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EFFECT OF SELF-REGULATED LEARNING STRATEGY ON SECONDARY SCHOOL STUDENTS' ACQUISITION OF SCIENCE PROCESS SKILLS IN BIOLOGY IN MAKURDI, BENUE STATE

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Abstract
Effect of self-regulated learning strategy on secondary school students' acquisition of science process skills in Biology in Makurdi. Benue State was studied using pre-test post-test non-randomised control group quasi-experimental design. Two research questions and two hypotheses guided the study. The population comprised of 1,996 senior secondary II students in Government grants aided schools in Makurdi. A sample of 65 students was drawn by multiple stage sampling procedure and was used for the study. Science Process Skills Test (SPST) was used for data collection. The SPST was trial tested and the data collected was computed using Pearson product moment correlation (PPMC) and yield the reliability coefficients of 0.81. The data collected was analysed using mean and standard deviation to answer research questions and analysis of covariance (ANCOVA) to test the null hypotheses at 0.05 level of significance. The finding showed that there was a significant difference in the mean science process skills of students taught Biology using self-regulated learning strategy and those taught using demonstration teaching method ($p= 0.000<0.05$). The finding also showed that there was no significant mean difference in the science process skills of male and female students taught Biology using self-regulated learning strategy ($p= 0.084 > 0.05$). The result revealed that the mean gain difference of students taught Biology was 6.48 in favour of those taught using self-regulated learning strategy and there was a mean gain difference of 1.64 in favour of male students taught Biology using self-regulated learning strategy. It was recommended that SRLS should be used in teaching and learning Biology to ensure better learning outcomes of students' science process skills in senior secondary schools.

Keywords: *Self-regulated Learning, Demonstration Teaching Method, Science Process Skills, Gender and Senior Secondary II Biology.*

Introduction

Education is a life-long process that inculcates values and norms that enable an individual to meaningfully fit into the society. Education can be seen as a process of imparting knowledge, skills and values to individuals for effective living and survival in the society (Ozoji et al., 2022). Education is one of the basic instruments every community or nation use to transmit ideals, values, culture and norms to their citizens. It encompasses the transformation of individuals or a group of people, through instruction and practice when linked to science (Juanda et al., 2024). That is to say that development of any nation in science, industrialization and other areas of human endeavour cannot be achieved without science education.

Science is an integral part of national growth and the cornerstone upon which today's technological advances are hinged. Through the scientific method, science continuously evolves as new discoveries challenge existing theories and lead to more refined understanding (National Academies of Sciences, Engineering, and Medicine, 2018). Progress in science is necessary for a higher standard of living, the planet's sustainable growth, and peaceful coexistence. Science is a systematic collection of knowledge in the form of ideas, concepts, rules, and generalizations (Bello, 2021). Science is an investigative process to proffer solutions to problems bordering on human mind. The scientific knowledge of science is relevant and applicable in all areas of life endeavours, without which life on the planets is miserable and primitive. The knowledge of Biology is applicable in medicine, physiology and anatomy to preserve and save lives. The knowledge of Agriculture gives way for the production of food and animals which serve as meat and sources of protein as well as raw materials for industries.

Science has been severally defined and all of the conceptions point to it as an attempt to seek for solutions to man's problems in every area of life. Some authorities see science as a pursuit for knowledge that can unravel the complexities of nature for man's good. Others perceive science as the knowledge itself that we seek in order to understand other things about the natural world. As viewed differently, its pertinent for those who have taken time to acquire this knowledge (science) to pass it to others so that they too could acquire it for their own survival instincts. They do this through methods and strategies that simplify the processes of knowing science and what this knowledge equips them to do in the society. This is what in some way can be described as science education. Simply put, the processes by which scientific knowledge is passed to persons so as to equip them for successful living in the society. Okebukola (2015) posit that science education is the provision of learning experiences in science in formal, non-formal and informal settings. This definition is in tandem with what goes on in the Nigerian school system where science is taught to students in classrooms and in the school's immediate environs as well as other locations in the larger society. Similarly, Aina (2018) defined science education as the sharing of science content and process with individuals who are not considered traditionally, to be members of the scientific community; the individuals could be students, farmers, market women or artisans. Adejoh and Ekele (2020) conceive science education as the aggregate of all the processes by which individuals develop interest, abilities, attitudes, knowledge and science process skills for the development of society. This definition underscores the intrinsic and extrinsic values of science to mankind that make its studies inevitable to all classes of persons in society.

