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Effect of Self-Regulated Instructional Strategy on students' self-efficacy in Geometry in Enugu Education Zone

Zinkat Olatomiwa. A.
Department of Science Education, University of Nigeria
olatomiwazinkat@gmail.com

Abstract

The study investigated the effect of Self-Regulated Instructional Strategy (SRIS) on senior secondary self-efficacy in geometry. "The study was carried out in Enugu Education Zone of Enugu State, and the entire SII mathematics students for the 2022/2023 academic session were used as the population of the study. Two hundred and forty-three (243) Mathematics students were drawn this population through a multi-stage sampling procedure of four stages. One research question and one hypothesis guided the study. The study employed the quasi-experimental research design, specifically, a pre-test post-test non-equivalent group design. The instrument for data collection was Geometry Self-efficacy Questionnaire (GSQ), which was face validated by two experts from Science Education (each from Measurement & Evaluation, and Mathematics unit), and one expert from Educational Foundation (Education Psychology), all three from the Faculty of Education. The reliability of GSQ was determined using Cronbach's Alpha, and an estimate of .82 was obtained. Mean and Standard deviation were used to answer the research question, while analysis of covariance (ANCOVA) was used to test the null hypothesis at 0.05 level of significance. The findings of the study showed that students taught geometry with Self-Regulated Instructional Strategy (SRIS) had a slightly higher mean gain in self-efficacy ratings than those taught with the traditional teaching method. The study further showed there was a significant difference in the mean self-efficacy rating of students taught with Self-Regulated Instructional Strategy (SRIS) and those taught with the traditional teaching method. Based on the findings of this study, it was concluded that a self-regulated instructional strategy can enhance students' self-efficacy in geometry. It was recommended that self-regulated instructional strategy should be encouraged in the teaching of mathematics, especially geometry."

Keywords: geometry, mathematics, self-efficacy, self-regulated instructional strategy

Introduction

Mathematics remains one of the subjects students still find challenging. Geometry content area of mathematics has been identified by the West Africa Examination Council (WAEC) Chief Examiner's report as a major area of weakness for mathematics students in external examinations. Findings from a study conducted by Zakariya (2020) show that students' low self-efficacy in geometry is a contributing factor to the varied levels of weaknesses reported by the WAEC Chief Examiner's report (WAEC 2019, 2020, 2021, 2022, 2023). Many students are unable to demonstrate a high level of confidence in their respective ability to produce a designated level of performance, thereby resulting in students' low perception of self in learning geometry. Thus, the quest to enhance mathematics students' self-efficacy in Geometry is paramount to mathematics educators.

Geometry is the aspect of Mathematics that enables human to identify shapes and describe the extent of sizes of objects, as well as the angle, and directions to which objects are located diversifies into content areas such as properties of lines, points, planes, and parallel lines, triangles, similarities in triangles, solid shapes, areas, and circles (Kuzle & Glasnovic, 2020). Battista (2007) note that fundamental skills such as logical thinking, deductive and analytical reasoning could be enhanced through the learning of geometry. Additionally, the National Council of Teachers of Mathematics (NCTM), (2000) emphasizes that the knowledge of geometry helps in the visualization of mathematical concepts such as arithmetic, algebra, and statistics to aid students' understanding. Most human daily activities such as measuring circumference, area and volume of an object, as well as measuring the angle of an object,

reflect the practical implementation of geometry, which also supports visualization of other mathematical concepts (Tanton, 2016). Generally, ability to solve real-life problems could be embedded in the learning of geometry (Chamberlin & Powers, 2010).

Despite the importance of geometry, students' self-efficacy in this content area remains low, thereby resulting in low academic achievement of students in mathematics. The Chief examiners' report of the West African Examination Council (2019, 2020, 2021, 2022, and 2023) identified geometry as a major area of mathematics that students find most challenging and difficult, in which students still showed varied level of weaknesses. Some of the specific weaknesses identified are;

- students' inability to interpret and manipulate geometry configurations
- difficulty to switch between multiple demands
- students' inability to recall and apply formula and theorems as required
- students' inability to recognize when tasks are to be merged or to be separated in multiple complex problems

These are indications that students still encounter major challenges in geometry as a result of low self-efficacy in this content area of mathematics. Awofala, Adeneye, and Fatade (2023) further noted that these major challenges in geometry persist in external examinations.

