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RELATIVE EFFECTIVENESS OF PROBLEM SOLVING APPROACH AND VEE MAPPING ON STUDENTS' PERFORMANCE IN CHEMISTRY IN SECONDARY SCHOOLS IN ONDO STATE, NIGERIA

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Abstract:
The study identified Gas laws in ordinary level West African School Certificate (WASSSC) chemistry syllabus, and examined the Relative Effectiveness of Problem Solving Approach (PSA) and Vee Mapping (VMA) on students' performance in chemistry. The study adopted a pre-test posttest experimental design with lecture method as the control group. The sample consisted of 130 participants selected from three senior secondary school I chemistry students in Akoko South East Local Government Area of Ondo State. Three intact classes were classified two experimental groups (PSA = 45), (VM=42) and a control group (LM=47). A 40 item instrument tagged Gas Laws Chemistry Achievement Test (GLCAT) 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 ANOVA. The result showed that there was a significant difference in the effectiveness of PSA and VMA on students' performance in chemistry $f(1, 130) = 18.42$, $p<0.05$. Furthermore, PSA was found to be more effective ($X = 33.24$) than VMA ($X=30.136$). The study concluded PSA as an effective method of teaching chemistry.

Keywords: problem solving, relative effectiveness, students' performance, Vee mapping

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1. Introduction

One of the major difficulties in teaching chemistry courses is helping students become efficient problem solvers. Most beginning chemistry students find the mathematics aspect as the most difficult aspect of the chemistry course. Chemistry is the study of matter, its composition, structure and the reactions that change matter from one form to another. The mathematical or abstract aspect of chemistry where we measure matter, express our measurement in numbers, and be able to manipulate these numbers to form conclusions or solve problems need a metacognitive approach which is the Problem Solving Approach. It has been observed that today's school learning amongst chemistry students consists of rote memorization of facts with little emphasis on meaningful interpretations where students are often asked to solve scientific problems, and conduct laboratory experiments in mere regurgitation rather than in a meaningful way [1]. Often, science knowledge is assumed to be absolute and students are viewed as passive recipients of information [2]. For students to be successful in their chemistry courses, these students must learn how to solve numerous mathematically-oriented homework problems. One of the purposes of this research paper is to expose students to applicable methods and techniques to solve problems and test questions. These methods and techniques are conventionally called Problem-solving strategies by Science Instructors [3].

Science educators have published lists of successful techniques that good problem solvers use or characteristics that those problem solvers possesses [4]. This principle applies to Vee mapping technique which is also a metacognitive teaching strategy used in this research work as the second teaching approach.

2. Theoretical Framework of Problem Solving Approach

Today's university and secondary school chemistry students are studying to be the scientists and professionals of the future, for students to be successful in their chemistry courses, they must learn how to solve numerous mathematically-oriented homework and test questions. The main theme of the Problem Solving approach is to teach students applicable methods and techniques of solving those homework problems and school assignments. This method is conventionally called problem solving strategies by science instructors [3].

2.1 Theoretical Framework for Vee Mapping

The Vee heuristic was developed by [5] to enable students understand the structure of knowledge in relational networks, hierarchies, combinations and to understand the process of knowledge construction. Gowin's fundamental assumption is that knowledge is not absolute, but rather, it is dependent upon the concepts, theories and methodologies by which we view the world. To learn meaningfully, individuals must choose to relate new knowledge to relevant concepts and propositions they already know. The Vee diagram aid students in this linking process by acting as a metacognitive tool that requires students to make explicit connections between previously learned and newly acquired information.

The Vee diagram separates theoretical / conceptual (thinking) on the left from the methodological (doing) elements of inquiry on the right. Both sides actively interact with each other through the use of the focus questions that directly relates to events and or objects. Epistemic elements are arranged around the Vee diagram, and represent units that form the structure of some segments or portion of knowledge required to construct a new meaning or piece of knowledge.

The conceptual side includes philosophy, theory, principles/conceptual systems, and concepts of all which are related to each other and to the events and/or objects. On the methodological side of the Vee diagram, records of these events/objects are transformed into graphs, charts, tables, experimental inferences and become the basis for making knowledge and value chains.

3. Statement of the Problem

There are many concepts in chemistry that are critical to chemical calculation such as the mole concept, gas laws, particulate nature of matter, thermodynamics and so on. There are evidences [6] that many students do not understand either of these concepts sufficiently well to use them in problem solving due to inability of some of the chemistry students to solve mathematical problems / operations in chemistry which has become a matter of concern to chemistry teachers, hence the need in helping students become efficient problem solvers in chemistry.

