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EFFECT OF CONSTRUCTIVIST INSTRUCTIONAL MODEL AND PROBLEM-SOLVING INSTRUCTIONAL STRATEGY ON SECONDARY SCHOOL STUDENTS' INTEREST AND ACHIEVEMENT IN PHYSICS AND CHEMISTRY IN IMO STATE

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Abstract

This study investigated the effects of constructivist instructional model (5PCIM) on students' achievement and interest in physics and chemistry in Imo State. Four research questions were asked, and Six hypotheses were formulated that gave this study a sense of direction. This study adopted quasi experimental non-equivalent control group design. The population for the study comprises all physics and chemistry students in Imo state. The sample of the study was 246 SSII physics and chemistry students drawn through multistage sampling technique. four instruments' Physics and chemistry Achievement Test, Physics Interest Inventory and Chemistry Interest Inventory were used and validated by experts. The reliability coefficients obtained for the PAT, CAT, PII and the CII were 0.71, 0.73, 0.81 and 0.83 using Kuder Richardson and Chronbach-alpha procedure respectively. Data obtained from this study were analyzed. Mean and standard deviation scores were used to answer the six research questions while the eight hypotheses were tested at P<0.05 level of significance using Analysis of Covariance (ANCOVA). The result showed that students taught using 5PCIM and PSIS obtained mean achievement score and mean interest score in physics and chemistry higher than those taught using Conventional Instructional Model (CIM). Gender did not influence significantly on mean achievement score and mean interest score of students taught using both 5PCIM and PSIS. Furthermore, the result revealed no significant interaction effect of gender and treatment on mean achievement score and mean interest score of students taught using both strategies. Therefore, this study recommended adequate training for teachers on the use of 5PCIM and PSIS which should be adopted in Nigerian secondary schools. It is effective in teaching and learning using 5PCIM and PSIS because both strategies promote the acquisition of scientific skills, technological skills, and even entrepreneurial skills.

Introduction

Physics is the science that studies the structure of matter, its motion and behaviour through space and time, along with related concepts such as energy and force while Chemistry is a branch of natural science that deals with the study of matter, its composition, structure, properties and the changes they undergo. Matter on the hand is the basic substance of which everything is made; energy is what makes matter move and change. Physicists and chemist study all aspects of nature.

They want to know what forces hold atoms together, how gases change into liquids, why metals conduct electricity, and how stars evolve. Physics can be loosely divided into two categories: classic physics and modern physics. Classic physics deals with fields of study that was well developed before the 1900's. It includes mechanics, heat, sound, light, and electromagnetism which are the relationship between electricity and magnetism. Chemistry on the other hand has various branches; Organic, Inorganic, analytical and physical chemistry. Virtually everything in the universe has its unique chemistry.

Physics and chemistry are one of the oldest academic disciplines, perhaps the oldest through its inclusion of astronomy. Over the last two millennia, physics was a part of natural philosophy along with chemistry, biology, and certain branches of mathematics, but during the scientific revolution in the 17th century, the natural sciences emerged as unique research programs. Physics and chemistry intersect with many interdisciplinary areas of research, such as biophysics, biochemistry, biophysical and quantum chemistry, and the boundaries of physics and chemistry are not rigidly defined. New ideas in physics often explain the fundamental mechanisms of other sciences while opening new avenues of research in areas such as mathematics and philosophy. Physics and chemistry also make significant contributions through advances in new technologies that arise from theoretical breakthroughs. For example, advances in the understanding of electromagnetism or nuclear physics led directly to the development of new products that have dramatically transformed modern-day society, such as television, computers, domestic appliances, and nuclear weapons; advances in thermodynamics led to the development of industrialization, and advances in mechanics inspired the development of calculus.

Physics and chemistry are core science that play important roles in explaining the events that occur in the universe. Both are subjects needed in the study of many courses which are basic for the technological development of any nation. Physics and chemistry have been the most utilized basic science subjects in most technology and technology-related professions. Hence the gigantic role both subjects play in the socio-economic development of a nation must not be undermined. Boyo (2010) viewed physics as a course of study which is perceived to be experimental and that almost all aspect of life science, both living and non-living has something to do with Physics, ranging from engineering to mathematics, biology and chemistry.

