

# Efficacy of Process-Based Instruction In Enhancing Secondary School Students' Academic Performance And Science Skills Acquisition In Identification of Cations In Faskari, Katsina State-Nigeria

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**Abstract** This study examined the effect of process-based Instruction on secondary school students' academic performance and science-skills acquisition in Faskari Education Zone, Katsina State, Nigeria. The study employed quasi-experimental design using a sample of 103 students drawn from a population of 984 in the study area. Two instruments namely Identification of Cations Performance Test (ICPT) and Test of Science Process Skills (TOSPS) duly Validated by expert with a reliability coefficient of 0.69 and 0.75 respectively were used for data collection. Research hypotheses were tested using t-test statistics at 0.05 levels of significance. One of the finding from the study indicates that there is significance difference in the acquisition of Science-Skills between students taught identification of cations using Process-Based instruction and those taught the same concept using lecture method. Based on the research findings, it was recommended among others that periodic workshops, seminars and conferences should be organised for teachers on the selection and implementation of appropriate strategy for teaching chemistry concepts.

**Keywords:** Process-Based Instruction, Science-Skills, Performance, Identification of Cations

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## 1. INTRODUCTION

A long term goal of science education has been that students learn science concepts in a meaningful way and apply them in solving problems. It is on this premise researchers like Mari (2006), Reid, (2008) and Briscoe (2013) recommended Process-based instruction as a medium through which science concepts can be made meaningful to the students. Similarly, Shuaibu (2012) observed that the central purpose behind the new curriculum projects launched in Western countries in 1960s was basically aimed at presenting science to students the way science really is. The new curriculum according to him was designed to shift emphasis significantly from the old methods of presenting science as mere collection of facts and terms to be memorized by students to deeper understanding of the key concepts and fundamental principles of the subjects through appropriate use of the inquiry processes.

The rationale behind this emphasis has been the training of students to develop the ability of applying the process and principle of science such as science process-skills to solve a wide range of problems. Science education therefore, is the systematic training of the individuals so as to be able to live a productive life through solving their day-to-day problems (Ajaja, 2007). Science education featured prominently the training of students in order to equip them with the “tool” that is instrumental to success in their future life. However, science teaching remains primarily didactic, dominated by lectures, demonstration, text-book readings and memorization. It was observed that many teachers teach science using lecture method where students passively listen to lectures and the teacher dominates most part of the class (Paul & Dantani, 2012). Conversely, Abdulmalik and Torpev (2016) reported that the predominant use of lecture method in teaching science makes science learning boring and uninspiring to the students. Hence the need for teachers to try other student-centred strategies like peer tutoring, cooperative learning, process-based instruction and computer assisted learning strategies among others.

Science Process-Based instruction is a strategy that simplifies learning of science through the use of science process skills. The strategy gives students’ sense of responsibility in their own learning, and increase the permanency of learning. Ibrahim (2012) reported that science process skills are transferable ability, appropriated to many science disciplines, and reflective of the behaviour of scientists. He further classified the process skills into two: Basic Science Process Skills which involves observation, question raising, measurement, communication, classification and inference and Integrated Science Process Skills that requires controlling variables, defining terms operationally, formulating hypothesis, interpreting data, experimenting and formulating

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models. Both basic and integrated skills improve the thinking, reasoning abilities, enhance problems solving and scientific investigation. Researchers like Ango (2002); Mari and Shuaibu (2003); Frazer (2004) and Danladi (2006) indicated that process based instruction of teaching enhance students academic performance at the senior secondary school level. Similarly, Olorontegbe and Oduntuji (2003) opined that the often perceived difficulty in some chemistry concepts can be clearly understood through process based instruction which combine the psychomotor and the cognitive skills of reasoning.

