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EFFECT OF LABORATORY STRATEGY ON ACADEMIC SELF-EFFICACY OF CHEMISTRY STUDENTS IN SECONDARY SCHOOLS IN KATSINA STATE, NIGERIA

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ABSTRACT
This study investigated the Effect of Laboratory Strategy on Academic Self-efficacy of Senior Secondary Chemistry Students in Katsina Zonal Education Quality Assurance. Two Research objectives and corresponding hypotheses were developed to guide the study. The Objectives are: To find out the effect of laboratory strategy on Academic self-efficacy among senior secondary school chemistry students in Katsina zonal education quality assurance. And to find out the gender based differences in the effect of laboratory strategy in academic self-efficacy among senior secondary school chemistry students in Katsina zonal education quality assurance. The theories used were Constructivism learning theory by Jerome Brunner and Social cognitive theory by Albert Bandura. The study adopted Quasi-experimental research design, involving pre-test and post-test experimental and control groups. The population of the study was 19,613 SSI Chemistry students. The sample was 147 students from two intact classes. The selection was based on purposive sampling technique. One validated instrument namely; Academic self-efficacy scale (ASES) was used to collect data. The reliability coefficient of the instrument was 0.911. Independent sample t-test was used in testing the hypotheses. Findings of the study showed that students in laboratory teaching group obtained higher academic self-efficacy compared to their control group counterpart. There was no significant gender based difference in the mean academic self-efficacy of chemistry students taught separation techniques using laboratory strategy. It was concluded that laboratory teaching strategy is more effective in facilitating academic self-efficacy of chemistry students. It was recommended among others that there is need for the government to retrain chemistry teachers on effective use of laboratory strategy in teaching and learning.

Key Words: Laboratory Strategy, Conventional Strategy, Academic Self-efficacy, Chemistry.

Introduction

Chemistry as one of the core science subjects offered in Nigerian secondary schools simply refers to the branch of science which deals with the study of matter. Its role in broadening the scientific and economic advancement in developed and developing countries cannot be over-emphasized. Chemistry is a central science that cuts across all the science disciplines and it has great number of applications. Chemistry is fundamental in the world of industrialization. Today, the world is seen as a global village; meanwhile, this perception of globalization is not unconnected with industrialization in which chemistry is central. Chemistry has multiple benefits for national development. It plays fundamental roles in food production, clothing, medicine and transportation. The work anchored on the identification of methodologies which may adduce the modus operandi of teaching this central or core science called chemistry. The subject chemistry must be taught at the secondary school level by experts (chemistry educationists) who are thoroughly grounded in chemistry education. This is because they are specialists and equipped with chemistry pedagogy, which is how to go about teaching their learners. However, in our secondary school system today, the numbers of students who are offering chemistry seem not motivated and not having strong self-efficacy towards learning the subject (Zudonu & Njoku, 2018).

Laboratory strategy as used in this study is one of the student centered learning approaches expected to boost students' conceptual understanding and lead to meaningful learning that involves critical reasoning and creative thinking. According to the constructivist leaning theory learners generate knowledge and meaning from their experiences (Eden, Akpan, & Noah, 2024). Laboratory strategy has also been shown in some studies to help improve the communication skills of students in order to solve problems in science and thus become more motivated in science. In addition to this, practical work encourages and increases students' interest in science and promotes it as an engaging subject (Shana & Abulibdeh, 2020).

Self-efficacy has been observed as one of the factors that influence academic achievement of students in science, and particularly chemistry (Ramnarain & Ramaila, 2017). The construct of self-efficacy reflects an optimistic self-belief, a belief that one can perform novel or difficult tasks, or cope with adversity in various domains of human endeavor (Okokon, Ojar, Ayuba, Eyeneka, Mark Ohiero Okoli & Eyo Bassey, 2023). Self-efficacy is the individual's confidence on his competences to execute the level of energy required to surpass in life. (Fakolade & Bamideles, 2017), also found out that, self-efficacy is a predictor of students' interest in the subject. Self-efficacy is a person's capacity to achieve the goals and accomplish tasks. It is actually the confidence that individual has with the help of which he can cope in different situations successfully. Self-efficacious person is one who strives to reach and achieve the goals. He operates with intelligent guesses to perform the work and derive the results and conclusion (Aamna, Irshad & Shah, 2020). High self-efficacious students fix higher goals to achieve and are able to face the complex situation compared to the pupils with low self-efficacy, as they will be unable to do the same (Okokon et al. 2023).

