IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388,p-ISSN: 2320–737X Volume 4, Issue 5 Ver. II (Sep-Oct. 2014), PP 50-53
www.iosrjournals.org

Enhancing Students' Attitude towards Science through Problem-Solving Instructional Strategy

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Abstract: *The study was designed to further clarify the claims by several authors that methods of instruction could change students' attitude towards science. It was the belief of the author that if students' were allowed to develop higher cognitive processes through problem-solving instructional strategy using The Seven Step Chemistry Problem-Solving Model as suggested by Frazer (1981) and Selvarantnam (1983), their attitudes might change positively. Therefore, the effect of problem-solving instructional strategy on students' attitude toward chemistry was investigated. The findings revealed that problem-solving instructional strategy influences students' attitude towards chemistry learning based on gender. Also, students' numerical ability do not have any significant interaction effect on students' attitude towards chemistry learning based on gender. It was then recommended that students' should develop a proper attitude towards problem-solving with a view to improving their performance in chemistry. Besides giving students the content, the process is equally important for them to comprehend some scientific concepts and principles. This could make them develop more positive attitude toward the learning of science.*

Keywords: *Students' Attitude, Science, Problem-Solving.*

I. Introduction

Many factors could contribute to student's attitude towards studying science. Slee (1964) indicated that students' attitude and interests could play substantial role among pupils studying science. Several studies (including Wilson, 1983 and Soyibo, 1985) reported that students' positive attitudes to science correlate highly with their science achievement. However, Balogun (1975) reported that, in general, the attitudes of Nigerian students' towards the basic sciences tend to decrease in the order- Biology, Chemistry, Physics and Mathematics. Defiana (1995) found that, using integrated science environmental activities improved high school students' attitudes towards and awareness about the environment. Frazer and Sleet (1984) in their studies determined that seventy-six percent of the twenty-two unsuccessful students selected in an attempt to solve chemical problems had negative attitude towards problem-solving.

Abimbade (1983) reported that students exposed to a programmed instruction recorded higher and more favourable attitude toward mathematics. Aiyelaagbe (1998) also reported a more positive attitude of students after exposing them to self-learning strategy. Similar results were obtained by Udousoro (2000) after using computer and text assisted programmed instruction and Popoola (2002) after exposing them to a self-learning device.

Halladyna and Shanghnessy (1982) have concluded that a number of factors have been identified as related to students' attitude to science. Such factors include; teaching methods, teachers' attitudes, influence of parents, gender, age, cognitive styles of pupils, career interest, societal view of science and scientists, social implications of science and achievement. Studies have revealed the influence of methods of science instruction on students' attitude towards science.

In a study of the relationship between achievement and attitude, it has been found that the attitudinal characteristics of students' in their responses to patterns, content or the nature of problems and their solutions distinguish the successful from the unsuccessful. Wheatley (1991) was of the opinion that poor attitude developed through repeated failures has been blamed on the teachers (Aiken, 1976), it rests squarely on the teachers to change the negative attitudes at least, partly through high quality instructional strategy as being proposed in the Problem-Solving Instructional Strategy.

The studies thus reviewed suggest that there is a relationship between attitude and methods of instruction and also between attitude and achievement; and that it is possible to predict achievement from attitude scores. What is needed to complement the results of such studies however is the nature of relationship between students' attitudes and problem-solving techniques.

In recent time, the problem-solving approach has been advocated as one of the methods of teaching Chemistry. In the present study, an important model of instruction that can achieve the purpose of helping students' to learn and study chemistry effectively is the Seven-Step Chemistry Problem-Solving Model. It is designed to help students solve problems by proceeding in a logical step sequence from a problem state to a

solution state. Thus, the student learn to define problem, collects information related to the solution of the problem and finally check and evaluate the solution obtained (Frazer, 1982 and Selvarantnam, 1983). Hence, enhancing students' attitudes towards science could be effectively determined through problem-solving.

Statement of the Problem

The study seeks to investigate whether the attitudes towards chemistry would change when students' are exposed to problem-solving instructional strategy.

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

H_{O1}: There is no significant interaction effect of problem-solving on students' attitudes towards Chemistry learning based on gender.

