

A Comparative Study of Effectiveness of Concept Mapping and Traditional Method of Teaching on Science Achievement of Secondary School Students

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Abstract—The present study was designed to compare the effectiveness of concept mapping and traditional method of teaching on science achievement of Secondary School Students. The Quasi-experimental pre-test-post-test Non-equivalent group design was adopted for the experimental study. The sample for the study was consisted of 82 students of grade IX from private school, CBSE, Mohali. The students were placed into experimental group and the control group. Experimental group was taught with concept mapping learning and the control group was taught with traditional method of teaching. A criterion referenced science achievement test was constructed and standardised by the investigator and was used it as for pre-test and post-test. The hypothesis were analysed by means of ANCOVA. The results of the study showed that students taught with concept mapping improved their scores significantly with mean score of 57.04 as compared to those who were taught by traditional method of teaching whose mean score was 48.78. On the comparison of performance of the students across gender group, the non-significant gain in the mean achievement scores of the boys and girls showed that gap between the gender groups in learning science has been disappeared. Based on the findings, it is recommended that concept mapping strategies should be adopted for teaching science in schools as it shifts the paradigm from behaviourism to constructivism.

Index Terms—Teaching Methods, Concept Mapping, Science Achievement.

I. INTRODUCTION

The fundamental aim of education is achieving or developing a full human potential and promoting national development. It is achieved by means of education only. By providing universal access to the quality of education can help our country to continue

ascend, leadership in terms of economic growth, scientific advancement, national integration and cultural preservation. Therefore, the aim of education should be to teach the learner, 'how to think rather than what to think. NEP (2020) also emphasised that "Education thus, move towards less content and more towards learning about how to think critically and solve problems, how to be creative and multidisciplinary, and how to innovate, adapt, and absorb new material in novel and changing fields" (p.3). It improves the students' cognitive thinking skills and enables the child to think the goals of his life. Therefore, high quality of education is only the medium to maximise the talent and resources for the benefit of the learners, society as well as the country. However, the increasing awareness of the learner centred teaching has generated a lot of attention due to rapid changes in the knowledge, skills, scientific and technological advancement, artificial intelligence etc. but there is a gap found between the current state of the learning outcomes as per report mentioned in the PGI (Performance Grading Index) 2018-19. Punjab attained the level V (751-800) whereas the level III has been attained by Chandigarh (851-900). NITI Aayog's SDG (Sustainable Developmental Goals) index 2021 states that there is no Indian state or union territory that has given the guarantee for the quality of education as per data out of 100 scores. Chandigarh and Kerala are front runners, they scored between 65-99 whereas there are states like Punjab, Karnataka, Rajasthan, Gujarat, Uttar Pradesh and West Bengal who scored 50 and below 50. There is no state or union territory that come under the Ist category. Therefore, there is a need to bridge the gap between the learning levels and learning outcomes. This generates an attention towards the students- how

they organize their knowledge in order to enhance meaningful learning.

To overcome the gaps between the rote memory and meaningful learning, Blooms (1968) learning for mastery will be helpful. He identified the higher level of cognitive performances that helps the teacher in evaluation. It also helps to shift the paradigm from low order thinking skills (LOTS) to high order thinking skills (HOTS). Blooms (1971a) discuss the mastery learning, where he talked about the shifts of the responsibilities and instructional strategies, so that all the students of the same class achieve the same level of learning. The poor understanding of the students about the concept and its relation can be fulfilled by means of concept mapping strategy.

II. CONCEPT MAPPING

Concept maps is a schematic device in which a concept on a particular topic can be represented in a hierarchical diagram so that it itself illustrate the meaning and the connections or inter-connections between or among the concepts (Novak and Gowin, 1984). The Joseph D. Novak and his research team at Cornell University developed the term in 1970. It is the development of the knowledge either in constructed or reconstructed way but represent in the form of graphs (Novak and Gowin, 1984). It facilitates the active learning of the students (Wilgis and McConnel, 2008). It encourages the students to discover new relations while learning (Caputi and Blach, 2008).

