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The Effect of Problem-Solving Technique on Students' Competence in Tackling Chemical Problems

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Abstract: This study investigated the effect of the enhanced problem-solving technique on students competence in tackling chemical problems. The study adopted the 4 stage model of solving chemistry problems as suggested by Ashmore. This was enhanced with the presentation of solution in the form of network and the use of a key relations chart Kramers-Pals. The study adopted a non-randomized pretest-posttest control group design. The findings revealed that students exposed to the enhanced problem solving technique performed better than those exposed to lecture method. It was therefore, suggested that formulae and equations relating to problems should be provided for students in a problem-solving situation.

Key words: Effect, problem-solving, competence, tacking, chemical problems, technique

INTRODUCTION

One of the basic characteristics of the basic sciences is problem-solving. The main problem in chemistry, as opined by Adesoji (1996) is the interpretation of mathematical models which would eventually lead to solving the problem. It should also be noted that all aspects of chemistry involve solving problems.

Solving problems, particularly in chemistry, involves breaking the barrier in the path from problem to solution. This barrier can only be broken when the learner develops problem-solving instructional skill. The development of this skill is better enhanced through problem-solving instructional strategy. Evidence from the literature tends to suggest that different instructional strategies help to improve students' problem-solving skills (Payne, 1984). Problem-solving, according to Obioha (1982) is a cognitive process and acquisition of this skill will help students to tackle some of the difficult topics in subjects like chemistry, biology and physics.

Many researchers have developed models for solving theoretical problems in science. Ashmore's 4 stage model for chemical problem-solving derived from their view that information needed as well as the reasoning which students make toward a solution are important factors. Wright and William (1986) developed a four-stage model which secondary school students can use effectively in solving chemistry problems.

The four-step model (known as the WISE-strategy) includes:

- What is happening
- Isolate the unknown
- Substitute give values
- Evaluate

The WISE strategy is based on a system of heuristics for easier application by students. Since acquisition of knowledge varies among student, the burden of having to memorise different relationship or formulae relating to different topics is solved by providing during the lesson, "key-relations chart".

The problem: The primary aim of a teacher is to ensure the success of his lesson. This he does by combing essential theories of education during the planning and execution stages of the lesson. How successful the lesson is, however, is a function of students' performance in a given task.

It is a well-known fact that students' performance in chemistry in the Secondary School Certificate Examination (SSCE) is not encouraging. This is reflected in Table 1.

Evidences from literature also showed that the methods used in presenting instructions to students include; lecture, demonstration, discussion, enquiry, laboratory, project, etc. Though most instructors want their students to leave their course proficient in solving chemical problems, but does the present system of teaching in our schools without the enhanced problem-solving instructional strategies adequately prepare the students to solve problem? This is the question to which this study addressed itself.

Table 1: Students' performance in Chemistry in the SSCE (1993-2000)

Year	Number enrolled	% Credit (1-6)
1993	170537	23
1994	161237	23.7
1995	133181	36.7
1996	144990	33.46
1997	138572	25.55
1998	200152	25.83
1999	223307	31.88
2000	195810	30.82

Source: Jegede (2003)

Purpose of the study: The purpose of this study, was to investigate the effect of the enhanced problem-solving technique on students' competence in tackling chemical problems. This will be done by comparing the performance of students taught with the enhanced problem-solving instructional strategy with those taught using the traditional lecture method.

Hypotheses:

- There is no significant difference in the ability level of students in the enhanced problem-solving instructional strategy group and those in the lecture method group.
- There is no significant difference in the achievement means scores of students taught with the enhanced problem-solving instructional strategy and those taught using the traditional lecture method.

MATERIALS AND METHODS

Research design: The study adopted the non-randomized protest-posttest control group design. There were two groups: one experimental and one control. The paradigm is represented as:

Experimental group: O_1 X_1 O_2

Control group: O_3 X_4 O_4

Where O_1, O_3 = Pretest

O_2, O_4 = Posttest

X_1 = Treatment (enhanced problem-solving instructional strategy)

X_2 = Treatment (lecture method)

Sample and sampling technique: Four schools were randomly selected at least one from each of the three senatorial districts of Ekiti State). Thirty senior secondary class two (SS2) chemistry students were randomly sleeted form each school to make a total of 120 student. The school were randomly assigned to the experimental and control groups repetitively. The testament group was tougher using both the lecture method and enhanced problem-saline instuchunal strategy while the control group was tongue using the lecture method alone.