Biology is the scientific study of life and living organisms, encompassing their structure, function, growth, evolution, and interactions with their environments. It explores life at multiple levels, from molecules and cells to ecosystems and the biosphere (Urry et al., 2020). Biology is such a vast field that encompasses everything from the intricate processes of the chemical machinery inside our cells to the larger ideas of ecosystems and climate change. Ali (2021) have maintained that the understanding of Biology constitutes the basis for other sciences such as Public Health, Medicine, Agriculture, Bio-chemistry, Microbiology, Zoology, Botany, Anatomy, Physiology, Genetics, and Ecology. Learning scientific methods should be an essential part of studying biological science in addition to other science courses. Orji and Ike (2020) opined that Education is a tool for developing the biological sciences, which in turn develops the various professional bodies that are

involved in the knowledge and abilities required for advancements in technology, agriculture, and medicine. Biology as a subject can be harnessed for technological development if taught with innovative teaching methods like Self-Regulated Learning Strategy.

Self-regulated Learning Strategy (SRLS) is a learning method driven by motivation to take charge of one's own learning, meta-cognition, and strategic action (planning, monitoring, and evaluating personal progress against standards, Panadero, 2021). Self-regulated learners are aware of their academic strengths and shortcomings and possess a skill set that they employ correctly to address the daily obstacles of academic assignments (Ejelue, 2017). Self-regulated learners are able to set short-term and long-term goals for their learning, plan ahead to accomplish their goals, self-motivate themselves, and focus their attention on their goals and progress. Self-regulated learners are able to employ multiple learning strategies and adjust those strategies as needed, self-monitor their progress, seek helps from others as needed, and self-evaluate their learning goals and progress based upon their learning outcomes (Panadero, 2021).

Stages of Self-Regulated Learning

Forethought Phase: This initial phase involves planning and goal-setting. Teachers should plan to guide students in setting clear learning objectives at the start of each lesson. Students identify what they aim to achieve and develop strategies to accomplish their objectives. For instance, they may set specific, measurable, achievable, relevant, and time-bound (SMART) goals. Motivation plays a crucial role here, as students assess their self-efficacy and intrinsic interest in the task (Schunk & DiBenedetto, 2021).

Performance Phase): Teachers can promote self-monitoring by integrating interactive tools like quizzes or progress trackers during lessons. For instance, while teaching, the teacher might use formative assessments such as concept maps or Question and Answer (Q&A) sessions to check students' understanding. Encouraging students to use learning aids, like flashcards or visual diagrams, fosters engagement and helps them stay focused. During this phase, students actively engage in learning tasks while employing strategies to optimize their performance. Key processes include self-monitoring and strategic implementation. For example, students might use note-taking, mnemonics, or concept mapping to retain information effectively. They also track their progress by comparing their current performance with their goals (Panadero, 2021).

Self-Reflection Phase: This final stage focuses on evaluating performance and outcomes. Teachers should encourage reflective activities where students evaluate their performance. Students assess whether they met their goals and analyze the effectiveness of their strategies. Reflective practices, such as journaling or discussing results with peers, help identify strengths and areas for improvement. Positive outcomes reinforce motivation, while setbacks provide valuable lessons for refining strategies (Boekaerts, 2021).

The SRLS is related to Bandura's social cognitive theory (1991) who proposed that learning occurs in a social context and that individuals learn not only through direct experience but also by observing others and interacting within their environment. Central to Bandura's theory, the idea of reciprocal determinism, which suggests that behaviour, personal factors and environmental influences all interact and influence each other. SRL is characterized by key components such as goal-setting, self-monitoring, self-evaluation, time management, and self-reflection (Panadero, 2017) which could be functional in inculcating Biology students' science process in skill.

Science process skills refer to employed procedures for carrying out scientific investigations. Dogan (2016) has stated that science process skills are those skills that help students learn the sciences, conduct research and engage in active learning. The instruments for acquiring data, coming up with and testing new ideas, creating new knowledge, understanding scientific concepts, and creating scientific interpretations of the world are the process skills of science. Kirimi et al. (2017) has opined that science process skills (SPS) are what students employ to conduct scientific inquiries, they are particularly crucial in inquiry-based learning. Broad transferable skills, or SPS, are those that can be cultivated through a variety of possibilities

for practical experiences related to scientific inquiries. These suit a wide range of scientific fields and represent how scientists behave. Science and environmental observation are related, and appropriate comprehension of the world can be achieved through appropriate experimental procedures (Lederman & Lederman, 2019).