H_{O2}: There is no significant interaction effect of numerical ability on students' attitudes towards Chemistry learning based on gender.

II. Method

Subjects: Two hundred and ten (210) Senior Secondary School class two chemistry students were randomly selected from six schools in Ekiti State of Nigeria. Thirty-five students were randomly picked from each of the six schools and were assigned to four groups- Three experimental groups and one control group. Allocation of schools to the experimental and control groups also followed a random process. The experimental groups were exposed to problem-solving techniques using the Seven Step Chemistry Problem-Solving Model (SSCPSM) with accompanying modes of instruction like Remediation, Feedback and Practice respectively while the control group was exposed to the conventional lecture method.

Treatments and Instrument: Four treatments and two instruments were developed for the study. The treatments were:

(a) Problem-solving Technique coupled with remediation based on mole-concept, solubility and gas laws.
(b) Problem-solving Technique coupled with feedback based on mole-concept, solubility and gas laws.
(c) Problem-solving Technique coupled with practice based on mole-concept, solubility and gas laws.
(d) Conventional Lecture Method based on mole-concept, solubility and gas laws.

The Instruments: An attitude measuring scale known as Problem-solving attitudinal scale known as Problem-solving attitudinal scale used for pre- and post-attitude measure and the numerical ability test designed to test the mathematical knowledge of students.

The SSCPSM was in line with Frazer's (1982) and Selvarantnam (1983) model of solving chemistry problems. The attitude measuring scale was a thirty-two item Likert-type of five options. They were constructed and validated by the researcher and experts in test construction. The options of the attitude scale Strongly Agree, (SA), Agree, (A), Disagree, (D), Strongly Disagree (SD) and Undecided (U).

The Numerical Ability Test (NAT) was structured based on the mathematics topics related to the academic level of the students. It was used as pre- and post-test numerical (mathematical) ability measure.

Validity and Reliability: Experts in Science Education helped to vet the 32-item attitude scale. They also helped to identify the positive and negative statements. The reliability determination of the instrument was carried out using the split-half method with the scores obtained from the scores of forty students. The value found was 0.69. The content of the Seven Step Chemistry Problem-Solving Model (SSCPSM) was checked and validated by four chemistry education lecturers who certified the procedures to be adequate for teaching steps and strategies of problem-solving as identified by Frazer (1982) and Selvarantnam (1983). Experts in test construction helped in validating the Numerical Ability Test (NAT). The value obtained for the reliability determination of NAT using test retest method was 0.71.

Procedure: The four groups had lectures in the selected topics for four weeks after the completion of the attitudinal scale. Problem-Solving groups were taught Problem-Solving Technique Procedure for another four weeks by the researcher before they were made to complete the attitude scale. The control group received lectures on the selected topics for four weeks without any trace of problem-solving. They were also made to complete the attitude scale thereafter. The same procedure was followed for the NAT.

III. Results

To test the earlier stated hypotheses, the scores of the Experimental and Control groups in PSAS and NAT were subjected to Analysis of Covariance (ANCOVA) in order to whether the groups had different attitude towards solving problems in mole concept, gas laws and solubility. The results are as presented in Tables below.

Table 1:- Summary of ANCOVA on pretest, post-test scores of students in Problem-Solving Attitudinal Scale (PSAS) based on gender.

Source	SS	Df	MS	F_{cal}	F_{tab}
Covariate (pre -psas)	15327.11	1	15327.11	329.60	3.84
Main effects:					
Sex	50.88	1	50.88	1.09	4.03
Group	1118.44	3	372.81	8.02	2.60
2-Way Interaction:					
Sex * Group	154.78	3	51.59	47.52	2.60
Explained	16298.93	8	2037.37	43.81	1.94
Residual	25645.92	209			
Total	598280.00	210			

$P < 0.05$

Table 1 shows that F_{cal} (47.5) was higher than F_{table} (2.60) at 0.05 level of significance. The null hypothesis was therefore rejected. This indicates that there was a significant interaction effect of problem-solving on the attitudes of students towards Chemistry learning based on gender. The implication of the above analysis is that, the attitude of male and female students towards Chemistry learning differs for the problem-solving (experimental) and controls groups.

