

Effect of Concept Mapping Strategy on Science Achievement in Relation to Scientific Aptitude and Problem-Solving Ability of Secondary Level Students

Dr. Nishant Sharma

305, Indira Nagar III, Meerut

Email: nishant151sharma@gmail.com

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Abstract

Concept mapping is a method for graphically depicting the cognitive framework of a subject or area in a two-dimensional format akin to a road map. According to Novak, the idea of regularity pertains to items or occurrences identified with a particular designation. Concept maps are graphical depictions of essential links among ideas expressed as propositions. Words link several idea labels to generate propositions, which provide information about relationships or delineate links between concepts. This research examined the impacts of idea mapping. Scientific Performance in Relation to Scientific Competence and Problem-Solving Skills of College Pupils. Researcher looked into previous studies related to these particular variables on the basis of the findings of these studies it has been proved that Scientific Accomplishment, Scientific Proficiency, Problem-Solving Abilities of Secondary School Pupils could be improved with concept mapping strategy.

Keywords

Concept Mapping, Science Achievement, Scientific Aptitude, Problem-Solving Ability, Secondary School Students.

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1. Introduction

In concept mapping, concepts are enclosed in circles, while lines are utilized to connect them. Lines are named using lining words, which explain how the connecting concepts are connected. Two interconnected notions offer a prepositional connection or explain how certain aspects of the words manifest or operate. The largest conception (super-ordinate) is less comprehensive than higher-level concepts, which are arranged in a hierarchical sequence. They may embody a synthesis of interrelated concepts, a fresh perspective of established perspectives, or any other manifestation of inventive thought. Facts, concepts, and generalization are the three forms of knowledge used in concept maps. It's a method of learning that originated as a research tool to reflect a student's past relevant information and has now evolved into a tool to help students study more effectively.

Concept mapping is a graphical technique for illustrating a collection of ideas in a hierarchical diagram illustrating their interrelations. As per Novak and Gowin (1984), this method may be used for both learning and evaluation. The concept map is used to make connections between new and previous information and to assist learners in externalizing those connections. Students may use concept mapping to analyze the interconnections among the scientific topics they have learned, systematically show the linkages between fundamental concepts, and enhance their understanding. Students will have a more profound understanding and enjoyment of the idea if they can see a well-organized representation of a whole unit including several themes.

A concept map can be utilized in the classroom and it is based on the principle of advance organizer. A visual idea map illustrating an abstraction is shown to students at the beginning of a lesson to elucidate the connections between concepts. Before the unit, a concept map offers an advance organizer that meaningfully connects existing schemas to the new concept.

2. Concept Mapping - It's Meaning

An approach for expressing knowledge in organized and visual way is called concept mapping. Knowledge graphs are concept networks. Networks include nodes (points/vertices) and connections (arcs/edges). Nodes symbolize ideas, while connections signify the interconnections among these notions. Ideas and links are sometimes designated. Non-unidirectional and bidirectional links are both possible. Concepts and connections can be classified as simple associative, specific, or split into categories like causal or temporal links.

Concept mapping can be used for a variety of reasons:

- To spark new ideas (brainstorming, so on).
- To establish a sophisticated structure (long texts, hypermedia large websites, so on.)
- To communicate intricate ideas.
- Overtly combining new and previous knowledge to enhance learning.
- To measure comprehension or to identify misunderstanding.

A concept map consists of a core concept; you draw the 5 to 10 essential thoughts that link to that term around the center word,” which explains concept map. Then you sketch the five to ten essential concepts that connect each of those children’s terms once again.

A concept map has a one core notion, but a conceptual diagram may include several core concepts. An idea map may be shown as a tree, although it may need depiction as a network. The principles of idea mapping are based on David Ausubel’s concept of substantial learning, which argues that significant learning transpires when new ideas are linked to pre-existing familiar concepts inside the learner’s cognitive structure and may be used across many subject areas.

Concept maps have been extensively utilized in numerous disciplines, particularly in scientific instruction, to encourage and assess significant learning. It was also used in various combinations. including teacher education, and assessing students’ misunderstandings or conceptual shifts. The use of idea maps as an instrument for assessing learning progress is relatively novel.

3. Steps to be Remembered while Preparing Concept Maps

Step 1: Selecting and evaluating a chapter from a book or a compilation of lecture notes on a certain subject, emphasizing key concepts and ideas.

