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EFFECTIVENESS OF PROBLEM OF SOLVING APPROACH ON GENDER RELATED DIFFERENCES IN TEACHING SECONDARY SCHOOL CHEMISTRY STUDENTS MATHEMATICAL CONCEPTS OF CHEMISTRY IN ONDO STATE, NIGERIA

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Abstract:
The study identified Mole Concept in Ordinary Level West African School Certificate (WASC) syllabus, and examined the effectiveness of Problem Solving Approach (PSA) on male and female chemistry students in Senior Secondary Schools in Akure South Local Government Area of Ondo State, Nigeria. The study adopted a pre-test post-test experimental design. The sample consisted of 60 participants selected from two non co-educational senior secondary schools in Akure South Local Government Area of Ondo State, Nigeria. Two intact classes from Senior School I were chosen from the two selected schools comprising 32 females and 28 males. The two intact classes were assigned school A (females) and schools B (Male). These two intact classes were taught mole concepts separately using Problem Solving Approach in their respective schools. A 20 item instrument tagged Mole Concept Achievement Test (MCAT) was developed by the researcher and ascertained for reliability ($r= 0.78$, $p<0.05$). The study was guided by two hypotheses. Data collected were analysed using t-test. The results showed that there was no significant difference in the performance of female ($\overline{X}=16.039$) and male ($\overline{X}= 16.013$) students after treatment, $t=0.087$, $p<0.05$. The study concluded that Problems Solving Approach is an effective method of teaching both male and female secondary school chemistry students the mole concept.

Keywords: effectiveness, gender related differences, mole concept, problem solving approach, non co-educational

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1. Introduction

A review of research in science teaching shows an almost exclusive domination of males over females in learning achievement in selected science concepts. The male dominance has been partly attributed to ineffective methods of teaching or lack of female models to serve as motivation for female learners. Renner & Schnelder (1980) have recommended the use of innovative and metacognitive teaching methods as an attempt to promote gender equality in science learning.

In Nigeria, much school learning consists of rote memorization and regurgitation of facts with little emphasis on meaningful interpretation of ideas. Students are often asked to solve scientific problems and conduct laboratory experiments in a rote rather than in a meaningful way (Novak, 1988, 1990). Often, science knowledge is assumed to be absolute and students are viewed as passive recipients of information (Driver, 1987). In these circumstances, knowledge construction is reduced to factual knowledge production with little regard to critical thinking and problems solving.

In teaching and learning of science, students' metacognition needs to be developed, that is, ability to monitor one own's knowledge about a topic of study and to activate appropriate strategies that will enhance students learning when faced with chemistry problems and other problem solving situations (Baker & Brown, 1984).

Chemistry is the study of matter, its composition, structure and the reactions that change matter from one form to another. There are two broad areas in chemistry; first, the descriptive chemistry, which is the collection of data and discovery of information, secondly, there is the using of this information to form laws and theories which explain our observations, and the using of these laws and theories to predict the future behaviour of matter. The mathematics or abstract treatment of quantities is of paramount importance to chemistry teaching where we must measure matter, express our measurements in numbers and be able to manipulate these numbers to form conclusions or solve problems.

There are many concepts in chemistry that involve chemical calculation. One of these is the mole concept. There are evidences that many students do not understand these concepts effectively well, hence, if chemistry problem solving skills are to improve, chemistry teachers need to spend much greater period of time on concept acquisition and how these concepts will be taught to the students using innovative and metacognitive pedagogical skills such as Problem Solving Approach and hand-on-activities (Novak, 1990).

2. Statement of the Problem

The existing literature in science education is inconclusive with regards to gender achievement in science. Studies, such as Ehindero (1982) had reported that males performed better in male related task while females perform better in females related task. Also, other studies including those by Lawson (1982), and Ehindero (1980), have reported that males perform better than females on tasks requiring logical operations. Perhaps, females see little significance for logical reasoning operations especially those involving quantitative skills and hence are not motivated to develop these skills. Ben & Ben (1970) pointed out that females are socialized to view themselves as incompetent in various fields, including mathematics. As a result of this inconclusiveness, there is the need to examine the role of metacognitive based teaching strategy on performance of male and female students in chemistry. The inability of some of the chemistry students to solve mathematical problems in chemistry is a matter of concern to chemistry teachers, hence the need for helping students become efficient problem solvers in chemistry.

3. Theoretical Framework of Problem Solving Approach

An important instructional strategy that can aid students in developing metacognitive awareness is the Problem Solving Approach (Polya, 1987, Roossink and Dramer-Pals, 1980). Developing metacognition, the ability to monitor one's own knowledge about a topic of study and to activate appropriate strategies, enhances students' learning when faced with solving chemistry problems and other problem solving situations (Baker & Brown, 1984). Metacognitive learning occurs whenever individuals are able to self-regulate and control his/her own learning when confronted with new knowledge.

To guide the study, two hypotheses were formulated:

1. There is no significant difference in the pre-test scores of male and female students on the Mole Concept Achievement Test (MCAT) in chemistry
2. There is no significant difference in the academic performance of male and female students when exposed to Mole Concept Achievement Test (MCAT) in chemistry after treatment using Problem Solving Approach.

4. Method

The study adopted a pre-test post-test control group design. The population for the study consisted of students who were offering chemistry in Senior Secondary I (SSI) in the (28) secondary schools in Akure South Local Government Area of Ondo State. From

these, two non co-educational schools were randomly selected and from which two SS1 science classes (intact) were chosen for the study comprising 28 males and 32 females totaling 60 chemistry students.

From the two science classes selected from the two sampled schools, the two groups were taught separately in their different schools using the Problem Solving Approach. The period of administration of the treatment was four weeks. The topics chosen were the mole and molar mass under mole concept.

