female students may even outperform males due to higher self-discipline and systematic learning approaches. Moreso, some research still posits to male students' advantage in specific high-level areas, such as complex problem-solving, abstract reasoning and spatial skills (Greary et al., 2023; Rodriguez et al., 2020). Although gender has been identified as one of the issues influencing achievement in mathematics, the problem might be linked to the type of instructional strategy learners are exposed to during mathematics lessons. As earlier stated, mathematics is the key to economic enhancement. Therefore, the instructional strategy students are exposed to, may determine their rate of achievement in the subject and subsequently, students' level of achievement in senior school certificate examination. This necessitates the need for the teacher to expose the students to effective instructional strategy.

In this study, effective instructional strategies are in various ways engaging, methods, techniques, strategies employed by the teacher during teaching and learning process aimed at aiding the learners attain a high achievement. Effective instructional strategy includes the use of active learning processes, such as problem-solving exercises or hands-on projects, group discussions. Visual aids, clear communication, assessment and feedback, technology integration, real-word application scaffolding; that is providing support and guidance to students as they progress. All these are expected to improve students' achievement. Tran (2014) reported that poor achievement of students is a direct result of techniques employed by teachers. Therefore, effective instructional strategy not only improves students' achievement, but also motivates the learners. It is in view of the importance of instructional strategy in improving students' achievement that researchers continue to seek for appropriate strategies that will ensure effective teaching and learning (Emaikwu, 2015). Emaikwu further stated that the adoption of inquiry based instructional strategy has gone a long way in improving students' achievement in mathematics.

Inquiry instructional strategy is a style of teaching where the learner is seeking to discover and create answers to recognized problems through procedure of making a diligent search, some time with minimum guidance from the teacher. Inquiry implies involvement that leads to understanding. According to Aulia, Poedjiastoeti and Agustini (2019), inquiry is a process of learning that is driven by questioning, thoughtful investigating, making use of information and developing new understanding. Involvement in learning implies possessing skills and attitudes that permit one to seek resolutions to questions and issues while constructing new knowledge. Aydin (2020) stated that inquiring approach is more focused on using and learning content as a means to develop information processing and problem-solving skills. It is more of students -centred. There is a great emphasis on "how one comes to know" and less on "what one knows". Students are more engaged in construction of knowledge through active involvement. It is an open system classroom where students are encouraged to search and make use of resources beyond the classroom and the schools. However, inquiry instructional strategy is a process that engages students by making real connections through the incorporation of active participation of students via exploration and questioning. This strategy focuses on moving students beyond general curiosity into the realms of critical thinking and understanding.

Inquiry teaching strategy can be classified into 4 classes, namely: structured inquiry, coupled inquiry, guided inquiry and unguided/open inquiry (Odupe and Opeusa, 2019). All these types of inquiry can be useful to students to learn science when taught appropriately. In this study, guided inquiry and unguided/open inquiry instructional strategies were considered. This was because the strategies were expected to help to develop students' thinking and decision-making abilities, too to help the students live and interact effectively and meaningfully with their environment towards the much-desired educational improvement.

Guided inquiry is the type of inquiry strategy in which students are provided with direct instructional guidance by the teacher as regards to the concepts and procedures required by a particular discipline, requiring the students to make generalizations (that is, the hypothesis). The teacher develops a working plan, while the students perform the activities, gather data and draw conclusion. Duran and Dokme (2016) in their study adopted a type of inquiry teaching strategy as the best inquiry teaching strategy. Duran and Dokme in their study supported the use of Guided Inquiry teaching strategy as the best Inquiry teaching strategy. While guided inquiry falls in the middle of the inquiry instructional spectrum, this type of inquiry is commonly used when students are asked to make tools or develop a process that results in a desired outcome (Guido, 2019).