Step 2: Creating a list with this notion prioritized and determining which concept (or concepts, if applicable) is the most fundamental or distinctive.

Step 3: Starting with the names of the widest, most comprehensive concepts Create an idea map at the top of a sheet of paper. Add additional particular ideas as go down the list.

Step 4: Using lines to connect the concepts and connecting words to mark the lines that indicate significant relationships between the concepts.

Step 5: Complete mapping every thought on the list, then keep adding to the map by linking new ideas from the list to ideas that are already there.

Step 6: Examining the map will reveal if there are any additional significant links between the terms on the map that should be depicted. If such links are present, they might be cross-links.

Step 7: An arrow indicates the direction of a connection, when two or more ideas are connected to form a cause-and-effect connection.

4. Theoretical Background of Concept Mapping

The idea mapping approach was developed in the 1970s by Joseph D. Novak and his research team at Cornell University to illustrate the evolution of pupils' scientific comprehension. There have been several applications since then, including promoting a greater understanding of science and other subjects and demonstrating the specialized expertise of Individuals and groups within the school, government, and business sectors. Concept maps originated from the constructivism movement of the 1920s and 1930s. Constructivists believe that students actively create their knowledge during the educational process.

“Meaningful learning” is characterized as “the assimilation of new concepts and propositions into existing cognitive structures,” as per Novak. Concept maps assist learners with creativity since they are utilized to encourage the development of concepts.

5. Concept Map as a Tool for Learning Knowledge

Concept mapping is an extremely adaptable technique that may be used by nearly any group of students, instructors, and educators from primary education institutions to higher education establishments. For example, idea mapping is characterized as a cognitive instrument that enhances academic achievement and comprehensive learning.

Ausubel's theory (1968) the essence of valuable education provides the basis for idea mapping. Concept mapping calls for the learner to make a concerted effort to discover and link new information's essential ideas to those already present in her knowledge structure. As a result, concept maps depict the organization of students' thoughts, with a special focus on the connections among such thoughts. For students to have a thorough cognitive comprehension, they must continuously navigate between the concepts and their inter-links.

6. Development of Concept Maps

The notion that concepts interrelatedness is a fundamental characteristic of knowledge is shared by most cognitive theories. Indeed, a well-structured knowledge

base is one of the criteria for determining domain competence. The parts of knowledge become increasingly linked when competence in an area is gained via learning, training, and/or experience. Students' knowledge progressively resembles the densely connected structures that define a subject-matter expert's representation of the information as they gain competence in a topic area.

