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IMPROVING SECONDARY SCHOOL STUDENTS' RETENTION IN PRACTICAL CHEMISTRY THROUGH THE USE OF PROBLEM-SOLVING SKILLS STRATEGY: THE MODERATING INFLUENCE OF GENDER

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ABSTRACT

The study investigated on the effect of Problem Solving Skills Strategy students' Retention in Practical Chemistry. Also, the moderating influence of gender on students' retention was considered. Two research questions and three null hypotheses guided the study. Quasi-Experimental research design was adopted. The sample of the study comprised 186 students drawn from two schools out of 46 co-educational secondary schools in Awka Education Zone of Anambra State. One of the schools was randomly selected and assigned to experimental group while the other was assigned to control group. Practical Chemistry Retention Test (PCRT) was the instrument used to collect data for the study. The PCRT with 17 items was trial tested on an intact class of 40 students outside the study area. The reliability coefficient of PCRT was established to be 0.78 using Cronbach alpha. PCRT was administered to the students as pre-test questions and post-test for data collection. Mean and standard deviation were used to answer the research questions while Analysis of Covariance was used to test the null hypotheses at 0.05 level of significance. The result reveals that Problem-Solving Skills (PSS) strategy had significant effect on students' retention in Chemistry. Also, female students had a significant higher retention score in practical chemistry than their male counterparts. This implies that Problem-Solving skill enhance students' retention in practical chemistry lessons. Based on the results of the study, it was recommended that Problem-solving skills should be adopted by Chemistry teachers for their practical lessons and other in teaching chemistry concept in the secondary schools.

Keywords: Problem-solving Skills, Practical Chemistry, Retention, Gender.

Introduction

The rapid advancement of science and technology has made scientific knowledge essential. The results of many scientific discoveries are used in practically every aspect of life. It is important that these products be accessible to the general public in areas where they are needed. Products require a certain level of science literacy to operate. According to Copriady (2015), science literacy is the comprehension of scientific concepts and procedures necessary for making independent decisions, engaging in civic and cultural activities, and generating economic output. Not only is it vital to be scientifically literate, but emerging nations like Nigeria also need to produce scientists through their educational systems who can

solve social issues and grow their economies. For a better quality of life, widespread science literacy and education are therefore necessary.

Science is nature. Man has made an effort to study, explore, understand, and work with the materials and forces of the cosmos around him. Every student needs to be literate in science in order for life to have any real purpose. However, integrating scientific activities into a child's schoolwork and daily life is the best method to make scientific literacy and abilities meaningful to them. Knowledge of science should not be limited to what happens inside the four walls of the classroom; rather, it should be such that the individual believes it can address his everyday needs, problems, and challenges. Chemistry is one of the science courses taught in secondary schools.

Chemistry studied matter's characteristics, applications, and synthesis. Opara and Waswa (2013) assert that chemistry is the oracle of contemporary science, that it is present everywhere, and that it is life. Thus, chemistry instruction should begin from the beginning of science education to help a child understand the world around them. The goal of chemistry education is to provide graduates with the scientific knowledge and abilities they need to meet the challenges and changes presented by science in their society. But according to Taber (2012), chemistry curricula frequently include a number of abstract ideas that are essential to understanding chemistry and other sciences in greater detail. According to Sirhan (2007), if students do not fully understand these foundational principles, it will be difficult for them to understand subsequent Chemistry/science concepts, theories, and practical chemistry.

Chemistry as a practical is concerned with how to make chemical compounds useful for the arts, how to apply these goods for financial reasons, and what conditions must be met for them to be used to their best advantage. This can be accomplished through quantitative (titration) or qualitative (salt analysis) Chemistry. According to Fatmah (2021), practical Chemistry focuses on investigation, experiments, and demonstrations that will be used in Chemistry classes and in solving real-life problems regardless of students' gender. Gender issues in the learning of sciences, especially Chemistry, are a serious concern to researchers and include all aspects and concerns related to women's and men's lives and situations in society, to the way they interrelate, to their differences in access to and use of resources, politics, and intervention. As a result, practical Chemistry instruction is necessary to improve students' academic performance in all schools.