Academic self-efficacy is one of the factors, which plays a significant role in the academic world of a student. Academic self-efficacy motivates the student to adopt specific and appropriate learning strategies to facilitate belief in academic goals. Academic self-efficacy traces its root in the Social Cognitive Learning Theory of Albert Bandura. Academic self-efficacy, in the words of Bandura (1986), is "the belief of an individual in his/her ability to take action by expectations". It is not concerned with what abilities or capacities a person possesses, it is related to the question of how an individual holds the belief in his/her ability to perform any

course of action or assigned task. (Okweye and Onoyase, 2024). Afriani (2020), Adie et al (2020), and Adie et al (2022) stated that, non-use of appropriate teaching methods or strategies, inadequate supply of teaching materials and learning processes, insufficient teacher training, inappropriate government policies and lack of care from parents for their children are several factors causing students to have poor academic achievement. Hence, the present study is aimed at investigating whether or not using practical method of instruction can influence the students believe in what they can do. Self-efficacy is of different categories or types among which the major ones are; General self-efficacy, Academic self-efficacy, Clinical self-efficacy and Social self-efficacy. Among these, academic self-efficacy is the target concern of the study.

Gender is also a crucial variable that was considered in this study. Gender issue in Nigeria has become an issue of concern in some years back. As schools and educational institutions are more structured, gender difference takes up more focus of researchers. Gender relates to the difference in sex (that is, either male or female) and how this quality affects their dispositions and perception toward life and academic activities (Zudonu, & Njoku, 2018). Gender disparity in self-efficacy is still very prevalent in Nigeria and perhaps the whole African countries. Some findings revealed that male students performed better than female students in cognitive affect and psychomotor skill achievement. This shows that there is a strong association between gender and response to science education. Again, some studies have shown that male show superiority in achievement than their female counterparts in chemistry and physics. Hence, the study examined the effect of laboratory strategy on academic self-efficacy of chemistry students in Katsina zonal education quality assurance Katsina state, Nigeria.

Statement of the Problem

The main problem of the study is the weak self-efficacy among chemistry students. It has been observed by the researcher that chemistry students seem to lack self-efficacy in learning chemistry which may be as a result of; poor practical knowledge of the subject, its abstract nature, and fear of the subject. The abstract nature of the subject implies that chemistry as a subject appears unfamiliar to the students because many of the chemical substances and equipment which the chemistry is dealing with are not familiar to them. As such when the chemistry teacher is explaining those things, the students may just perceive or imagine it wrongly. This may eventually be responsible for their lack of self-efficacy in chemistry.

Poor practical knowledge of the subject is the fact that many students are taught chemistry without the practical aspects just through mere explanations by using explanation or discussion method of instruction. Also, some chemistry students have some fear in their minds towards learning the subject, because some chemistry aspects or portions contain calculations especially physical chemistry and the students panic whenever they meet calculations.

Many teachers obviously cite to the unavailability of laboratory facilities in their schools is the reason for not teaching the practical aspects of the subject. However, it has been observed that the students' poor performance in the practical aspect of the subject is due to lack of adequate laboratory materials, (Gafai, 2016). Lack of proper exposure to laboratory activities and the use of ineffective and inappropriate teaching methods and strategies contribute to the observed poor self-efficacy of Chemistry students (Olufunke, 2020). Therefore, these problems might be the factors that led to the students' poor self-efficacy. So, the researcher is trying to interrelate the laboratory strategy with academic self-efficacy to see if there is any significant effect and to generate ways to improve the students' motivation and self-efficacy in chemistry.

Research Objectives

The following objectives were raised to guide the study:

1. To find out the effect of laboratory strategy on Academic self-efficacy among senior secondary school chemistry students in Katsina ZEQA, Katsina State Nigeria.
2. To find out the gender based differences in the effect of laboratory strategy in Academic self-efficacy among senior secondary school chemistry students in Katsina ZEQA, Katsina State Nigeria.

Research Hypotheses

The following Null hypotheses were formulated and tested at the 0.05 level of significance;

Ho_1: There is no significant difference in the mean academic self-efficacy scores of students taught chemistry using laboratory strategy and their counterparts taught the same topic without it in secondary schools Katsina ZEQA, Katsina State, Nigeria.

Ho_2: There is no significant difference in the mean academic self-efficacy scores of male and female experimental students taught chemistry using laboratory strategy in senior secondary schools Katsina ZEQA, Katsina State Nigeria.

