Use of Concept Mapping as an Innovative Teaching-learning Strategy in Mathematics

ROOHI FATIMA*

Abstract

'If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly' are the famous words of Ausubel. For this, to help students in making conceptual connections, a technique called 'Concept Mapping' was evolved by Novak (1983).

In this article, the author attempts to find out whether concept mapping can be used to facilitate the teaching-learning process of mathematics or not? This article is research based. The author, who is a teacher educator, gave an assignment to her B.Ed. students (pedagogy of mathematics) to teach at least one topic or unit during their internship program with the help of technique of Concept Mapping. In this article, she discusses the effectiveness of concept mapping in the teaching-learning process of Mathematics by giving a practical based example of a unit of mathematics of class VIII by using Concept Mapping as a teaching-learning strategy. In the end of this article, she summarises the observation of her students under the heading of "Concept Map as an Evaluation Tool".

INTRODUCTION

I have a long experience in teaching Mathematics in a Middle School, I have found that some students had so much trouble in understanding some relatively simple ideas, while they might have been good at spelling and some other things, but they didn't appear to understand why 2+2= 4 was the same as 2×2 = 4 or why 2 half or

Assistant Professor, Department of TT and NFE (IASE), Faculty of Education, Jamia Milia Islamia

4 quarter both equals to a one whole. They were just learning differently, the reasons for these differences may be understood by going through David Ausubel's 'Assimilation Theory of meaningful learning'. Ausubel made the sharp distinction between learning by rote, where the learner makes little or no effort to integrate new concepts and propositions with relevant concepts and propositions already known and the meaningful learning where the learner seeks to integrate new knowledge with relevant existing knowledge.

In contrast to the students who learn by rote, those who employ meaningful learning are expected to retain knowledge over an extensive time span and find new related learning progressively easier. As a teacher or teacher educator, I can arrange my instruction and assessment to encourage either learning by rote or learning meaningfully, the main responsibility for learning is the learner's, and this responsibility cannot be shared. I wish to give this message to my pre-service as well as in- service teachers.

The changing views, higher expectations and enhanced responsibilities of teachers demand the use of practical and innovative methods of teaching which lay stress on building and clarifying the basic concepts underlie the content. These methods should be capable of linking various concepts to one another and also to the previously acquired concepts. These searches of improvised instructional methods carried out in the classroom and improve student's learning; "Concept Mapping" has been evolved as a useful strategy for leading students towards meaningful learning and a conceptual understanding of the subject. It has been associated with exploring learner understanding in terms of how they make links between concepts. There has been a growing interest in the use of concept mapping in teaching and research across various fields of education.

What are Concept Maps?

Concept Maps, developed by Professor Joseph D. Novak of Cornell University (1983), is a two-dimensional technique for visually representing the hierarchical arrangement of concepts as well as their relationships or it is a type of graphic organiser used to help students to organise and represent knowledge of a subject. Concept map begins with a main idea (or concept) and then branch out to show how that main idea can be broken down into specific topics.

Concept maps are also called mind maps. They can be defined as a way of representing relationship between ideas or images or words in the same way that a road map represents the locations of roads and houses in the colonies, a blue print represents an achievement test or a chemical equation represents the chemical process. It organises information like an outline but less linear and more spatial. In a concept

map, connections are made between pieces of information in different areas. Here, every word or concept is associated to another and linked back to the first idea, word or concept.

Concept maps are mirrors of how your brain actually makes connections. They can be used to develop logical thinking and study skills in the students; by displaying the connections between the individual ideas and helping them to observe that, how individual ideas form a larger whole. The concept map represents the hierarchical relationships among concepts within the structure or segment of a discipline. They help to improve understanding of a given subject and facilitate building student's own knowledge. We can say that, concept maps were developed to enhance meaningful learning.

Use of Concept Mapping as a Teaching-learning Strategy in Mathematics

Mathematics has been recognised as one of the pivotal strings of human intellectual activities. It has its roots in everyday activities and forms basic structure of our highly advanced technological developments. Mathematics is a complex system of concepts and its knowledge has the character of a network, as mathematical objects, e.g., concepts, definitions, theorems, proofs, algorithms, axioms are only interrelated but one can easily find its use in daily life.

Understanding is one of the most important traits associated with the teaching-learning process and with the attainment of educational goals. A significant concern in school mathematics is learning i.e., understanding of mathematical concepts. Kilpatrick, Swafford and Findell (2011) have described conceptual understanding as a critical concept of mathematical proficiency that is necessary for anyone to learn mathematics successfully.

Vygotsky (1962) makes the observation that: "Concepts don't lie in the child's mind like peas in a bag, without any bonds between them. If that were the case, no intellectual operation requires, coordination of thoughts would be neither possible, nor any general conception of the world. Not even separate concepts could exist; their very nature presupposes a system."