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## 2. STATEMENT OF THE PROBLEM

The Nigeria Federal Ministry of Education has tried to enhance the teaching of Science in most schools by introducing projects such as strengthening mathematics and sciences in secondary Education in order to improve performance Federal Republic of Nigeria (F.R.N,2007) Moreover, Educational organisation and agencies such as Science Teachers Association of Nigeria (S. T. A. N.), Nigeria Educational Research and Development Council (N. E. R. D. C.), National Teachers Institute (N. T. I.), Chemical Society of Nigeria (C. S. N.), among others are committed to improvement of teaching and learning of science through workshops, conferences and seminars to science teachers. However, the performance of students in science generally and chemistry in particular is not encouraging in the Senior Secondary Certificate Examinations as noted by the west Africa Examination council (W. A. E. C. Chief Examiners Report, 2014)

This poor performance of students in chemistry has continued to be of major concern to science educators. Olorundare and Sam (2011) contend that students' mass failure in chemistry was attributed to the use of inappropriate instructional strategies, this shows that teachers nowadays are not using instructional strategies that equipped students with learning skills that ease their understanding. Mari (2001) reported that the use of science process-based instruction could help to stimulate the performance of students in sciences. This study is aimed at exploring the impact of process based instruction on secondary school students' academic performance and science skills acquisition in identification of cations in Faskari Education Zone, Katsina State-Nigeria.

## 3. OBJECTIVES OF THE STUDY

The objectives of the study are to:

1. determine the effects of Process based instruction on students' academic performance in identification of cations.

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- investigate students' level of acquisition of science process-skills when taught identification of cations using process based instruction.

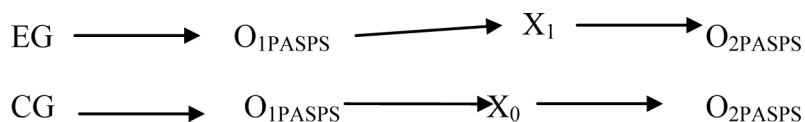
#### 4. NULL HYPOTHESES

**HO<sub>1</sub>:** There is no significant difference in the academic performance of students taught identification of cations using process-based instruction and those taught the same concept using lecture method

**HO<sub>2</sub>:** There is no significant difference between students in experimental and control groups in acquisition of science process-skills of: (i) Observation (ii) Measurement (iii) Inference (iv) Interpretation (v) Hypothesis.

#### 3. METHODOLOGY

Quasi-experimental control groups design involving pre-test and post-test was used for this study. This involves two groups in which one group was assigned as experimental and the other as the control group. Students in the experimental group were taught using process based instruction while those in control group were taught using lecture method. The same pre-test on academic performance and science process-skills acquisition were administered to the chemistry students in the two groups before treatment (X<sub>1</sub>). After treatment, both the subjects in experimental and control groups were post-tested on performance and acquisition of science process-skills in identification of cations. This is illustrated in figure 1



**Figure 1:** Illustration of Research Design

EG= experimental group exposed to science process-based instruction,

CG= Control group expose to lecture method,

O<sub>1</sub>PASPS= pre-test on Performance and Acquisition of Science Process Skills,

O<sub>2</sub>PAS= post-test on Performance and Acquisition of Science Process Skills,

X<sub>1</sub> = Treatment (Science Process-based), X<sub>0</sub>= Lecture method.

#### 4. POPULATION, SAMPLE AND SAMPLING TECHNIQUES

The target population for the study comprised of all the S S 2 students in Faskari Education Zone, Katsina State-Nigeria. The sample was drawn using multistage sampling techniques as follows: firstly, the population of

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secondary schools in the study area were stratified according to the three (3) Local Government Areas (LGAs) in the zone namely: Faskari, Sabuwa and Dandume. Secondly, Proportionate stratified sampling technique was then used to select two schools from each LGA. Thirdly, simple random sampling was used to select two schools using balloting. Fourthly, the two schools selected were assigned in to experimental and control groups using hart and draw method. The sample subjects for each school were intact classes of fifty four (54), for experimental and fourty nine (49), for control group respectively.