If chemistry problem solving skills of students are to improve, chemistry teachers will need to spend much greater period of time on concept acquired and how these concepts will be taught to the students using innovative pedagogical skills such as Problem Solving Approach and Vee Mapping.

4. Purpose of the Study

The purpose of the research was to determine the effects of problem solving and Vee mapping approaches on students' performance in chemistry.

Two research questions were raised to guide the study. They are:

- Are students who apply the techniques of problem solving approach perform better than in Gas law Chemistry Achievement Test (GLCAT) than those that applied the techniques of Vee Mapping?
- Do the correct use of Problem Solving Approach, Vee Mapping and Lecture Method improve students' performance in chemistry concept (GLCAT) after treatment?

5. To guide the study, two hypotheses were formulated namely:

- There is no significant relationship in the pre-test scores of students on the selected chemistry (Gas laws) concept-Boyle's law when exposed to PSA, VMA and LM.
- There is no significant relationship in the academic performance of students exposed to Problem Solving Approach and Vee Mapping after treatment.

6. Methodology

The study adopted a pre-test post-test control group design. The population of the study consisted of students who were offering chemistry in Senior Secondary I in the 18 secondary schools in Akoko South East Local Government Area of Ondo State. From these, three schools were randomly selected and from which three SSI science classes were chosen for the study.

From the three science classes selected, one was exposed to Problem Solving Approach, and the other two were taught using Vee-Mapping Approach and Lecture method respectively. The period of administration was six weeks. The concept chosen was gas laws.

6.1 The Instrument and Administration

The instrument used for the study was Gas Law Chemistry Achievement Test (GLCAT) which consisted of 40 questions were given to University and Secondary school chemistry teachers to vet. This was to ensure content validity and suitability of the instrument for the study. The instrument had a test-retest reliability coefficient of 0.78.

6.2 Procedure for the Study

The first step was to identify some mathematical concepts such as mole concepts, gas laws, chemical combinations and so on.

Through interaction with the students in form of informal interviews for a period of one week, Gas law was identified as one of the most difficult aspect of chemistry courses, and was chosen for the study. Next, the GLCAT was administered on the experimental and control groups in their respective schools separately during the second week of the study to obtain the pre-test scores. Thereafter, the experimental group was exposed to treatment in Problems Solving Approach and Vee Mapping while the control group was exposed to the traditional lecture method. The two groups were taught separately by the researcher for a period of four weeks after which the post-test was administered.

6.3 Method of Instruction

The main purpose of the Problem Solving Approach is to teach students applicable methods and techniques of solving those homework problems and test questions. These methods are conventionally called problem solving strategies by science instructors [7]. Many of these problem-solving strategies contain a sequential set of procedures that students carry out to solve problems.

6.3.1 A Three–Step Problem Solving Approach

The techniques used in Problem-Solving Approach are conveniently organized into a three-step for solving problem. Some science instructors have reported measurable success by students who use these problems solving strategies [7]. They believed it is the most helpful and effective teaching strategy.

Step I – Analyse

Solving a word problem is not too different from taking a trip to a new place.

- You must determine where you are starting from (identify the known)
- Identify where you are going (identify the unknown)
- Find out how you are going to get there (plan a solution).

What is known in a word problem may include a measurement and one or more relationships or equations that link measurements.

You identify the unknown by reading the problem carefully to be sure that you understand what the problem is asking you to find. If the problem is to have a numerical answer, write down the units that the answer should have before you begin your solution.

For example in Boyle's law (one of the topics in Gas Law), where the kinetic theory describes the behaviour of perfect or ideals/gas in relation to pressure –volume at constant temperature, it is mathematically represented as

$P_1 * V_1 = P_2 * V_2$

Using the known values for the volumes and initial pressure, the unknown final pressure can be determined.

P_1 = 600unit/lg

P_2= ?

V_1= 250cm^3

V_2 = 750cm^3

Step 2: Calculate. Solve for the unknown (P_2). Solve the equation for the unknown variable (pressure) by re-arranging the equation to isolate P_2 on one side, by making the unknown (P_2) the subject of the formula.

$P_1 * V_1 = P_2 * V_2$

$$\frac{P_1 * V_1}{V_2} = P_2$$

$$P_2 = \frac{P_1 * V_1}{V_2}$$

Substituting the known values for volumes (V_1 & V_2 and Initial pressure (P_1)

$$P2 = \frac{600*250}{750} = \frac{600}{3}$$

Therefore final pressure P_2 = 200mm/tg

Step 3: Evaluate. Is the result meaningful?