5. Method of Instruction

The students (males and females) were taught separately in their different schools.

5.1 What is Mole?

Mole is defined as the amount of substance containing the same number of particles and the number of carbon atoms in exactly – 12 (C^{12}). The particles may be atoms, molecules, ions or electrons. In other word, mole can be expressed in different terms, chemistry adopts the convention that:

One mole = 6.02×10^{23} particles

Mole as a concept can be expressed in the following ways

1. Mole and Avogadro's constant

   The number 6.02×10^{23} is called Avogadro's constant.

   Summarily, number of moles equal number of particles of Avogadro's constant that is,

   1 mole of carbon atoms = 6.02×10^{23}

   2 moles of $Na^{+} = 2 \times 6.02 \times 10^{23}$

   1 mole of $H_20 = 6.02 \times 10^{23} \times H_20$ units

2. Mole and the molar mass

   A three–step Problem Solving Approach conventionally called problem solving strategies by science instructions (Ashmore, Frazer & Cassey, 1979; Bodmer, 1997) was used.

Step I - Analyse

- Identify the known
- Identify the unknown
- Plan a solution

Step II - Calculate

- Solve for the unknown

Step III - Evaluate

- Is the result meaningful?

Evaluating the answer involves a number of checks. Has the unknown been found for example?

Mole and molar mass.

Number of moles = $\frac{Mass\ of\ the\ substance}{Molar\ mass\ of\ the\ substance}$

5.2 Exercise

What is the mass of 0.2mol of calcium trioxocarbonate (iv) oxide (C=12, O=16, Ca=40).

Using the problems solving approach

Step I - Analyse

Identify the known and the unknown

Number of moles = $\frac{Mass\ of\ the\ substance}{Molar\ mass\ of\ the\ substance}$

0.2 = $\frac{Unknonw\ Mass\ of\ the\ substance}{Unknown\ (Molar\ mass)}$

Step II - Calculate

Plan a solution.

Mass of the substance?

Molar mass of the substance = 40.1+12+3 (16)

= $100.1gmol^{-1}$

Step III - Evaluate

Substituting the unknown values for number of moles (0.2) and molar mass of $CaCo_3$ = $100.1gmol^{-1}$.

0.2 = $\frac{Unknonw\ Mass\ of\ the\ substance}{100.1gmol^{-1}}$

Mass of the substance = $2.0x100.1gmol^{-1}$

= 20.02g

6. Procedure for Data Collection

The pre-test was administered on the students in the two schools separately. This was followed by the administration of the Mole Concept Achievement Test (MCAT). Students (male and female) in the two schools were exposed to teaching using the problem solving approach for a period of three weeks after which the post-test was administered.

7. Results

Tables 1 & 2 present the results.

Table 1: Difference between pre-treatment scores of male and female students in school A & B

Group (s)	N	$\overline{X}$	Std Dev.	df	t	Sig
A (Female)	32	8.03	1.51			Not Sig
B (Male)	32	8.006	1.74	30	0.071	

p >0.05

Table 2: Difference between post-treatment scores of male and female students in School A and B

Group (s)	N	$\overline{X}$	Std Dev.	df	t	Sig
A (Female)	32	16.039	1.21			Not Sig
B (Male)	28	16.013	1.11	30	0.087	

p >0.05

8. Discussion

The results showed that Problem Solving Approach was an effective method in teaching mole concept to both male and female chemistry students in secondary schools in Ondo State. It was observed from tables 2 that both male and female chemistry students performed well in the post treatment scores. Also, results from table 2 showed that the overall performance of both male ($\overline{X}$ = 16.013) and female ($\overline{X}$=16.039) chemistry students after treatment where both sexes performed well in the Mole Concept Chemistry Achievement test (MCCAT) is an indication that PSA is an effective method of teaching mathematical concepts in Chemistry.

The results of this findings negates the assertions of Lawson (1973), and Ehindero (1990), which indicated that females should perceive problems involving logical reasoning especially those related to mathematical concepts as extremely difficult to solve. The results in table 2 aptly revealed that both male and female chemistry students possess the understanding of problem solving skills involving Analysing, Calculating and Evaluating mathematical concepts in chemistry.

Also, these findings suggest that the rather ommibus view which seems to have established itself, that males are better than females in science education, needs to be approached and interpreted with caution. This finding draws support from such studies as Brown (1977), and Widean (1977).

Furthermore, the t-test result (t =0.087 p<0.05) shows that there was no significant difference in the performance of both male and female chemistry students exposed to problem solving teaching technique. These findings agree with Omoniyi (2007) in her study of Test of Reasoning Ability between male and female students which suggests that both male and female chemistry students have intellectual development to solve problem involving logical reasoning.

9. Conclusion

In conclusion, problem solving techniques help students (male and female) to perform better on Mole Concept Chemistry Achievement Test (MCCAT), hence, students should be taught to focus on the three specific problem solving techniques when solving mathematical concepts in chemistry. Previous researchers (Bunce & Heikkinen, 1986) have already shown that students' problem–solving skills are more easily measured if teachers simplify the three steps that are involved in problem-solving - Analyse, Calculate and Evaluate. This technique helps to emphasize the general-to-specific process that has been identified as important.

It is thus recommended that secondary school teachers should give homework that requires more practice with problem–solving techniques and should grade test questions by giving more weight to the adequacy of problem-solving-techniques with emphasis on the three steps - Analyse, Calculate and Evaluate and with less concern on the accuracy of the final answer. Also, from the beginning of the term, teachers should require that students demonstrate in writing the application of specific techniques of problem-solving that will enhance their performance in examinations.

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