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## 5. INSTRUMENTATION

Two instruments were used to generate data for the study. These are:

1. Identification of Cations Performance Test (ICPT)
2. Test of Science of Process Skills (TOSPS)

Identification of Cations Performance Test (ICPT) comprises of 40 multiple choice items. Five(5) items in the instrument were adopted from Gumel (2007), five (5) items were adopted from Ojokuku (2014), 6 items were adopted from a collection of West African Examination Council (WAEC, 2014) past question paper while the remaining items were constructed by the researcher One mark was allocated for each question answered correctly.

The Test of Science of Process Skills (TOSPS) was designed to measure science process skills acquisitions. The test consisted of 25 multiple choice items designed to measure five skills of observation, measurement, inference, interpretation of data and hypothesis. Five questions were set for each of the science skills.

## 6. VALIDITY OF THE INSTRUMENTS

The validity of the instruments ICPT and TOSPS was insured by submitting the instruments along with the research objectives, questions and hypothesis to five experts in the Departments of Science Education. All the suggestions offered by the experts were considered and effected before the production of the instruments.

## 7. RELIABILITY OF THE INSTRUMENTS

This was established by administering the instruments to a group of students in the study area that do not form the population twice at an interval of two weeks in line with Sambo (2008) recommendation. The results of the two tests were correlated using Pearson Product Moment Correlation. A reliability coefficient of 0.69 and 0.75 were obtained for ICPT and TOSPS respectively.

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## 8. RESULTS

### 8.1 Hypothesis One

There is no significant difference in the academic performance of students taught identification of cations using process-based instruction and those taught the same concept using lecture method

Table 1, indicated that there is a significant difference in the performance of students exposed to identification of cations using process based instruction and those exposed to the same concept using lecture method at ( $t= 8.69$ ,  $p= 0.001$ ).

**Table 1:** Comparison of Students Performance in Identifications of Cations in Experimental and Control Groups.

Groups	N	Mean	Std.	t	df	p	Remark
Experimental	54	28.81	4.85	8.69	101	0.001	Sig
Control	49	16.98	4.25				

Significant at  $P \leq 0.05$ .

**Table 2:** Comparison of Experimental and Control Group students' Skills Acquisition Levels in Observation, Measurement, Inference, Interpretation and Hypothesis.

Variables	Group Type	N	Mean	S.D	DF	T	p	Decision
Observation	Expt.	54	3.57	1.19	101	4.85	0.01	Sig.
	Cont.	49	2.37	1.33				
Measurement	Expt.	54	3.28	1.28	101	2.53	0.03	Sig.
	Cont	49	2.69	1.02				
Inference	Expt.	54	3.14	1.26	101	3.68	0.02	Sig.
	Cont	49	2.29	1.09				
Interpretation	Expt.	54	3.48	1.21	101	3.38	0.01	Sig.
	Cont	49	2.69	1.18				
Hypothesis	Expt.	54	3.19	1.35	101	2.68	0.02	Sig.
	Cont	49	2.51	1.24				

Significant at  $P \leq 0.05$

## 8.2 Hypothesis Two

There is no significant difference in the level of acquisition of science process-skills of observation, measurement, inference, interpretation and hypothesis between students in the experimental and control groups.

Table 2 reveals that, there is difference in the acquisition of science skills between students' in the Experimental and those in the Control groups. The acquisition of skills in observation, Measurement, inference, interpretation and hypothesis recorded a t-value of ( $t=4.85, 2.53, 3.68, 3.38$  and  $2.68, p <0.05$  respectively). Students in experimental group acquired more skills in observation, Measurement, inference, interpretation and hypothesis than students in Control group counterparts. It is worthy to note that the acquisition level is low in both Experimental and Control group. Students in experimental group had an average of 2.08 out of the maximum obtainable score of 10 in observation skills while students in control group had 2.75.

## 9. DISCUSSION

The result in Table1 reveals that there was significant difference between performance of the students in experimental group and those students in the control group. The significant difference is in favour of experimental group. The higher performance in favour of the experimental could be attributed to the fact that process based instruction allows students to participate actively in the lesson. The finding is in support of research finding of Mari (2006), Ango (2002) and Roselyn (2013). However, the work contracted the work of Gumel (2007). Who asserted that there is no significant differences in process approach when both experimental and control group are exposed to it analysis of inorganic compounds.

