GRADIVA

Volume 64 | Issue 12 | December 2025
DOI: 10.5281/zenodo.17919990

Effect of Procedural Knowledge Instructional Technique on Chemistry Students' Interest in Qualitative Analysis

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Abstract

The study investigated the effect of Procedural Knowledge Instructional Technique on Chemistry Students' Interest in Qualitative Analysis. The main purpose of this study was to determine the effect of procedural knowledge instructional technique on chemistry students' interest in qualitative analysis. The population of the study consisted of all SS2 chemistry students in Nsukka Education Zone of Enugu State. The sample size for the study was 237 students from eight schools out of fifty – eight public schools in the area. The design of the study was non- randomized control group quasi-experimental design. Two research questions and two hypotheses guided the study. Mean and standard deviation were used to answer the research questions. The hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). Findings showed that: Procedural knowledge instructional technique (PKIT) increases students' interest in qualitative analysis and in scientific investigation activities irrespective of gender.

Keywords: *Procedural Knowledge Instructional Technique, Qualitative Analysis, Students' Interest, Chemistry practical skills and Gender.*

INTRODUCTION

Procedural knowledge instructional technique is an innovative technique that guides teacher's action during practical work in qualitative analysis in chemistry. It is a problem solving technique Procedural knowledge instructional technique is of paramount importance to a teacher's effective delivery of practical lesson in qualitative analysis. For the purpose of this study, Procedural knowledge instructional technique is a structured and systematic technique to qualitative analysis in order to characterize chemical samples and identify their constituent ions.

Procedural knowledge instructional technique is to follow a consistent sequence of carrying out qualitative analysis in order to arrive at the correct identification of the qualities of the substance being analyzed. Procedural knowledge instructional technique involves assisting individuals to acquire skills and knowledge so that they are able to perform a task to a specific standard. In procedural knowledge instructional technique, the outcomes to be achieved are clearly stated so that students may know exactly what they have to do.

A teacher knows what training or learning to be provided. The emphasis on procedural knowledge instructional technique is on performing rather than just knowing. Teachers are advised to adopt instructional techniques that can bring about attitudinal change and skills acquisition by learners to facilitate problem solving in the subject. These techniques were described as techniques of activity, enquiry and discovery which are cognitive, affective and psychomotor. Such techniques may arouse and genuinely promote the interest of the students.

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DOI: 10.5281/zenodo.17919990

Procedural knowledge is the understanding of rules, algorithms and procedures in teaching. Procedural knowledge is routine knowledge. Procedural knowledge is an ideal situation for being active, creative and responsive in the physical world. In order to teach, teachers must be proficient in exploring, justifying, representing, discussing, using, describing, investigating and predicting which are important for effective practical lesson. This theme measures what teachers do in the classroom/laboratory to enhance their learning. Lessons that engage teachers and varied opportunities for making predictions, estimations, or hypotheses and designing ways to test them help students to understand the nature of scientific inquiry (Deborah et al., 2011). Through practice and reflection, students are able to apply these skills in new contexts and recognize their own critical thinking abilities. In learning chemistry, the understanding of chemical concepts and problem- solving (procedural) is very important. Procedural knowledge can be measured using the science process skills (Basic scientific process skills and integrated scientific process skills). However, emphasis on students' mastery of science process skills should be regarded as an important element in the process of teaching and learning of qualitative analysis in Chemistry.

Chemistry is essentially a practical oriented subject which demands proper exhibition of science process skills acquisition and concept for effective interpretation of existing phenomena. Chemistry practical skills are science process skills. Science process skills are those skills which scientists employ in data gathering, transformation and interpretation in order to arrive at conclusions. The science process skills (SPS) are cognitive, psychomotor and affective skills which scientists employ in problem identification, objective inquiry, data gathering, transformation, interpretation and communication. Science process skills may be described as abilities which can be developed by experience and which are used in carrying out mental operations and physical actions. Studies by Okoli (2006) and Njoku, (2005) assert that when one acquires the science process skills of observing, measuring, questioning, designing experiments, interpreting data etc., such a person becomes specially equipped with the tools required for scientific inquiry or problem-solving as well as ability to use these skills in the laboratory for a variety of investigations. Laboratory skills are therefore synonymous in many ways with science process skills. Hence instructional strategies that enhance the acquisition of science process skills also enhance the laboratory skills acquisition (Eilks & Hofstein, 2013). The use of procedural knowledge instructional technique may enhance the acquisition of such science process skills.

