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## EFFECTIVENESS OF CONCEPT MAPPING STRATEGY ON LEARNING ACHIEVEMENT IN PHYSICAL SCIENCE OF SECONDARY SCHOOL STUDENTS

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### ABSTRACT

The present study is an attempt to investigate the effectiveness of concept mapping strategy on learning achievement in Physical Science of Secondary school students. A total of 60 students of class-IX of a Govt. High school of Jagatsinghpur district, Odisha had participated in this experimental study. The study was quasi-experimental in nature. A non-equivalent pre-test post-test design was used to determine the effect of concept mapping strategy on students' learning achievement. Samples were collected using the purposive sampling method. Concept maps for the various concepts in the selected chapters of Physical Science were developed and used for delivering the contents. A Learning Achievement Test in Physical Science was prepared and administered as pre-test and post-test for both control and experimental groups. Mean, standard deviation, and t-test were used to analyze the data. Results of the study showed that the use of the concept mapping strategy was more effective than the traditional teaching method in enhancing students' achievement in physical science. Also, no significant difference was found between the learning achievements of boys and girls taught through the Concept Mapping strategy.

**KEYWORDS:** Physical Science, Learning achievement, Concept Map, Concept Mapping Strategy.

## INTRODUCTION

The systematic nature of Science in studying the structure and behavior of the physical, social, and natural world has led to newer innovations and human progress. It is inevitable that the advancement in science should continue for the welfare of society ("Importance of Learning Science: Teaching Strategies for Today's Educators," n.d.). Physical Science as an important fundamental science is studied in schools due to its applicability in student's life. It develops universally applicable problem-solving skills and critical thinking skills. These are important life- skills that help students to generate new ideas and intelligent decision-making ability ("Importance of Science Education in Schools," 2017). But it has been found that the performance of students in this subject is extremely low which clearly depicts the poor understanding level of the subject. So, it is inevitable to innovate and employ new teaching strategies for enhancing better understanding of the subject matter. The highly abstract and complex nature of Physical science makes it particularly difficult to understand for secondary school level students. The teaching and learning strategies commonly followed in the classroom only promote rote memorization of the concepts that results in continuous unsatisfactory performance in the subject. Rote learning only results in acquiring factual knowledge and can't promote critical analysis and reflective thinking skills that are very much essential at the secondary school level. Concept mapping is a powerful instructional strategy that enhances the process of knowledge construction and reduces the scope for rote memorization. Concept maps are graphical tools for organizing and representing knowledge. A concept map consists of a set of interconnected propositions, consisting of two or more concepts connected by labeled links. It can be simultaneously used as a learning strategy, a method to assess the understanding of students about any topic, and a resource to represent a set of conceptual meanings included in a structure of propositions (K, Abdul Gafoor, Akhiles, 2010).

### Theoretical Background of the study

Concept mapping is a constructivist teaching-learning strategy developed by Novak, which derives its theoretical base from David Ausubel's Assimilation theory of cognitive learning that helps to foster meaningful learning in the classroom (Ausubel et. al., 1978, Novak & Gowin 1984). It's a two-dimensional diagram that includes concepts, generally represented within enclosed circles or boxes, and relationships among concepts are indicated by connecting lines among them and words or phrases written on the line show the relationship among concepts (Dammani, 2012). The concept map is a kind of flow chart showing interconnections among different concepts. Another unique characteristic of concept maps is its hierarchical nature which arranges more general concepts at the top of the structure and specific concepts below. Thus, a concept map represents concepts hierarchically and the existing relationships among concepts. These special features of concept maps enable students to identify the relationships among various concepts and thereby resulting in acquiring deeper understanding and clarifying misconceptions about any topic. Thus, it enhances the cognitive performance of the students by providing scope for divergent thinking (Novak and Canas, 2006).

## RATIONALE OF THE STUDY

Students entering to science classroom always have acquired some previous knowledge due to prior exposure to the topic or from everyday life experiences. There exists a contradiction between learners' prior knowledge and target knowledge, that may pose threat to student's new learning. Hence, there is a need to augment the process of acquiring new knowledge and its integration with the existing knowledge structure through conceptual change. Concept mapping can be used to investigate the restructuring of knowledge that happen in conceptual change process. The results of the study on concept mapping in Magnetism and Electrostatics revealed a change in the knowledge structure of students as it was observed that the student-made concept maps became more similar to expert's concept maps (Thurn et al., 2020). Luchembe et al., (2014) studied the effect of concept mapping on student's attitude and achievement in physics topics of Circular and Rotational motion using a mixed method approach. They found that the mean score of experimental group's post-test was higher than the control group which was taught through tutorial sheet strategy (Luchembe et al., 2014). Also, the data collected from questionnaires and interviews revealed that students developed a positive attitude towards concept mapping strategy. A comparative study on achievement of students in biology taught with concept mapping, cooperative learning, 5E learning cycle, and lecture method revealed that achievement and retention of students in concept mapping group outscored those in lecture group and performed lower than 5E learning group and cooperative learning group (Patrick Ajaja, 2013). Various research studies indicated that the concept mapping had positive effect on learning achievement at secondary level in the subjects of physics (Pankratius, 1990, Karakuyu, 2010), in chemistry (Singh, 2015) and biology (Esiobu and Soyibo, 1995; Sakiyo and Waziri, 2015; Muni, S. & Mishra, B.C, 2021). Keeping in view of this, the researcher was interested to ascertain to what extent concept mapping was effective in creating meaningful learning in the topics of "Laws of Motion and Gravitation".