It provides the visual representation of an individual structural knowledge and his conceptual understanding of the concept (Novak and Gowin, 1984). Jonassen et al. (1993) took the concept maps as spatial representation in which concept and their relation has been intended the knowledge that stores in the human mind. Lawson (1994) defined it as a method of visualisation of the structure of the knowledge. The representation of knowledge in the form of semantic networks often claimed a long-term memory. The visual representation helped the students to learn quickly and easily recognized the large amount of content in the form of labels, icons and arrows. It leads the students towards the holistic understanding of the concept.

Novak and Canas (2006) considered it as a technique that helps to represent an idea, knowledge and

information in boxes and circles either in spatial or hierarchical arrangement. The words and ideas used in the content is connected with arrows. The relationship between or among the concept can be articulated by means of linking phrases and answers the cause and effect relations.

Concept mapping is an approach to teaching and learning which enables the teachers and the students to present their ideas, information in a graphic form (Alshatti et al., 2010). Concept maps are generally graphical tools that can be used to represent one's knowledge in an organised way (Novak and Canas, 2006) and showed the relationship among the terms (Vanides et al., 2005).

III. OBJECTIVES OF THE STUDY

1. To study the effect of concept mapping on the science achievement of grade IX secondary school students.
2. To study the interaction effect of concept mapping and gender on science achievement of grade IX secondary school students.

HYPOTHESIS OF THE STUDY

1. There will be no significant gain in mean achievement scores of science achievement of grade IX secondary school students either taught by concept mapping or by traditional method of teaching.
2. There will be no significant interaction effect of treatment (i.e. concept mapping and traditional method of teaching) and gender on science achievement of grade IX secondary school students.

METHOD AND PROCEDURE

In the present study, investigator has employed the quasi-experimental method. In order to determine the effectiveness of the concept mapping and traditional method of teaching on science achievement of grade IX secondary school students, investigator has developed the various tools.

- Construction and standardisation of achievement test in science for assessing the science achievement of grade IX secondary school students.
- Development of instructional material based on concept mapping and traditional method of

teaching in science of grade IX secondary school students.

secondary school students has been collected from the private school, affiliated to C.B.S.E, New Delhi. The medium of instruction of the grade IX secondary school students is English. The description of the sample is given in the table 1

SAMPLE OF THE STUDY

In the present study, the sample of grade IX

Table 1 Description of the Total Sample for the Experimental Study

	Gender → Group ↓	Boys	Girls	Total
Experimental Group	Concept Mapping	23	18	41
Control Group	Traditional Method of Teaching	22	19	41
	Total	45	37	82

DESIGN OF THE STUDY

In the present study, experimental method was used to conduct the further proceedings. The design was on the lines of pre-test-post-test Non- equivalent group design.

Table 2 Non-equivalent Pre-test-post Control Group Design

Experimental Group	Concept Mapping	Pre-test	Treatment (Concept Mapping)	Post-test
Control Group	Traditional Method of Teaching	Pre-test	Traditional Method	Post-test

IV. PROCEDURE OF THE STUDY

In the present study, experiment was conducted in 3 phases.

- Phase 1: In the first phase, the investigator administered the science achievement test of Grade IX secondary school students as the pre-test to the experimental group i.e. concept mapping and the control group: traditional method of teaching. Along with pre-test, Raven’s Progressive Matrices (Non-verbal intelligence test) was also administered in order to see the point of equivalence of both groups.
- Phase 2: In the second phase, treatment was given to the both groups by using the lesson plans based on concept mapping and traditional method of teaching developed by the investigator. Content of the lesson plans was same for all the both groups.
- Phase 3: In the third phase, post-test was administered in order to see the effectiveness of treatment given to the same groups.