Academic achievement deals with the extent students have gained from a particular course of instruction. According to Omachi (2000) achievement is the scholastic standing of a student's performance at a given moment. It has to do with the successful accomplishment of goal(s). The purpose of testing an achievement is to help the teacher and the students evaluate and estimate the degree of success attained in learning a given concept. It is also useful in testing the retention of information and skill. It is equally appropriate in determining the efficiency of instruction. One of the issues at stake in education today is students' achievement measure in relation to teaching and the overall success of learning outcome. Hassan (2006) pointed out that effective learning and sound academic achievement contributes to national development. It is something of great importance to parents, teachers, and students themselves; even the larger society is aware of the long-term effects of high and low academic achievement since the product of schools are expected to shape the destiny of the society. In the context of this study, academic achievement would mean scores of students obtained in physics and chemistry achievement tests.

Moreover, some researchers have identified individual interest as a key component to learning. Hilgardin Okigbo (2010) defined interest as a persisting tendency to pay attention and enjoy some activity or content. Interest promotes learning because very little learning can take place without the learner becoming interested in the subject matter and activities. Though some children may be intellectually and physically capable of learning, they may never learn until their interest is stimulated (Onyemerekaya, 2008). Once the students are stimulated, they will continue to learn as long as the teacher is capable of sustaining their interest in the subject matter. Harbor-Peters (2001) also defined interest as a subjective feeling of concentration or curiosity over something. Harbor-Peters pointed out that interest can be expressed through simple statements made by individuals of their likes and dislikes and one is likely to do well in a discipline of interest. Interest can be seen also as a mother of attention because once there is direct interest, attention is guaranteed, and learning is assured. Interest in this context would mean feeling of likeness or curiosity of students over physics and chemistry which is measured by the use of inventories.

Theoretical Review

Constructivist Approach

Constructivism is an epistemology, a learning or meaning-making theory that explains the nature of knowledge and how human beings learn. It maintains that individuals create or construct their own new understandings or knowledge through the interaction of what they already know and believe and the ideas, events, and activities with which they come in contact (Cannella & Reiff, 2000; Richardson, 2003). Knowledge is acquired through involvement with consent instead of initiation or repetition (Kroll & LaBoskey, 2005). Learning physics or chemistry is a complete and slow process. Students' have difficulty in understanding most of the concepts in physics and chemistry and hold misconceptions. Often, they have misconceptions about the natural phenomena before coming to the classroom and these misconceptions prevent meaningful learning. Therefore, instruction should focus on students' ideas. Students should be encouraged to think, ask questions, test ideas, and explain phenomena.

These can be achieved by constructivist approach. From constructivist point of view, knowledge cannot be transferred into the student, instead students' construct their own meanings from the words or visual images they hear or see. Knowledge is not passively received from the teacher or through the senses. It is actively built up by the learner. Constructivism focuses on the way learners construct useful knowledge. It may be through personally constructed or socially mediated. Learner's form, elaborate and test new knowledge until they become satisfied. Knowledge develops and continues to change with the activity of the learner. Then, learning occurs by changing and organizing cognitive structure.

Based on this perceptive, teaching is not providing information and checking whether students have acquired it or not, teaching is creating situations in which students are actively involved in scientific activities and they make their own construction. Teachers see students' constructions through student's sensory motor and mental activities and communication. Teaching from constructivist theory aims at applicability of knowledge in situations. Problem solving, reasoning, critical thinking and active use of knowledge are goals of constructivism.

Constructivist approach gives priority not to teach the same concepts to all students but to carefully analyze students' understanding to increase learning. Constructivist teachers consider what students think about concepts and formulate lessons and plan instruction based on students' needs and interests (Brooks & Brooks, 2000).