The investigator attempted to inquire about the following research questions-

1. Is there any effect of teaching strategy based on concept mapping on learning achievement in Physical Science of secondary school students?
2. To what extent concept Mapping strategy is effective on learning achievement in science At the Secondary school level?
3. Does any relationship exist between learning achievement in Physical Science of boys and girls of experimental group taught through teaching based on concept mapping strategy?

## Objectives of the Study

The objectives of the present study are stated as follows-

1. To develop instructional material based on concept mapping strategy in two selected chapters of Physical Science of class -IX.
2. To study the effectiveness of concept mapping strategy on learning achievement in Physical Science of class IX Students.
3. To determine the influence of gender on learning achievement in Physical Science of experimental group taught through concept mapping strategy.

## Hypotheses of the study

**Ho1-** There is no significant difference between mean achievement scores in Physical science of control group and experimental group.

**Ho2-** There is no significant difference between mean achievement scores in Physical science of secondary school boys and girls of experimental group taught by concept mapping strategy.

## METHODOLOGY OF THE STUDY

### Design

In the present study, a nonequivalent pre-test post-test control group design was adopted which was quasi experimental in nature. Two intact sections of class -IX of the selected school were taken and randomly chosen as experimental and control group. Lesson plans based on Concept mapping were prepared on the Chapters – “Laws of Motion and Gravitation” of Physical Science Text book of class-IX science book prescribed by Board of Secondary Education, Government of Odisha. A Learning Achievement Test in Physical Science of 30 multiple choice questions was constructed on the selected chapters. In the first phase, the achievement test was applied as pre-test to both the groups. In the second phase, experimental group and control group were exposed to concept mapping teaching method and traditional method teaching respectively. A total of 20 lessons were delivered on the selected chapters. In the last phase, the same physical science achievement test was applied again as a post-test for the purpose of determining whether the use of concept mapping strategy had any positive impact on understanding the concepts of the aforesaid chapters.

The diagrammatic representation of the design is shown in following figure.

Experimental Group:  $O_1$      $X_1$      $O_2$

Control Group:         $O_3$      $X_2$      $O_4$

where,  $O_1$  and  $O_3$  represent pre-test

$O_2$  and  $O_4$  represent post- test

$X_1$  represents Concept mapping teaching strategy

$X_2$  represents Traditional teaching method

## Population and Sample

Purposive sampling technique was used for the present investigation. The class-IX students of “Kunja Bihari Govt. High school, Nuagaon, Jagatsinghpur” were chosen to participate in the study. Two intact groups of students having 30 students (both boys and girls) each were selected from the two sections of class-IX. Then the two groups were assigned randomly into experimental and control group. Thus, total sample size comprised of 60 students.

## Tool for Data Collection

Data were collected from the students through Concept mapping as instructional tool and Achievement test on Physical Science as measuring tool in three phases such as Pretesting, Experimental treatment and Post testing.

## ANALYSIS AND INTERPRETATION OF DATA

Analysis of data was done using inferential statistics. For data analysis, Mean, S.D and t-test were used. The t-test was used to compare the means for the two groups on the pre-test and post-test for possible test of significance. Significance level 0.01 was used.

## RESULTS

**Table 1: Comparison of pretest scores of Experimental and Control group on Learning Achievement Test in Physical Science**

Group	N	Mean	SD	df	t-value
Experimental	30	18.733	3.618	58	0.333
Control	30	18.433	3.458		p <0.01

From Table -1, it is

evident that the t-value of 0.333 (less than the critical value of  $t=2.66$ ) is not significant at 0.01 level that infers the pretest scores of experimental group students did not differ significantly as compared to the pretest scores of control group students. So, it is concluded that the two groups were equivalent in terms of previous knowledge and conceptual understanding in Physical Science. Again, it indicated that if any significant difference would be seen in the post test scores that would be attributed to the intervention of concept mapping strategy only, not due to any chance.

