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# CONCEPT MAPS IN THE TEACHING OF SCIENCE: AN EXPERIMENTAL STUDY

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**ABSTRACT**

*Assessment and evaluation is one of the most important aspect of the teaching-learning process. Formative assessment plays a key role in evaluation the understanding of the students on regular basis. Concept maps is one such tool which can be used to evaluate the students. Hence keeping this in mind the study conducted focused on investigating the use of concept maps in the teaching of Science which is full of processes and complex concepts. The experimental study conducted on standard sixth students focussed on their ability to make concept maps to represent their understanding of the topics taught by the teacher in the classroom. These findings suggest the importance of using concept maps in teaching of Science to enhance students critical thinking, retention, interest, creativity and the comprehension level. The study emphasized the significance of concept map as a tool and its implications focussing on knowing the students perspectives, support holistic learning and support students discussion.*

**KEY WORD:** *Science, Concept Maps, Evaluation*

## INTRODUCTION

Concept map is a way of representing and organizing the knowledge. It shows the relationship between the concepts, including bidirectional relationships. Generally, a concept map is divided into nodes and links. The nodes are often in form of circles which represent various concepts and the links in form of lines represent the relationships between the main concept and the sub concepts. Words are used to label the links so that the viewer gets a clear understanding of the relationships that exists. It is a visual graphical tool that shows what and how the designer thinks about the topic.

Concept maps were first used by Joseph D. Novak of Cornell University in the 1960s. It is based on the sound philosophy of constructivism. Constructivism is a philosophy of education that emphasizes the active role of learners in constructing their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When a teacher uses concept maps in the classroom, they are applying this philosophy by helping students visualize and understand the relationships between different pieces of information. This approach goes beyond rote memorization, encouraging deeper comprehension and critical thinking.

According to Martin (1994), concept maps are two dimensional representations of cognitive structures showing the hierarchies and the interconnections of concepts involved in a discipline or a subdiscipline.

**Constructing a Concept Map -Steps of designing a concept map:**

- **Step 1: Brainstorming Phase**
- **Step 2: Organizing phase**
- **Step 3: Layout phase**
- **Step 4: Linking phase**
- **Step 5: Finalizing the concept map**

**Brainstorming Phase:** In step identify the topic that you would like to work on. Later based on your previous knowledge and understanding make a list of the facts, figures, ideas and sub concepts that are related to the main topic selected. This can be written on post it notes, either in brief form, or single word or short phrase. Since this is a brain-storming process, so feel free to express and write down every idea that anybody in your group thinks is important. The objective should be to generate the largest possible list you can.

**Organizing Phase:** In this phase spread out all the ideas, facts that you have put on every post it notes on a flat surface so that all can be read easily and, together at a glance. Next, based on the similarities and differences try to create groups and sub-groups of the related items. If required you may also use the hierarchy to represent the ideas. The ideas or the words can be rearranged or even addition of new words if required.

**Layout Phase:** On a large sheet of paper, try to come up with an arrangement (layout) that best represents your collective understanding of the interrelationships and connections among groupings. Feel free to rearrange things at any time during this phase. Use a consistent hierarchy in which the most important concepts are in the center or at the top. Within sub-grouping, place closely related items near to each other. Think in terms of connecting the items in a simple sentence that shows the relationship between them. Do not expect your layout to be like that of other groups. It may be advisable to meet outside of class to work on this assignment and plan for its completion. Creating a concept map can be a dynamic and collaborative process. Steps to be followed by the group in arranging and connecting the ideas generated on a sheet of paper or chart paper etc:

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**Central Concept**: Place the main concept in the center of the sheet.

**Primary Categories**: Identify primary categories that branch out from the central concept.

**Subcategories and Details**: Branch out from each primary category with subcategories and specific items.

**Linking Phase/Connecting Ideas:** Use lines or arrows to show connections between related items. If required write simple short sentences or phrases along the lines/arrows to explain relationships. There is a possibility that more than one arrow can originate or terminate on particularly important concepts. Add any additional items or connections as your understanding deepens during the discussion.

**Finalizing the Concept Map:** In this phase you can rearrange as desired to ensure clarity and logical sequence of the ideas represented. Make use of color-coding for different categories and connections for better visual appeal. After your group has agreed on an arrangement of items that coveys your understanding, you need to convert the concept map into a permanent form that others can view and discuss. Be creative in a constructive way through the use of colours, fonts, shapes, border thickness, etc. to interconnect all the ideas. You can also use related images in the concept maps to make it more attractive and the visuals will add in the concept clarity. Give your concept map a suitable title. If you want to construct your final concept map on a computer, try using PowerPoint or free online software.