Five phases of Constructivist Instructional Model

The philosophy about learning, that proposes learners need to build their own understanding of new ideas, has been labelled constructivism. Much has been researched and written by many eminent leaders in the fields of learning theory and cognition. The five phases, whose titles capture the essence of the student's actions, are listed as follows:

- Engagement phase
- Exploration phase
- Explanation phase
- Elaboration phase
- Evaluation phase

1. Engagement Phase:

In most instances the teacher will want to begin with "Engagement". In this phase, teacher want to create interest and generate curiosity in the topic of study; raise questions and elicit responses from students that will give teacher an idea of what they already know. During this stage, students should be asking questions (Why did this happen? How can I find out?). In this phase, there is no lecturing, and the past experiences are connecting with actual experiences. Students derive some questions and try to find answers to them. For teachers, this phase provides opportunities for determining their students' misconceptions (Balci 2005).

2. Exploration Phase:

During the "Exploration" phase, students should be given opportunities to work together without direct instruction from the teacher. Teacher should act as a facilitator helping students to frame questions by asking questions and observing. Using Piaget's theory, this is the time for disequilibria. Students should be puzzled. Motivated to the subject in engage phase, student makes some research activities which consist of gathering data, observation, guessing and testing them and making hypotheses (Wilder & Shuttle worth, 2005).

3. Explanation Phase:

During explanation, teacher should encourage students to explain concepts in their own words, ask for evidence and clarification of their explanation, and listen critically to one another's explanation and those of the teacher. Students should use observations and recordings in their explanations. A representative in each group, formed in the explore phase, explain the results of their work, and let their friends discuss about them. The explain phase is a teacher-centered phase in 5E model, because teachers become active for correcting mistakes and completing the missing parts in students' results. Teachers may choose lecture method or may use another interesting method like showing a film or a video, making a demonstration or giving an activity which leads students to define their work or to explain their results.

4. Elaboration Phase:

In this phase, students can practice their new knowledge, suggest solutions, create new problems and make decisions and /or introduce logical implications. The situations can be realized by presenting a new research activity or by extending the activities done in the explore phase (Wilder & Shuttle worth, 2005). Working in groups also in this phase, students are close to end up the asked problem. The groups present and explain their final situations. This phase can be considered as the extension of research step because of the existence of supplement problems.

5. Evaluation Phase:

The evaluation phase is important in determining whether the students learn the concept correctly in scientific context and reflect it to the context. This phase may be realized in formal or informal method (Wilder & Shuttle worth, 2005). In this phase, the teacher should observe students' knowledge and/or skills, application of new concepts and a change in thinking. Students should assess their own learning. Ask open-ended questions and look for answers that use observation, evidence, and previously accepted explanations.

Studies on Gender, Students' Achievement, and Interest

Ukozor (2011) investigated the effect of constructivist teaching strategy on senior secondary school students' achievement and self-efficacy in physics. The study employed a quasi-experimental design. The sample size of the study comprised of 184 students from four secondary schools (two boys and two girls), drawn from the population of the study. Five research questions and three null hypotheses guided the study. Mean and standard deviation were used in answering the research questions and ANCOVA used in testing the hypotheses. A significant effect of gender on students' physics academic achievement was found in favour of male students. This study is related to the present study because gender is a moderating variable in the study, but the two studies differ in terms of the methods employed in the study.

Madu (2004) conducted a study on the effects of constructivist's instructional model (PEDDA) on student's conceptual change. The study employed a quasi-experimental design. Five research questions and four null hypotheses guided the study. The sample for the study comprised of 134 SSII students. Mean and standard deviation was used to answer the research questions, while ANCOVA was used to test the hypotheses at 0.05 level of significance. The result from conceptual change trace analysis revealed that conceptual change depends on gender, with male students in science having conceptual shift than the female students. The researcher concluded that gender influences the students' level of understanding from preconception or alternative conception to scientific conception. This study is related to the present study because gender is a moderating variable in the study, but the two studies differ in terms of the methods employed in the study.

Agommuoh and Nzewi (2003) investigated the effects of videotaped instruction on secondary school students' achievement in physics. Three hundred and ninety-eight SS1 students were selected from two co-educational schools. Purposive and stratified sampling techniques were used. Data generated were analyzed using mean and standard deviation and Analysis of Covariance (ANOVA) was used to test the hypotheses at 0.05 significance. The results indicated that the achievement of students in physics greatly improved with the use of videotaped instruction.