Research instrument: The only instrument used to collect date for the study was a 20-item, four-option multiple-choice objective test based on electrolysis and its prerequisite concepts. The instrument served as both pre-test and post-test.

Validation of the instrument: The face and content validates of the instrument were established by two seasoned secondary school chemistry teachers, colleagues in science education as well as experts in test and measurement.

The reliability of the test was established through the test-retest method. The estimate of internal consistency computed for the instrument using Kuder Richardson formular (KR_{21}) was 0.75.

Experimental procedure: The teachers used for the study were adequately trained as to the objectives of the study. The pretest was administered to the two groups, respectively. Teachers in the experimental group taught electrolysis and its pre-requisite concepts using the lecture method for three weeks and the problems-solving technique (which involved solving problems on electrolysis with solutions presented in a net work form and the use of key-relations chart) for another three weeks. Thus teaching lasted for six weeks. The students were exposed to the post-test after the teaching.

Teachers in the control group on the other hand only taught electrolysis and its pre-requisite concepts for three weeks without any trace of problem-solving technique. Students in this group were however provided with questions to practise with for the remaining three week of the experiment after which they were also exposed to the post-test.

RESULTS AND DISCUSSION

The two hypotheses were tested using t-test analysis. The results are presented in Table 2 and 3.

At 0.05 level of significance and df_{118}, calculated t-value (0.4585) is less than table t-value. This confirmed that there was no significant difference in the ability level of the subjects used for the study.

At 0.05 level of significance and df_{118}, calculated t-value (30-31) is greater than the table value (1.96) thus the null hypothesis was rejected and we conclude that there is a significant difference in the post-test means scores of students in the experimental and control groups, respectively.

The result presented in Table 1 showed that students taught using the problem-solving technique performed better than their counterparts taught using

Table 2: T-test analysis of pre-test mean scores of experimental and control groups, respectively

Group	Total number of students	Mean scores	Standard deviation	t-value
Experimental	60	7.9	7.13	
Control	60	7.3	6.30	0.4885

Table 3: T-test analysis of post-test mean scores of experimental and control groups, respectively

Group	Total number of students	Mean scores	Standard deviation	t-value
Experimental	60	14.70	3.25	
Control	60	10.20	2.18	30.31

lecture method only. This implies that the problem-solving technique is an effective method of learning problem-solving in Chemistry. Thus is because a systematic approach to problem-solving encourages good learning habits, pin-points areas of confusion, contributes to clarity in thinking and promotes intellectual development (Selvaratnam, 1983). This implies that exposing students to the problem-solving instructional strategy could enhance their understanding of problem-solving technique in chemistry and expose the area they find difficult while solving problems.

There are 2 major attributes of the problem-solving strategy adopted for this study. One is the provision of the solutions to the problems in a net-work fashion. This implies that more than one routes could be followed to get to the answer and if a student fails in one route, he could still follow other routes to get to the answer. The other attribute is the provision of the 'key relations chart' which acted as a guide in solving the problem.

Nachtigall and Otuka (Jegede, 2003) opined that the learning of physical sciences (chemistry inclusive will lead to acquisition of three types of knowledge; declarative, procedural and operational. According to them, declarative knowledge involves memorization of simple definitions and relationships (e.g., $Q = It$) and this requires short-term memory. Procedural knowledge on the other hand, involves solving problems through direct substitution in the algorithm without having the knowledge of the origin of the relationship between the different quantities in the algorithms. This is simply solving the problems without following the different steps involved in solving them. This approach does not show understanding of problems. Operational knowledge involves the ability to use, apply and connect declarative and procedural knowledge. Science students are expected to be able to declare and set out appropriate procedure before going through the operation for solving problems. This is exactly what problem solving instructional strategy does.

CONCLUSION

The findings of this study had reveled that it is better for students to learn the art of solving problems in a relaxed atmosphere by providing them with the equations and formulae required for solving such problem. However, it should be noted that the students, when provided with the equation and formulae for solving problems would use them correctly if and only if they understand the relationships between the physical quantities that make up the equations.

RECOMMENDATIONS

Based on the findings of this study, it is recommended that the various examination bodies (i.e., WAEC and NECO) should hence forth make the relevant equations and formulae available in their questions papers. In this case, students will be given equal opportunity to solve the problems given.

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