The gender of a student refers to the biological function which the student can perform. Gender issues in science education have remained a point of interest for a number of researchers (Parajuli & Thapa, 2017). There is a strong argument that gender is a prediction factor on learning outcomes in science. Gender issues in science education have remained a point of interest for a number of researchers (Shidiq et al., 2017). The literature presents conflicting results about the effect of self-regulated learning on the of male and female students, their Science Process Skill, and recommendations based on the research work that is necessary to raise the level of science process skills of science students, particularly Biology students were made.

Regarding related empirical studies, Mustopa et al. (2020) explored the relationship between self-regulated learning, learning motivation, and metacognitive skills in Biology students in SMAN 1 Tasikmalaya and the results show that the correlation coefficient (R) was high positive. Choirunnisa et al. (2018) examined effectiveness of 5E instructional model-based learning to improve primary school students' science process skills Primary School 1and 2 of Karangsari, at Depok, West Java, Indonesia and found The result of this study showed that the implementation of learning in both of classes, IVA and IVB, show that the percentage of learning implementation increased which indicates a better quality of learning and the percentage of students' science process skills test results on the aspect of observing, formulating, hypotheses, determining variables, interpreting data and communicating increased well. Effiong and Okon (2021) investigated gender comparison of science process skills among senior secondary students taught Biology using self-regulated learning (SRL) in Calabar, Cross River State and found that there was a significant difference between the experimental and the control group. The study also found no significant gender difference when taught Biology using SRLS. Iloabuchi and Okoye (2022) examined the impact of Self-Regulated Learning on Male and Female Science Process Skills in Biology in Awka, Anambra State and found that a significant difference existed in the science process skill of students taught Biology using SRLS and those taught using lecture method. The study also showed no significant gender disparity in process skills under SRL. All the empirical studies have shown similarity with the current study on SLRS, science process skills and gender. However, these studies created gaps in geographical locations, methodologies, cultural variations sample sizes and samplings. To bridge these gaps this study bids to determine the effect of self-regulated learning strategy and Demonstration teaching method on the students' Science Process Skills in Biology and establish the mean of science process skills between male and female students taught Biology using self-regulated learning strategy.

Statement of the Problem

Science education is supposed to produced scientists who could harness science for self-reliance, national development and global competitiveness. However, there is a yawning problem of student's poor acquisition of science process skills in Biology due to inadequate teaching methods. Isa et al (2020) stated that despite the critical role of Biology in fostering scientific literacy and technological advancement, students' mastery of science process skills in this subject have remained poor. Research has established that ineffective teaching methods significantly contribute to students' poor acquisition of science process skills. Traditional teaching methods often fail to engage students actively during classroom instruction, leading to passive learning and a poor acquisition of science process skills. Demonstration teaching method engages learners by allowing them to observe procedures and ask questions (Okey & Madu, 2020). Adamu et al (2020) stated that One key shortcoming of the Demonstration Teaching Method is that it tends to be teacher-centered, often limiting opportunities for learners to engage in hands-on exploration or independent inquiry. The situation of a poor acquisition of science process skill and ineffective teaching methods has been so worrisome to stakeholders. This study bid

to investigate the effect of self-regulated learning strategy on secondary school students' acquisition of science process skills in Biology in Makurdi Metropolis.

Purpose of the Study

The purpose of this study is to assess the effect of effect of self-regulated learning strategy on secondary school Biology student's science process skills in Makurdi with the following objectives to:

1. determine the effect of self-regulated learning strategy and Demonstration teaching method on the students' Science Process Skills in Biology
2. establish the mean of science process skills between male and female students taught Biology using self-regulated learning strategy.

Research Question

The study was guided by the following research questions:

1. What is the difference in the mean science process skills of students taught Biology using self-regulated learning strategy and those taught using Demonstration teaching method?
2. What is the difference in the mean science process skill of male and female students taught Biology using self-regulated learning strategy?

Hypotheses

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

$H0_1$ There is no significant mean difference in the science process skills of student taught Biology using self-regulated learning strategy and those taught using Demonstration teaching method

$H0_2$ There is no significant mean difference in the science process skills of male and female students taught Biology using self-regulated learning strategy.