Methodology

The study employed a quasi-experimental research design involving an experimental and a control group, utilizing pre-test and post-test measures to determine the effect of laboratory teaching strategy on chemistry students' academic self-efficacy. The experimental group (EG) was exposed to laboratory teaching strategy, while the control group (CG) was taught using the conventional teaching strategy. Prior to the treatment, both groups were subjected to a pre-test (O_1) to establish their initial academic self-efficacy level equivalence before the commencement of the intervention. The research design is illustrated as follows:

Illustration of Research Design

$$\mathbf{EG} \longrightarrow \mathbf{O_1} \longrightarrow \mathbf{X} \longrightarrow \mathbf{O_2}$$
$$\mathbf{CG} \longrightarrow \mathbf{O_1} \longrightarrow \mathbf{X_0} \longrightarrow \mathbf{O_2}$$

Where O_1 represents the pre-test, O_2 represents the post-test, X represents the treatment (Laboratory teaching strategy), and X_0 represents the absence of treatment (conventional teaching strategy).

The experimental group was exposed to laboratory teaching strategy for a period of six weeks, while the control group received instruction using the conventional strategy without exposure to the treatment. At the end of the six-week instructional period, both groups were subjected to a post-test using the same instrument administered during the pre-test to determine the effect of the treatment on students' academic self-efficacy.

The population of the study comprised all public Senior Secondary School one (SSI) students offering Chemistry in Katsina Zonal Education Quality Assurance, Katsina state. In this zone, there are twenty four (24) public senior secondary schools with a population of nineteen thousand six hundred and thirteen students (19,613) out of which ten thousand two hundred and sixty eight (10,268) are males and nine thousand three hundred and forty-five (9,345) are female students. A sample of one hundred and forty-seven (147) students was selected from two schools using a cluster and purposive sampling technique. Sixty seven (67) students were assigned to the experimental group and were taught using Laboratory teaching strategy, while eighty (80) students constituted the control group and were taught using the conventional strategy. The choice of 147 students as a sample is in line with Central Limit Theorem which recommends a minimum of 30 subjects as sample size in a research of this nature. The sample is illustrated below;

Table 1: Sample of the study

S/N.	School	Status	Males	Females	Total
1.	A	Experimental Group	30	37	67
2.	B	Control Group	34	46	80
Total			**64**	**83**	**147**

Data for the study were collected using an instrument called Academic self-efficacy scale (ASES). The instrument was designed to measure students' academic self-efficacy in Chemistry. The instrument was validated by four validators; two lecturers in the Department of Science Education Umaru Musa Yaradua University Katsina, one Psychologist from Hassan Usman Katsina Polytechnic and one experienced secondary school chemistry teacher. The validators scrutinized the instrument in terms of: Clarity of instrument to the subject, proper wording of items, appropriateness and adequacy of the items for the study. Thirty (30) students from GDSS Yandaki were used for pilot testing and eventually a reliability coefficient of 0.911 was obtained through Cronbach alpha statistics (Internal consistency method). The data collected were analyzed using SPSS. Independent sample t-test statistics was employed to test the null hypotheses at a 0.05 level of significance.

Results

The results were presented and analysed as follows;

Hypotheses

It was earlier mentioned that two null hypotheses were formulated to guide the study. The analysis is as follows;

Ho1: There is no significant difference in the mean academic self-efficacy scores of students taught chemistry using laboratory strategy and their counterparts taught the same topic without it in secondary schools Katsina ZEQA, Katsina State, Nigeria.

Table 2: t-test independent sample analysis on difference in Academic self-efficacy among the students in experimental and control groups

Groups	N	Mean	SD	Df	t-value	p-value	Decision
Experimental	67	46.64	9.90	145	11.824	0.000	Significant
Control	80	30.35	5.89				

Level of significance = 0.05

Table 2 presents t-test Analysis on difference in Academic self-efficacy among the students in experimental and control groups. From the results, t-value recorded is 11.824 and p-value observed is 0.000 at degree of freedom of 145. P-value observed is less than alpha value (0.05), therefore the hypothesis earlier established is rejected. The reason for the rejection is because, there is statistically significant difference between the experimental and control group.

Ho2: There is no significant difference in the mean academic self-efficacy scores of male and female experimental students taught chemistry using laboratory strategy in senior secondary schools Katsina ZEQA, Katsina State Nigeria.