They are taught as part and parcel of chemistry curriculum. They are acquired in activities through training and direct experiences. The importance of chemistry practical skills cannot be over stressed. The science process skills are the tools that teachers and students use to investigate the world around them and to construct science concepts, so it is essential for teachers to have a good understanding of these skills (Anaekwe & Ezeuchu, 2015). Qualitative analysis may be perceived to be difficult by students. This is because most of the times chemistry teachers do not teach it effectively. Qualitative analysis should not be difficult to students if the teachers have adequate procedural knowledge and skills for teaching the students. The poor performance may be attributed to lack of interest in the subject by the students.

Interest is another important determinant of practical skills acquisition in teaching – learning process. It is a component of attitude that measures the degree of a person's unalloyed likeness. Students' interest significantly correlates with their academic performance in school subjects and as such has significant influence on their learning outcomes. Interest determines

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the zeal with which students' study and solves their academic problems. It therefore becomes pertinent for teachers to explore and find avenues/ ways of arousing students' interest in teaching – learning process so as to help them perform creditably high in different school subjects especially science practical that acquaints them with scientific and technological skills. Interest is a feeling of like or dislike towards an activity. It is that innate tendency which helps an individual to participate in a particular activity which includes science. The willingness to be involved in science activities depends on the degree of interest that students have in the subject. Studies have been conducted on students' interest in science (Nwoji 2015, Okoye et al., 2015). Okoyefi and Nzewi (2013), looked into the apparent lack of interest shown by female students towards science and resolved that students' aversion for mathematics and general lack of interest in sciences are due to various laws and principles to be committed into memory. Also, the persistent lack of interest by students to science could be as a result of teacher's use of ineffective instructional approach. One of the issues at stake in education today is students' interest in relation to teaching and the overall success of learning outcome. Use of procedural knowledge instructional technique in teaching qualitative analysis may make qualitative analysis lesson stimulating and interesting to the students. This study therefore, investigated if the use of procedural knowledge instructional technique increased students' interest in qualitative analysis. However, interest in qualitative analysis in chemistry may also be influenced by gender.

Gender is another issue of contention in Nigeria today and in our society including the educational system. Gender is a set of characteristics distinguishing between male and female, particularly in the case of boys and girls (Okoyefi & Nzewi, 2013). The concept of gender is a broad based analytical concept which draws out women role and responsibility in relation to those of men. It tends to aggregate the female roles and responsibility in relation to those of male. This concept, according to (Nwagbo & Ugwuanyi, 2015), Njoku and Akwali (2016), Agommuoh and Ndirika, (2017) is not synonymous with sex nor with women though there may be some relationship. Gender refers to the socially or culturally constructed characteristics and roles, which are ascribed to males and females in any society. On the other hand, sex refers to the biological differences between boys and girls. There has been a renewed debate on the controversial issues of gender differences and practices in chemistry instruction. Gender is one of the factors interacting with performance in chemistry and other sciences. Agommuoh and Ndirika (2017), reported that male students have a higher performance and interest in chemistry than females. And some of the factors identified to have accounted for the observed differences in the performance of male and female students in chemistry are sex –role stereotyping, masculine image of science and female socialization process. Nevertheless, contrary reports which said that gender influence favored women found no significant difference in the performance of students due to gender. In fact, they opined that performance of both males and females can be affected by teaching and learning styles. There is need for teaching strategies that will enhance students' interest in qualitative analysis for both males and females. Therefore, this study investigated the influence of procedural knowledge instructional technique in enhancing male and female students interest. This study also investigated whether the use of procedural knowledge instructional technique enhanced students' interest in qualitative analysis irrespective of gender in chemistry.