ANALYSIS, INTERPRETATION OF DATA

The analysis and the interpretation of the data are the two major steps in the research. Analysis is the study in which the data is collected and organised in order to find the facts and meaning related to the study. In the present study, the main objective is to compare the study of effectiveness of concept mapping and traditional method of teaching on science achievement of secondary school students. The analysis and interpretation of data is given below:

EFFECTIVENESS OF CONCEPT MAPPING AND TRADITIONAL METHOD OF TEACHING ON ADJUSTED MEAN SCORES OF SCIENCE ACHIEVEMENT OF GRADE IX SECONDARY SCHOOL STUDENTS

The comparison of both groups i.e. concept mapping and traditional method of teaching has been carried out by means of ANCOVA (Analysis of Co-variance). ANCOVA has been employed to test the significance of the differences in the mean of science achievement of grade IX secondary school students.

“Through covariance analysis one is able to effect adjustments in final or terminal scores which will allow for differences in some initial variables” (Garrett & Woodworth, 2008, p.295).

The mean score of pre-test, post-test and adjusted mean scores of post-test on science achievement of grade IX secondary school students is given in table 3.

Table 3 Adjusted Mean Scores of Science Achievement of Grade IX Secondary School Students among the Groups of Concept Mapping and Traditional Method of Teaching

Group	N	M _x (Pre-test)	M _y (Post-test)	M _{y.x} (Adjusted)	M _D	t-value
Concept Mapping	41	22.42	57.20	57.04	8.26	3.95**
Traditional Method of Teaching	41	21.64	48.62	48.78		
General Mean		22.03	52.91	52.91		

p < 0.01

The table 3 shows that the mean of the pre-test of grade IX secondary school students in science achievement among concept mapping group is 22.42 and the traditional method of teaching group is 21.64. After given the treatment, the mean of the post-test of science achievement of concept mapping group is 57.20 and the traditional method of teaching group is 48.62. The table 3 further shows the adjusted mean score (M_{y.x}) of concept mapping group is 57.04, which is decreased from the mean score of the post-test i.e. 57.20. The adjusted mean score of traditional method of teaching (M_{y.x}) is 48.78, which is

increased from the mean score of the post-test i.e. 48.62. The mean difference between the adjusted mean score is 8.26. The table further shows the general adjusted mean i.e. 52.91 and the t-value testing the significance difference between the means came out to be 3.95. The difference found between the mean is statistical significant at 0.01 level. This indicates that group of concept mapping of grade IX secondary school students have performed significantly better as compared to traditional method of teaching.