On the other hand, Bernido (2020) advocated that people learn best when guided. In line with this assertion, Guido (2019) stated that a child learns best when the learner's education is guided. Unguided or Open inquiry, is the type of inquiry that allows the students to state the problem for investigation, formulates hypothesis and develop the working plan in line with stated generalization. That is, students identify or pose questions, discover, specifics construct essential information with reference to generalized principle. Unguided inquiry is a type of inquiry which requires the least amount of teacher intervention and is student centred (Bernido, 2020). Students, in this case, often work in groups and plan all phases of their investigations. Unguided inquiry allows the students to solely rely on their ability to utilize various scientific processes to solve or arrive to a conclusive solution. Bernido (2020) supported the use of Unguided Inquiry teaching strategy as the best inquiry teaching strategy; This adoption is heavily supported by Aydin (2020) who advocated that people learn best in an unguided or minimally guided environment which makes the learner instead of being presented with essential information, discovers or constructs for himself or herself information. In other words, Kenley (2017) stated that for a student to learn, he should be subjected to a problem, and the student should be provided with necessary materials and left alone (unguided) to find the solution to the problem. In support of these assertions, Omokaadejo (2015) revealed that the child's achievement might be enhanced if he/she is allowed ample opportunity to act on the environment in an unrestricted way (that's unguided but safe).

However, it has been observed that a child learns best when the learner's education is structured (Guido, 2019). According to this philosopher, a child learns best when he or she is guided to an extent and then allowed (unguided) to explore his innate abilities. This is because it is nature and nurture that forms a child's education. In view of these, this present study investigated the effect of inquiry teaching and learning strategies using guided or unguided inquiry. Too, to establish how both strategies can enhance and improve students' achievement in mathematics in Owerri, Education zone 1 in Imo State.

Research Questions

The following research questions guided the study

1. What is the effect of guided inquiry strategies on secondary school students' achievement in mathematics?
2. What is the effect of unguided inquiry strategies on secondary school students' achievement in mathematics?
3. What is the effect of guided inquiry strategies on secondary school students' achievement in mathematics as it moderates with gender?
4. What is the effect of unguided inquiry strategy on secondary school students' achievement in Mathematics as it moderates with gender?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

- H₀₁: There is no significant effect of guided inquiry strategies on secondary school students' achievement in Mathematics.
- H₀₂: There is no significant effect of unguided inquiry strategies on secondary school students' achievement in Mathematics.
- H₀₃: There is no significant effect of guided inquiry strategies on secondary school students' achievement in Mathematics as it moderates with gender.
- H₀₄: There is no significant effect of unguided inquiry strategy on secondary school students' achievement in Mathematics as it moderates with gender?

Methods

This study adopted a quasi-experimental pre-test-post-test control group design involving two experimental groups (guided and unguided instructional strategies) and one control group (conventional lecture method). The population comprised 1,456 SS1 students in public secondary schools, while a sample of 150 students (75 males and 75 females) from three intact classes was selected through random sampling. The instrument for data collection was the researcher-developed Students' Mathematics Achievement Test (SMAT), consisting of 15 multiple-choice items covering fractions, algebraic processes, and mensuration. The instrument and lesson plans were validated by experts in Educational Foundations, Mathematics Education, and Measurement and Evaluation, University of Nigeria, Nsukka. A pre-test was administered before the four-week treatment, during which the experimental groups were taught using guided and unguided inquiry strategies, while the control group received conventional instruction. At the end of the treatment, a reshuffled

post-test was administered. Data collected were used to determine the effect of the instructional strategies on students' achievement in Mathematics.

Results

Research Question 1: What is the effect of guided inquiry on secondary school students' achievement in Mathematics?

Table 1: Mean and Standard deviation for the effect of guided inquiry on secondary school students' achievement in Mathematics.

Group	Pre-Test		Post-Test		Mean Gain
	N	$\bar{X}$	SD	$\bar{X}$	
Guided inquiry	52	4.60	1.64	9.60	5.00
Control	50	5.74	1.65	6.96	1.22

Results on table 1 shows that the experimental group taught Mathematics with guided inquiry method had a pre-test mean achievement score of 4.60, with a standard deviation of 1.64, and a post-test mean achievement score of 9.60, with a standard deviation of 2.17. The difference between the pre-test and post-test mean achievement score for the guided inquiry group is 5.00. Comparatively, the control group taught Mathematics with conventional lecture strategy had a pre-test mean achievement score of 5.74, with a standard deviation of 1.65, and a post-test mean achievement score of 6.96, with a standard deviation of 1.94. The mean gain for this group was 1.22.

Hypothesis 1

There is no significant effect of guided inquiry on secondary school students' achievement in Mathematics.

Research Question 2: What is the effect of unguided inquiry on secondary school students' achievement in Mathematics?

Table 2: Mean and Standard deviation for the effect of unguided inquiry on secondary school students' achievement in Mathematics?