**Evaluation:** The teacher can use a rubric for evaluating the students work. This rubric can help provide a structured approach to evaluating a concept map, ensuring all important aspects are considered.

1) Accuracy and Thoroughness: Focus is on correctness of concepts and relationships. Confirm all the concepts presented are accurate and based on reliable information. Ensure that the relationships between the concepts are logically and correctly presented.
2) Completeness: Confirm that all significant concepts related to the main topic are included. Identify if any key concepts or relationships are missing, which would hinder a comprehensive understanding of the topic.
3) Misconceptions: Look for any misunderstandings or incorrect representations of concepts.
4) Organization (Clarity of Layout): Assess whether the concept map is organized in a way that makes the hierarchical relationships and connections between concepts easy to understand.
5) Title: Check if the concept map includes a clear and descriptive title that reflects the main topic.
6) Appearance (Attention to Detail): Check for spelling, grammar, and overall presentation. Ensure that the penmanship (if handwritten) or font (if digital) is clear and legible.
7) Neatness: Assess whether the concept map appears neat and orderly or if it is cluttered and confused. Check for consistency in formatting, such as the use of colours, shapes, and lines.
8) Creativity (Innovative Elements): Look for unique features that enhance the communication of ideas, such as the use of colour coding, icons, or illustrations. Ensure these elements are not distracting but rather contribute positively to the understanding of the content.
9) Engagement: The concept map should be visually appealing and engaging, making it interesting to look at and easy to understand.

**Need of Concept Maps**

Martin, 1994, conducted a study in which he taught education majors to use concept maps to make lesson plans. The teachers in the study found the maps quite useful for the development of course plans. The teaching- learning process should be student centric. Keeping this in mind concept maps fits well with the constructivist approach that learners construct their own idiosyncratic understanding of concepts. The teacher can use a map to understand how students see the information received. Concept maps also help the teachers to understand if students have formed any incorrect misconceptions or assumptions about the concept or topic understudy. The learners think critically on the concepts taught. It also helps in better retention and in depth understanding for the learners

**Objectives of the study**

For the present study following objective was framed:

1. To develop lesson plans by incorporating the concept maps for Science subject.
2. To measure the effectiveness of concepts maps in teaching of Science for standard sixth students in terms of:

i) Increased Engagement and Understanding
ii) Better Retention
iii) Advance Critical thinking
iv) Generate Interest

**Operational Definition of the terms**

Concept maps: For the present study concept maps are defined as graphical representation of the concepts or topics dealt. It helps to see the relationship and patterns that exist between the various sub concepts or the topics at a glance.

**Sample for the study**

For the present study, the population comprises of 47 students studying in standard sixth in English medium school, western suburbs, Mumbai.

**Sampling Technique**

For the present study the sampling technique used was purposive and convenient sampling.

**Research design**

The research design used was single group experimental study.

**Tools for the study**

For the present study the lesson plans were made such that the topics taught to the sixth standard students were evaluated by

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asking the students to make concept maps. Total six topics were evaluated through the concept maps.

Learning Outcomes: The learners will be able to:

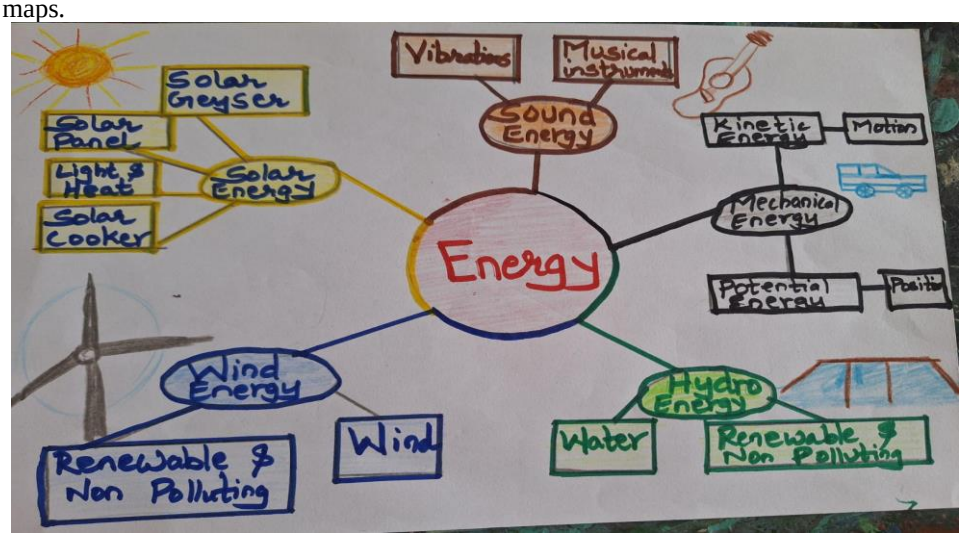
- explain the relationship between the different aspects related to the main concept.
- brainstorm for better expression of their ideas and thoughts in form of the concept maps.
- reflect on their understanding of the concepts learnt.
- collaborate and enhance their social skills.