Self-efficacy is an essential component of successful human functioning and a critical component in mathematics learning. Bandura's Social Cognitive theory asserts that students' level of self-efficacy is dependent on the synergy between three human components which are personal factors, human and environmental factors. Bandura's theory was supported by study conducted by Bernacki, Nokes-Malach, and Alevan, (2015) who stipulates that students with higher sense of self-efficacy in mathematics display a high level of persistent effort to provide solutions, and outperform their peers with low sense of self-efficacy.. According to Ifdil, Apriani, Yendi, and Rangka (2016), a high level of self-efficacy may result in an in-depth understanding of spatial relationships as well as willingness to tackle challenging problems in geometry. A low self-efficacy on the other hand may result into a perception of self as lacking in mathematics abilities, and mathematics phobia. Generally, the development of self-efficacy beliefs has been reported to occur through a process of selecting and interpreting thoughts, behaviors and environmental information (Bandura, in Yorulmaz & Altiner, 2021). In other words, a student's self-efficacy could be enhanced by students' confidence and ability levels, classroom structures and social interactions with peers which are elements of personal and environmental factors respectively.

Students' self-efficacy has consistently received increased attention in mathematics education. In mathematic learning, especially in learning of geometry, it could be observed that fostering a strong sense of self-efficacy in students is important to unlock students' full potential in mathematics. Several efforts have been made through research (Omolola, 2020; Salar & Turgut, 2021; Zakariya, 2022) to nurture and improve students' mathematics self-efficacy. However, Zakariya (2022) reported that students' self-efficacy in geometry is still low, owing to attributed factors such as teaching strategies adopted by mathematics teachers, stereotypes about mathematics ability; for instance, a case of labeling a child as "weak in mathematics", which may alter students' mindset about the subject.

"Many factors were reported to be responsible for the ugly reports attributed to students' self-efficacy in geometry, which have consequently impacted students' achievement in Mathematics. According to Ubi, Odiong, and Igiri (2018), difficulty in the learning of geometry concepts could be attributed to methods of teaching, unavailability of instructional materials, insufficient time allocation, students' gender, complexity and misconceptions of concepts, and students' inability to understand the basic concepts in geometry. Isa, Mammam, Badar, and Bala (2020) further opine that adequate attention should be given to the method of teaching employed by teachers, as it largely dependent on students' self-efficacy level. This situation calls for exploration of instructional strategies that have been found effective in some other subjects and other areas of mathematics, which are constructive in nature and involve students' active participation (Ukwueze, Ugwuanyi & Ogbu 2022; Adigun 2021). Such constructive teaching strategies that tap into the diversity of students, which could improve the self-efficacy of students, is self-regulated instructional strategy. The study, therefore, sought to answer the question" "What is the effect of Self-Regulated Instructional Strategy on students' self-efficacy in geometry?"

"Self-Regulated Instructional Strategy is a concept that centers on the strategic and active participation of students in their own learning process. Zimmerman and Schunk (2010) describe self-regulated learning as a systematic learning process that encourages self-generated thought, actions, and behavior towards the attainment of

personal learning goals. Self-regulated instructional strategy encompasses students' active participation in setting learning goals, performing at their highest potential in tasks, and assessing progress through self-monitoring and self-control (Rasheed & Akhtar, 2021). Self-regulated learners process their behavior to align with learning processes, to achieve learning goals, and tend to be more reflective (Daniel, Wang, & Berthelsen, 2016). Self-regulation, according to Baumeister and Vohs (2004), is the ability to control and express behavior that accomplishes tasks effectively. It enables the students to control their thoughts, feelings, and performance towards a task. Self-regulated Instructional strategy describes the class activities that inculcate in students the act of planning and goal setting (Akudo, 2018; Alotaibi, Tohmaz & Jabak, 2017), which contribute in making the students proactive towards their studies and proper time management (Sahranavard, Miri & Salehiniya, 2018; Veas, Castejon, Gilar & Minano, 2016). Operationally, Self-Regulated Instructional Strategy is referred to as the strategy that allows students to exercise autonomy and agency in their learning of geometry.