Student gender had no significant effect in their achievement in physics when video-taped instructions are used.

Statement of the Problem

Evidence of poor performance in physics and chemistry shown by researchers (Zubairu, 2014; Obasi et al, 2018; Okediji, 2022; WAEC, 2016-2018, NECO, 2018) points to the fact that the current methods of teaching physics and chemistry may not be exciting to the students. This may lead to students' lack of understanding of the concepts, functionality, and application of physical ideas. The WAEC Chief Examiners consistently reported that students dodge questions on projectiles, measurement of heat, waves, simple harmonic motion, redox reaction, thermodynamics etc. and when an attempt is made, they show lack of understanding of the concepts in their workings. The reports also show a general poor performance in both subjects. Based on the forgoing, the study tends to find out the effect of five phases' constructivist instructional model (5PCIM) and problem-solving instructional strategy in teaching some concepts in physics and chemistry on students' achievement and interest. In other words, the statement of problem of this study is: 'could the use of five phases' constructivist instructional model (5PCIM) and problem-solving instructional strategy in teaching physics and chemistry enhance achievement and interest of physics and chemistry students in secondary schools?'

Purpose of the Study

The main purpose of this study was to determine the effects of five phases' constructivist instructional model (5PCIM) and problem-solving instructional strategy on students' interest and achievement in physics and chemistry in Imo State. Specifically, the study is designed to:

i. determine the effect of the use of five phases' constructivist instructional model (5PCIM) on the achievement of physics and chemistry students.
ii. find out the effect of the use of problem-solving instructional strategy on the achievement of physics and chemistry students.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught physics and chemistry through the use of five phases' constructivist instructional model (5PCIM), problem solving instructional strategy and lecture method?
2. What are the mean interest scores of students taught physics and chemistry using five phases' constructivist instructional model (5PCIM), problem solving instructional strategy and lecture method?

Hypotheses

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

1. There is no significant difference in the mean achievement scores of students taught physics using five phases' constructivist instructional model (5PCIM) problem solving instructional strategy and lecture method.

2. There is no significant difference in the mean achievement scores of students taught chemistry using five phases' constructivist instructional model (5PCIM) problem solving instructional strategy and lecture method.

Methodology

The design for this study was quasi-experimental. The use of intact classes will not allow for randomization of the research subjects. Also, the administrative set up in the schools is such that students are already organized in classes and the administrators would not allow the classes to be disorganized for the purpose of the study. Thus, the specific design used for the study is pre-test, post-test nonrandomized control group design.

Group	Pretest	Treatment	Posttest
Experimental 1	O_1	X	O_2
Experimental 2	O_3	X	O_4
Control	O_5	X	O_6

The researcher adopted four instruments for data collection. The instruments are Physics Achievement Test (PAT), Chemistry Achievement Test (CAT), Physics Interest Inventory (PII) and Chemistry Interest Inventory (CII). PAT and CAT were based on the senior WAEC past question papers and marking scheme, three instructional tools (5PCIM, PSIS teaching plan, and lesson plan) were prepared for both subjects.

Physics Achievement Test (PAT) and Chemistry Achievement Test (CAT)

The PAT and CAT are a 25-item Achievement Test constructed based on the topics chosen for the study. The test consists of 25 multiple-choice objective items adopted from Senior Secondary School WAEC past question papers on physics and chemistry. The choice and number of items in each unit depended on the time spent during the teaching period. The instruments were used as pre-test and after the treatment has been made, the same instruments were reshuffled and used as post-test. The post-test was used to determine the effect of using 5PCIM and PSIS strategies and conventional method on students' achievement in physics and chemistry. The preliminary part of the instrument made provisions for getting bio-data information on school code, class, age and gender of the students. The researcher used code 01 to identify the 5PCIM group, code 02 for PSIS group while code 03 was used for conventional method group.

