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Students` Aptitude Indices as predictors of Learning Outcomes in Chemistry

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Abstract

Chemistry is very important in the Sciences but it is observed that students do not have good understanding of many of the concepts in the subject. Many factors have been identified to be responsible for students poor performance in the subject at the secondary school level. Studies have concentrated on teacher, school and learning environment factors but very few on students aptitude. This study, therefore, investigated the extent to which student`s science aptitude indices viz background in science, mathematical ability, practical skills and mental ability predict senior secondary school students` achievement in chemistry. The study adopted survey design of the ex-post factor type. The sample comprised 826 senior secondary school, 11 chemistry students from 20(twenty) secondary schools drawn from 20 local government and development area out of the 57 in Lagos state. Six(6) Instruments were developed and validated for the study. These include, Checklist of Chemistry Apparatus and Reagents (CCAR), Mathematical Ability Test (MAT), r = 0.84,Student Mental Ability Test (SMART), r =0.80, Student Practical Skill Test (SPSTC), r = 0.84, Student Chemistry Achievement Test (SCAT), r = 0.88. Three(3) research questions were answered in the study. Data were analyzed using Pearson Product moment correlation and multiple regression statistics. After a careful look at the findings, recommendations were made for teachers and parents to ensure that only students with high positive aptitude for science are encouraged to enroll in science classes and that government and relevant agencies should make adequate provision in terms of materials, facilities and equipment necessary for effective teaching and learning of science in schools. This is likely to enhance the development of needed aptitude by students.

Introduction

Chemistry, which is a branch of pure science is a body of knowledge that deals with abstraction, conceptual thinking and generalization of facts, all of which require a minimum level of intellect or cognitive development on the part of the students. The relevance of this subject to the individual and the nation in general, then calls for its inclusion in the curriculum of senior secondary classes in Nigerian schools.

Despite the important place of Chemistry to mankind and its central position in science generally, the learning outcomes of students in the subject is not encouraging (Oginni, 2009). The poor learning outcome of students in chemistry has continued to be a major cause of concern to all, particularly those in the mainstream of chemistry education in Nigeria (Olorunlegbe 2000, Eze 2002, Okonkwo2002, Olaloye and Afuwape, 2004, Alake 2006),and this depressing situation has no doubt, informed so many research efforts which have been directed towards identifying the factors responsible for this deplorable condition and what efforts are to be made to improve such situation. Among the factors that have been identified to be responsible for low learning outcomes in chemistry are poor methods of instruction(Ojo 1989),teacher's attitude(Ogunniyi 1982,Okpala 1985 and Onocha 1983), laboratory inadequacy(Brotherton and Preece 1996,Okegbile1996,Bajah 1999 and Adeyegbe 2005),poor science background(Bello, 1995 and Adesoji 1999) and non-availability of effective teaching and learning resources in classrooms(Nwosu 1993,1998 and Bassey 2002).In order to alleviate this problem , more research efforts need to be directed towards the factors responsible for the deplorable condition so as to put students learning outcome back on track. This dismal performance had no doubt, informed the present study to investigate some factors such as students' background in chemistry, mathematical ability, practical skills and mental ability among others as they relate with students performance in the subject.

One of the students` aptitude indices is student background in chemistry. Olaloye and Afuwape (2004) in a study revealed that achievement in Integrated science is related to later achievements in Biology, chemistry and physics. Bello (1995) in his study reported that poor academic background of students in Integrated science in Junior Secondary class (JSS 1-3) level is one of the factors responsible for the poor learning outcomes in chemistry. A student cannot learn chemistry effectively without going through some experiences in integrated science (Osokoya 1998 and Adesoji, 1999). In the light of this, students with good background in Integrated science are likely to perform well in chemistry.

Mathematical ability of students is considered very important in the learning of chemistry as the present age of computer and information technology owes a lot to mathematics(Akinsola and Tella 2001).Also in a developing country like Nigeria where manpower is needed more especially in science, a good mastery of mathematics would ensure that more of this much-needed manpower is developed (Aremu,2001).Like other science subjects, chemistry needs sound grounding in mathematics to survive, in the light of this Salau(2000) pointed out that there exists an impregnable link between mathematics and other science subjects. The teaching of practical aspect of other subjects can hardly be achieved without the knowledge of mathematics thus Harbor-Peters (2000) advanced that the culture of mathematics has afforded many people the opportunity of knowing and accessing things in the environment that they would not have been able to without mathematics.