Mathematics students can be more successful and improve in their practical decision-making process with respect to their learning goals, should better learning strategies be employed. Self-Regulated instructional strategy has been reported in several studies to positively impact students' self-efficacy in various subject areas such as; Chemistry (Olakami & Gumbo, 2017), History, Science, Literature, Arts, Music, and Physical Education (Fernandez-Rio et al., 2017), English study (Rasheed & Akhtar, 2021), and Physics (Money-Enwefah & Kpangban, 2023). As maintained by Money-Enwefah & Kpangban, this is possible because SRI encourages a learning process that centers explicitly on human agency, helping students to understand the relationship between knowledge, skill, and motivation. Also, self-regulated strategy aims to drive curiosity and a sense of challenge that requires students to make clear plans and specific techniques that can be utilized to manage thought processes, feelings, emotions, and behaviors during learning.

In addition to the foregoing, students who self-regulate are aware of the importance of learning, have control of their emotions, and assess their own learning, which consequently may result in a high level of self-efficacy. In a study conducted by Adesola and Li (2018) showed a positive relationship between self-regulated learning and academic self-efficacy. Students' level of confidence to take actions and to achieve set goals is reported to be high. These positive impacts of self-regulated learning may be attributed to students being aware of their academic strengths and shortcomings, as well as having a toolbox of techniques they can use to complete the daily obstacles of academic work, as against the traditional teaching methods (Ejelue, 2017).

The study conducted by Adel and Yousra (2020) on self-regulated strategy and students' academic self-efficacy also revealed that self-regulated instructional strategy enhances academic self-efficacy and creative problem solving skills of eleventh-grade students. The study adopted an experimental research design with 80 eleventh-grade students as the sample size. The findings revealed a significant difference in the mean creative problem-solving scores of students, favoring the experimental group. The findings also revealed a significant difference in the mean academic self-efficacy ratings of students in the experimental group than those in the control group. Based on the findings of this study, it was concluded that self-regulated learning strategy enhance students' academic self-efficacy. The reviewed study is related to the current study because both investigated the effect of self-regulated instruction on students' self-efficacy. However, the two studies differ in scope. While the reviewed study investigated academic self-efficacy and creative problem-solving skills of students, the current study focus on only self-efficacy of students in geometry as the dependent variables."

Traditional teaching methods often fall short in addressing the diverse needs of secondary school students. A mathematics classroom usually filled with students with varied level of autonomy and self-efficacy required more personalized and constructive learning strategies which could improve upon students' self-efficacy in geometry. Studies have shown that traditional teaching methods do not foster students' confidence in their ability to succeed in geometry learning. This prompted educators to explore more personalized instructional strategies that are students-centered. With respect to the empirical evidences of Self-Regulated Instructional Strategy improving self-efficacy of students in other subjects, this study sought to investigate if Self-regulated instructional strategy can enhance self-efficacy of students in geometry.

Theoretical Framework

"The Social Cognitive Theory by Albert Bandura (1989) is a triadic process that encourages students to regulate personal, behavioral, and environmental factors that play a significant role in their learning processes. The theory assumes that students can exercise autonomy in ther learning activities by monitoring and adjusting their cognitive and

emotional states, and through observation and performance adjustment. According to the theory, this process is influenced by external feedbacks teachers or peers, with which students are been motivated to succeed. In the context of this study, self-regulated instructional strategy is viewed as an activity-based approach that incorporates many of this theory's assumptions, which could enhance students' level of confidence in geometry by engaging their sense of agency throughout the learning process.

Purpose of the Study

The purpose of the study was to determine the effect of Self-Regulated Instructional Strategy on students' self-efficacy in geometry. Specifically, the study sought to determine the mean self-efficacy ratings of students taught geometry using Self-Regulated Instructional Strategy and those taught using traditional teaching method.

Research Question

The research question below was posed to guide the study.

What are the mean self-efficacy ratings of students taught geometry using Self-Regulated Instructional (SRI) strategy and those taught with traditional teaching method?