Chemistry belongs to the compulsory group of subjects studied in secondary school. The goals of chemistry teaching include being able to describe the properties of matter or chemical substances in terms of internal structure; the arrangement and interrelationship of its parts as evidenced in our day- to- day functioning. This should be done in such a way to make the

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teaching and learning of chemistry in our schools real by linking it with learners' day – to – day activities. The broad goals of Secondary School Education outlined in the National Policy of Education (FGN, 2014) is to prepare the individual for useful living within the society and higher education and specifically to offer diversified curriculum to cater for the differences in talents, opportunities and future roles. To achieve the stated goals, secondary school education in Nigeria has six years' duration given in two stages as junior secondary school stage and senior secondary school stage. Chemistry is studied in the senior secondary school stage of the two-stage secondary school education in Nigeria. Chemistry is an important ingredient of technology and has lots of benefits that need to be realized. There is the need for proper means of dissemination of its knowledge and skills in senior secondary school. Based on the above relevance of chemistry, it is expected that the achievement of the students in public examinations ought to be high. Unfortunately, despite the importance and relevance of the subject, indices from various examination bodies have shown a consistent trend of poor achievement. Indices from research reports show that the overall achievement of chemistry students in the West African Secondary School Certificate Examination in Chemistry in secondary schools is unsatisfactory Ifeakor, (2005); Ogunmade, (2005); Offiah and Samuel; (2008), Oloruntegbe, (2008)]. Analysis of WAEC result data from the year 2007 to 2018 also confirms the students' poor achievement in chemistry. In effect, the poor achievement in chemistry has adversely affected the realization of national goals for scientific and technological development. Also, the poor achievement in chemistry has affected the 60:40 ratios (60% for sciences and 40% for arts) for the intake of science and arts students into the universities in the country. Students fail to understand the chemistry concepts and principles, fail to follow learning instructions, and therefore fail to acquire the necessary basic practical skills needed for success in external examination.

This unfortunate situation is giving major stake holders in chemistry education great concern (Njoku, 2007). The root cause of poor performance by students may be traceable to the approaches and teaching methodologies employed to deliver the subject matter contents (Muhammad, 2014). Some teachers consistently use obsolete lesson notes for teaching for several years without updating their knowledge. Chemical education under the umbrella of the Science Teachers Association of Nigeria, (STAN) had identified several factors as contributing to this ugly trend. These include lack of qualified chemistry teachers, insufficient number of chemistry teachers, lack of instructional materials, over-loaded chemistry syllabus, abstract and difficult nature of many chemistry concepts, poor teaching methods/inappropriate medium of instruction/ ineffective teaching strategies employed by most chemistry teachers as well as lack of interest among chemistry students (Igboegwu & Egolum, 2010; and Njoku & Ezinwa 2014). The aforementioned research all reported that inappropriate teaching strategies are major factors responsible for the observed poor performance of students in chemistry. Recent research efforts have focused on some aspects of chemistry targeted at finding out what exactly is responsible for the evident high failure rate in chemistry. Some of the research such as Okonkwo (2012) and Ochu (2010) point to poor and ineffective instructional method as the major cause of the poor performance of students in chemistry in external examination.

In an attempt to provide solutions to this persistent poor performance in chemistry among students, content areas of learning difficulties and areas where teachers need to emphasize are being identified. Recently, researchers like (Muhammad, 2014; Ijioma, 2011 & Deborah, 2011) observed that teaching practical skills has often been a neglected aspect of chemistry by teachers in Nigeria. This neglect makes chemistry a difficult and abstract subject. According to Muhammad, (2014), Ijioma, (2011) and Deborah, (2011), qualitative analysis had remained

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an important aspect of chemistry curriculum after many revisions because of its importance to science process skills development which enable students to perform favorably in external chemistry examinations. The external examination in chemistry consists of three aspects, namely: the objective test, the essay test and the practical test. The practical test usually has two sections, namely: the volumetric or quantitative analysis and the qualitative analysis. The two aspects of external chemistry examination have equal points. A good performance of students in each of these aspects is therefore needed for overall good performance in the external examination. The WAEC chief examiners reports have consistently indicated that Nigerian students perform very poorly in practical chemistry examination, especially the aspect of qualitative analysis (WAEC, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017 & 2018). The qualitative analysis demands knowledge of basic principles and procedures as well as manual dexterity or skills in conducting analysis. It is the students who are able to follow procedural instructions and skills from their chemistry teachers, make accurate observations and inferences based on observations that have chances of getting good scores in the practical test or examination. Students' persistent and consistent failure in this aspect of the external chemistry examination (WAEC, 2007- 2018) indicates that students find it difficult to follow instruction or procedures and interpret the observations that would lead to correct inference. The spate of students' mass failure in this aspect of the chemistry examination raises questions as to what the chemistry teachers teach and whether the teachers themselves possess procedural knowledge and skills for teaching students. Nobody can give what he/she does not have. If chemistry teachers lack procedural knowledge and skills, then they cannot teach their students practical procedures in qualitative analysis. It becomes necessary to determine the effects of procedural knowledge instructional technique on student's interest in qualitative analysis.