**Table -2 Comparison of Post test scores Experimental and Control group on Learning Achievement in Physical Science**

Group	N	Mean	SD	df	t-value
Experimental	30	22.133	3.077	58	2.98
Control	30	19.7	3.297		P <0.01

From Table-2, it is revealed that t -value of 2.98 is significant at 0.01 level (greater than the critical value of  $t=2.66$ ) which signifies posttest achievement scores in Physical Science of experimental group students differs significantly compared to the control group students. Hence, the stated null hypothesis is rejected. It was concluded that the experimental group that was exposed to the intervention i.e., concept mapping strategy, performed significantly better than the control group on learning achievement in Science. So, the results of post-test concluded that teaching of Physical Science concepts through concept mapping strategy was proved effective in enhancing learning achievement of students than traditional method of teaching.

**Table-3 Comparison of post test scores of boys and girls of experimental group on Learning Achievement in Physical Science**

Experimental Group	N	Mean	SD	df	t-value
Boys	16	21.875	2.731	28	0.35
Girls	14	22.428	3.266		$P < 0.01$

Table -3 revealed that t-value of 0.35 is not significant at 0.01 level (less than the critical value of  $t=2.76$ ) that indicates post-test achievement scores of boys and girls of experimental group do not significantly differ from each other. So, the null hypothesis “there is no significant difference between mean achievement scores in Physical Science of secondary school boys and girls of experimental group taught by concept mapping strategies” is accepted. Hence it was concluded that the strategy is equally effective for both boys and girls of experimental group exposed to concept mapping strategy.

## MAJOR FINDINGS OF THE STUDY

### Objective -I

To develop instructional material based on concept mapping strategy in two selected chapters of Physical Science of class -IX.

### Finding-I

The experimental group students showed better conceptual understanding of the concepts related to “Laws of Motion and Gravitation” due to the use of concept maps. The students were able to explain the concepts like Balanced and Unbalanced forces, relation between mass and inertia, momentum as well as concepts related to Gravitation. It was observed that students were also able to solve complex mathematical problems related to the above concepts as they were aware about the relationships among the concepts. It helped them to brainstorm their ideas and offered a scope for establishing linkage between their previous knowledge and existing knowledge structure. There was curiosity among students to create and organize the concepts in various possible ways for meaningful learning.

## Interpretation-I

The concept maps were seen to enhance conceptual understanding of the students and restructuring their knowledge base by possibly replacing their misconceptions with scientifically accepted meanings. Students learnt to prepare concept maps of their own.

## Objective-II

To study the effectiveness of concept mapping strategy on learning achievement in Physical Science of class IX Students.

## Findings- II

The pre-test mean score of the experimental group students was not significantly different from that of control group students. Both the groups possessed equal level of understanding about the concepts before the intervention was applied. The post-test mean score of students showed significant difference between the achievement level of experimental group and control group. **Interpretation - II**

Concept mapping strategy proved to be more effective than the traditional method in improving learning achievement and understanding level of students in physical science of class XI students in the selected topics.

## Objective -III

To determine the influence of gender on learning achievement in Physical Science of experimental group taught through concept mapping strategy.

## Finding -III

The experimental group was consisting of 30 students including 16 boys and 14 girls. In post-test, the calculated t- value was found to be less than the critical value of 't'. so, the post-test mean score of boys in the experimental group was not significantly different from the mean score of girls.

## Interpretation – III

The concept mapping strategy is equally effective in enhancing learning achievement of Physical Science for all the students of the experimental group. Hence, it is recommended to use concept mapping in science classroom to increase the achievement of all students.

## CONCLUSION

The results of the study clearly showed that the students in the experimental group taught through concept mapping strategy outperformed the students in the control group taught through traditional method. The pretest scores of control and experimental groups indicated their equivalent level of previous knowledge and conceptual gain before the application of concept mapping strategy as treatment to the experimental group. This confirms that significant difference was observed in the post-test mean scores of the two groups only due to the intervention of instructional strategy. In this study, the concept mapping strategy enabled the students to visualize the relationships between the various concepts and create meaningful learning instances. They were able to perceive complex and abstract concepts and organize concepts and sub-concepts in organized manner to establish relationships for better understanding. It was also observed that it encouraged the students for self-

learning and better retention of information for further studies. Moreover, students actively engaged in the process of learning.

## SUGGESTIONS FOR FURTHER STUDY

The present study investigated the effect of concept mapping strategy on learning achievement in Physical Science of secondary school students. Further meta-analytic research would be appropriate on the effects of concept mapping instructional strategy on other topics of Physical Science and other subjects like social science, mathematics, language taking into consideration factors such as attitude, motivation, retention or anxiety and levels of learning. Comparative studies between concept mapping strategy and other constructivist instructional strategies could be done using higher statistical techniques.

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