The result of learning is academic achievement, or the degree to which pupils have met the objectives of instruction (Hattie, 2009). Achievement shows how much a student has learned on their own. Numerous factors influence chemistry students' achievement. These factors have such a significant impact on chemistry students' achievement that over time, students have shown in examinations that they prefer to memorize facts rather than fully understanding the concepts being taught (Alabi, 2014). As a result, their achievement have remained meagre. The teaching strategy used by chemistry teachers is the most frequently cited cause of low achievement in the subject (Onyi et al., 2022; Odukwe and Nwafor, 2022; Alabi, 2014). Ineffective teaching strategies lead to rote learning,

which causes students to forget what they have learned. In order for students to remember what they have learned, meaningful learning must take place. The majority of students lack problem-solving abilities, which exacerbates the situation and negatively impacts their capacity to retain Chemistry information and, as a result, their academic performance in the subject. According to Kapur (2019), both male and female students can succeed more academically if their teachers use effective teaching techniques, such as problem-solving techniques.

The process of defining an issue is known as problem-solving. This includes determining the cause of the problem, identifying, prioritizing, selecting alternatives for a solution which are all tagged problem-solving skills (PSS) (Zoe, 2020). The capacity to recognize a problem, ascertain its root cause, and find every potential remedy is referred to as problem-solving skills. Kim, Choi, and Park (2018) define problem-solving skills as the capacity to apply suitable techniques to address unforeseen obstacles in a systematic way. The study conducted by Gambari, Yaki, Gana, and Ughovwa (2014) investigated the impact of multimedia instruction based on video for problem solving skills on the achievement and retention of biology students in secondary schools. The findings indicated that there was no statistically significant difference in the academic performance of male and female biology students, possibly due to gender equality. Similarly, Ozdayi (2019) conducted research on how problem-solving abilities affect both male and female students' attitudes and retention in science courses. He went on to say that achievement is independent of gender and instead depends on how much exposure a student gets to problem-solving techniques. The researcher also claimed that PSS has been demonstrated to be a critical component of success in both personal and organizational settings including science-related endeavours. Regardless of a student's gender, the recall of practical and other chemistry concepts can be facilitated by the use of problem-solving skills in teaching and learning.

A child uses retention to preserve knowledge in his memory for use at a later time (Ngwoke and Eze 2010). It is the capacity of a learner to store knowledge in long-term memory, which he may access anytime necessary. Chemistry retention has grown to be a significant problem that calls for creative teaching strategies that might boost students' retention capacity. Hence, the need for the present study.

Purpose of the Study

The purpose of the study was to investigate the effects of problem-solving skill on secondary school student‘s Retention in practical chemistry. Specifically, the study investigated the;

1. Effect of student’s problem-solving skill on students’ retention scores in practical Chemistry when compared with those taught with conventional teaching method
2. Find out the effect of problem-solving skill on the male and female student’s retention in practical Chemistry
3. Interaction effects of problem-solving skills and gender on the student’s Retention in practical chemistry

Research Questions

The following research questions guided the study

1. What are the main retention scores of students of student's taught practical chemistry using Problem-solving skills and those taught using conventional method?
2. What are the mean retention scores of male and female student's taught practical chemistry concepts using Problem-solving skill?

Hypotheses

The following hypotheses were tested at 0.05 level of significance:

1. There is no significant difference between the mean Retention scores of students' taught practical chemistry using Problem-solving skills and those taught using the conventional method.
2. There is no significant difference in the mean Retention scores of male and female student's taught practical chemistry using problem-solving skill.
3. There is no significant interaction effect of teaching methods and gender on student's mean retention scores.

Research Method

The study adopted a quasi-experimental research design. Specifically non equivalent control- group design was used. Quasi- experimental is an experiment where random assignment of subject to experimental and control groups is not possible rather intact or pre-existing groups are used (Nworgu, 2015). The researchers used two streams of a class as experimental and control groups respectively. This research design is considered suitable because participants were not randomly assigned to groups rather treatment condition was randomly assigned to two intact groups which were organized.