Qualitative analysis is a branch of practical chemistry that deals with the identification of elements or grouping of elements present in a sample. The techniques employed in qualitative analysis vary in complexity, depending on the nature of the sample and in some cases, it is necessary only to verify the presence of certain elements or groups for which specific tests is directly applicable to the sample (*e.g.*, flame tests, spot tests) may be available. It is customary to classify the methods into two classes: qualitative inorganic analysis and qualitative organic analysis. These are the two areas derived from inorganic and organic chemistry that constitute qualitative analysis. Qualitative analysis indicates whether a particular substance is present or not. It does not tell how much of the substance is there or its concentration. The classical procedure of qualitative analysis for the examination of a substance of unknown nature involves the following steps which include preliminary examination, examination for cations, examination for anions, examination of gases and qualitative organic analysis.

Qualitative analysis activities seldom enjoy enthusiasm from chemistry teachers and students. Qualitative analysis according to Muhammad (2014) is aimed at demonstrating proficiency in making reasonable, acceptable and accurate inferences from experimental observations, and identifying unknown ions and elements present in chemical samples such as compounds. Also, Njoku (2007) stated that in qualitative analysis, the students are required to identify a mixture of two salts through a systematic series of tests for the constituent ions. The question on qualitative analysis assesses students' skills in problem identification, conducting of experiment, manipulation of equipment, hypothesizing, careful observation, interpretation of observation, making of inferences/ deductions, organizing and recording of data, and effective communication of findings.

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Every chemistry teacher is expected by the nature of the subject to be practical minded while presenting various chemistry topics to the students using the activities that can enhance practical skills acquisition. These are activities involved in the practical work in qualitative analysis in chemistry. The practical work is activity- based. If chemistry teachers utilize activity-based approach effectively, it would possibly lead to productive practical skills acquisition and interest. Activity-based science education guarantees greater opportunity for national development, acquisition and application of skilled knowledge for productive enterprise (Idigie et al., 2017). There are a number of these activity- based techniques and strategies for teaching practical chemistry in secondary schools. They include field-trip; project, laboratory, play, computer assisted and demonstration. Demonstration is one of them and is usually referred to as the conventional demonstration strategy (CDS). CDS can be used for teaching qualitative analysis. Conventional demonstration strategy as a teaching strategy refers to the visual presentation of the action and activities or practical work related to the facts and principles of a delivered lesson by the teacher in the classroom, aiming to facilitate the task of teaching and learning. Demonstration strategy of teaching serves as a model laboratory instruction but conventional demonstration strategy is teacher- centered

Evidence of poor achievement in chemistry at Senior Secondary Certificate Examination has been shown by authors. Data obtained from West African Examination Council and also from the result of the years 2007 to 2018 confirm the students' poor achievement. Chemistry is essentially a practical oriented subject. Practical chemistry has been shown to have a good influence in the learning and retention of chemistry practical skills, concepts and principles. Chemistry practical skills are science process skills. The External Examination in Chemistry consists of three aspects, namely: the objective test, the essay test and practical test. The practical test usually has three sections, namely: the quantitative analysis, the qualitative analysis and test on knowledge of basis of inferences during practical activities and procedures. The WAEC Chief Examiners reports have consistently indicated that Nigerian students perform very poorly in practical chemistry examination, especially the aspect of qualitative analysis. The qualitative analysis demands knowledge of basic principles and procedures as well as manual dexterity or skills in conducting analysis. The spate of students' mass failure in this aspect of the chemistry examination raises questions as to what the chemistry teachers teach and whether the teachers themselves possess procedural knowledge and skills for teaching students. If chemistry teachers lack procedural knowledge, then they cannot teach their students practical procedures in qualitative analysis. What then is the effect of procedural knowledge instructional technique on student's interest in qualitative analysis? The study determined the effect of procedural knowledge instructional technique on chemistry student's interest in qualitative analysis. The study answered the following research questions:

1. What are the mean interest scores of students taught qualitative analysis using procedural knowledge instructional technique and those taught with conventional demonstration strategy?
2. What are the mean interest scores of male and female students in qualitative analysis?