Table 3: t-test independent sample analysis on difference in Academic self-efficacy of male and female students of experimental group

Gender	N	Mean	SD	Df	t-value	p-value	Decision
Male	27	44.22	9.41	65	1.665	0.097	Not Significant
Female	40	48.27	10.0				

Level of significance = 0.05

Table 3 presents t-test Analysis of the post-test of Academic self-efficacy of male and female students in experimental group. From the results, t-value recorded is 1.665 and p-value observed is 0.097 at degree of freedom of 65. P-value observed is greater than alpha value (0.05). Hence, the hypothesis which earlier stated no significant gender based difference in the Academic self-efficacy of students taught chemistry using laboratory strategy in senior secondary schools katsina zonal education quality assurance is retained. The reason is because based on the analysis there was no statistically significant gender based difference in the performance of male and female students.

Summary of the Findings

The findings of the study are summarized as follows:

1. Laboratory teaching strategy improves academic self-efficacy of chemistry students in senior secondary schools of Katsina zonal education quality assurance better than the conventional strategy. (t=11.824, p=0.000).
2. Laboratory teaching strategy boost academic self-efficacy of male and female chemistry students in senior secondary schools of Katsina zonal education quality assurance better than conventional strategy. (t=1.665, p=0.097).

Discussion of the Findings

This study investigated the effect of laboratory teaching strategy on academic self-efficacy of chemistry students in secondary schools in Katsina zonal education quality assurance, katsina State Nigeria. The data collected was analysed using t-test statistics for independent sample at level of significance 0.05. The first finding shows that students from experimental group obtained higher academic self-efficacy better than control group. There is significant difference in the mean academic self-efficacy scores of chemistry students taught separation techniques using laboratory teaching strategy and those taught the same topic using conventional strategy. The finding is in agreement with that of Garba (2021), who revealed that laboratory strategies enhances academic Achievement, knowledge and cognitive development of the students when compared to conventional method. It also goes in line with the finding of Eden et al. (2024) who revealed that hands-on activity (laboratory strategy) is very effective in producing students' positive scientific attitude. Again, Shana, and Abulibdeh (2020) found that there is a positive correlation between practical work and the academic attainment of most students in science. The study of Okweye, and Onoyase, (2024) also revealed that there is a significant relationship between academic self-efficacy and academic performance of secondary school students. However, the finding controverts that of Foulstone and Kelly (2018) who stated that the

laboratory intervention was not associated with improvements in self-efficacy, meaning it did not improve significantly after treatment. This finding may be attributed to the laboratory materials intervention that helped in arousing the interest and attention of the students towards learning the particular aspect. That is, using a suitable teaching strategy such as laboratory strategy that firmly keep the students focused, eventually boost their academic self-efficacy.

The second finding on the issue of gender shows that there is no significant difference in the mean Academic self-efficacy scores of male and female chemistry students taught separation technique using laboratory teaching strategy in senior secondary schools of Katsina zonal education quality assurance, Katsina State Nigeria. The findings of Baji (2020), supports this assertion in his study which indicated no significant gender difference in academic self-efficacy. In contrary to above, Olayinka, Awelewa, and Musa (2024), opines that, the male students taught biology using practical activities achieved better than the female students taught using a conventional teaching strategy. The absence of significant gender-based differences might be as a result of the fact that both male and female students could attain the manipulation skills of using the laboratory materials and can both be influenced by the laboratory strategy of instruction thereby having their academic self-efficacy altered almost at the same rate.

Conclusion

Based on the findings of the study, it was concluded that laboratory teaching strategy is more effective in facilitating academic self-efficacy of chemistry students. Similarly, the strategy is effective in both male and female chemistry students in senior secondary schools students of Katsina zonal education quality assurance, Katsina State Nigeria. The findings confirm that laboratory strategy provides an interactive, learner-centered environment that fosters creativity and higher-order thinking, and above all, lab strategy is an effective instructional strategy for improving learning outcomes in science education and should be integrated into teaching activities.

Recommendations

Based on the findings, the researcher put in place the following recommendations;

1. Katsina state government should be organizing workshop trainings for chemistry teachers on effective use of laboratory strategy in teaching to improve academic self-efficacy of students.
2. Teachers should ensure that they use laboratory strategy of instruction in teaching chemistry especially when dealing with a class that has a mixed gender because the strategy works efficiently on both.
3. Stakeholders in education like curriculum designers and school administrators should enhance supply of laboratory resources in schools, and design activities that incorporate laboratory activities so as to develop learners' creativity, academic self-efficacy and motivation towards learning chemistry in the study area.
4. Future researchers should replicate the study by taking other science subjects or by using a larger population and sample size to have a more comprehensive coverage leading to broadening the scope.

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