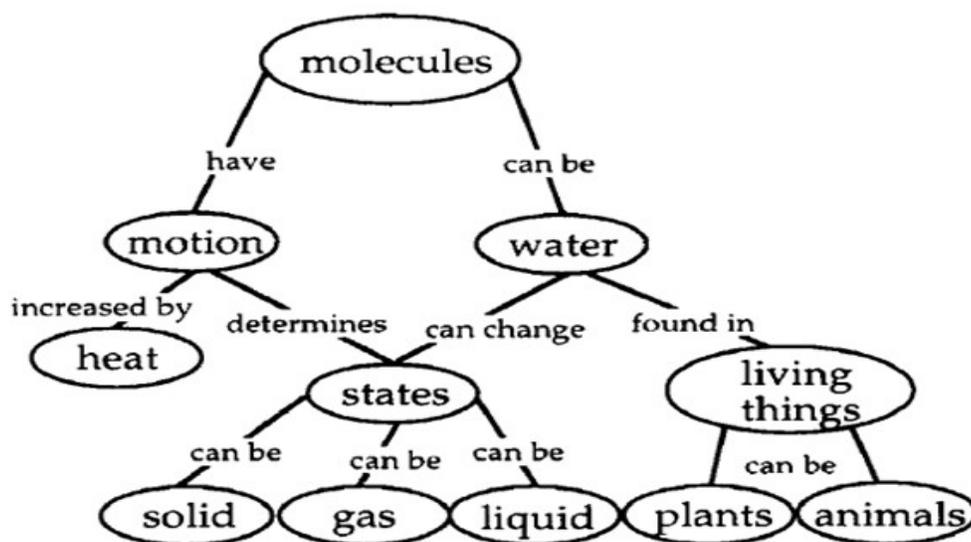


Figure 1: Hierarchical concept map

Considering that information inside a content domain is organized around key concepts, Understanding the domain requires a very cohesive framework among these notions. Structured representations can capture this organizational characteristic of knowledge. The structure's nodes correspond to the domain's keywords (concepts). Two concepts (nodes) are linked by lines, and the label on the line shows how they are connected. There are two nodes joined by a labeled line that make up a proposition. A proposition in a map of ideas serves as the essential unit of meaning used to evaluate the legitimacy of the relationship established between two notions. As a result, concept maps claim to reflect a significant portion of a student's explicit understanding in a certain subject area.

7. Review of Related Literature

Moreira (1979) used concept maps with physics students at university level. In experimental group, concept maps were utilized in conjunction with usual rearrangement of concepts, whereas in control group, the standard technique was

employed. When Moreira tested the experimental students, he discovered that they did substantially better on exams that required them to graphically organize the concepts. This discrepancy widened over the semester-long research period. No substantial difference existed between the groups for regular course examinations and association tests. As the semester progressed, students exhibited growing enthusiasm for the value of idea maps.

Novak (1983) utilized concept maps with students and students and teachers both expressed an interest in them. Aiming to evaluate concept mapping methods with various courses and subject matter areas, these early impacts focused on instructors' responses, as well as techniques for introducing concept mapping in varied contexts.

Basconas and Novak (1985) observed elevated average outcomes in high school philosophical problem-solving examinations were found among students who developed concept maps as an integral component of a standard philosophy curriculum instead of using concept maps. According to Raven's Progressive Matrices Test, the idea map group excelled at all proficiency levels.

James Wandersce (1990) used principles and notions from cartography for concept mapping. He advocates for doing a research on the graphical representation of scientific information to Develop, evaluate, and enhance visual and graphic mental processes instruments, including idea visualization, utilized in modern education.

Olugbemi and Jegede (1990) researched to see if concept mapping, a meta-cognitive approach decreases anxiety and, as a result, improve achievement. Anxiety was studied, and results show that concept mapping is considerably more helpful than standard explanatory methods.

Pankratius (1990) conducted a research on 'Building an Organized Base'. For efficient knowledge structure, the study titled "Concept Mapping and Achievement in the Secondary School Subject Physics" determined that The use of Idea Mapping is crucial. The study included six full high school physics courses given by this researcher. The control group consisted of two classes that received conventional training. Before the subject under study, four classes got six weeks of concepts mapping training.

Mason (1992) find that reflective scientific training has been developed using experiments using Concept Mapping as a tool. A successful idea map develops inside a contextual framework defined by a certain "focus question." The participant was introduced Utilize diagramming ideas as an early learning tool. The particular

concept was given to the instructors. The findings demonstrate that Concept Mapping is a potent tool for conceptual restructuring and improving introspective scientific education.

Roth & Choudhary (1992) examined the social construction of scientific ideas or concept maps as a technique of conscription and a tool for social cognition in secondary school science. The findings indicate Concept maps may serve as a mechanism for social cognition, a recruitment system, and a notation technique to facilitate crafting suitable group experiences and enhancing the heuristic for interactive classrooms.

McClure, Sonak, and Suen (1999) conducted study on ‘Concept Map Assessment of Classroom Learning, Validity, and Logistical Utility.’ The findings demonstrate the time necessary for administering Concept Mapping training, constructing Concept Maps, and evaluating them aligns Employing Concept Mapping as a method for classroom assessment.

Roberts (1999) used concept maps to assess the comprehension of basic concepts in statistical inference and issue characterization among university science students. Students’ with concept map scores were also compared to the grades they received for the practical project they completed following their statistical research.

Edmundson (2000) looked into students studying eternity reported that the concept map considerably aided their comprehension of the underlying path of psychological process. According to the study, the answers from the teachers were likewise quite good. It is also suggested that concept mapping can aid in the clear expression of conceptual links, the identification of mistakes and omissions, and the discovery of misconceptions in student understanding.

Pongodi (2000) examined the use of idea mapping in concept acquisition in chemistry for ninth-grade pupils, and it was determined that concept mapping helped pupils to grasp concepts more quickly and effectively.