A non-equivalent pre-test post-test control group quasi-experimental design was employed to study self-regulated learning strategy on students' science process skills in secondary school Biology in Makurdi Metropolis. The aimed to develop Biology students' science process skills to harness science for self-reliance, national development and global competitiveness. A multistage sampling procedure (stratified, purposive and random sampling) was used to obtained a sample of 65(M = 32 and F = 33) SS 2 students from a population of 1,953 (male = 814 and female = 752) SS 2 students offering Biology in all the Makurdi Metropolis, Benue State (Directorate of Planning Research and Statistics, Benue State Teaching Service Board, 2024). Science Process Skill Test (SPST) was adapted and used for data collection. It contained section A which was made up of bio-data and section B was consisted of 16 activities to be followed in the process of science to develop science process skills. The SPST was validated by three experts from science and mathematics education to improve it's face and content validity. It was trial tested on 20 SS 2 Biology students who were not part of the main study. Test scores were collected and computed with Pearson Product moment Correlation (PPMC) statistic and yielded a reliability coefficient of 0.81.

After the trial test and pre-test, treatment was given to experimental group and the control and the post-test was administered for data collection. Mean and standard deviation were used to answer research questions, while hypotheses were tested at a 0.05 significance level using Analysis of Covariance (ANCOVA). This was due to two independent variables (SRLS and demonstration teaching method) comparing group means while controlling for previous science process skills, data was on interval scale and the data was normally distributed (Emaikwu, 2013).

Results

Research question one: What is the difference in the mean science process skills of students taught Biology using self-regulated learning strategy and those taught using Demonstration Teaching Method?

Table 1: Mean Standard Deviation of students' Science Process skills of Students Based on Teaching Method

Method	Sample (n)	Pre-SPS		Post- SPS		Mean Gain	Mean Gain Difference
		Mean	St. D	Mean	SD		
SRLS	35	4.92	2.28	18.86	2.30	13.95	6.48
DTM	30	4.52	2.22	11.99	3.16	7.47	

Table 1 shows that 35 students were taught using self-regulated learning strategy (SRLS) and 30 students were taught using Demonstration teaching method. The results from the table shows a mean science process skills (SPS) score of 4.92 during the (pre-SPS) with a standard deviation of 2.28 and a mean post(SPS) scores of 18.86 with a standard deviation 0f 2.30 for students in the experimental group (those to be taught using SRLS). The result shows that the students in the control group (those to be taught using demonstration method) had a mean SPS score of 4.52 during the pre-SPS with a standard deviation of 2.22 and a mean SPS score of 11.99 with a standard deviation of 3.16 in the post-SPS. Table 2 further shows a mean SPS gain of 13.94 for students taught using SRLS While those taught Biology using Demonstration teaching method had a mean gain of 7.48.The mean gain difference of students taught Biology was 6.48 in favour those taught using self-regulated learning strategy.

Research question two: What is the mean science process skill of male and female students taught Biology using self-regulated learning strategy?

Table 2: Mean and Standard Deviation Science Process Skill Based on Gender

Gender	Sample (n)	Pre-SPS		Post-SPS		Mean Gain	Mean Gain Difference
		Mean	St. D	Mean	SD		
Male	16	4.68	1.79	19.52	2.23	14.84	1.64
Female	19	5.12	2.66	18.32	2.28	13.2	

Table 2 shows that 16 male students and 19 female students were taught Biology using self-regulated learning strategy. The result from the table shows a mean science process skills (SPS) score of 4.68 in the male student with a standard deviation of 1.79 in the pretest. 19.52 and 2.23 are the mean SPS scores and the standard deviation of the post-test for the male students respectively. The result reveals that the female students scored 5.12mean SPS with a standard deviation of 2.66in the pretest. The mean SPS score of the female students in the post-test was 18.32 and the standard deviation was 2.28. The result also revealed that the males taught Biology using SRLS had a mean SPS gain of 14.84 while the females students taught using SRLS had a mean SPS gain of 13.2.The table also reveals a mean gain difference of 1.64 in favour of male students taught Biology using self-regulated learning strategy.

Hypotheses

Hypothesis One: There is no significant mean difference in the science process skills of student taught Biology using self-regulated learning strategy and those taught using Demonstration teaching method?