METHODOLOGY

The design of the study was non- randomized control group quasi-experimental design. Specifically, the study adopted the pre-test and post-test non- randomized control group design. In this design research participants are not randomly assigned to the experimental and control groups, and both groups took a pretest and a posttest. The study was carried out in Nsukka

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Education Zone of Enugu State. The choice of Nsukka Education Zone is because most schools in Nsukka Education Zone have well equipped and standard laboratory for the practical work in chemistry. Nsukka Education Zone is large consisting of Nsukka, Igbo-Etiti and Uzo-Uwani Local Government Areas (LGAs). The LGAs have 30, 16 and 12 government owned secondary schools respectively. It has a relative balance of urban and rural schools. The population for this study was 2,134 SS2 Chemistry students (Post Primary Schools Management Board (PPSMB, 2017) from 58 secondary schools in Nsukka Education Zone of Enugu State in 2017/2018 academic session. The sample size for the study was 237(male = 109 and female = 128) students. Multistage sampling techniques were used to draw the sample for the study. In stage 1, purposive sampling technique was used to select coeducational schools because gender is a major variable in the study.

Also, the school must have at least 40 SS2 students studying Chemistry, the school must have Chemistry laboratory that is well-equipped, the school must be willing to participate in the study and the school must have Chemistry teachers. Stage 2, Proportionate stratified random sampling technique was used to select eight (8) co- educational schools out of fourty-eight (48) co-educational schools from the zone according to each LGAs. Stage3: The design of the study was non- randomized control group quasi-experimental design. Specifically, non-equivalent control group design was used. In this design research participants are not randomly assigned to the experimental and control groups, and both groups take a pretest and a posttest . In this design, intact groups which are not equivalent are assigned randomly to treatment conditions. The design is often used in classroom experiments when experimental and control groups are such naturally assembled groups as intact classes which may be similar. The design is appropriate because it establishes a cause-effect relationship between the independent variables (PKIT & CDS) and dependent variable (interest & gender). This design is also adopted because it is not possible to have a complete randomization of the subjects. Furthermore, intact classes were used as experimental and control groups since it is not advisable to disrupt existing classes in the school for six (6) weeks.

Qualitative Analysis Interest Questionnaire (QAIQ) was used for data collection. The QAIQ consists of 32- items, which were developed by the researcher. It is a 4-point rating scale type questionnaire designed to ascertain the student's interest in qualitative analysis problem solving. The scoring for positively phrased items is: Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, Strongly Disagree (SD) = 1. And for negatively phrased items the scoring was reversed as: Strongly Agree (SA) = 1, Agree (A) = 2, Disagree (D) = 3, Strongly Disagree (SD) = 4. The respondents were expected to indicate their degree of agreement or disagreement on number of statement about the qualitative analysis problems. Care is taken to write the items in simple language for easy understanding. QAIQ was subjected to both face and construct validation. Specifically factor analysis was used to determine the construct validity of QAIQ and Steven's (2002) criteria of 0.40 and above index for selecting items was employed. Based on the Steven's (2002) criteria, 14 (fourteen) items were found to be factorially complex because they loaded in more than one factor, 14 (fourteen) items were factorially impure because their indices were not up to 0.40 and 32 (thirty- two) items were factorially pure because they loaded in just one factor. All the 32 factorially pure items were used for the study whereas all the factorially complex and impure items were discarded.

The instrument, QAIQ was trial tested using 64 SS 2 students of a co-educational school in Obollor –Afor Education Zone having same geographical characteristics with the area of study. Trial testing was conducted to determine the appropriateness of the instrument. The data

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obtained from the trial testing of the instrument, QAIQ, was used to estimate the reliability. The internal consistency reliability coefficient of QAIQ was estimated using Cronbach Alpha (α) method with a value of 0.86 with the application of SPSS was obtained.

Three (3) regular chemistry teachers from the selected schools and classes for the study were trained. The training is supposed to drill them on the content, methodology and the procedural knowledge instructional technique design of the study. At the end of the training, two (2) teachers were selected to serve as research assistants following their performance at the end of the training. The other teacher functioned as a stand-by instructor. Other research assistants were also selected and given training since they taught the control group using the conventional demonstration strategy. The purpose of the study was never revealed to the subjects. Teaching started immediately after the pretest in each of the class. A research assistant used the lesson notes prepared for the procedural knowledge instructional technique to teach students in the experimental group in each selected school. And another research assistant used the lesson notes prepared for the conventional demonstration strategy to teach students in the control group in each sampled school. In each selected school, four (4) research assistants were used to give a total of thirty -two (32) research assistants for the eight (8) sampled schools. Ten students were assigned to a rater during the qualitative analysis practical activity.