Evaluating the answer involves a number of checks. Has the unknown been found? Yes, the problems asked for the final pressure, and the value was calculated and the answer has the correct unit of mmHg.

6.4 Method of Instruction – Vee Mapping

The Vee diagram aids students in the linking process by acting as metacognitive tool that requires students to make explicit connections between previously learned and newly acquired information. An instructional strategy that can aid students in developing metacognitive awareness is the Vee diagram (Gowin, 1981; Novak &

Gowin, 1984). Vee diagram aids students in comprehending and learning science concepts meaningfully.

A typical lesson using a Vee diagram is explained in which the teacher guides students in understanding the concept of Boyle's law. A Vee diagram, is a structured visual means of relating the methodological aspects of an activity (such as a science experiment) to the underlying conceptual aspects. The Vee heuristic was developed by Gowin (1981) to enable students understand the structure of knowledge in terms of relation and networks, hierarchies, combinations and to understand the process of knowledge instruction

6.4.1 Procedure

The teacher gave each student a skeletal Vee diagram that contained these headings: focus question, event, object, concepts to be taught, records, transformations, knowledge claims, values claims, theory and principles.

[4], Q-5 Technique of questioning strategy is used to guide students notations on their Vee diagram. The Q-5 Technique of questioning comprised the following questions

1) What is the question?
2) What concepts are needed to be taught?
3) What methods/procedures are useful in answering the questions?
4) What answers are produced?
5) What value do these claims have?

6.4.2 Presentation

Step I - The teacher states and explains the principle of Boyle's law as Boyle's law states that the volume of a fixed mass of a gas at a constant temperature is inversely proportional to its pressure

$PV = K$ (at constant T, n)

Where T is temperature of the gas and n the number of moles of the gas.

Step II - The teacher draws and explains the pictorial expression, in which the other mathematical expression one can be inferred thus,

$P_1V_1 = P_2V_2$

Step III - The teacher gives some values and asks questions on how to find the missing values.

6.4.3 Guidelines when introducing the steps of the Vee

1) Students should first be familiar with the two elements of the Vee and be able to construct maps before using the two elements of the Vee-concepts, and events objects
2) Explain and define the terms

i) Concepts
ii) Events and objects
iii) Records of events / objects
iv) Focus questions

3) After the records have been made of the facts, the information is transformed into a format that allows the student to construct answers to the focus questions.
4) Using the information from the transformed data, knowledge claims are constructed to answer the focus question(s).
5) Principles and theories follow knowledge claims when introducing the Vee are carried out.
6) The findings / results of the question are obtained.

6.4.4 Scoring Procedure

Scoring procedures of students' Vee diagrams followed the protocol suggested by [8]. Each student was asked to develop a hierarchical map showing the results of their findings. Upon completion, students within groups shared their maps with one another.

Students are informed that they could revise and reconstruct their maps resulting from these comparison and discussions. Using the transformed information derived from their maps, the students begin to generate answers to their focus questions. From these knowledge claims, students make judgments as to the worth of these findings by listing their value claims.

7. Results

Tables 1 to 4 present the results.

Table I: Mean, Standard Deviation of pre-test scores

Group	N	X	Standard Deviation
Problem solving Approach	45	10.21	1.76
Vee mapping Approach	42	10.19	2.82
Lecture Method	47	10.12	2.35

P >0.05

Table 2: ANOVA Summary Table of Pre-Test Scores

Source of Variation	SS	df	Ms	f_{cal}
Between Groups	3158.204	2	1579.102	3.531
Within Groups	58137.43	130	447.211	
Total	61295.634	132		

p<0.05

Table 3: Mean and Standard Deviation of Post-test scores of students in the experimental and control groups

Group	N	X	Std
Problem solving Approach	43	32.243	3.13
Vee mapping Approach	42	30.41	2.71
Lecture Method	45	20.160	2.23

p>0.05

Table 4: ANOVA Summary Table of Post-Test Scores

Sources of Variation	SS	df	Ms	f
Between Groups	378.0973	1	378.0973	18.424
Within Groups	2667.86	130	20.522	
Total	3045.9573	132		