Table 3: ANCOVA Summary of Academic Performance Scores Based on Teaching method

Source	Type III Sum of Squares	Df	Mean Square	F	?	Partial Eta Squared
Corrected Model	803.234[a]	2	401.617	57.808	.000	.651
Intercept	2223.152	1	2223.152	319.999	.000	.838
Pre-SPS	40.241	1	40.241	5.792	.019	.085
Teaching method	725.939	1	725.939	104.491	.000	.628
Error	430.737	62	6.947			
Total	17240.125	65				
Corrected Total	1233.971	64				

Table 3 reveals that F (1,62) = 104.491; p= 0.000<0.05. This implies that there was significant difference in the mean science process skills of students taught Biology using Self-regulated Learning Strategy and those taught using Demonstration teaching method. Thus, the null hypothesis was rejected. The partial Eta square of 0.628 was obtained for the strategy meaning that 62.8% of the students Science Process Skills in Biology were as a result of the strategy employed in the teaching.

Hypothesis Two: There is no significant mean difference in the science process skills of male and female students taught Biology using self-regulated learning strategy?

Table 4: ANCOVA Summary of Science Process Skills of Male and Female Students Taught Biology using Self-Regulated Learning Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	?	Partial Eta Squared
Corrected Model	27.574[a]	2	13.787	2.884	.071	.153
Intercept	1843.094	1	1843.094	385.561	.000	. 778
Pre-SPS SRLS	15.070	1	15.070	3.152	.085	.090
Gender	15.202	1	15.070	3.180	.084	.090
Error	152.969	32	4.780			
Total	12635.688	35				
Corrected Total	180.543	34				

R Squared = .153 (Adjusted R Squared = .100)

Table 4 reveals that F (1,32)=3.180; p = 0.084 > 0.05. This implies that there is no significant mean difference in the academic performance scores of male and female students taught Biology using self-regulated learning strategy thus the null hypothesis is not rejected. The partial Eta square of 0.090 was obtained for the strategy meaning that 9.0% of the students Science Process Skills in Biology was as a result of the SRLS employed in the teaching of Biology.

Discussion

Regarding students' acquisition of science process skills based on teaching methods, there was a Significant difference between students who were taught Biology using SRLS and those who were taught using demonstration method. Students taught using SRLS had more Science Process Skills acquisition than the students taught using the Demonstration teaching method. The SRLS is a student-centred teaching method and has shown to help students take charge of their learning process. In the course of their learning, the students are able to imbibe sciences process skills such as observation, measurement, inference, classification, communication,

prediction, employing numbers, data hypothesis testing, experimenting, interpreting data, building models, identifying and controlling variables. This was also possible because students in the self-regulated learning strategy were engaged in goal-settng, self-monitoring, self-evaluation, time management, and self-reflection. This result is similar to Mustopa et al. (2020), Effiong and Okon (2021), Iloabuchi and Okoye (2022), Choirunnisa et al. (2018) who found in their studies that there was a significant difference in the acquisition of science process skills in students who were taught Biology using innovative teaching such as self-regulated learning strategy compared to those who were taught Biology using traditional teaching methods such as lecture method. While on gender, there was no significant difference in the acquisition of science process skills of male and in female students who were taught Biology using SRLS. This result agrees with those of Effiong and Okon (2021), Iloabuchi and Okoye (2022), Choirunnisa et al. (2018) who found in their studies that no significant difference existed between male and female students' science process skills when taught Biology using SRLS. Self-regulated learning (SRL) strategies showed to bridge gender gap in Science Process Skills (SPS) in Biology by ensuring that both male and female students get equal opportunities, confidence, and competence in performing scientific investigations, interpreting data, and communicating findings.

Conclusion

Based on the findings, it can be concluded that the use of Self-Regulated Learning Strategy had positive effect in student's science process skills without gender disparity as it improved the science process skills of both male and female in secondary school Biology students in Makurdi Metropolis. It is therefore, a good alternative in the teaching and learning of Biology.

Recommendations

Based on findings, the following recommendations were made:

1. Ministry of education should encourage the use of SRL among Biology teachers in the classroom by funding seminars, workshops, conferences and refresher courses for teachers to ensure meaningful, functional and lasting teaching and learning.
2. Principals and school administrators should encourage Biology teachers to use SRLS in teaching Biology to improve students' science process skills in Biology.
3. Authors of Biology textbooks should include in the teachers' guide illustrations on how to provide support for the use of SRLS in the classroom to promote the students' participation, their comprehension and performance in Biology.
4. Future researchers should reference material and basis for further studies to other

5.5 Limitations

The following limitations were observed in the course of undertaking the study.

1. Only government grant-aided secondary schools in Makurdi Metropolis were involved in the study. This factor may affect generalization of the study's findings to private and rural schools.
2. The curriculum content was restricted to Conservation of Natural Resources, and Ecological Association. This factor may limit generalizations to other curriculum contents.

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