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Effect of Concept Mapping on Student's Achievement in Inorganic Chemistry

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Abstract: The efforts in assisting the learner to learn have led to the development of metacognitive strategies to enhance meaningful learning. Concept mapping- a kind of metacognitive strategy- assists learners to organize their cognitive frameworks into more powerful integrated patterns. The purpose of the study is to find the effect of the metacognitive strategy of concept mapping on academic achievement in chemistry at a higher secondary level in relation to gender. This study is of Quasi-Experimental in nature consisting of two intact groups where pre and post-test design was employed. The sample of the present study includes 40 students for the control group taught the traditional method of teaching and 40 students for the experimental group (morning shift) taught with concept mapping method from XII grade studying chemistry subject in Vishwaniket secondary school, Kathmandu metropolitan city. It was concluded that the concept mapping strategy has the potency to improve the achievement of learners (through enhanced conceptual understanding) without bias to gender.

Key Keywords: *Concept Mapping, Traditional Method, Achievement, Quasi-Experimental*

Introduction

Concept maps were first developed in 1972 in the course of Novak's research program at Cornell University where he sought to follow and understand changes in children's knowledge of science (Novak & Musonda, 1991). Concept mapping is a technique of visually representing the structure of information, concepts, and their relationship. Research studies in the field of science education reflect that concept mapping can be used as a successful teaching-learning strategy from primary school to the university level. Concept maps are used as a tool for meaningful learning, assessment, instructional planning, and finding out the alternative concepts or misconceptions held by the learners (Enger, 1998; Nesbit & Adesope, 2006; Novak & Canas, 2006a; 2006b; Novak, 1980). Concept maps can be used as a dependable, current assessment method and as a research tool, which gives a great advantage in academic studies (Novak & Gowin, 1984). Investigated the effects of concept mapping on students' achievement in basic science.

Concept maps are graphical tools for organizing and representing knowledge. A concept map consists of various concepts which are hierarchically arranged and interlinked with each other. The interlinkages are further defined to elicit the relationship between concepts. The concept mapping was developed by Joseph D. Novak and his research team at Cornell University in the 1970s as a means to help students represent knowledge (Karla and Gupta 2012). It has subsequently been used as a tool to impart meaningful learning in science and other subjects. Concept maps have their origin in the learning movement called constructivism. Individual constructivists believe that an individual can construct new understanding using his knowledge and beliefs thus, they focus on the knowledge, beliefs, and self-concepts of an individual (Davar 2012). In particular, constructivists hold that learners actively construct knowledge. Novak's work is based on David Ausubel's theory of meaningful verbal learning (Karla and Gupta 2012), which stressed the importance of prior knowledge while learning new concepts. His work was based on two important ideas in Ausubel's (1968) assimilation theory of cognitive learning: Most new learning occurs through derivative and correlative subsumption of new concept meanings under the existing concept or propositional frameworks. Learning that is meaningful involves the reorganization of existing beliefs or the integration of new information with existing information. The cognitive structure is organized hierarchically, with new concepts or concept meanings being subsumed under broader, more inclusive concepts.

The theoretical framework that supports the use of concept mapping is consistent with a constructivist epistemology and cognitive psychology (Mohan 2013). Wellington (2000) describes a science concept map as a special kind of metacognitive tool and he further says, it relates science words or phrases to one another in a scientifically valid form (as cited Tonny, Matt, Bernie & Judith., 2010). Concept mapping is a method to visualize the structure of knowledge. Since the knowledge expressed in the maps is mostly semantic, concept maps are sometimes called semantic networks. Often it is claimed that concept mapping bears a similarity to the structure of long-term memory. Instead of describing all concepts and their relations in text, one may choose to draw a map indicating concepts and relations in a graph or network. Visual representation has several advantages. Visual symbols are quickly and easily recognized, and this can be demonstrated by considering a large number of logos, maps, arrows, road signs, and icons that most of us can recall with little effort. The teaching-learning process in which active mental participation of learners is involved is supposed to affect an effective method of teaching. Concept mapping is a powerful cognitive strategy to design instruction for making teaching and learning successful and result-oriented (Ahmad 2011).

The question of gender influence on science achievement and attitude has also generated a lot of concern in science education. Research has clearly shown that this is an important factor that affects both the individual's achievement and preference for science careers (Gardner, 1997; Jacobowitz, 1983). The dearth of women in most scientific fields may be a result of their perception of science, as male pursuit (Jacobowitz, 1983). Thus, gender has also been found to influence students' attitudes toward science (Kalinin, Fensham, & West, 1989).

