Humanity & Social Sciences Journal 5 (1): 01-06, 2010
ISSN 1818-4960

Comparative Effect of the Guided Discovery and Concept Mapping Teaching Strategies on Sss Students' Chemistry Achievement

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Abstract: The study compared the relative effectiveness of the guided discovery and concept mapping teaching strategies in relation to students' performance in chemistry. Chemistry is a very important subject as its knowledge is required for the successful study in very many important professions. Therefore the chemistry teacher should adopt methods that would enable the students to understand whatever concepts, topics or principles that are being taught. Guided discovery (GD) has been recommended for teaching the contents of senior secondary schools (SSS) chemistry curriculum. This paper aims at finding out the relative effectiveness of the guided discovery method as against the new teaching method of concept mapping. A total of 360 SSS chemistry students who have registered for SSCE were drawn from four secondary schools in Bauchi Local Government Area formed the sample for the study. 40-item chemistry teachers made achievement test (CMAT) was administered on the students to generate data for the study. Results showed that there is a significant difference in the retention of the two groups in favour of the students taught using concept mapping. The study showed that both the GD and concept mapping strategies are equally powerful in terms of improving students performance in chemistry, but students taught using concept mapping has a higher retention of information. Thus, both teaching strategies should be used to teach chemistry.

Key words: Chemistry · Teaching method · Concept mapping · Guided discovery · Senior secondary school · Nigeria

INTRODUCTION

Background to the Study: Chemistry is a very important subject as its knowledge is required for the successful study in very many important professions. Because of this importance, chemistry is occupying a pride of place in the Senior Secondary School (SSS) curriculum in Nigeria. It is therefore necessary that students studying chemistry should understand the subject so that they can apply their knowledge to their everyday interactions with people and their ever changing environment.

Therefore, the chemistry teacher should adopt methods that would enable the students to understand whatever concepts; topics or principles are being taught. There are a variety of methods for teaching chemistry such as projects, field trips, expositions, demonstrations, experimental and the guided discovery strategies. All these methods rely on various forms of teacher-student activities; however some are more activity oriented than others. The Guided Discovery (GD) has been recommended for teaching the contents of Senior Secondary School (SSS) chemistry curriculum [1]. This approach

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is activity oriented for both the students and the teacher. It applies abundantly the principle of effective questioning appropriate directives, demonstration by the teacher, high quantity and quality student activities (laboratory work, field trip, class discussion).

In all these, the students accumulate the products of science by vigorously engaging in various processes of science [2]. According to Kolb [3] knowledge is constantly extracted from a learning individual's experience and tested. Thus, in the guided discovery approach, the students are active participants in the teaching-learning situation and so they actually do chemistry and not just being taught about chemistry. To make the strategy effective, Teacher Vacation Courses (TVC) were organized by the authorities to put the teacher up to date in respect of the role(s) they should play while employing the GD approach. Despite these improvements in the training of the chemistry teacher and his teaching capabilities, student's achievement in chemistry continue to be low according as contained in the West African Examination Council (WAEC) Chief Examiners report for Senior Secondary School Certificate Examination in chemistry for the year 2000 - 2007 [4]. Oloyede [5] identified that one of the reasons for the poor performance of students in chemistry is the methods used by the teachers. Dede [6] reported that learning is not bound to any time or place and new knowledge, skills and concepts can be learned through experience which are organised and arranged within individual's existing cognitive structures. From the above discussion, it is clear that there is need to seek other methods of teaching chemistry to students and one of such teaching strategy is concept mapping. In this strategy concept is regarded as the key to learning.

Inomiesa [7] defined a concept as an idea generalized from particular relevant experience. Concept mapping teaching lessons involves class discussion practical demonstration and concept mapping activities. During such lessons the relationship between concepts are concretely established as such lessons precede either from general to specific ideas or from specific to general ideas. However, Udeani [8] outlined the steps involved in concept mapping as follows:

- Select an item for mapping. This could be an important text, passage, laboratory background materials;
- Choose and underline key words or phrases, include objects and events in the list.
- Rank the list of concepts from the most abstract and inclusive to the most concrete and specific.
- Cluster the concepts according to two criteria concepts that function at similar level of abstraction and concepts that inter relate closely.
- Arrange the concepts as a two dimensional array analogous to a road map. Each concept is in effect, a potential destination for understanding. Its route is defined by other concepts in the neighbouring territory.
- Link related concepts with lines and label each line in propositional or prepositional form.