Table 2:- Post-Hoc Analysis Showing the Effect of Problem-Solving on Students' Attitudes towards Chemistry.

Groups	E_1	E_2	E_3	C	N	Mean
Problem-solving coupled with Remediation (E_1)			*	*	70	33.56
Problem-solving coupled with Feedback (E_2)					70	30.26
Problem-solving coupled with Practice (E_3)					35	28.41
Control (C)					35	27.97

*The mean difference is significant at 0.05 level.

Table 2 shows that there was a significant difference between the attitudinal scores of students in Experimental Group 1 and Experimental Group 3. Similarly, the mean difference between Experimental Group 1 and control group is statistically significant at 0.05 level.

Table 3:- Summary of ANCOVA on pre-test, post-test scores of high and low ability level students' in Problem- solving Attitudinal Scale (PSAS) based on gender.

Source	SS	Df	MS	F_{cal}	F_{tab}
Covariate (pre- psas)	14790.64	1	14790.64	318.71	3.84
Main effects:					
Ability	3.99	1	3.99	0.09	7.71
Sex	60.19	1	60.19	1.30	4.00
Group	1151.56	3	383.85	8.27	2.60
2- Way Interactions:					
Ability * Sex	138.53	1	138.53	2.99	3.84
Ability * Group	166.98	3	55.66	1.20	2.60
Sex * Group	188.30	3	62.77	1.35	2.60
3- Way Interactions:					
Ability * Sex * Group	127.42	3	42.48	0.92	2.60
Explained	16689.20	16	1043.08	22.48	1.67
Residual	25645.92	209			
Total	598280.00	210			

$P < 0.05$

Table 3 shows that F_{cal} (0.92) was less than F_{tab} (2.60) at 0.05 level of significance. The null hypothesis was therefore accepted. This indicates that no significant interaction effect of students' numerical ability could be linked to their attitudes towards Chemistry learning based on gender. Hence, high and low ability students in the experimental (problem-solving) groups and the control group exhibit similar attitude towards Chemistry learning based on their gender structure.

IV. Discussion

Findings from the results of the hypotheses tested showed convincingly that the problem-solving approach proved to be a more effective and reliable method of teaching than the conventional lecture method**.** This finding provided empirical support to earlier findings: Bodner (2000) and Domin et- al (2001) which remarked that there is significant improvement in students' achievement when problem-solving is accompanied with corrective measures such as verbal feedback and teacher-directed remedial instruction. Other empirical studies which gave positive effects of problem- solving models on achievement in other science subjects includes Martin and Oyebanji (2000), Decorte and Scriners (2002), Payne (2004).

Concerning the effect of problem-solving on attitudes towards Chemistry learning based on gender, the findings of Aiyelaagbe (1998) revealed that male students exhibits a more positive attitude than female students after exposing them to a self-learning strategy. Similar result was obtained by Udousoro (2000).

V. Conclusion and Recommendation

The major conclusion that could be drawn from the study based on the performance of students is that the conventional lecture method of teaching Chemistry proved less effective than the problem-solving method. In addition, the incorporation of problem-solving into Chemistry learning improves the performance as well as the attitude of students with high ability than their counterparts with low ability.

If problem-solving instructional strategy could improve students' learning outcomes in Chemistry, it would be necessary to overhaul the mode of instruction of teaching Chemistry at the Senior Secondary so as to accommodate functional student–centred and activity-oriented instructional strategy that will make Chemistry students good problem-solvers, thereby causing improvement in the performance of students in School Certificate Chemistry Examinations thereby replacing the Conventional Lecture Method (i.e. Chalk and Talk Method) of teaching Chemistry in Schools. Also, Secondary School teachers who are already in service should be given adequate training through workshops, symposia, conferences and seminars to enhance and acquire better strategies of teaching Chemistry. Schools' Curriculum should be overhauled to accommodate problem-solving and activity-oriented instructional strategies.

Teachers should take into consideration the numerical ability of students in the teaching-learning process for effective delivery of their lessons with a view to improving the performance of students in Chemistry. Students should develop a proper attitude towards problem-solving with a view to improving their performance in Chemistry as well as making them functional to themselves and the society at large.

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