Significance of The Study

The findings of the study would provide information about the effect of Concept mapping in teaching inorganic chemistry at a higher secondary level about gender. A wide range of concept mapping is now applicable to most of teachers in educational institutions. A concept mapping strategy is helpful in this regard as an instructional strategy to develop equally the knowledge construction and representation skills/ abilities of both male and female students. In addition, this is crucial for preparing future teachers to be ready to teach their students in this new era of pedagogies to raise the achievement levels of students without bias to gender. The study would, therefore, try to develop students' ability to think critically, creatively, and vividly.

Hypothesis

i. There is no significant difference between the pretest and posttest of academic achievement in Inorganic chemistry of boy students in the control group.
ii. There is no significant difference between the pretest and posttest of academic achievement in inorganic chemistry of girl students in the experimental group.

Methodology

The study is Quasi-Experimental in nature wherein both intact Control and Experimental groups were considered. The target population of this study was students of grade XII studying Chemistry in higher secondary school including 40 students for the Control group and 40 students for the Experimental group. Each group consists of 18 girl students and 22 boy students. Data Collection Tools One set of achievement test items constituting 15 objective-type questions related to the topic structure of atoms was utilized as a tool for data collection. The content validity of the test questions was established and approved by the University professor, Lecturer as well as school subject teacher. The reliability Kuder-Richardson 20 (KR-20) of the test item was 0.82. Data were analyzed with descriptive and differential statistical techniques by using SPSS software of version 20.

Analysis and Interpretation

In order to study the difference between the pre-test and post-test of Academic achievement of students in inorganic chemistry in the Control group and Experimental group in relation to gender, paired t-test and one-way ANOVA are presented in the following tables.

$H0_1$: There is no significant difference between the pretest and post-test of academic achievement in the Inorganic chemistry of boy students in the control group.

To achieve this hypothesis, the paired t-test was applied and the results are presented in the following table.

Table 1: *Results of 't-test between pretest and post-test academic achievement of boy students in inorganic chemistry in the control group*

Achievement	Mean	Std. Deviation	Mean Diff.	SD Diff.	Paired t	p-value	Sign.
Pretest	33.64	2.97	-0.14				
Posttest	33.77	2.62		1.36	-0.4718	0.6419	>0.05NS

Above Table 1 shows that no significant difference was observed between the pretest and post-test academic achievement of boy students in inorganic chemistry in the control group (t=-0.4718, p>0.05) at a 0.5% level of significance. Hence, the null hypothesis is accepted. This shows that the pretest and post-test academic achievements of boy students in inorganic chemistry are similar in the control group.

$H0_2$: There is no significant difference between the pretest and posttest academic achievement of girl students in inorganic chemistry in the experimental group.

To achieve this hypothesis, the paired t test was applied and the results are presented in the following table.

Table 2: *Results of 't-test between the pretest and post-test academic achievement of girl students in* inorganic chemistry in *the experimental group*

Achievement	Mean	Std. Deviation	Mean Diff.	SD Diff.	Paired t	p-value	Signi.
Pretest	31.83	1.62	-13.67				
Posttest	45.50	2.26		2.17	-26.7287	0.0001	<0.05S

The above Table 2 shows that a significant difference was observed between the pretest and post-test academic achievement of girl students in physics in the experimental group (t= -26.7287, $p<0.05$) at a 0.5% level of significance. Hence, the null hypothesis is rejected. This shows that the posttest scores in the academic achievement of girl students are significantly higher as compared to the pretest scores in the academic achievement of girl students in inorganic chemistry in the experimental group.

Conclusion

The findings reveal that concept mapping has a noticeable impact on student achievement. Further, using concept mapping tools in science classes will help students to develop a better understanding of important concepts. Students in this study demonstrated that concept maps helped them to understand the learning processes of developing interrelationships, creating meaning schemes, and constructing knowledge bases. Once they were able to learn in this fashion and explain their own learning, they were much better prepared to function in future science courses. Using concept maps necessitates that science teachers have a good understanding of constructivist learning and the ways in which maps represent students' thinking. Finally, to use mapping science teachers need to be willing to foster an approach to learning as meaning construction.

Concept mapping requires the learner to make an effort to understand concept meanings, organize concepts hierarchically and form meaningful relationships between concepts to form a coherent, integrated network of the material learned. Engaging the learner in such constructive and transformative cognitive operations during learning enhances memory and recall of the material learned. According to research, students better remember information when it's represented and learned both visually and verbally. Concept mapping tools are based on proven visual learning methodologies that help students think, learn, and achieve. Visual learning is absorbing information from illustrations, photos, diagrams, graphs, symbols, icons, and other visual models. By representing information spatially and with images, students are able to focus on meaning and recognize and group similar ideas easily. The use of concept mapping as a learning tool should therefore be more widely encouraged.

In summary, this study indicates that concept maps can effectively promote the learning of students and thus, can be added to the teaching strategies of science teachers. The maps contribute to student success, foster a long-term change in thinking, and contribute to changing students' learning strategies. The maps support both constructivist teaching and learning approaches and may have wider applicability.

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