Instructional Procedure

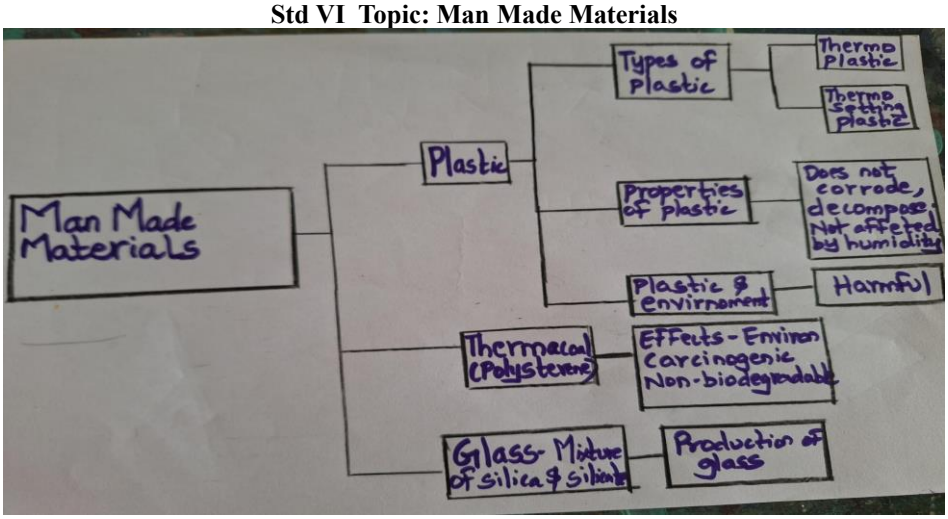
1) The teacher explained the topic to the students by including various activities.
2) The students were oriented to the entire procedure of making concept maps.
3) Later the teacher formed the groups consisting of five members each group.
4) The time given was 20mins for preparing the concept maps.
5) As it was part of the evaluation so the teacher just supervised the activity. Any doubts raised by the learners regarding the steps of making concept maps was clarified. It was ensured that each member in the group is involved actively.
6) Later one or two representatives from every group were asked to present their work.
7) Feedback was given to the learners as required.

Examples of the concept maps made by the learners for the different topics

Std VI Topic: Forms of Energy

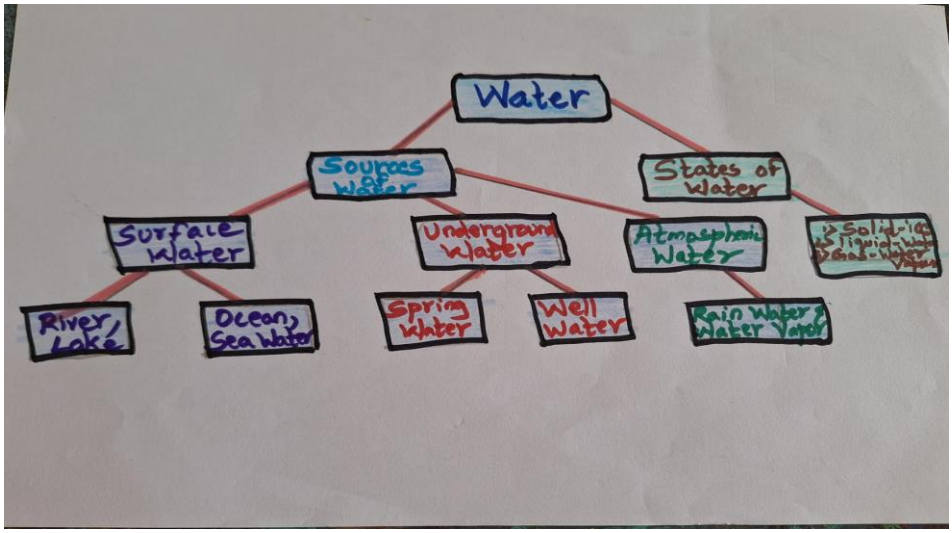



**Std VI Topic: Man Made Materials**




**Std VI Topic: Water**

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**Delimitations and limitations of the Study**

The present study has been restricted only to the students of standard sixth studying in an English medium school affiliated to SSC board from western suburbs, Mumbai. The present study is limited to the use of concept maps only in teaching of Science.