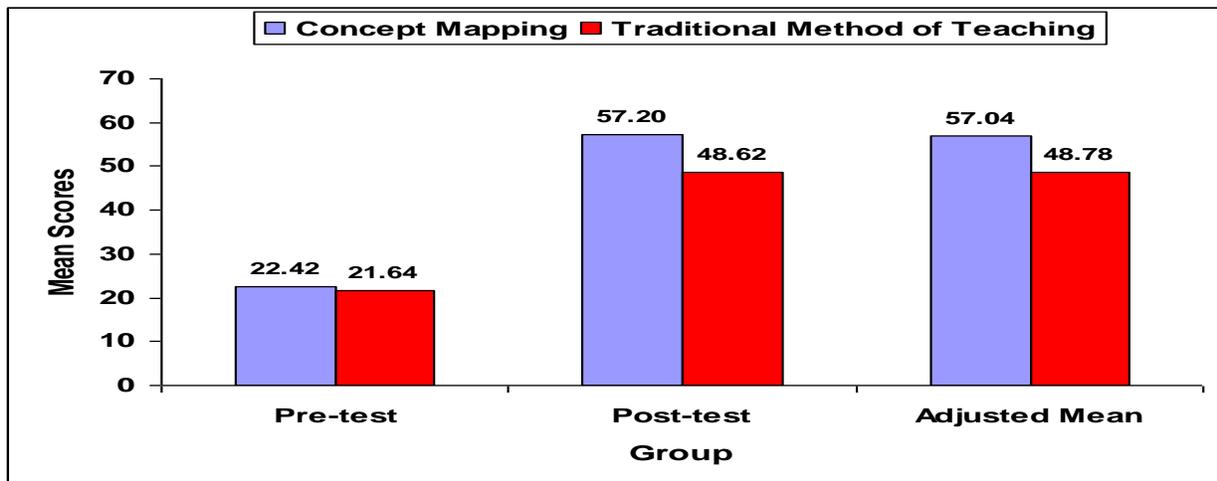


Figure 1: Comparison of Mean Achievement Scores of Pre-tests, Post-test and Adjusted Mean Score of Science Achievement among the Groups of Concept Mapping and Traditional Method of Teaching of Grade IX Secondary School Students

The figure 1 shows the mean gain scores of science achievement of grade IX secondary school students, when exposed to concept mapping learning strategy is significantly higher than the mean gain scores of grade IX secondary school students, when exposed to traditional method of teaching.

Hence, it can be concluded that H_1 is rejected, since the results of the present study indicate that there is a significant gain in the mean achievement scores of grade IX secondary school students on science achievement, when taught by concept mapping as compared to traditional method of teaching.

INTERACTION EFFECT OF THE TREATMENT

i.e. CONCEPT MAPPING AND TRADITIONAL METHOD OF TEACHING AMONG BOYS AND GIRLS

In the present study, the interaction of the difference of the treatment (i.e. concept mapping and traditional method of teaching) with gender group is carried out with use of ANCOVA (Analysis of Co-variance). The results of ANCOVA were worked out separately for boys and girls group of grade IX secondary school students.

The adjusted mean scores of both boys and girls of grade IX secondary school students on science achievement is given in the table 4.

Table 4 Adjusted Mean Scores of Boys and Girls with Respect to Concept Mapping and Traditional Method of Teaching

Group → Gender ↓	Concept Mapping (My.x)	Traditional Method of Teaching (My.x)	Mean Difference
Boys	55.68	47.02	8.66
Girls	58.52	49.78	8.74

The table 4 shows the adjusted mean scores of boys and girls of grade IX secondary school students of two groups i.e. concept mapping and traditional method of teaching. The adjusted mean score of boys of concept mapping group is 55.68 and girls are 58.52. The adjusted mean score of boys of traditional method of teaching group is 47.02 and girls are 49.78 respectively. The mean difference found among boys is 8.66 and the girls are 8.74.

