Investigating Gender Difficulties And Misconceptions In Inorganic Chemistry At The Senior Secondary Level

Francis A. Adesoji
Department of Teacher Education,
University of Ibadan,
Ibadan.

&

A.G. Babatunde
Department of Chemistry,
Osun State College of Education,
Ila-Orangun

Abstract

This study was designed to analyse the difficulties and misconceptions of students in inorganic chemistry. This was done by making use of Ashmore, Casey and Frazer (1979) stages of solving problems in chemistry. The sample comprised of three hundred and twenty (320) Senior Secondary III (SS3) students randomly selected from eight secondary schools in Ibadan, Oyo State, Nigeria. The subjects were made up of one hundred and sixty (160) males and one hundred and sixty (160) females. The instrument used was a Test to Identify Students' Misconceptions (TISM) in inorganic chemistry. The results showed that more females than males had difficulties and held misconceptions in inorganic chemistry. The implications of this was discussed and recommendations given.

Introduction

Previous studies have revealed that students hold misconceptions in chemistry. (Aguirre, Haggerty and Linder 1990; Adigwe, 1993a and b; Clerk and Rutherford, 2000; Voska and Heikkinen, 2000). Prominent among the factors that have been identified to be responsible for these misconceptions are poor method of instruction (Kilbourn, 1992; Schmidt, 1994; Ochonogor, 1999), improper exposure to laboratory activities (Lawton, 1990; Brotherton and Precce, 1996), lack of organizational skills and inadequate exposure to problem-solving procedures. (Onwu and Moneme, 1986; Ahiakwo, 1988;1991). The term misconception has been conceived as a conceptual and propositional knowledge that is inconsistent with or different from the commonly accepted scientific consensus (Sanger and Greenbowe, 2000). Students’ misconceptions are therefore erroneous, fallacious or naïve conceptions which students hold.

The influence of gender on students’ performance has for a long time been a concern to many educational researchers. But surprisingly, no consistent result has been obtained. For instance, Inyang and Jegede (1991) reported that gender has no effect on students’ achievement in science. Similarly, Shaw and Doan (1995) also asserted that emerging data on differential gender performance in science indicated that elementary students did not exhibit any gender difference in achievement and attitude towards science.
Erinosho (1994) stated that the difference between the mean scores for boys and girls was not statistically significant in chemistry achievement.

In their own findings on the effect of gender on students’ problem-solving skills, Shaibu and Mari (1997) explained that female subjects were significantly better than their male counterparts and that there was significant difference between the male and female subjects in their ability to solve quantitative problems. Kahle and Meece (1994) argued that while two decades of researching indicated that the gender gap was closing in mathematics achievement, the reverse was the case in science achievement and that gender gap in science achievement increased from age 9 to 13. Catsambis (1995) however opined that gender in science achievement began to appear in the middle ages.

Similarly, Ahiakwo (1988) in his study captioned “cognitive style and students’ problem-solving behaviour in chemistry” concluded that there was sex difference in performance with chemistry process skill test. In this study, he concluded that girls performed better than boys and that the difference between their mean scores was significant beyond P<0.001. However, contrary to the above arguments, Trigwell (1990) argued that male subjects were superior over their female counterparts in problem-solving and achievement in chemistry and science-related courses and this was responsible for the observation that the number of women studying science subjects in most tertiary institutions was considerably less than the number of men. Bazler and Simon’s (1991) similarly noted that women represented only 20.5% of the Natural Sciences and 5.8% of the engineering work force in U.S.A. According to Whitely (1996), 53 out of 65 academic staff in the faculty of Natural Sciences, University of West Indies were males in 1991.

From the above discussions therefore, it could be deduced that the effect of gender on problem-solving learning outcomes in general, has attracted attention of educational researchers in the past years. It is also note-worthy that these various researchers have come up with different findings. Therefore, it is as a result of this that this research work focuses on the effect of gender on students’ difficulties and misconceptions in inorganic chemistry. Based on these facts, two hypotheses were formulated and tested in this study.

They were:

$H_o_1$: There is no significant relationship in the difficulties of male and female students in inorganic chemistry.

$H_o_2$: There is no significant relationship in the misconceptions of male and female students in inorganic chemistry.

Research Design

The design used for this study was evaluative (Campbell and Stanley, 1980). This design can be designated as R – X - O, where

- R = Randomization
- X = Treatment
- O = Observation.

This is a one-group, randomized subjects, post-test only design. No pre-test is used; the randomization controls for all possible extraneous variables. The only group is exposed to the experimental treatment. The design controls for the main effect of history, maturation and pre-testing; because no pre-test is used, there can be no interaction effect of pre-test and X (treatment). The design therefore enables researchers to see the true situation of subjects’ problem-solving difficulties and misconceptions in the topics under investigation.
Population and Sampling Technique

The target population was all the SS III chemistry students in Ibadan, Oyo State, Nigeria. Using the method of proportionate stratified random sampling, eight schools were selected for the study. These schools were made up of four mixed (i.e. boys and girls), two boys only and two girls only schools. From each of the selected school, random selection of students were made as follows:

(i) From each mixed school, twenty boys and twenty girls were chosen;
(ii) From single schools, forty students were chosen.

This resulted in an overall total sample of three hundred and twenty (320) subjects, comprising of one hundred and sixty (160) boys and one hundred and sixty (160) girls.