Hypothesis

The null hypothesis below was formulated and tested at 0.05 level of significance.

H_0: There is no significant difference in the mean self-efficacy ratings of students taught with self-regulation learning strategy and those taught using a traditional teaching method.

Method

The study employed quasi-experimental research design. Specifically, a pre-test post-test non-equivalent groups design. Quasi-experimental design, according to Nworgu (2015), is an experiment where random assignment of subjects to both experimental and control groups is not possible. Thus, intact or pre-existing groups are used. The design was considered appropriate because intact classes were used in the study for both experimental and control groups, respectively, without randomization. This helped not to disrupt the classroom setting. This study was carried out in Enugu Education Zone, Enugu State, which is one of the six education zones in the State. The population comprised all Mathematics students in the zone within the 2022/2023 session.

The sample size for the study was 243 mathematics students who occupied the four intact classes from the four schools randomly selected from the zone through a multi-stage random sampling procedure involving four stages. At the first stage, a simple random sampling technique by ballot was used to draw two local government areas from the three Local Government Areas in Enugu Education Zone. Purposive sampling technique was used at the second stage to select co-educational schools from the two sampled Local Government Areas. Purposive sampling was considered appropriate at this stage because it allows the researcher to target schools that have both male and female students, as gender is a moderating variable in this study. Simple random sampling by ballot was further used at the third stage to select two secondary schools from two earlier selected Local Government Areas, making a total of four schools drawn for the study. At the fourth stage, a simple random sampling technique was also used to select one stream of SS II class each from the selected schools in each LGA, making a total of four intact classes drawn across the two LGAs. The population of students across these four intact classes constituted the 243 sample size used for this study.

The Geometry Self-Efficacy Questionnaire (GSQ), adapted from Sherer et al. (1982), was used for data collection. The original 22-item scale was modified to measure students' confidence and strategy use in solving geometry problems. After modification of the instrument by the researcher, the 22-item scale was subjected to factor analysis after being administered to students who were not part of the population of this study, to establish construct validity using the principal component method with varimax rotation, 15 items met the 0.40 loading criterion proposed by Tabachnick and Fidell (2007). The 15 items were retained and constituted the items on the General Self-Efficacy Questionnaire used in this study. The instrument was rated on a 4-point scale from Strongly Disagree (1) as the minimum obtainable rating to Strongly Agree (4) as the maximum obtainable rating. The reliability estimate of the final instrument was determined using Cronbach's Alpha statistics, and a reliability index of 0.82 was obtained.

The experiment spanned five weeks and involved two groups. Four qualified mathematics teachers, two assigned for each group, were trained as research assistants using instructional manuals developed by the researcher. Upon completion of the training, the General Self-Efficacy Questionnaire (GSQ) was administered to students in both groups to obtain pretest scores. Treatment commenced in the second week and continued through the fifth week. Group 1 received instruction based on the Self-Regulated Instructional Strategy, whereas Group 2

was taught using the traditional teaching method. After the treatment, the GSQ was re-administered to generate posttest scores.

The data collected from the students after the administration of the instrument were analyzed using Mean and Standard deviation to answer the research question and Analysis of Covariance (ANCOVA) to test the formulated null hypothesis. The mean gain difference was used to evaluate the effectiveness of instructional strategies across the groups, while the standard deviation provided understanding for degree of homogeneity within groups in order to ascertain variability of data from the mean. The decision to reject or not reject the null hypotheses was dependent on whether the exact probability of the test statistics was less than or greater than the a priori probability level of 0.05. The pre-test scores were used as a covariate for the post-test scores. ANCOVA, however, served as a control for the initial differences across groups as well as increasing the precision due to the extraneous variable, thus reducing the error variance. The researcher ensured each of the groups was drawn from different schools to prevent inter-group interaction."