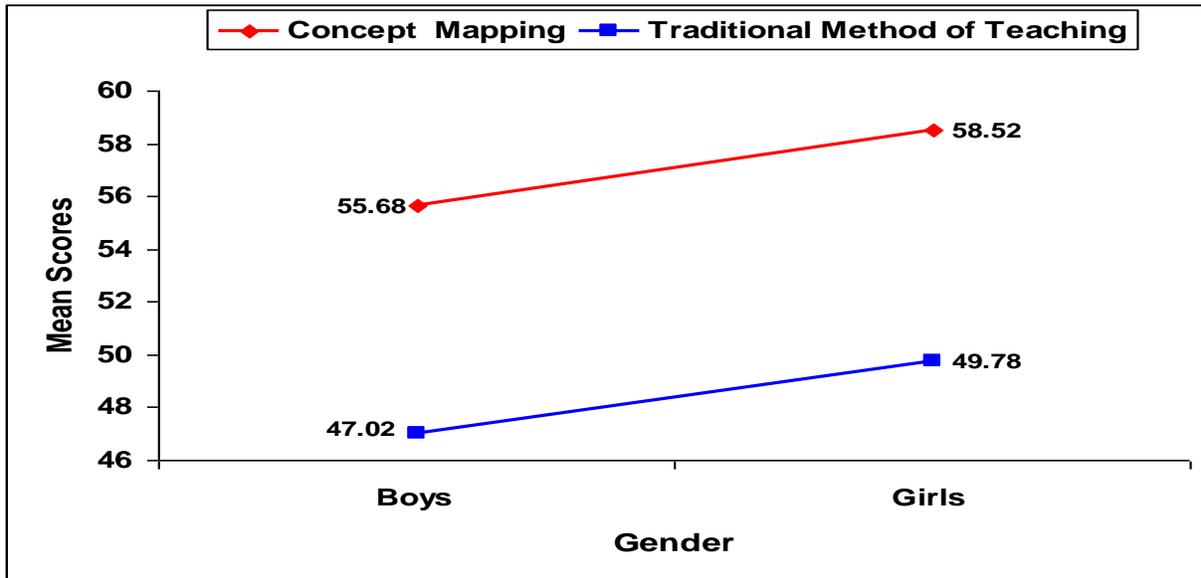


Figure 2 : Interaction Effect of the Treatment i.e. Concept Mapping and Traditional Method of Teaching with Gender Group

- From figure 2, it may be observed that there is no gender difference in the performance of:
 1. In concept mapping group
 2. In traditional method of teaching group
- Concept mapping is better than traditional method of teaching both at par
 1. Boys
 2. Girls
- There is no interaction effect of the treatment (i.e. concept mapping and traditional method of teaching) with gender on science achievement of grade IX secondary school students.

Hence, it can be concluded that H_2 is accepted i.e. there is no significant interaction effect is found among the two groups of boys and girls of grade IX secondary school students on science achievement, one taught by concept mapping and other by traditional method of teaching.

V. DISCUSSION OF THE RESULTS

- There is a significant gain in mean achievement scores of science achievement of grade IX secondary school students, when exposed to concept mapping as compared to traditional method of teaching

As far as concerned with the present study, the experiment is conducted to see the effectiveness of concept mapping over traditional method of teaching. Therefore, keeping in view of the results of the present study, these finding are consistent with the study done by Akintola and Odewumi (2023), "Students who were exposed to concept mapping performed significantly better as compared to the students who exposed to traditional method of teaching".

Another reason for using of concept mapping strategy is, it enables the students to synthesized the complex concepts into simple sub-concepts for the depth understanding of the concept and at the same time, students are able to put the whole sub-concepts together with linking words to form meaningful learning (Shakoori et al., 2017).

The noticeable impact of concept mapping is due to its visual representation of ideas, information, and knowledge of a domain, which further showed the relationship among the concepts and fosters the meaningful learning.

The above stated results are lined up with earlier studies i.e. (Chawla, 2015; Adeniran et al., 2018; Adiyiah et al., 2020; Muni, 2021; Choudhary, 2022 and Akintola & Odewumi, 2023).

- There is no significant interaction effect of treatment (i.e. concept mapping and traditional method of teaching) and gender on science achievement of grade IX secondary school students

The present study has been done to see the interaction effect of the treatment i.e. concept mapping and traditional method of teaching with gender group on science achievement of grade IX secondary school students. The study revealed the non-significant interaction effect of the treatment with respect to gender group.

The results of the experiment strengthened that concept mapping is better than traditional method of teaching as concept mapping promotes high order thinking skills among the students and helps them to retain the concept for long term (Ajaja, 2011 and Sharma, 2016). It improves understanding of the concept and impact of concept mapping reflects in science achievement of grade IX secondary school students.

Despite of all, this method is beneficial irrespective of gender group. These results are in line with Francis and Baba (2023) "there was no significant difference in the performance of the students across gender group." These results are supported by earlier studies also viz (Chawla, 2015; Nwoke et al., 2015; Kaur, 2019; Enebechi, 2021, Bizimana et al., 2022; Ogundiya, 2022 and Francis & Baba, 2023).

VI. CONCLUSION

It may be concluded that the mean gain scores in science achievement of grade IX students, when exposed to concept mapping is significantly higher as compared to the mean gain scores of grade IX secondary school students, when exposed to traditional method of teaching. In addition to this, there is no significant interaction effect of treatment (i.e. concept mapping and traditional method of teaching) and gender on science achievement of grade IX secondary school students.

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