Research Instrument

The research instrument used was a Test to Identify Students’ Misconceptions (TISM) in inorganic chemistry, which comprised of six questions of senior school certificate standard. Two Ph.D. candidates and two chemistry educators of University of Ibadan certified the questions suitable for secondary school students. The reliability determination was carried out by using test - retest method. Pearson Product Moment correlation was used to determine the reliability coefficient, which gave a value of 0.73.

Research Procedure And Data Collection

Eight chemistry teachers were involved in the process of the study (one from each of the selected schools). They were given adequate information on the objectives of the study and on what to teach the students. The researcher made sure that all the teachers followed the guide by touring the schools. Teaching took place for eight weeks, after which the students were given the test by their teachers during their normal classes. Students’ answer scripts were collected immediately after administering the instrument for the purpose of fishing out students’ misconceptions and difficulties. Students’ difficulties were analysed using the frame work of Ashmore, Casey and Frazer (1979) model for solving problems in chemistry.

These stages are:

(a) Defining the problem goal;
(b) Selecting information from problem statement;
(c) Selecting information from memory;
(d) Reasoning, and
(e) Computation.

Results

The hypotheses were tested by making use of frequency counts, percentages and χ² statistic. The 320 students solved the problems and a total of 1920 scripts were presented for Analysis. To test for Ho, the frequencies of male and female students involved in various difficulties were compared as shown in table 1.
**Table 1:** Comparison of students’ problem-solving difficulties in inorganic chemistry, using Ashmore et al (1979) model.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Stages of Problem-solving</th>
<th>Boys (N = 960)</th>
<th>Girls (N = 960)</th>
<th>χ²c</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No. Involved</td>
<td>%</td>
<td>No. involved</td>
</tr>
<tr>
<td>1.</td>
<td>Diff. in defining the problem.</td>
<td>201</td>
<td>20.9</td>
<td>245</td>
</tr>
<tr>
<td>2.</td>
<td>Diff. in selecting information from data.</td>
<td>31</td>
<td>3.2</td>
<td>29</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>33</td>
<td>3.4</td>
<td>41</td>
</tr>
<tr>
<td>4.</td>
<td>Diff. in selecting information from memory.</td>
<td>78</td>
<td>8.1</td>
<td>85</td>
</tr>
<tr>
<td>5.</td>
<td>Diff. in reasoning.</td>
<td>108</td>
<td>11.3</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td>Errors in computation.</td>
<td>509</td>
<td>5.30</td>
<td>418</td>
</tr>
<tr>
<td></td>
<td>No error (correct solution)</td>
<td>960</td>
<td>100</td>
<td>960</td>
</tr>
</tbody>
</table>

χ²t = 11.07; df = 5   *Significant at P<0.05

Table 1 shows that female students were more frequently involved in more difficulties than their male counterparts in all stages of the model except state 2. Moreover, apart from stage 1, χ²c < χ²t, implying that there was no significant relationship in the difficulties of male and female students in inorganic chemistry. Hence H₀₁ was not rejected.

To test for H₀₂, the misconceptions of male and female students were compared as shown in Table 2.

**Table 2:** Comparison of Male and Female Students’ Misconceptions in Inorganic Chemistry

<table>
<thead>
<tr>
<th>Nature of Misconception</th>
<th>Total no of student involved</th>
<th>No of male</th>
<th>% of males</th>
<th>No of females</th>
<th>% of females</th>
<th>χ²c</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inability to write formulas of compounds correctly.</td>
<td>124</td>
<td>48</td>
<td>38.7</td>
<td>76</td>
<td>61.3</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>2. Misunderstanding of IUPAC</td>
<td>311</td>
<td>122</td>
<td>39.2</td>
<td>189</td>
<td>60.08</td>
<td>0.8</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 5 shows that female students were more frequently involved in the various misconceptions than the male students. In each of the cases, $\chi^2_C < \chi^2_t$, implying that there was no significant relationship in the misconceptions of male and female students in inorganic chemistry. Hence, $H_0$ was not rejected.

Discussion

This research work investigated male and female chemistry students’ difficulties and misconceptions in inorganic chemistry. The results showed that:

- Both male and female chemistry students held misconceptions in inorganic chemistry;
- Female students had more problem-solving difficulties than their male counterparts in inorganic chemistry;
- Female students held more misconceptions than their male counterparts in inorganic chemistry.

In nearly all the cases, $\chi^2_C < \chi^2_t$, implying that male students outperformed their female counterparts in inorganic chemistry. These results are consistent with Tamir (1990), Trigwell (1990), Adelman (1991), Bazler and Simonis (1991), and Baker and Leary (1995) who claimed that female students had more difficulties than their male counterparts in chemical problem-solving.

Recommendations

- Curriculum planners, authors and teachers should lay emphasis on the processes of science rather than the content of science. This will make the discipline more understandable and foster transfer of learning.
- There should be improved evaluation procedures, which discourages memorization of facts and principles, and which places emphasis on higher cognitive processes.
• Teachers should try to expose the learners to profitable learning experiences, which are deliberately planned into the lesson to enable learners, acquire individual contact with the concepts being taught, irrespective of sex, talents and potentials. It is when learning experiences have become individualized that the students can be effectively involved in the reasoning processes.

• Experienced teachers should be assigned to teach science subjects in senior secondary classes.

REFERENCES