Result

Research Question

Table 1: Mean and standard deviation of mean self-efficacy rating scores of students taught geometry with self-regulated instructional strategy and those taught with differentiated instructional strategy

Groups		Pre-test		Post-test		Mean Gain Scores	Mean Gain Difference
	n	Mean	SD	Mean	SD		
SRIS	124	20.23	3.69	46.12	8.05	25.89	1.90
Control	119	19.72	2.58	43.71	9.59	23.99	

"Result in Table 1 shows that Mathematics students exposed to self-regulated instructional strategy had pre-test mean self-efficacy rating score of 20.23 with standard deviation of 3.69 and post-test mean self-efficacy rating score of 46.12 with standard deviation of 8.05, while those exposed to traditional teaching method had pre-test mean self-efficacy rating score of 19.72 with standard deviation of 2.58 and post-test mean self-efficacy rating score of 43.71 with standard deviation of 9.59. Mean gain scores of 25.89 and 23.99 were obtained for students in experimental and control groups, respectively with mean gain difference of 1.90 in favor of students exposed to the self-regulated instructional strategy in the experimental group. The obtained post-test standard deviations of 8.05 and 9.59 for the two groups of students, respectively, showed that the variation from the mean was small for SRIS, indicating higher consistency in the outcomes of students against the obtained standard deviation for the control group, which showed the variation from the mean was is small, indicating less consistency in the outcomes of students.

Hypothesis

Table 2: Summary of Analysis of covariance (ANCOVA) of significant difference in the mean self-efficacy ratings of student taught with self-regulation instructional strategy and those taught using traditional teaching method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	423.171[a]	4	105.793	1.344	.254	.022
Intercept	12514.193	1	12514.193	158.941	.000	.400
PreSelfEfficacy	3.631	1	3.631	.046	.830	.000
Treatment	349.322	1	349.322	4.437	.036	.018
Error	18738.903	238	78.735			
Total	509888.000	243				
Corrected Total	19162.074	242				

Result of the analysis in Table 2 shows that learning strategy is not a significant factor on students' self-efficacy in geometry; F (1, 238) = 4.437, P = .036. Hence, the null hypothesis of no significant difference in the mean self-efficacy ratings of students taught geometry using self-regulated learning strategy and those taught using traditional teaching method was rejected. This is

because the exact probability value of .036 is less than the level of significance set at 0.05. Therefore, the researcher concludes that there is a significant difference in the mean self-efficacy ratings of students taught geometry using self-regulated learning strategy and those taught using traditional teaching method. However, the Partial Eta Square (effect size) value of .018 shows that learning strategies contributed 18% effect on students' self-efficacy in geometry.

Discussion

Effects of self-regulated instructional strategies on senior secondary school students' self-efficacy in Geometry

The findings of the study revealed a significant difference in the mean self-efficacy ratings of students taught geometry using self-regulated instructional strategy and those taught using traditional teaching method. Self-regulated instructional strategy is an active and constructive process whereby learners set goals for their learning and attempts to monitor, regulate and control their cognition, motivation and behavior, guided by their goals and contextual features in the environment. Moreover, the strategy gives students an explicit plan for improving upon their achievements in science subjects and also helps them to understand the relationship between knowledge, skill and motivation

The findings of the study is in agreement with the findings of Adesola and Li (2018) that revealed the self-regulation learning approach had a significant positive effect on science students' self-efficacy. This finding is also in consistent with that of Adel and Yousra (2020), who investigated the effect of self-regulated learning strategy on academic self-efficacy and creative problem solving among high school students. The findings reported that students' self-efficacy improved after being exposed to a self-regulated learning strategy."

Conclusion

The theoretical assumption that students can self-regulate their personal, behavioral, and environmental factors based on the influence of external feedback, therefore, enhances self-efficacy was tested in this study, and the findings provide empirical support to the earliest proposition. Based on the findings of this study, it was concluded that Self-Regulated Instructional Strategy can enhance students' self-efficacy in Geometry.

Recommendations

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

1. Mathematics teachers should be encouraged to use self-regulated instructional strategy in the teaching of mathematics especially geometry in schools as this will enable them to cater for diverse students' needs in Mathematics classroom and hence, enhance the academic self-efficacy of secondary school students.
2. The Federal and State Governments and other educational bodies should deem it fit to popularize the use of self-regulated instructional strategy in schools by organizing technical workshops, seminars, and regular in-service innovation-oriented training programs for teachers on this efficient and effective teaching strategy.

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