Area of the study

The area of the study was Awka Education Zone of Anambra State. Awka Education Zone consists of five local government areas namely; Awka North ,Awka South, Njikoka, Anaocha and Dunukofia. The zone is the heart of Anambra state capital territory. It has basic modern facilities such as good roads and electricity. The people living in the zone have high value for education. The area has two universities and a teaching hospital with 61 public secondary schools. This study is better carried out here because it is an urban center, the seat of the government of the Anambra state. The people working there have value for qualitative education

Population of the Study

The population of the study comprised 2,927 senior secondary school year two (SS 2) chemistry students in 61 public secondary schools (46 coeducational schools and 15 single-sex schools) in Awka Education Zone of Anambra State (Source: post primary school services commission 2021/2022 academic session)

Sample and Sampling Technique

The sample for the study consisted of 186 senior secondary school (SS 2) Chemistry students drawn from four classes in two co-educational schools out of the 46 co-educational secondary schools in Awka Education Zone. Using a lucky dip, one of the schools was designed the experimental school and the other, control group. From the experimental schools, two intact classes were chosen with 45 males and 50 females giving a total of 95 students. From the control

schools another two intact classes were chosen with 40 male and 51 female giving a total of91 students. The classes were chosen that way so that the same chemistry teacher would teach them. This was done to check teacher's variables.

Instruments for Data Collection

The instrument used for data collection was Practical Chemistry Retention Test (PCRT). PCRT was adapted from problem-solving skill inventory by (SPSI-R:D'Zurilla et al 2002). The original reliability index of the scale was 0.90. The researchers modified some of the statement to suit the purpose by replacing the word sex abuse with Practical Chemistry, and also included some of Chemistry practical content taught to the students. The PCRT was measured using on a four point retention scale of Strongly agree (SA), Agree (A), Disagree (D) and Strongly Disagree (DS) to enable the students indicates their level of retention. It was also used for both pretest and posttest.

Validation of Instruments

The Practical Chemistry Retention Test (PCRT) was sent to the expert in the Department of Science Education and Education Foundation in Nnamdi Azikiwe University, Awka for face validation. The expert were specifically requested to find out the suitability of the language used in the construction of the PCRT with regards to the students level of understanding; and extent to which the statements on PCRT assess retention of students in the areas of study. After the validation, some of the items were modified, reduced and some negatively response were included.

Reliability of the Instruments

The PCRT were trial tested. PCRT was administered on the same 40 SS2 students in the secondary school in Ogidi Education Zone in Anambra State. The original reliability index of sex abuse inventory was 0.90 but because it was adapted a new reliability was established using Cronbach Alpha method and the reliability index of 0.86 was obtained.

Experimental Procedure

The regular school teacher of the experimental group was used to teach the student in the experimental and then in the control group. The difference is that teachers in the experimental group were briefed on how to use the lesson plan prepared using problem-solving skill strategies. They were also trained on how to use the problem-solving skills like identifying a problem, defining a problem, analyzing a problem, proffering solution and finally drawing conclusion to the problem. This is to ensure that they were familiar with before using it to teach. The teachers in the control group were asked to use usual teaching technique.

The study lasted for 8 weeks. The treatment (teaching) was done according to the regular timetable by the research assistants who were the regular school teachers of the school used. The time table allotted one double period (80 minutes) and one single period (40 minutes) for Practical Chemistry every week. These periods were used to teach the students for four weeks, where each topics lasted for one week. The PCRT was administered to thestudents in the first week of the six weeks as pretest. This is to ascertain the previous knowledge the students have on the concept they were exposed to during the study. This took effect in both the control and experimental group. The pretest marks the beginning of the treatments in both the group, thereafter the school (teacher took off with the treatment which lasted for four weeks. The 6th weeks in

the study was used for posttest for practical chemistry achievement. During these periods was a regular monitoring by the researcher on the research assistants. However, two weeks after the post- test the PCRT was re-administered to the students as retention.

