Abstract
This study was concerned about the effect of three teaching methods, gender and numerical ability on students' performance in Electrochemistry in Uyo LGA of Akwa Ibom State. The 200 senior secondary two students used in the study were taught in three groups using problem solving approach, guided inquiry method and expository method. Subjects were classified into high, average and low numerical abilities based on their performances in Numerical Ability Test (NAT), as well as gender (male and female). Thereafter, subjects were pretested with Achievement Test on Electrochemistry (ATOE) before treatment and later post-tested with same ATOE after four weeks of treatment to determine their level of performance. The reliability index of NAT was 0.74 while that of ATOE was 0.71, these were considered reliable and capable of measuring intended outcomes. The data collected were analyzed using means, standard deviation and analysis of covariance (ANCOVA). Results revealed that students taught using problem solving approach performed significantly better than their counterparts taught using guided inquiry and expository methods. On the other hand, gender had no significant effect on students’ performance of learned concepts. Recommendations made include that teachers of chemistry should adopt problem solving approach in chemistry teaching and as well afford both male and female students equal opportunities to excel during science class lessons.

The role of chemistry in raising the level of productive force and the standard of living of any nation cannot be overemphasized. The impact of fertilizers, detergents,
paints, polymers, etc has been so far-reaching that it is not easy to visualize modern life without these products. However, chemical and allied industries require the services of qualified personnel in areas of material analysis, evaluation, product analysis and quality control, product development, laboratory organization and management as well as personnel management. In response to these needs, the Third National Development Plan (1975-1980, P.75) which aimed at transforming Nigeria into a united, strong and self reliant nation adopted a plan strategy which included programme of expansion of secondary, technical and university education with a view to overcoming the manpower problem for Nigeria industries and industrialization programme (Ikoku, 1982). The National objectives of chemistry education at the secondary level were to, among others, expose students to; basic chemical concepts, individual experimentation using simple inexpensive equipment, the role of chemistry in the study of other disciplines as well as the relevance of chemistry to society. In spite of concerted efforts at ensuring quality chemistry education programmes at various levels of education in Nigeria, studies on students output in science and technology reflect general and consistent poor performance (Omole, 2002, Nnaka & Anaekwe, 2006).

Researchers (Omole, 2002; Ekpo & Udo, 2004; and Udo 2007), blame the poor performance of students in chemistry and other science subjects on poor teacher quality, inadequate and inappropriate learning instructional strategies adopted by science teachers. Again, certain topics and concepts in science have been tagged difficult either because teachers find them difficult to teach or students find them difficult to learn (Adesoji, 1992). Such topics included collision theory, thermodynamics, chemical equilibria, electrochemistry, etc. (WAEC, 2003a). Particularly in electrochemistry, the observed poor performance is attributed to students’ inability to tackle most of the numerical questions as well as inadequate exposure to practical activities.

This scenario of poor performance cuts across gender as Afuwape and Olupide (2008), as well as Ogunleye and Babajide (2011) noted that both males and females achieve equally in science, though Catsambis (1995) and Ahiakwo (1998) reported of inequality in gender achievement in favour of the females.

This has called for a deep and incisive interest on how best to improve science teaching generally towards enhancing students’ performances especially in chemistry quantitative problems.

This study therefore sought to profer some answers to which best methods/approaches would benefit which gender and which abilities of students.
Method and Procedure

Design: Non-randomized pretest-posttest control group design was used for this study since the nature of the study did not allow for randomization.

Sample: The sample consisted of 200 SS2 students of chemistry in the selected schools in the study area. The students were used in their intact class settings. Purposive sampling technique was used in selecting the schools, such as, that the school must have a functional laboratory; the school must have presented candidates for WACE examinations in the past 5 years, as well as having a highly qualified chemistry teacher with B.Sc (Ed) degree with at least 5 years teaching experience.

Training assistants were qualified chemistry teachers in their selected schools who were exposed to one week training using validated instruments and lesson notes. Numerical ability test (NAT) and Achievement Test on Electrochemistry (ATOE) were administered to subjects as pretest after which subjects were exposed to four weeks classroom instruction by the Research Assistants. At the expiration of the four weeks teaching ATOE was reshuffled and administered as post-test. The test scripts were thereafter collected immediately after completion for marking and analysis.

Instrumentation

Achievement Test on Electrochemistry (ATOE) was developed by the researcher and consisted of 25 item multiple choice objective tests with 5 options lettered A, B, C, D and E. The items were drawn to cover basic concepts under electrochemistry. The instruction was used in measuring the respondents pretest and posttest performances.

Again, the Numerical Ability Test (NAT) was a 20 item multiple choice objective test with 5 options lettered A, B, C, D and E. The result was used in classifying subjects into high, average and low numerical ability groups.