Snead (2003) conducted a study among secondary school pupils and during a five-week module of teaching, 282 high school students were given concept maps, and their success was compared to 259 students who got the same topic but were not given concept maps. The interaction between treatment and locus of control significantly influenced retention test outcomes, with ‘external’ children deriving more benefit from the concept map-assisted instructions a difference favoring internal locus of control children.

Liu, Xiufeng (2004) has done a study among the students of IX class with chemistry and students collaborated using digital concept mapping. It was shown that computerized concept mapping may assess student progression in ontological, philosophical, and social/affective areas when used in conjunction with transcripts of representative student and instructor interviews. Much research was carried out in other countries. As a result, the current study was picked by the investigator. Using a concept mapping technique, the researchers hoped that the findings might benefit the classroom teaching system.

Kharatinal M. and Nagarjuna G. (2006) discovered how concept mapping affects biological knowledge organizers. According to their findings, concept mapping is a useful educational instrument.

Ahuja Amit (2007) assessed the efficacy Using idea mapping as a pedagogical tool instrument to augment pupils' comprehension and retention regarding notions, and discovered that be favorable when compared to traditional methods of instruction.

Mary, R. Sahay and Raj, I. Paul (2007) investigated the effectiveness of idea mapping as a teaching technique for environmental studies B.Ed. trainees. The outcomes were positive.

Moon, B.M., Hoffman, R.R. and Canas, A.J. (2011) performed an investigation on the importance of idea mapping in knowledge dissemination, institutional memory maintenance, and ideation were among the topics covered in the research. As concept mapping and knowledge modeling software packages become more widely available, it is being used more frequently and with greater success in the workplace to solve a wide range of issues.

Starr (2015) studied in scientific curriculum creation, using concept maps as a heuristic can lead to improvements in both process and result. It was shown that instructors' perceptions of curriculum alter when concept maps are updated. The use of idea maps as a methodology for developing scientific curricula was examined in this research. Science educators may use diagrams to facilitate curriculum development. That is theoretically driven, integrated, and organized hierarchically.

Muni, S. & Mishra, B. C. (2021) have done a study to see if the concept mapping approach has any influence on secondary school students' attitudes about science. A quasi-experimental technique was utilized in this study. This study used a design with both pre- and post-test control groups. The sample was selected via a

process known as purposive sampling. Only one public high school in Cuttack, Odisha, was chosen for the study. The findings indicate that pupils in the experimental group did not vary substantially from their counterparts taught using traditional methods in their average attitude about the results of the science pre-test. Students' attitudes toward science improved significantly after teaching-learning was done using the concept mapping technique as opposed to teaching-learning done using the standard way of teaching.

8. Conclusion and Discussion

This study looked at Concept mapping's effect on science students in secondary school's success regarding scientific proficiency and analytical problem-solving skills. The research revealed that the idea mapping technique enhances scientific achievement and fosters scientific aptitude and problem-solving abilities. This research indicates that the idea mapping strategy used by the experimenters significantly outperformed the control group in accomplishing scientific outcomes.

Researchers discovered the experimental group students outperformed control pupils on measures of scientific success, scientific aptitude, and the capacity to solve problems. Concept mapping was shown to be a successful teaching technique since in addition to helping kids succeed in science; it also enhanced their scientific aptitude and problem-solving abilities. Using this study's findings, it's clear that enhancing the teaching method might serve as a valuable resource for pupils as well as teachers. The use of maps of concepts in secondary education has shown improve students' scientific aptitude, problem-solving skills, and science achievement.

Concept mapping technique may be tested in other school disciplines including language, social science, physical science, and mathematics in the future considering the results of this investigation Depending on the characteristics like location, socioeconomic level, gender, motivation, and interest, etc. Research may be conducted to assess the efficacy of concept mapping methodology in comparison to conventional scientific teaching techniques.

This paper adds to previous studies Regarding idea mapping and its influence on learning. Students' accomplishments and attitudes are positively affected by concept mapping. Furthermore, even though the learning outcomes are positive. A valuable technique for arranging a lecture or teaching science has been discovered to be concept maps. Furthermore, they were not only assisted in the design of instruction, but their comprehension Students' understanding of the subject matter

also improved. Using In this research, students indicated that they used idea maps better understood how knowledge bases are constructed and how linkages are developed.

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