Control of Extraneous Variables

The following measures were taken to control the extraneous variables likely to adversely affect the conduct of the experiment and the result obtained thereof:

Pretest Interference: To ensure that there was no interference of pretest on the student during the posttest, the PCRT used for pretest was reshuffled and reprinted using different paper color from that of pretest when used as posttest. This is to ensure that there is no pretest interference with the posttest.

Initial Group Difference: In order to ensure that the schools used are similar in characteristics and composition, Government schools and co-educational were used for both the experimental group and control group. However, beyond school characteristics and composition, other initial group difference and limitations inherent in experimental group and control groups were adjusted by using (ANCOVA) in data analysis.

Hawthorne Effect: Hawthorn is as a result of students faking their behaviour when they perceive that they are being used in an experiment and this may affect the outcome of the study. The regular school class teachers were therefore used for the study.

Class Interaction: To ensure that the experiment subject did not interact, the school used in the study where mile apart.

Experimenter Bias: The regular Chemistry teacher were trained and used to teach students. This helped to curtail the effect of experimenter bias.

Method of Data Collection

The instrument for data collection was Practical Chemistry Retention Test (PCRT). PCRT was administered on the research participant (experimental and Control Groups) before the actual experiment began. The experiment started after the pretest and lasted for four weeks of eight lesson periods. Each lesson period was forty five minutes. At the end of the treatment, the items were reshuffled and administered again to the students as posttest. The Chemistry teachers in both experimental and control groups were used to administer PCRT to their students.

Method of Data Analysis

Mean and Standard deviation scores were used to answer the research questions while two-way analysis of variance (ANCOVA) was used to test the hypotheses at 0.50 alpha levels. Two ways ANCOVA was used to analyse the experiment because the experiment has two variables, and there are three basic types of effect that are tested: Main effect of independent variable A, main Effect of independent variable B, and effect for the interaction of A and B. For the hypotheses, when the P-value was greater than 0.05, null hypotheses was rejected.

Presentation of Results

Research Question 1: What are the mean Retentionscores of students taught Practical Chemistry using Problem-solving skill and those taught using conventional method?

Table 1: Mean Pretest and Posttest Retention Scores of Students Taught using Problem-solving skill and Conventional Method

Method	N	Pretest mean	Posttest mean	Gain	SD in mean pretest	SD in posttest
PSS	95	39.32	77.57	38.34	9.89	7.50
Convectional	91	36.26	59.72	23.46	13.33	7.19

Table 1 shows that the group taught practical Chemistry using problem-solving skill has a gain in mean Retention score of 38.34, while those taught using conventional method has gain in mean Retention score of 23.46. This reveals that students taught practical Chemistry using problem-solving skills technique have higher mean retention gain scores in practical Chemistry than students taught using the conventional method. The use of problem-solving skills decreases the spread of scores among the students from pretest to posttest. The use of conventional method also decreases the spread of scores among the students.

Research Question 2: What are the mean Retention scores of male and female students taught practical Chemistry using problem-solving skills?

Table 2: Mean Pretest and Posttest Retention Scores of Male and Female Students Taught using Problem-Solving Skills

Gender	N	Pretest mean	Posttest mean	Gain in mean	Pretest SD	Posttest SD
Male	45	45.71	79.42	33.71	8.106	7.70
Female	50	33.40	75.90	42.50	7.431	6.97

Table 2: Shows that the male taught practical Chemistry using problem-solving skills have a gain in mean Retention score of 33.71 , while the females have a gain in mean score of 42.50. Female students taught practical Chemistry using problem-solving skills have higher mean Retention scores in practical chemistry than their male counterparts. The use of problem-solving skills decreases the spread scores in both male and female students.