The research assistants taught qualitative analysis via procedural knowledge instructional technique in four of the selected school (experimental group). The other research assistants taught qualitative analysis using the conventional demonstration strategy in the four selected schools which constituted the control group. The researcher monitored the teaching at all the stages. Teaching lasted for 6 weeks that is, 2 periods of 60 minutes (1hr) each for the 6 weeks (60 minutes' x 2 x 6) = 12hrs x 8 = 96hrs. Post-testing took place at the end of teaching in all the 8 groups. The same QAIQ used for pre-testing were administered as the post test. Strict examination conditions were observed during post-testing. The procedural knowledge instructional technique and the conventional demonstration strategy lesson plans developed by the researcher were used in the training of teachers who participated in the study. The training lasted for 4(four) days. The Chemistry teachers from the sampled schools were involved in the training. The chemistry teachers (research assistants) were separated on the basis of whether they are in experimental group or control group. All the teachers in experimental group were trained on the use of procedural knowledge instructional technique for teaching qualitative analysis, while the teachers in control group were trained on the use of conventional demonstration strategy for teaching qualitative analysis. Each group of teachers were trained in one place. Mean and standard deviation were used to answer the two (2) research questions. Hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). The pre-test scores were used as covariates to the post-test scores (i.e. control measure to the post-test scores).

RESULTS

Result on Table 1 shows that the experimental group taught qualitative analysis using procedural knowledge instructional technique had a pretest interest mean score of 81.35 with a standard deviation of 11.53 and a posttest interest mean score of 94.71 with a standard deviation of 6.46. The difference between the pretest and posttest interest mean for the group taught qualitative analysis using procedural knowledge instructional technique was 13.36. The control group taught qualitative analysis using conventional demonstration strategy had a pretest interest mean score of 80.64 with a standard deviation of 10.33 and a posttest interest

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mean score of 86.14 with a standard deviation of 4.30. The difference between the pretest and posttest interest mean for control group was 5.50. However, for each of the groups, the posttest interest mean score was greater than the pretest interest mean score with the experimental group having the highest interest mean gain. This is an indication that procedural knowledge instructional technique had more positive effects on students' interest in qualitative analysis than the conventional demonstration strategy.

Table 1: **Mean and standard deviation of pretest and posttest of interest scores of students taught qualitative analysis using Procedural Knowledge Instructional Technique and those taught with Conventional Demonstration Strategy**

		Pre-test Interest		Posttest Interest		
Instructional Technique	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean gain**
Procedural Knowledge Instructional Technique	133	81.35	11.53	94.71	6.46	13.36
Conventional Demonstration Strategy	104	80.64	10.33	86.14	4.30	5.50

The result in Table 2: shows that with respect to the significant difference in the mean interest scores of students taught qualitative analysis using procedural knowledge instructional technique and those taught with conventional demonstration strategy, an F-ratio of 100.544 was obtained with associated probability value of 0.00. Since the associated probability value of 0.00 was less than 0.05 set as benchmark, the null hypothesis (H_{01}) which stated that there is no significant difference in the mean interest scores of students taught qualitative analysis using procedural knowledge instructional technique and those taught with conventional demonstration strategy is rejected. Inference drawn therefore is that, there was a significant difference in the mean interest scores of students taught qualitative analysis using procedural knowledge instructional technique and those taught with conventional demonstration strategy with those taught with procedural knowledge instructional technique having a higher interest mean in the posttest.

Table 2: Analysis of covariance (ANCOVA) of students overall Interest Scores by Gender and method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Dec.
Corrected Model	3653.757[a]	4	913.439	29.778	0.00	
Intercept	29182.093	1	29182.093	951.341	0.00	
Pretest Interest	268.244	1	268.244	8.745	0.00	
Group	3084.154	1	3084.154	100.544	0.00	S
Gender	19.399	1	19.399	.632	0.42	NS
Group * Gender	16.625	1	16.625	.542	0.46	NS
Error	7116.530	232	30.675			
Total	1990147.000	237				
Corrected Total	10770.287	236				

S = Significant, NS = Not Significant at 0.05 level.