Group	Pre-Test		Post-Test		Mean Gain
	N	$\bar{X}$	SD	$\bar{X}$	
Unguided inquiry	48	5.96	2.06	10.29	4.33
Control	50	5.74	1.65	6.96	1.22

Results on table 2 shows that the experimental group taught Mathematics with unguided inquiry method had a pre-test mean achievement score of 5.96, with a standard deviation of 2.06, and a post-test mean achievement score of 10.29, with a standard deviation of 1.64. The difference between the pre-test and post-test mean achievement score for the unguided inquiry group is 4.33. Comparatively, the control group taught Mathematics with conventional lecture strategy had a pre-test mean achievement score of 5.74, with a standard deviation of 1.65, and a post-test mean achievement score of 6.96, with a standard deviation of 1.94. The mean gain for this group was 1.22. This shows that students taught Mathematics with unguided inquiry method had a better mean gain than those taught with conventional lecture strategy.

Hypothesis 2

There is no significant effect of unguided inquiry on secondary school students' achievement in Mathematics.

Research Question 3: What is the effect of guided inquiry on secondary school students' achievement in Mathematics as moderated with gender?

Table 3: Mean achievement rating and standard deviation of male and female students exposed to guided inquiry method.

Group	Pre-Test		Post-Test		Adjusted Mean
	N	$\bar{X}$	SD	$\bar{X}$	
Female	22	4.83	1.62	9.27	4.44
Male	30	4.43	1.65	9.83	5.40

Results on table 3 shows that male students taught Mathematics with guided inquiry method have a pre-test mean achievement score of 4.43, with a standard deviation of 1.65, and a post-test mean achievement score of 9.83 and a standard deviation of 2.21. The difference between the pre-test and post-test mean achievement for male students taught Mathematics with guided inquiry method is 5.40. Comparatively, female students taught Mathematics with guided inquiry method had a pre-test mean achievement score of

4.83, with a standard deviation of 1.62, and a post-test mean achievement score of 9.27, with a standard deviation of 2.11. The mean gain for female students is 4.44. This shows that the achievement score of male students improved slightly better than that of female students when taught Mathematics with guided inquiry method.

Hypothesis 3

There is no significant effect of guided inquiry on secondary school students' achievement in Mathematics as it moderates with gender.

Research Question 4: What is the effect of unguided inquiry on secondary school students' achievement in Mathematics as moderated with gender?

Table 4: Mean achievement rating and standard deviation of male and female students exposed to unguided inquiry.

Group	Pre-Test			Post-Test		Adjusted Mean
	N	X	SD	X	SD	
Female	20	6.20	2.17	10.65	1.69	4.45
Male	28	5.79	2.01	10.04	1.57	4.25

Results on table 4 shows that female students taught Mathematics with unguided inquiry method have a pre-test mean achievement score of 6.20, with a standard deviation of 2.17, and a post-test mean achievement score of 10.65 and a standard deviation of 1.69. The difference between the pre-test and post-test mean achievement for female students taught Mathematics with guided inquiry method is 4.45. Comparatively, male students taught Mathematics with unguided inquiry method had a pre-test mean achievement score of 5.79, with a standard deviation of 2.01, and a post-test mean achievement score of 10.04, with a standard deviation of 1.57. The mean gain for male students is 4.25. This shows that the achievement score of female students improved slightly better than that of male students when taught Mathematics with unguided inquiry method.

Hypothesis 4

There is no significant effect of unguided inquiry on secondary school students' achievement in Mathematics as it moderates with gender.

Discussion of the Findings

This study showed that students taught Mathematics with guided inquiry strategy did better than those taught with guided inquiry strategy. A study carried out by Agu and Azih & Ndirika and Ubani (2019, 2017) respectively reported a significant improvement in students' achievement when taught with guided strategy intervention. The findings agreed with the work of Lazarus (2014), who tested the comparative effect of guided inquiry and conventional method of learning and revealed that guided inquiry method of learning improved students' achievement more than conventional method. The findings from the analyzed data on this study showed that students taught Mathematics with unguided inquiry strategy has a better mean gain than those taught with conventional lecture strategy. Unguided inquiry is a type of inquiry which requires the least amount of teacher intervention and is student centred (Bernido, 2020). Students, in this case, often work in groups and plan all phases of their investigations. Unguided inquiry allows the students to solely rely on their ability to utilize various scientific processes to solve or arrive to a conclusive solution. Bernido (2020) supported the use of Unguided Inquiry teaching strategy as the best inquiry teaching strategy. Aydin (2020) also in support of unguided teaching strategy advocated that those individuals learn best in an unguided or minimally guided environment which makes it possible for the learners, instead of being presented with essential information, discovers or constructs the vital information needed by them.