**Analysis and Major findings of the data:** The data was analysed qualitatively based on the firsthand observations by the researcher during the sessions conducted.

**Researchers Observations and Reflections**

1. Increased Engagement and Understanding:

During the making of the concept maps the learners were actively engaged throughout. It also helped for in-depth understanding of the concepts on the part of the learners. The learners discussed the concepts and topics in depth, clarified their misconceptions in understanding the relationship and the patterns. Once clear then they started working on representing the data in form of concept maps.

2. Better Retention: The act of making concept maps helped the students in better retention of the concepts for a longer period of time as deeper understanding of the concept demonstrates a thorough understanding of the minutest the details in comparison to rote memorisation.

3. Advance Critical Thinking Skills:

The learners showed proficiency in analysing the complex topics to find out the relationship and patterns that existed. They were very innovative and original in designing their concept maps It helped them to dissect the complex topics and evaluate their thinking strategies. The researcher could clearly observe the student's capacity to apply analytical thinking, engage in insightful discussions to identify the patterns and relationships that exists in the concepts and draw meaning out of it. This skill of critical thinking will undoubtedly help them in their academic pursuit and later in their professional endeavours.

4.Interest level of the learners:

The findings highlight the positive outcomes of incorporating such teaching methods in the classroom. By encouraging students to actively engage with learning the concepts, the educators can foster a learning environment that promotes critical thinking, understanding and collaboration.

The findings highlight the profound impact of interactive and participatory teaching methodologies. By prioritizing experiential learning, educators can create an immersive educational experience that fosters active student engagement and nurtures essential life skills like critical thinking. In comparison to the traditional ways of evaluation by just asking the questions in form of objective or long answers this approach gives the learners to reflect, review and revisit the concepts learnt. It also enhances their metacognitive skills. Overall, these findings emphasize the transformative potential of student-centered teaching methods and a curriculum that reflects real-world issues.

**Implications of the Study**

This list highlights the benefits of using concept maps in course design and instruction. Here are the key points:

- **Identify trivial concepts**: Concept maps can help you identify areas that may not be essential to the course, allowing you to streamline the content.
- **Emphasize key themes**: The mapping process can help you identify the most important themes and concepts, allowing you to focus on the most critical aspects of the course.
- **Understand student perspectives**: By constructing a concept map, you can gain insight into how students may organize knowledge and think differently from you, enabling you to better relate to them and challenge their thinking.
- **Break down disciplinary boundaries**: Concept maps can help you identify concepts that are relevant to multiple disciplines, promoting a more interdisciplinary approach.
- **Select instructional materials**: Concept maps can be used to select appropriate instructional materials, incorporating teaching strategies, time allocations, and task assignments.
- **Visualize conceptual relationships**: Concept maps can be used to illustrate the relationships between concepts and objectives, making it easier for students to understand the connections.
- **Facilitate course reconceptualization**: The mapping process can help you reexamine your course content

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and objectives, leading to a more holistic and integrated approach.

- **Provide a framework for student discussion**: Concept maps can be used as a starting point for student discussions and summaries of course concepts.
- **Support holistic learning**: Concept maps promote a holistic approach to learning, emphasizing the connections between different concepts and ideas.
- **Increase meaningfulness**: By integrating concepts through mapping, you can increase the meaningfulness of the course content for students.
- **Enhance multiple perspectives**: Concept mapping can help you develop a broader understanding of different ways of constructing meaning, allowing you to cater to diverse student perspectives.
- **Develop well-integrated courses**: The mapping process can help you create courses that are logically sequenced, have continuity, and are well-integrated.
- Overall, concept maps offer a powerful tool for course design and instruction, enabling instructors to create more effective, engaging, and meaningful learning experiences for students.

## CONCLUSION

The action research conducted in the classroom reveals that implementing concepts maps as a tool to test the students understanding in Science teaching leads to positive outcomes in student engagement, critical thinking development, and collaborative learning. The findings indicate that using concept maps to evaluate students' knowledge in Science enhances their awareness of their understanding and fosters creativity and innovation in expressing their ideas and thoughts. This approach also helps teachers capture students' complete attention during the learning process, as students understand that they will be evaluated based on their in-depth understanding rather than mere memorization of concepts. Furthermore, the students' ability to critically analyse topics and collaborate effectively with peers demonstrates the success of the implemented teaching strategies.

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