Result in Table 3: shows that the male students taught qualitative analysis had a pretest interest mean of 80.12 with a standard deviation of 10.90 and a posttest interest mean of 90.33 with a standard deviation of 6.63. The difference between the pretest and posttest interest mean for the male students taught qualitative analysis was 10.21. The female students taught qualitative analysis had a pretest interest mean of 81.82 with a standard deviation of 11.08 and a posttest interest mean of 92.29 with a standard deviation of 6.76. The difference between the pretest and posttest interest mean for the female students taught qualitative analysis was 10.47.

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The result of the study showed that for each of the groups, the posttest mean was greater than the pretest mean with the female students having slightly highest mean gain. This is an indication that female students' interest when taught qualitative analysis is higher than the male students' interest. In order to ascertain if this observed difference is real or an error variance the result is subjected to inferential testing.

Table 3: Mean and standard deviation of pretest and posttest interest scores of male and female students in qualitative analysis

		Pre test		Posttest		
Gender	**N**	$\bar{x}$	**SD**	$\bar{x}$	**SD**	**Mean gain**
Male	109	80.12	10.90	90.33	6.63	10.21
Female	128	81.82	11.08	92.29	6.76	10.47

The result in Table 2 shows that with respect to significant difference in the mean interest scores of male and female students in qualitative analysis, an F-ratio of 0.63 was obtained with associated probability value of 0.42. Since the associated probability value of 0.42 was greater than 0.05 set as level of significance for testing the hypothesis, the null hypothesis (H_{02}) which stated that there is significant difference in the mean interest scores of male and female students in qualitative analysis is not rejected. Inference drawn therefore is that, there was no significant difference in the mean interest scores of male and female students in qualitative analysis.

DISCUSSION

The result of this study also shows that, PKIT as a main effect has significant effect on students' interest in qualitative analysis. However, for each of the groups, the posttest interest mean scores were greater than the pretest interest mean scores with the experimental group having the highest interest mean gain. This is an indication that procedural knowledge instructional technique had positive effects on students' interest than the conventional demonstration strategy. Hence the need to find out if student's interest may be raised in qualitative analysis (QA) through the use of procedural knowledge instructional technique (PKIT) for teaching QA in secondary school is significant to this study and has positive effects. Perhaps, this is because the PKIT is student centered and activity- based. The result of the study showed there was a significant difference in the mean interest scores of students taught qualitative analysis using procedural knowledge instructional technique and those taught with conventional demonstration strategy with those taught with procedural knowledge instructional technique having a higher interest mean in the posttest.

Student's interest in qualitative analysis will induce him to behave and act in a certain way towards his studies (Owodunni, 2011). Also Interest is a persisting tendency to pay attention and enjoy some activities or contents (Hiland, 1989). Obodo (2004) pointed out that the type of interest a student brings to the classroom is very important. This means that if a student has positive interest towards a particular subject, he or she not only enjoys studying it but would also derive satisfaction from the knowledge of the subject.

The finding of the study showed that procedural knowledge instructional technique had positive effects on students' interest in qualitative analysis than the conventional demonstration strategy. The result of this study also shows that, PKIT as a main effect has significant effect on students' interest in qualitative analysis. However, for each of the groups, the posttest interest means scores were greater than the pretest interest means scores with the experimental group having the highest interest mean gain.

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Students' interest in science has always contributed to performance in sciences (Obodo, 2004). From the previous researches carried out on students' interest, it has been discovered that students' interest in science subjects is very poor (Adprima, 2009). Perhaps, a student's interest in qualitative analysis will induce him to behave and act in a certain way towards his studies (Owodunni, 2011). Gender is one of the factors that might affect students'interest in chemistry and other sciences (Ekweueme and Umoinyang, 2005; Isa, 2005; Ayodele, 2002 and Ukwungwu, 2002. However, studies on how it actually influences performance have till now reported conflicting results, implying contradicting evidences in performance of students due to gender.Some researchers have reported widespread of significant gender differences in interest in chemistry and all in the favor of males (Onwukwe, 2009; Longjohn, 2009;; Ifeakor, 2005; Isa, 2005; Mari, 2002; and Joseph, 1996). Some of the factors identified to have accounted for the observed differences in the performance of male and female students in chemistry include the teaching strategies adopted, economic, cultural, social, political and religious beliefs, sex-role stereotyping, masculine image of science and female socialization process. Others factors include, family's preference of boy's education, lack of sustained government policies, early marriage, etc.