A well constructed and competed concept, map thus show the clear relationship between various sets of concepts and thus basic relationship is well communicated to other persons. Various science educators such as Cliburn [9], Okebukola [10] and Inomiesa [7] have compared the concept mapping strategy with other teaching methods and found that the concept mapping teaching strategy improved student's performance more than the other methods. The focus of this study is therefore to compare the guided discovery and concept mapping teaching strategies of senior secondary students and their achievement in chemistry.

RESEARCH QUESTIONS

The major research focuses connected with this study are:

- Is there any significance difference in performance of SSS chemistry students taught using GD strategy and those taught using the concept mapping strategy?
- Is there any significance difference in retention of chemical materials taught to students using the GD strategy and the concept mapping strategy.

- Is there any significance difference in retention of male and female students taught using the GD strategy.
- Is there any significance difference in retention of male and female taught using the concept mapping strategy?

Hypotheses

$H0_1$: There is no significance difference between the pretest means score of students taught using guided discovery approach and those taught using the concept mapping strategy.

$H0_2$: There is no significance difference between the post test mean score of students taught using the guided discovery approach and those taught using the concept mapping strategy.

$H0_3$: There is no significance difference in the level of retention of chemical materials by students taught using the concept mapping strategy

$H0_4$: There is no significance difference in the level of retention of chemical materials taught between male and female students using the Guided Discovery and concept mapping strategy

MATERIALS AND MATHODS

Sampling – Four schools were selected from the twenty three (23) schools in Bauchi Local Government Area of Bauchi state, Nigeria. The criteria for selection are:

- Presence of a laboratory where meaningful teaching and learning activities could be carried out and
- Quality of teachers teaching chemistry.

Only professionally qualified teachers were used. The aim of the above is to ascertain that instructions proceed as required and directed by the researcher.

All the students who registered for Senior Secondary Certificate examination in chemistry and were attending classes in each of the selected schools were chosen as subjects for the study. The schools and the students therein were then randomly assigned to the guided discovery and concept mapping strategies. Thus all the students who registered for SSS chemistry examination during 2006/2007 school year were subjects for this study. Thus all shades of students were accommodated in the samples and their distribution presented in Table 1.

Thus for this study, 170 students were taught using the guided discovery strategy and 190 students for the concept mapping strategy.

Instrument – This was Chemistry Teacher Made Achievement Test (CMAT), CMAT was constructed by the researcher and the test items covered the area "orbital and electronic structure of the atom" The sub-contents contained in this broad outline are

Table 1: Distribution of subjects for the Study

	School Teaching Method used	No of males	No of females	Total
1	Guided Discovery	48	30	78
2	Guided Discovery	50	42	92
3	Concept mapping	35	37	72
4	Concept mapping	65	53	118
Total		198	162	360

- Electronic Structure of the atom
- Nature of light
- Light as a wave function
- Light as a form of energy
- The simplest spectrum (hydrogen)
- Quantum Mechanics (historical) Orbital and the principal quantum number
  Shapes of S and p orbital
- Arrangement of electrons in the energy levels, main levels, sub-levels electron spins FME [11].

Sixty (60) objective items of SSCE type were set on the above content areas and were given to 100 SSS chemistry students to answer. These were scored and using the split-half method, the facility and discrimination indices were calculated. The reliability index was calculated using Kuder-Richardson formula 20 (K-R 20). Forty (40) items were selected and used for the study based on the following criteria:

- Acceptance of items as effectively covering the content area (face validity by a team of two (2) science educators and two experts in measurement and evaluation
- Facility index of $0.35 \leq f \leq 0.72$
- Discrimination index of $0.21 \leq d \leq 1.00$
- Reliability (K-R 20) =0.86

The items were distributed among the six intellectual levels of the cognitive domain thus;- Knowledge -10, comprehension – 10, application 10, analysis 5, synthesis 3, evaluation 2

Design: Pre-test/ post-test design was used for this study. This was to make it possible for equivalent groups to be compared.

Procedure: A pre test was administered on the two groups. This was to determine the entry behaviour of the students in terms of what they already know about what is to be taught and to determine whether or not the two groups to be compared are equivalent. Thereafter the teachers assigned to the various groups were made to teach the students using the appropriate method for the group. The teaching was based on lessons certified by three science teachers as being appropriate for the two different teaching strategies. There was however ample opportunities in the 5 prepared notes of lessons for the various teachers to display their individual creative capabilities. The teaching period lasted for three weeks. In each of the schools used for the study, chemistry classes are held thrice and each lesson lasted for 40 minutes.