In addition to the influence of mathematical ability on students' learning outcomes in Chemistry is the effect of practical skills possessed by students in question. Practical skill is the application of the knowledge students acquire in chemistry class. This needs to be thoroughly investigated. The practical skills have the enduring quality that will contribute to students' abilities to answer questions and solve problems even when the information base of science and technology changes .However, the aim of practical skill has been the focus of a good number of researchers(Woolnough and Allsop;1958,Beattyand Woolnough,1982;Tamir,1984;Goot et al,1988;

Hodson,1990;Miller et al,1998; Watson 2000).When this happens, students need to acquire these skills during practical chemistry teaching for it is assumed that a student who learns Chemistry contributes to the development of the society as it is stipulated in the National Policy on Education(FME,2004) section 5; 21(a) pg 13.

Mental ability is another students' aptitude indicator which is examined in this study. Like any other school subjects, Chemistry requires mental ability of the students to able to cope with the learning of the subject. There has been a great deal of work in the study of mental processes of students in the learning of Science in the last two decades(Lee, Goh, Chia and Chin,1996).Incidentally, the thinking aspect has to do with the students reasoning particularly in Science. Thus, their level of mental (cognitive) development is of interest in this study. By Piaget's categorizations, Senior Secondary Students are expected to be formal operators and therefore reason abstractly. It is expected that as formal thinkers, they could attempt questions that demand formal and concrete levels of reasoning. Poor performance of students and perception of Chemistry by students are believed to be attributed to lack of appropriate formal operational thought and this, of course, can be addressed when students as partners in their own learning, can reason in coming to conclusion on how to solve problems and processes.

Statement of the Problem

The dismal performance of students in external examinations in chemistry over the years calls for concern. Researchers have delved into finding solutions to this problem but more need to be done. This paper is out to call for more positive actions to be initiated in order to create room for enhancement of the performance of students in the subjects. The extent to which this is to be achieved is considered in this paper.

Research Questions

1. What is the composite effect of students' aptitude indices on students' achievements in chemistry?
2. What are the relative contribution of students' aptitude indices to students' achievements in chemistry?
3. Which of the selected students' aptitude indices will predict students' achievement in chemistry?

Methodology

Research design:

This study adopted the ex-post facto research type with a survey design

Variables in the study:

These include both the independent and dependent variables. The independent variables are student's aptitude indices viz students background in science, students mathematical ability, students practical skills and students mental ability while the independent variable comprises students achievement in chemistry.

Population and Sample:

The population consisted of 826(Eight hundred and twenty six)SS11 Chemistry students who had completed SS1 Chemistry Curriculum and had also done much in SS11 Chemistry syllabus and also 20(twenty) teachers in Lagos State, ten(10) from urban and ten(10) from peri-urban schools were randomly selected from all the schools in 20 local governments and 37 development areas of Lagos State .In all ,seven public and three private schools were selected from 10(ten) urban schools as well as the same number of schools from 10(ten) peri-urban schools. All the SS11Chemistry students in each of the schools selected were used in the study .Also, the Chemistry teachers teaching the SS11 Students in the selected schools were purposively selected for inclusion in the study.

Instruments

- Checklist of Chemistry Apparatus and Reagents(CCAR)
- Mathematical Ability Test(MAT)
- Student Practical Skills Test in Chemistry (SPSTC)
- Student Mental Ability Test(SMAT)
- Student Chemistry Achievement Test(SCAT)

CCAR was validated for content validity as the lists of required apparatus and reagents were consulted so that the various recommended apparatus and reagents were covered in the list of items included in CCAR, Also, Chemistry teachers of some schools were consulted so that they can see to the appropriateness of the items in CCAR and Chemistry Syllabus.

Scoring of CCAR

CCAR was scored by attaching (1) to available,(0) to not available, while level of adequacy was determined by matching the insignificant quantity available with the number of Chemistry students in each school.

MAT was validated using test-re-test method .The correlation coefficient between the two sets of scores was calculated using Pearson's product moment correlation formula to determine the reliability of the instrument. The reliability index obtained was 0.89.

Scoring of SMAT

SMAT was scored by awarding a point to each correct response made by the student and zero for wrong ones.

Also, for SMAT, Test-re-test reliability method was computed and found to be 0.79 using Pearson's product moment correlation formula.

Scoring of MAT

MAT was scored by awarding a point to each correct response made by the student and zero for wrong ones.