Contrary to the above finding, Ekwueme and Umoinyang (2005) reported that gender influenced performance in favor of females. Also, Okonkwo (2007) found a significant difference in the acquisition of science process skills in chemistry in favor of girls. Ibiene (2009) also found a significant difference in the performance of boys and girls in favor of girls in a study of the effect of game method of teaching on students' performance in chemistry. In contrast, Okodile, (2009); Danmole and Adeoye (2004) and Aiyedum, (2000) found no significant difference in students' performance in chemistry due to gender. Instead, they opined that performance of both males and females can be affected by teaching strategies that will enhance interest in qualitative analysis for both males and females; hence this study investigated the effect of procedural knowledge in enhancing male and female student's interest in qualitative analysis. Furthermore, Opara (2003) also found no significant effect of gender on students' performance in qualitative analysis. These trends of inconclusiveness in the studies provided a gap which this study intended to fill. There is a need to reconcile these discordant notes on the result of gender and instructional methods on interest in chemistry.

Meanwhile the differences in performance due to gender as observed by some researchers (Ekwume & Umoinyang, 2006; Ukwungwu, 2002), maybe attributed to other factors other than gender. These reports do not however mean that males are superior to females in intellectual capacity (Njoku, 2000). She maintained that the under- performance of females relative to males in science subjects at school level is not due to any superior mental ability on the part of males. According to Njoku, (2000), the under-representation and under-performance of females in science disciplines are historical and have been brought about by several inter-related socio-cultural and interacting school factors which act singly and jointly to depress female interest, enrolment, participation and performance in science subjects at various levels of Nigerian educational system. At the school level, females experience a lot of discouraging conditions that deter them from enjoying and performing well in science subjects. These school based factors are responsible for the observed low interest, poor participation, low aspiration and under-performance of females in Science Technology and Mathematics (STM).

These school-based factors inhibiting female performances and in science according to Njoku (2008) include the following: Gender bias in curriculum materials, teacher expectations of female students, inappropriate guidance and counseling services to girls in science

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discipline, unconducive science teaching strategies by science teachers, sexual harassment of females in science subjects. Umar (2009) also pointed out that community roles expectations for women, the science and technology curriculum that is gender biased and the teacher and teachers' preparations which is also gender biased are some gender related challenges that can affect the performance of girls in science subjects. Furthermore, Njoku (2009) outlined the following school-based strategies for meeting the gender issues in STM subjects. These strategies includes: placing emphasis on the relevance of science education to learners through effective teaching, creation of awareness among science teachers about gender issues in STM education, de-sexing science curricula and teaching learning resources, adoption of gender-inclusive guidance and counseling services for STM students, elimination of sexual harassment of females by male classmates and science teachers etc.

Ahmed (2008), in his own view explained that the following strategies will help to meet the school-based gender challenges in STM education. Teachers should be encouraged to go for in-service training so as to develop and equip them with teaching methods and skills to meet the new demands and challenges. Seminars should be held seasonally for the girl students where career women would be invited to give lectures with regards to the nation. Concerning school textbooks there is need to ensure that these textbooks do not reinforce gender stereotypes evident in the society. The programmes in many science curricula which usually contain very few programmes that feel feminine should not be encouraged to avoid engagement of females. In spite of all these, the fact from empirical researches still remains that boys perform better than girls in STM. This is why this study investigated the effects of gender on students' interest in qualitative analysis using procedural knowledge instructional technique to be able to come out with a concise result that may definitely underline the status of males and females interest in qualitative analysis in chemistry.

CONCLUSIONS

The study also shows that PKIT engendered more interest in students, especially female students who performed better than their male counterparts in qualitative analysis. It implies that the adoption of PKIT as a mode of instruction is most appropriate in bringing about reduction in gender-related differences in students' interest in qualitative analysis in Chemistry. The study has shown that PKIT had significant effect on students 'interest in qualitative analysis. The study showed that PKIT was more effective and efficacious than the conventional demonstration strategy in bringing about more students' interest in qualitative analysis. Similarly, gender had no significant influence on the interest of students in qualitative analysis. Female students however, scored higher in the qualitative analysis interest questionnaire, than their male counterparts did. Since PKIT has been found to be effective and efficacious in improving the quality of interest of students in qualitative analysis, teachers of chemistry should be encouraged to use more of PKIT in teaching qualitative analysis. In so doing, the interest of students in qualitative analysis in chemistry could be enhanced.

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