Physics and chemistry Interest Inventory (PII & CII)

The PII & CII are a 30-item inventories selected and adopted by the researcher from Vocational Interest Inventory developed by Bakare (1977). The scale is a five-point response type which includes:

- Like very much if you like very much to engage in the activity.
- Like, if you like to engage in it
- Neither like nor dislike, if you neither like nor dislike it
- Dislike, if you dislike engaging in the activity and
- Dislike very much, if you very much dislike engaging in it.

For both PII and CII, Like very much, Like, Neither like nor dislike, Dislike, Dislike very much have the scores of 5,4,3,2 and 1 respectively. Any item with mean score above 3.00 was regarded as being liked by the students and if below 3.00 was regarded as being disliked by the students.

Table of Specification/Test Blue Print on Contents of (PAT)

Duration in weeks	Content (Topic)	Knowledge	Comprehension	Application	Analysis	Synthesis	Total	%
Week 1	Projectile Motion	1	1	-	1	-	3	12%
Week 2	Time of Flight, Maximum Height and Range	1	1	1	-	-	3	12%
Week 3	Simple Harmonic Motion	2	1	1	1	-	5	20%
Week 4	Energy of SHM and Resonance	1	1	2	1	1	5	20%
Week 5	Elasticity	2	1	1	-	-	4	16%
Week 6	Hooke's Law	2	2	-	1	-	5	20%
Total							25	100%

Table 1: Table of Specification with Item Distribution for CAT

Duration in weeks	Content (Topics)	Knowledge (24%)	Comprehension (24%)	Application (28%)	Analysis (12%)	Synthesis (12%)	Total (100%)
Week 1	Oxidation and Reduction	1(21)	1(22)	1(23)	1 (24)	1(25)	5
Week 2	Definition of terms in electrolysis and factors affecting the preferential discharge of ions	2(1,15)	1(9)	1(10)	-	-	4
Week 3	Electrolysis of specified electrolytes	-	1(4)	1(20)	1(2)	1(18)	4
Week 4	Electrochemical cells and application of electrochemical cells	2(3, 13)	2(5)	2(12, 17)	1(19)	1(11)	7
Week 5	Application of electrochemical cells	-	1(14)	2(7, 6)	-	-	3
Week 6	Faraday's law of electrolysis	1(8)	1(16)	-	-	-	2
	Total (100%)	6	6	7	3	3	25

The 25-items each of Physics and chemistry Achievement Test selected by the researcher from Senior Secondary WAEC physics and chemistry past question papers were given to four experienced secondary school physics and chemistry teachers and four Physics and chemistry Educators from Imo State University, Owerri for validation. They were given the research title, purpose of the study and the contents to be covered for the five-week teaching period. For validation of PII and CII they were given to one Measurement Expert and one Guidance Counsellor from Michael Okpara University of Agriculture, Umudike for evaluation of the items. This was for them to rate the list of interest statements based on: (a) appropriateness for measuring interest (b) quality of the interest statements on language clarity and length of the statement.

The reliability of PAT and CAT were established using Kuder Richardson via SPSS (Statistical Package for Social Sciences) version 20. This is because the items were dichotomously scored.

Forty students that will not take part in the study were given the 25-item objective test and at the end scores were obtained for the 40 students. The reliability index of the instruments (PAT and CAT) were found to be 0.71 and 0.73 respectively. The reliability of PII and CII were established using Cronbach reliability technique. Cronbach alpha was used because the items in PII and CII were not dichotomously scored but have multiple ratings. The PII and CII (30-items each) were given to the same 40 students to respond to. The reliability indices were found to be 0.81 and 0.83 respectively. The PAT, CAT, PII and CII were administered to the subjects before the treatment started and from this pre-test, results were obtained. Immediately after the five-week teaching (treatment) period, the same instruments were administered to the same students in their classrooms under the same classroom conditions but this time, the test items were re-arranged starting with even number item from the bottom. For PAT and CAT, the test lasted for 1 hour 30 minutes, but the PII and CII had no time of response but the students were advised by their class teachers to finish in 30 minutes time. The teachers of the participating classes in each school administered the tests under the guidance of the researcher to avoid experimenter bias. In PAT and CAT each item was scored 4 marks making a total of 100 marks for the 25 items. For PII and CII, like very much, like, neither like nor dislike, dislike, and dislike very much were scored 5, 4, 3, 2, and 1 point respectively.