At the end of teaching period, a post test was administered to test the instructional effectiveness of the two methods. Then four weeks later, a post- post test was administered on the students. The post-post test was meant to determine the amount of content materials the students were able to retain after a period of four weeks. The same CMAT test items were used for post test and post-post test. The only minor difference was the serial rearrangement of the items when it was time to administer the post -post test.

Data were analysed and the t-test statistics was used to test the null hypotheses at 5% level of confidence.

RESULTS

$H0_1$: There is no significant difference between the pretest mean score of students taught using the guided discovery approach and those taught using the concept mapping strategy.

Table 2 showed that there was no significant difference between the two groups of students when a pretest was administered. Therefore $H0_1$ is accepted. Hence the two groups are equivalent at the starting point of the study.

Table 2: Analysis of pretest performance of students

	No of students	Range of score	Mean score	S.D	t-calc	t critical	Decision
Guided Discovery	170	20	17.37	4.11	1.42	1.96	NS
Concept mapping	190	23	17.80	4.09			$H0_1$ accepted

Table 3: Analysis of post test performance of students

Method	No of students	Range of score	Mean score	S.D	t-calc	t critical	Decision
Guided Discovery	170	20	21.59	4.46	1.25	1.96	NS
Concept mapping	190	23					$H0_2$ accepted

Table 4: Analysis of Post- post test (Retention) performance of students

Method	No of students	Range of score	Mean score	S.D	t-calc	t critical	Decision
Guided Discovery	170	20	21.22	4.21	2.82	1.96	Significant
Concept mapping	190	19	19.55	4.19			$H0_3$ rejected

Table 5: Analysis of Students Performance in post-post tests (Retention) by Gender

Method	Gender	No of students	Range of score	Mean Score	S.D	t-cal	t-critical	Decision
Guided Discovery	Male	98	20	21.17	4.60	1.02		NS
	Female	72	21	21.68	4.34		1.96	
Concept mapping	Male	100	21	20.16	5.21	0.87		$H0_4$ accepted.
	Female	96	19	20.75	5.06		1.96	

$H0_2$: There is no significant difference between the post test mean score of the students taught using guided discovery and those taught using the concept mapping strategy.

Table 3 above showed that t-cal is less than the t-critical which means that there is no significant difference in the mean score performance of students taught using the two approaches. Hence $H0_2$ is therefore accepted.

$H0_3$: There is no significant difference in the level of retention of chemical materials by students taught using the guided Discovery method and those taught using the concept mapping strategy.

Table 4 showed that there was a significant difference at 5% level of confidence in the level of retention of both groups of students. This difference is in favour of students taught using concept mapping strategy. Therefore $H0_3$ is rejected.

$H0_4$: There is no significant difference in the level of retention of chemical materials taught between male and female students using the Guided Discovery and Concept Mapping Strategy.

Table 5 showed that there was no significant difference in students level of retention by gender hence $H0_4$ is accepted.

DISCUSSION

Tables 2 and 3 showed that there were differences between the means obtained during pretest and those obtained during post test administered to the students. This showed that the students improved on their performance after being subjected to both the guided discovery and concept mapping teaching strategies. This result agreed with the findings of Yilmaz *et al*. [12] who reported that visualization improved the mathematics knowledge of secondary school students in

Turkey. Table 4 showed that there was a significant difference in the retention of the two groups in favour of the students taught using concept mapping. This finding is in agreement with those of Okebukola [10] and Udeani [8]. Similarly, Given [13] observed that when students are taught in their preferred learning styles, there is increasing academic success and development of the student. However, there are often student's individual differences to learning styles and teachers should endeavour to organize their teaching activities to meet their needs by providing suitable teaching-learning environment.

Table 5 showed that there was no significant difference on the basis of gender in respect of the two teaching strategies. This finding is in agreement with Oloyede [14] who found no significance differences in students' science achievement by gender.

CONCLUSION

The implication of this study is that both the guided discovery and the concept mapping strategies are equally powerful in terms of improving students' performance in chemistry. However, students taught using concept mapping are likely to retain chemistry information better than those taught with discovery strategy. It is therefore recommended that both teaching strategies should be used to teach chemistry and while doing this no special attention may be attached to the gender of the students concerned.

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