The SPSTC was tested for reliability using the test-re-test method which yielded reliability coefficient of 0.78.

Scoring of SPSTC

5 marks for each sub-question in question 1; 7 marks for (a) 9 marks for (b); 2 marks for each sub question; 2 marks for each sub question.

For SCAT, reliability coefficient was computed using Kuder-Richardson formula-20, since all the test items were not of equal difficulty level.TheKR-20 value obtained was 0.89, average item difficulty index obtained was 0.46 and the discriminating index was 0.82.

Scoring of SCAT

SCAT was scored by giving a point each to every correct response.

Procedure for Data Collection

The instruments designed for the study were administered to both the teachers and SS11 students by the researchers and some research assistants and they were retrieved immediately. Mathematical Ability Test (MAT) and SMAT were first administered on the same day while SPSTC was done on another chosen day. SCAT was administered last.

Method of Data Analysis

Data collected were analyzed using Multiple Regression Analysis. This was used to provide answers to the research questions raised in this study.

Results and Discussion

The results obtained are presented as follows:

TABLE 1: Summary of Regression on Student Aptitude Indices

R	R Square (R^2)	Adjusted R Square	Std. Error of the Estimate
.605	**.362**	**.362**	**1.5395**

Table 1 shows that the four student aptitude indices jointly correlate positively with Achievement in Chemistry (R=.605).This implies that the variables are quite relevant in predicting students' achievement in Chemistry .The table also shows an adjusted R^2 value of .362 which indicate that 36.2% of the variance in student achievement in chemistry is accounted for by the four science aptitude indices, when combined. The remaining 63.8% could be due to errors and other factors not investigated in the study. The significance of the R-value is reflected in table 2.

Table 2

Source of variance	Sum of squares	Df	Mean Square	F	Sig.
Regression	1120.834	4	280.209	118.231	.000*
Residual	1945.782	821			
Total	3066.616	825			

- **Significant at p<.05 F(4,821)=118.231;p<.05**

From Table 2, the R value was significant. This implies that the R value was not due to chance. Hence it is found that there is a significant composite effect of the student aptitude indices on student achievement in chemistry.

Table 3: Relative effects of students` Aptitude Indices on Achievement.

Student Aptitude Indices	B	Std Error	Beta	Rank	t	Sig.
(constant)	25.023	.639			39.164	.000
Student Background	-.559	.195	.229	3rd	4.916	.000*
Mathematical Ability	9.509 E-02	.016	.270	2nd	5.780	.000*
Practical Skills	1.980 E-02	.006	.098	4th	3.341	.000*
Mental Ability	-.585	.031	.543	1st	18.625	.000*

Significant at p<.05

Table 3 shows that of the four student Aptitude Indices, mental ability made the highest contribution followed by mathematical ability. The third in ranking of the contributions is that made by student background in science while student practical skill made the lowest contribution to achievement in chemistry. Thus, they all contribute significantly towards the determination of student achievement in Chemistry. However, all the four independent variables have t values which are significant. Therefore they are all predictors of the dependant measure (achievement in chemistry)

Discussion

The study revealed that 36.2% of the total variance in the students' achievement in Chemistry is accounted for by the four students aptitude indices .This shows that the performance of students depends largely on the students' aptitude indices in Chemistry. Further, it was found that each of the four students aptitude indices made significant contributions and could also predict students achievement in chemistry.

The implication of this is that as students' aptitude indices improve, student performance also Improves . Also, for a subject such as Chemistry which is experimental in nature, Students need good science background at the JSS Integrated Science as it has a strong relationship with achievement in Chemistry as well as good practical skills. These findings are In consonance with those found by Olatoye and Afuwape,2004; Ogunleye,2002 and Osokoya,1999.The earlier findings of (Ezeliora,1999,Adebayo,1998; Oriaifo,2003andUgwu,2007) support this finding in that students poor achievement in Chemistry can only improve if the passion for practical activities by the students are sustained throughout the O' level stage. It is expected as a matter of necessity that students of Chemistry need some considerable level of mental ability to perform well in Chemistry. Past studies corroborated this claim (Bomide1986and Lawson,1983).A look at the composite and relative effects of mathematical ability on achievement is a pointer to the fact that it is an aptitude index that must be considered seriously if improved performance is to be achieved in Chemistry. This outcome confirms the earlier findings of Ojo, 1999andAremu, 2001.

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