p>0.05

8. Discussion

The result showed that Problem Solving Approach was an effective method in teaching chemistry in secondary schools. This was evident in the students score (X=33.24) after treatment while the mean score of students who were exposed to the Vee mapping was relatively low (X=30.41) compared with the former. Considering the lecture method teaching strategy, students' performance in the GLCAT was very low (X=28.16) because students in this school were not exposed to innovative and metacognitive method of teaching which could enhance their academic performance. Furthermore, the ANOVA result $f_{(1,\ 130)}$ = 18.42 p>0.05 shows that there was a significant difference in the performance of students exposed to the three approaches, PSA (X =33.24) was the most effective compared with Vee mapping (X=30.41) and lecture method (X=28.16) in improving students' performance. The reason for the better performance of students in Problem Solving Approach could be due to the analytical procedures involved in Problem Solving Approach which made it easier for students to solve problems involving mathematical analysis. These are in consonance with those of [7] who found Problem Solving Approach as the most helpful and effective teaching strategy where science instructors have reported measurable success by students who use problem

solving approach which contain a sequential set of procedures that students carry out to solve problems, and a three-step technique used in problem solving approach which are conventionally organized. Also, the better performance of students in Vee mapping approach could be linked with the findings of [3] [9] who found that the vee diagram and concept mapping aid students in the linking process by acting as a metacognitive tool that requires students to make explicit connections between previously learned and newly acquired information.

9. Conclusion

In conclusion, Problem Solving Approach is very effective in teaching mathematical Chemistry concepts in secondary schools. There is the need therefore for teacher in general, and chemistry teachers in particular to realize the three-step Problem Solving Approach – Analyse, Calculate & Evaluate which is a method of instruction used to teach students applicable methods and techniques of solving problems especially mathematical concepts.

Also, Vee diagrams were seen as viable tools in learning the structure of knowledge and the processes of knowledge production. They enabled students to examine a piece of knowledge and come out with a deeper understanding of how knowledge is constructed by showing how the concepts, events, and records of the events are formulated when attempting to create new knowledge. Teachers when versed in the Vee diagramming seem to be receptive to this learning strategy in order to achieve meaningful rather than rote learning and sees this strategy as an independent learning aid to be used by the students [8].

Evidently, both problem solving approach and Vee mapping provide the learner with metacognitive tool by which facts and ideas can be learned meaningfully through effective thought.

10. Recommendations

From the results of this study, the following recommendations were made;

1. Science teachers should complement all science teaching with metacognitive strategies by which concepts are sequentially learned through reflective thoughts.
2. Problem solving approach is a teaching strategy which can be used to solve mathematical concepts in a sequential manner that enhance students

understanding, hence, chemistry teacher should be encouraged to use PSA in teaching chemistry especially the mathematical concepts.

3. Seminars and training workshops on metacognitive strategies that will improve teachers' pedagogical skills should be organised for teachers in general and science teachers in particular.

References

[1] J. D., Novak, D. B. Gowin, Concept maps and Vee diagrams: two metacognitive tools to facilitate meaningful learning. *Instructional Science, An International Journal of the learning Sciences, 19 (1), 1990, 29 – 52.*

[2] R. Driver, (1987), Promoting Conceptual Change in Classroom Setting: The Experience of the Children's learning in Science Project. In J. D. Novak (ed), *Proceedings of the second international seminar: Misconception and educational strategies in Science and Mathematics. Vol. 2 pp. 97 – 107, Ithaca NY: Cornell University, Department of Education.*

[3] A. D. Ashmore, M. J. Frazer, & R. J. Casey, Problem Solving and Problem Solving Networks in Chemistry, *Journal of Chemistry Education, 56 (6) 1979, 377 – 379.*

[4] A. L. Brown, L. Baker, Metacognitive Skills and Reading. In P. D. Pearson (Ed.), (Handbook of reading research, 1984.) 353 – 394. New York; Longman

[5] D. B. Gowin, Educating. Ithaca, (NY: Cornell University Press, 1981).

[6] G. O, Onwu, M. J. Ahiakwo, A study of Pupils' perception of topics difficulties in O' and A' Level Chemistry in some selected Nigerian Schools. *Journal of Research in Curriculum, 4 (2), 1986, 1- 13.*

[7] A. D. Ashmore, M. J. Frazer, & R. J. Casey, Conceptual and Procedural knowledge in Problem Solving, *Journal of Research in Science Teaching, 23 (9) 1979 759 – 769.*

[8] J. D. Novak, D. B. Gowin, G. T. Johanasen, The use of concept mapping and knowledge Vee mapping with junior high school science students. Science Education, 67(5), 1983, 625-645.

[9] A.O. Omoniyi, Relative effectiveness of cognitive constructivist approach and concept mapping in improving student's performance in chemistry in Ondo State, Nigeria. Vol. 05(01) 351-360