Experimental Procedure

In the six co-educational schools chosen for the study, two intact classes (code 01) from two schools were exposed to 5PCIM and two other intact classes (code 02) from two other schools received the treatment using PSIS. These four intact classes formed the experimental groups A and B. Two intact classes (code 03) from two schools different from those used in the experimental groups were used as the conventional class (group C). Group C did not receive the same treatment as groups A and B but received their treatment using lecture method. The study was conducted in the school classroom at the time of normal classes. Before starting the teaching, PAT, CAT, PII and CII were given to the students to answer and respond to respectively and no feedback on the pre-test achievement was given to them. This measure was used to reduce Hawthorne effect. The class teachers for groups A and B were trained by the researcher before teaching groups A and B with 5PCIM and PSIS teaching plan respectively. The procedure used by the researcher in conducting this study was presented in three stages. Namely; training programme for physics and chemistry teachers, teaching of the students and evaluation/testing period.

Control of Extraneous Variables

1. Experimenter bias: The researcher did not teach the research subjects. This was done by their regular classroom teachers of the participant classes but under the supervision of the researcher.
2. Teacher variable: The materials for teaching the students were prepared by the researcher. Also, there was a training programme for the teachers who taught the students in groups A and B. During the training, the researcher gave the teachers instructions on how to teach the students in each group. At the end of the training, the teachers applied the selected instructional strategies as they relate to the chosen topics.
3. Class interaction: To solve the problem of interclass discussion among students, one intact class only was used in each school. Also, only one school was chosen from each L.G.A. from the two zones used.

4. Initial group difference: Due to the nature of the administrative set up in the schools, there was non-randomization of the research subjects because the students were already organized in classes. ANCOVA was used for data analysis in this respect.
5. Effect of Pre-test on Post-test: The research lasted for five weeks and it was expected that this period was long enough as not to permit the pre-test to affect the post-test scores. Also, the items were re-arranged before administering the post-test in the seventh week.
6. Control of Hawthorne effect

All the research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The choice of ANCOVA was because of the nature of the design of the study i.e. quasi experimental (specifically non-equivalent control-group design). This was because the design permits the use of pre-test, which acts as covariate; therefore, ANCOVA helps to establish the homogeneity or equivalence of the two groups before treatment. Besides this, since intact classes were used for the study, ANCOVA also helps to increase the power of the test because of error that may occur because of non-randomization of the subject of the study (i.e. Type 1 error was reduced). Decision rule: The null hypothesis was rejected when p-value (Sig.) is less than 0.05 ($p < 0.05$) otherwise, it was up-held.

Results

Research Question 1

What are the mean achievement scores of students taught physics and chemistry through the use of five phases' constructivist instructional model (5PCIM), problem solving instructional strategy (PSIS) and lecture method?

Table 1: Mean achievement scores of students taught physics through the use of five phases' constructivist instructional model, problem solving instructional strategy and lecture method

Group	n	Mean Pre-test	Mean Post-test	Mean Gain Score	SD Pre-test	SD Post-test
5PCIM	84	31.9	59.5	27.6	9.407	12.697
PSIS	105	31.4	57.1	25.7	9.269	13.899
Lecture Method	57	30.1	54.4	24.3	8.685	13.231

From Table 1, 5PCIM group has a mean gain score in achievement of 27.6, followed by PSIS group who has mean gain score in achievement of 25.7 while conventional lecture mean gain score of 24.3. This shows that 5PCIM and PSIS are very effective on students' achievement in physics. Also, from Table 1, 5PCIM group has a higher standard deviation score of 9.407in pre-test than the PSIS and lecture method group with standard deviation in pre-test of 9.269 and 8.685 respectively. Conversely in the post-test, 5PCIM group had a lowest standard deviation of 12.697 followed by lecture method (13.231) while the PSIS had the highest standard deviation of 13.889. Thus, the table reveals that the standard deviation score for each group is low in both pre-test and post-test. By implication, it shows that groups used in this study are homogeneous.