The reliability indices of both instruments were ATOE-0.71 and NAT-0.74 which were considered high enough for the tests to be considered reliable.

Instructional Packages

These consisted of lesson notes for the treatment groups. The lesson notes for the Experimental group 1 featured problem-solving approach; that of Experimental group 2 featured guided inquiry approach, while that of the control group featured the expository approach.
Problem-solving approach package was developed based on Selvaratnam-Frazer Problem Solving Model (SPSM) devised for solving problems in chemistry. SPSM is a 5step problem-solving model which involves clarifying and defining the problem, selecting the key equations, deriving the equation for the calculation, collecting data, checking and learning from solution. Worked exercises were designed to be taught to experimental group 1 students.

Guided inquiry approach package was one which students were guided to answer questions, solve problems and verify electro-chemical laws through certain structured questions and procedures. This lesson note was for experimental group 2 students.

In expository method package, students were presented concepts in electrochemistry in a manner that the teacher was in control and talked to the students who are passive listeners based on the prepared lesson notes.

**Hypothesis**

There is no significant joint effect of teaching methods, students’ numerical ability and gender on their performances in electrochemistry.

**Table 1: Multiple Regression Analysis of Students’ Posttest Performance with Treatment, Numerical Ability and Gender as Predictors**

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-cal</th>
<th>P&lt;0.05</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>4024.60</td>
<td>3</td>
<td>1341.53</td>
<td>29.21</td>
<td>0.00</td>
<td>S</td>
</tr>
<tr>
<td>Residue</td>
<td>6165.18</td>
<td>196</td>
<td>45.93</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11189.78</td>
<td>199</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

df = degree of freedom; F-cal = calculated F-value; S=significant at p<.05 alpha

In table 1, the F-cal = 29.21 at 0.00 probability level is less than 0.05 alpha, indicating that the F-cal is statistically significant at p<.05 alpha. That is, there is a joint effect of the instructional approaches, students’ numerical ability and gender on their performances in electrolysis. Hence, null hypothesis (There is no significant joint effect of teaching methods, students’ numerical ability and gender on students’ performances in electrochemistry) is rejected.

To determine the joint contribution of the three independent variables to the observed variations in the students’ performances in electrochemistry, a multiple...
classification analysis (MCA) of the students’ posttest scores was done and the results are summarized in Table 2

**Table 2:** Multiple classification analysis (MCA) of students’ posttest scores classified by treatment, numerical ability and gender

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>Un-standardized coefficients</th>
<th>Standardized coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eta</td>
<td>Std. Error</td>
</tr>
<tr>
<td>Instructional approach</td>
<td>-1.59</td>
<td>.67</td>
</tr>
<tr>
<td>Numerical ability</td>
<td>-5.73</td>
<td>.66</td>
</tr>
<tr>
<td>Gender</td>
<td>-1.41</td>
<td>1.10</td>
</tr>
</tbody>
</table>

R = .600; R Squared = .360; Adjusted R Squared = 34.7

Eta = Unadjusted regression index for the variable; Beta = Adjusted regression index for the individual variable; R = multiple regression index for the joint effect of the variables

In Table 2, the beta² values for teaching methods, numerical ability and gender were .023, .314 and .006 respectively. This implies that the instructional approaches contributed 2.3% to the observed variation in students’ performance while the students’ numerical ability and gender contributed 31.4% and 0.6% respectively. The highest contribution therefore came from students’ numerical ability, closely followed by instructional approaches.

With respect to the joint contribution of the three independent variables to the observed variation in students’ performance, Table 2 displays an adjusted R squared value of .347 indicating a 34.7% contribution.

**Discussion of Findings**

The results in Table 1 and 2 showed that the joint effect of the three independent variables – instructional approaches, students’ numerical ability and gender on their performances in electrochemistry was statistically significant. The three variables jointly contributed 34.7% observed variance in students’ performances. Out of numerical ability, 2.3% was due to the instructional approaches and only 0.6% contribution was due to gender. The relative contribution indicates that students’ numerical ability is the most significant followed by the instructional approach used. The 0.6% contribution due to gender clearly indicates that gender is not a significant factor to be associated with achievement in chemistry. The above findings agree with Afuwape and Olupide (2008), as well as Ogunleye and Babajide (2011).
Conclusion

This study has opened a new course in the teaching of chemistry quantitative problem such as electrochemistry and the likes. It is hoped that new training curricula in chemistry would emphasize the embrace of problem-solving approach alongside guided inquiry method towards ensuring better performances of students of different abilities as well as male and female students in this area of study.

Recommendations

Chemistry teachers should encourage their students to tackle problems in chemistry using problem-solving sequence as proposed by Selvaratnam/Frazer. Again, teachers of chemistry should master Selvaratnam-Frazer problem-solving approach and apply same in the teaching of chemistry quantitative problems.

References