Hypothesis 1: There is no significant difference between the mean retention scores of students taught practical Chemistry using problem-solving skillsand those taught using conventional methods

Table 3: Analysis of Covariance for the test of Difference in Retention of Students Taught Practical Chemistry using Problem-Solving Skills and those Taught with Conventional Teaching Method

Source	SS	Df	Mean Square	F	P-value	Decision
Corrected Model	15675.358[a]	4	3918.839	79.203	.000	
Intercept	39553.507	1	39553.507	799.414	.000	
Pretest	412.084	1	412.084	8.329	.004	S
Gender	381.270	1	381.270	7.706	.006	S
Method	13221.419	1	13221.419	267.217	.000	S
Method* Gender	51.148	1	51.148	1.034	.311	NS
Error	8955.546	181	49.478			
Total	669268.000	186				
Corrected	24630.903	185				

Table 3: Shows that at 0.05 level of significance, there was significant main effect of the treatment in the Retention scores of the students F(1,185) = 267.217, P-(0.000)< 0.05. Thus, the null hypothesis is rejected. Therefore the effect of problem-solving skills on students' retention in practical chemistry is significant when compared with those taught using conventional method

Hypothesis 2: There is no significant difference in the mean retention scores of male and female students taught practical chemistry using problem-solving skills. Shows that at 0.05 level of significance, there was significant main effect of the treatment in the retention scores of the male and female students, F (1,185)= 7.706, P – (0.006). Therefore, the null hypothesis is rejected. Therefore there is a significant difference between the mean Retention scores of male and female students taught practical chemistry using problem-solving skills in favour of the female students.

Hypothesis 3: There is no significant interaction effect of teaching methods and gender on students' Retention in practical Chemistry. Table 3 also furtherthat at 0.05 level of significance, there was no significant interaction effect of teaching method and gender on the retention scores of the students , F(1,185)= 1.034 P – (0.311) >0.05 . Therefore, the null hypothesis eight is not rejected. Therefore there is no significant interaction effect of teaching methods and gender on student's mean retention scores

Discussion of Findings

The findings of the study showed that the mean retention gain of students taught with problem-solving skills strategy was higher than that of those students taught with conventional method. The findings in table 3 showed that there was statistically significant difference in the mean retention score of students taught with problem-solving skills than those taught with conventional method of instruction. This finding is in line with that of Akinsola and Odeyemi (2014) who reported that students perform better through the use of innovative method of problem-

solving skills. In contrast to the findings of other researchers Mandina and Ochinogor (2018) reported that problem-solving skills do not enhance students' retention.

The result of the study on male and female student's mean retention score in Practical chemistry revealed that female students had a significant higher retention score in practical chemistry than their male counterparts. The finding is in line with Gambari, Yaki, Gana and Ughovwa (2014) who carried out an experimental research on the effect of video base multimedia instruction on student's retention on biology and found out that female students achieved more than male students in both the experimental and control groups. The study also revealed that female students performed better than the male counterparts in both the experimental and control groups in their level of Retention. Conversely, Iweka (2015) who investigated on enhancing students' academic achievement and retention through discussion method and lecture method observed no significant difference in the mean Retention scores of male and female students which is not in line with this study.

The interaction effect of instructional methods and gender on students' mean retention scores in Practical chemistry was not significant. The findings of this study with respect to instructional method is in line with the findings of Abumchukwu (2018) who found no significant interaction effect between gender and instructional treatment on student's retention in chemistry. Omiko (2015) in his study on student's interaction pattern on retention in chemistry, found no interaction effect of gender and instructional treatment on students' retention. Ugwuadu (2011) also found no interaction effect between instructional method and gender on the effect of discourse patterns on students' retention in biology. On the other hand, Iweka (2015) found a significant interaction effect of treatment and gender on the effect of inquiry and laboratory approaches of teaching geometry on students retention..

Conclusion

The study established that Problem-Solving Skills is effective in arousing, sustaining and enhancing students' retention in practical Chemistry.

Recommendations

The following recommendations were made based on the findings.

1. Problem-Solving Skills should be adopted in the Chemistry curriculum delivery in the public secondary schools.
2. The ministry of education and other government policies should mandate and help the professional bodies in terms of providing adequate fund to ensure that the workshops and seminars do not end on paper.
3. Curriculum planners should incorporate and lay emphasis on different Problem-Solving Skills as an alternativesto conventional teaching method.

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