Table 2: Mean achievement scores of students taught chemistry through the use of five phases' constructivist instructional model, problem solving instructional strategy and lecture method

Group	n	Mean Pre-test	Mean Post-test	Mean Gain Score	SD Pre-test	SD Post-test
5PCIM	84	33.2	61.3	28.1	9.423	12.721
PSIS	105	34.5	62.1	27.6	9.274	13.942
Lecture Method	57	29.8	55.1	25.3	8.567	13.453

From Table 2, 5PCIM group has a mean gain score in achievement of 28.1, followed by PSIS group who has mean gain score in achievement of 27.6 while conventional lecture mean gain score of 25.3. This shows that 5PCIM and PSIS are very effective on students' achievement in chemistry. Also, from Table 2, 5PCIM group has a higher standard deviation score of in pre-test than the PSIS and lecture method group with standard deviation in pre-test of 9.423, 9.274 and 8.567 respectively. Conversely in the post-test, 5PCIM group had a lowest standard deviation of 12.721 followed by lecture method (13.453) while the PSIS had the highest standard deviation of 13.942. Thus, the table reveals that the standard deviation score for each group is low in both pre-test and post-test. By implication, it shows that groups used in this study are homogeneous.

Research Question 2

What are the mean interest scores of students taught physics and chemistry using five phases' constructivist instructional model (5PCIM), problem solving instructional strategy (PSIS) and lecture method?

Table 3: Mean and standard deviation on interest scores of students taught physics using 5PCIM, PSIS and conventional lecture method

Group	n	Mean Pre-test	Mean Post-test	Mean Gain Score	SD Pre-test	SD Post-test
5PCIM	84	94.3	117.4	23.1	7.098	13.677
PSIS	105	91.3	114.9	23.6	9.204	12.888
Conventional Method	57	91.6	102.4	10.8	9.170	4.898

From Table 3, the gain score in interest of students taught physics using PSIS is higher (23.6) than the gain score in interest (23.1) of those taught with 5PCIM while students taught physics with lecture method had 10.8 mean gain score in interest. This indicates that the use of PSIS and 5PCIM enhanced the mean interest score of students. Also, the standard deviation shows that the two groups have homogeneous interest in physics before and after treatment.

Table 4: Mean and standard deviation on interest scores of students taught chemistry using 5PCIM, PSIS and conventional lecture method

Group	n	Mean Pre-test	Mean Post-test	Mean Gain Score	SD Pre-test	SD Post-test
5PCIM	84	93.5	118.1	24.6	7.522	14.123
PSIS	105	90.2	115.6	25.4	9.621	13.409
Conventional Method	57	88.5	99.2	10.7	9.67	5.410

From Table 4, the mean gain score in interest of students taught chemistry using PSIS is higher (25.4) than the mean gain score in interest of students taught chemistry using 5PCIM (24.6) while students taught chemistry with lecture method had interest mean gain of 10.7. This indicates that the use of PSIS and 5PCIM enhanced the mean interest score of students. Also, the standard deviation shows that the two groups (PSIS and 5PCIM) have homogeneous interest in chemistry before and after treatment.

Test of Hypothesis 1: There is no significant difference in the mean achievement scores of students taught physics using five phases' constructivist instructional model (5PCIM), problem solving instructional strategy (PSIS) and lecture method.

Table 5: ANCOVA comparison difference between the achievement scores in Physics of 5PCIM, PSIS group and conventional lecture group

S/N	SS	df	MS	F	Sig.	Partial Eta Squared
Corrected Model	6032.606[a]	6	1005. 434	6.299	.000	.137
Intercept	40894.989	1	40894.989	256.219	.000	.517
Pre-test	2514.610	1	2514.610	15.755	.000	.062
Method	1189.992	2	594.996	3.728	.025	.030
Gender	2346.180	1	2346.180	14.700	.000	.058

Table 5 shows that the F-ratio of 3.728 at degrees of freedom of (1, 111) and P-value of .025 is significant because p-value is less than 0.05, therefore, a significant difference exists between the achievement scores of students taught physics with five phases' constructivist instructional model (5PCIM), problem solving instructional strategy (PSIS) and lecture method.