This study also revealed that the achievement score of male students improved slightly better than that of female students when taught mathematics with guided inquiry method. This result shows that male students had more achievement in Mathematics than female students when taught mathematics using guided inquiry strategy. There is no significant influence of gender on students' mean achievement scores in mathematics when taught with guided inquiry of learning and conventional lecture strategy. However, observation showed that male students had better retention when taught using guided inquiry strategy compared to their female counterparts. This can be attributed to the fact that guided inquiry often encourages hands-on, active participation and group discussions which male students are more inclined with. Especially as it concerns practical work.

The findings from the analyzed data showed that the achievement score of female students improved slightly better than that of male students when taught mathematics with unguided inquiry method. This result showed that female students had more achievement in mathematics than male students when taught mathematics using unguided inquiry method. There is no significant influence of gender on students' mean achievement scores in mathematics when taught with unguided inquiry of learning and conventional lecture strategy of learning. The result is however not in conformity with the reports of (Ericson, 2018) who reported no significant difference in the mean achievement scores of male and female students in mathematics. In other study Imoinyang (2014) reported that males achieved significantly higher than females in mathematics. These contradicting reports on effect of gender in mathematics achievement among students could imply that intellectual ability of intelligent quotient is not a function of sex of individuals but could be attributed to the genetic makeup of individuals and or other environmental factors like school location, teacher personality, teaching strategies to mention but a few. This means that the rate at which individuals grasps, capture, comprehend or decode mathematics concepts or information does not depend on gender but on individual's genetic makeup or environment.

Conclusion

The instructional teaching and learning strategies used by Mathematics teachers in delivering lessons had significant effect in learning outcomes. This study has shown that students' achievement in mathematics significantly improved and enhanced when guided and unguided inquiry strategies were used to teach mathematics. The use of these strategies created an interactive environment for students to interact, explore, think critically as well as solve problems with one another and settle their personal challenges too. Guided and unguided inquiry is student-centred teaching and learning process which gave students room to participate actively and fully. In short guided and unguided strategies are so efficacious especially as it concerns learning and understanding mathematics contents which invariably resulted to outstanding achievement in mathematics.

Educational Implications of the Study

The study demonstrated that the use of guided and unguided instructional strategies in teaching and learning improved students' achievement in Mathematics. This implied that the strategy can be applied in teaching any aspect of mathematics contents in the secondary schools and beyond. The finding challenges teachers to see the need to utilize these strategies in teaching mathematics contents as both strategies proved efficacious in improving students' learning outcomes. Mathematics textbook authors are also challenged by these findings to provide illustrations for teaching Mathematics contents that lend themselves to guided inquiry and unguided inquiry instructional strategies. Mathematics teachers were encouraged to apply these strategies for teaching Mathematics contents. Another implication of the findings was that mathematics teachers will be exposed to a new lessons pattern that allows them to utilize guided or unguided instructional strategies. This will invariably lead to students being actively involved in the lesson and possessed improved learning outcomes in Mathematics. It has been well established in research that students' gender plays a significant role in students' achievement in all subject areas. However, this study demonstrated that gender does not significantly influence the effect of guided and unguided instructional strategies on students' achievement in Mathematics. This implied that teachers do not have to worry about the gender-related implications of using these strategies as male and female students alike will benefit significantly from being taught with this strategy.

Recommendations

Based on the findings of this study, the following recommendations were made.

1. The adoption of both guided and unguided inquiry instructional strategies which have been found to be very efficacious in enhancing students' achievement should encouraged through mathematics teachers' reinforcement and motivation.
2. The implementation of existing policies that encouraged teachers to use guided and unguided inquiry strategies in teaching and learning of contents in Mathematics can be possible when educational policy makers mandate school principals and headteachers to access the implementations in schools.
3. Students should participate actively in teaching and learning using guided and unguided inquiry which invariably will foster their interaction among students, explore, take decision, think-critically and solve problems which can be facilitated through good knowledge of ICT and AI assistance

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