The finding in Table 2 shows that there was significant difference in the level of acquisition of science process-skills of observation, measurement, inference, interpretation and hypothesis which supports Mari (2001) study. However the experimental students have slightly higher means score than the controlgroup students in observation, measurement, inference, interpretation and hypothesis, the mean scores of experimental students are slightly higher than that of the control group students. Students did not show good level of science skills acquisition in observation, measurement, inference, interpretation and hypothesis, the skills acquisition levels are below average. The reasons why the experimental group perform better than control group could be attributed to the fact that the process-basedinstructions allow students to participate actively in the lesson.

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This finding was supported by the works of Danladi (2003) and Nwosu (2005). Who in their separate reports confirmed that there is significant difference in the levels of acquisition of science-skills between students taught science concepts using process-based instruction and those taught the same concepts using lecture method.

## **10. CONCLUSION**

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This study has established the fact that process based instruction has significantly affected the performance of the students in identification of cations. These findings tend to provide justification for teachers who have found active strategies like process-based in teaching science as an alternative to traditional passive strategies that are teacher cantered like lecture method. It is however important to stress that students' mean performance scores in both experimental and control group are below average. This shows that a lot of work still needs to be done to raise students' performance in both experiment and control groups.

## **11. LIMITATIONS**

The following are the limitations of this study:

- The study was restricted to only senior secondary schools in Faskari, Katsina State; this made the scope of generalisation that can be made from this study fairly narrow. Thus, a limitation to the study.
- The use of a sample of size of only one hundred and seventeen (117) is a limitation observed by the researcher. If a larger sample size is used for the study, it might wider the scope of generalization that can be made from the study.
- The study is also limited to Identification of cations concept.

## **12. RECOMMENDATIONS**

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

1. Chemistry teachers and educators should adopt processed based instructional strategy as purposeful and efficient instructional strategy in teaching qualitative analysis so that students could reap the full benefits of active classroom involvement.
2. Education stakeholders should organize conferences, seminars and workshops for chemistry teachers to acquaint them with the use of process based instruction to improve the process and product of learning.



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3. Textbook authors should adopt process based instruction in their books to support student's organizational process.

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### 13. IMPLICATIONS FOR DIFFERENT STAKEHOLDERS

It is hoped that the results of this study would benefit chemistry teachers, students, curriculum planners, policy makers in education, text books publishers as well as other researchers undertaking research in similar field in various ways. It is hoped that the findings from the study will:

1. Avail curriculum developers and education planners the opportunity to plan the process and evaluation of teaching and learning redox reaction concepts in the senior secondary schools. This will also help in suggesting the way forward in the inculcation of process based instruction or lecture method in the teaching and learning of qualitative analysis.
2. Provide chemistry teachers with relevant information on skills needed to make in identification of cations more interesting and productive and assist teachers in choosing appropriate teaching strategy that will reduce the stress of teaching large classes and make abstract chemistry concepts simpler and easier for improve students' academic performance.
3. Contribute to the existing literatures by providing reference materials for chemistry teachers and researchers in the areas of science teaching methods in schools and prepare ground for interested researchers who may wish to conduct further research in related areas.
4. Help governments, agencies and organization like Federal and State Ministries of Education, Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN), National Educational Research and Development Centre (NERDC), among others, in realizing their various mandates.

### 14. FUTURE RESEARCH

Based on the findings of this study the following suggestions may be found useful for future research:

- That similar study could be conducted elsewhere to see whether it will yield similar or different result with the present study.
- The result obtained in this study was for identification of cations concepts in chemistry. The strategy can therefore be tried for other concepts in chemistry and other science disciplines like Biology, Mathematics and Physics.

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- More studies should be conducted on impact of process based instruction on academic performance, attitude, gender, confidence, retention and interest in secondary schools and tertiary institutions in different part of the country.

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