Hypothesis 2: There is no significant difference in the mean achievement scores of students taught chemistry using five phases' constructivist instructional model (5PCIM) problem solving instructional strategy and lecture method.

Table 6: ANCOVA comparison difference between the achievement scores in Chemistry of 5PCIM, PSIS group and conventional lecture group

S/N	Type III Sum of Squares	df	Mean Square	F	Sig. P	Partial Eta Squared
Corrected Model	3524.015	6	440.502	53.057	.000	.793
Intercept	821.174	1	821.174	98.907	.000	.471
Pre-test	1074.976	1	1074.976	129.476	.000	.538
Method	608.831	1	608.831	73.331	.000	.398
Gender	15.026	1	15.026	1.810	.181	.016

Table 6 shows that the F-ratio of 73.331 at degrees of freedom of (1, 111) and P-value of .000 is significant because p-value is less than 0.05, therefore, a significant difference exists between the achievement scores of students taught chemistry with five phases' constructivist instructional model (5PCIM), problem solving instructional strategy (PSIS) and lecture method.

Discussion of the Findings

This study revealed that mean achievement score of students taught physics and chemistry using 5PCIM and PSIS were significantly higher than those of the students taught using conventional teaching method (5PCTM). The reasons for the higher achievement by the experimental groups could be that they were more actively involved in five phases' constructivist instructional model (5PCIM) and problem-solving instructional strategy (PSIS) of the concepts and principles of physics and chemistry which involved cooperative and collaboration which were absent in the control group throughout their lesson periods. It could also be that the experimental group members were able to link up new concepts in physics and chemistry to the relevant concepts in their constructive mind which they were familiar with. This was absent in the conventional lecture method. In addition, it could be as a result of excitement over creating new problems as well as construction of their knowledge emerging on their own from each topic which was similar or nearly the same with that of their teachers. Furthermore, the mode of presentation provided by the 5PCIM and PSIS was completely absent in the CIM. The teacher and students participatory role in 5PCIM and PSIS strategies is unique which made for better achievement of the experimental groups than the CIM. This was also completely absent in CIM group.

The above findings observed when 5PCIM and PSIS teaching strategies were used to teach two groups of students supported the findings of Ukozor (2011), Adebola (2012) and Ajaja (2013) who used different constructivist as well as problem-solving model as strategies for improving secondary school students' achievement and retention in school subjects. The result also supported the works of Okereke (2006), Dori *et al*. (2005), Oludipe, et al. (2013) and Omwirhiren (2015) that used various teaching methods on students' achievements, acquiring laboratory skills and the dimensions of learning activity. The researcher therefore tenders that most teaching strategies which involve active participation of the students and encourage cooperation by the students have been found significant achievement score in their studies.

Conclusion

This study has shown that the 5PCIM and PSIS have significant effect on students' cognitive achievement and interest in physics. The 5PCIM and PSIS are more efficacious than the CIM. The influence of gender on mean achievement score and mean interest score were not significant. Male students showed to be superior to their female counterparts in physics. The interaction effect of gender and treatment on the mean achievement score and mean interest score were not significant.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Since 5PCIM and PSIS were found to be effective teaching strategies for improving students mean achievement score and mean interest score in physics. Physics teachers should adopt it as teaching strategies in physics classrooms and laboratories.
2. Workshops and seminars should be organized for in-service physics teachers. The teacher training institutions should include the use of 5PCIM and PSIS in their physics method course content to ensure the training of the pre-service physics teachers.
3. Authors of physics text-books should include 5PCIM and PSIS in their texts for easy access for students and teachers.
4. Finally, the curriculum planners should include 5PCIM and PSIS in senior secondary physics scheme for teachers and students.

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