The teaching of mathematics is aimed at developing proper abilities and right attitude. But, it is very general to hear that mathematics is a tough subject. This is the perception of a student with which she comes in a class. It is because of abstract nature of the subject, that students find it difficult. It is observed that mathematical ideas and concepts build on one another to create a comprehensible structure and also, the teaching of mathematics is generally based on lectures. It aims at imparting the material to students without offering the opportunities to sharpen their intellectual skill. The

teaching and learning of mathematics is supposed to enable learning of mathematics by "developing a deep conceptual understanding in order to make a sense of mathematics". Therefore, by finding out how learners have organised their knowledge of mathematical concepts might be a way of establishing how they understand those concepts. Thus, teaching of mathematics entails modification by some innovative and revolutionary change. One of the currently emerging new strategies that we are discussing so far is "concept mapping".

As a mathematics teacher or teacher educator, the author strongly feels that, concept map could be used as an effective teaching strategy for Mathematics as it allows the teacher, to break the content into several parts and then link the parts with one another and creating a particular clarity of thought in the student's mind. The students will find a topic or a concept interesting if the teacher links the unknown with the known or if they could find it in resonance with the previous knowledge. They find relation among the previous and new knowledge. This helps them to see a topic or concept as a sum total of subtopics and not separate and isolated ones. At the end of the teaching process of the topic, the concept map will also be used for evaluation or revision. With the help of concept map, children are able to identify logical sequence and connection between subtopics and hence learn with clarity and without confusion.

To justify her believes; the author first discusses the concept of concept mapping to her B.Ed. students and then she asked them to teach at least one topic of mathematics with the help of it during the practice teaching. The objective of this assignment is to explore the practical implication and the effective use of concept mapping in teaching, learning and evaluation of students in the subject of mathematics. Although, the success of class depends on many factors other than teaching methodology, the teaching methodology being prominent requires much attention and innovation as well. The following is a practical example of teaching the topic of 'Mensuration' to Class VIII students has been done during the teaching practice of B.Ed. course at the "Shafeeq Memorial School" by a student named Nasir Hassan. He planned his lesson in the following manner and then taught accordingly.

Topic: Mensuration

Sub Topics: The unit includes the following sub topics;

(i) Let us recall

(ii) Area of Trapezium

(iii) Area of general and special quadrilateral

(iv) Area of polygon

(v) Solid shapes

(vi) Surface Area of Cube, Cuboid and Cylinder

(vii) Volume of Cube and Cuboid

(viii) Volume and Capacity

Number of proposed Lesson: 09

Time duration of each Lesson: 35 minutes

Previous knowledge

After going through the syllabus, it was found that the unit is based on the concepts taught in previous classes such as;

Class VII:

Chapter 8; Triangle and its properties
Chapter 11; Perimeter and Area
Chapter 15; Visualising Solid Shapes
Class VI:
Chapter 5: Understanding Elementary Shapes
Chapter 10: Mensuration

Key Words of the Topic

Plane figures, Solid shapes, Area, Perimeter, Volume, Surface Area, Triangle, Quadrilateral, Parallelogram, Rectangle, Square, Circle, Cylinder, Cuboids, Cube

TEACHING-LEARNING STRATEGIES

We can teach the topic 'Mensuration' effectively with the help of concept mapping. This concept involves the above mentioned sub concepts. These sub concepts, if not all, by large are related to each other. By using this relationship, we can teach Mensuration to the Class VIII students with the help of concept mapping. The flow of the teaching can be in the following form—

We can divide the whole chapter Mensuration for Class VIII in three phases—

1. In the first phase, we will introduce the term Mensuration and what factor distinguishes plane figure and solid shapes etc?
2. In the second phase, we will discuss the various plane figures and their area.
3. In the third and the last phase, we will discuss about the solid shapes and relation between the parameters of solid shapes (such as volume) and plane figure (such as area).

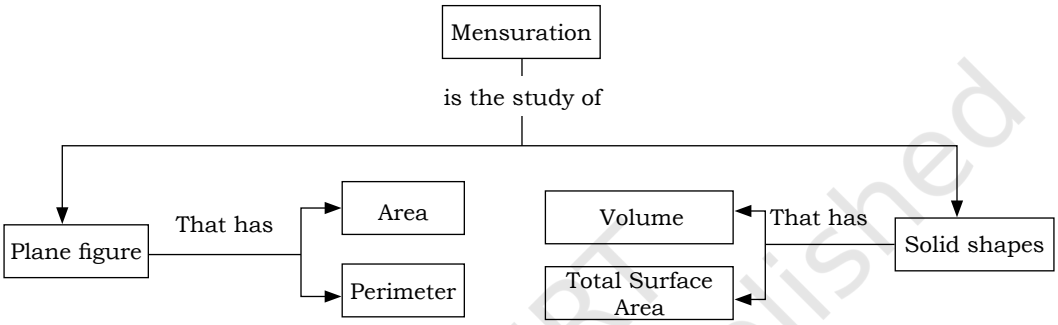
We can discuss all these three phases in following manner.

LESSON 1: INTRODUCTION TO THE TOPIC

- In the first lesson we will introduce the students with the name 'Mensuration', that, in our daily life, we come across many situations in which we need to 'measure the spread' of a given shape like wrapping a gift, carpeting the floor, painting the walls, putting up wall paper, making furniture, setting cloths in the cupboard, lace for chunnis or border for sarees, making a box for biscuits or sweets etc.
- In the next step, we will make the students make difference between the plane figure and the solid shape, that a solid shape must have a height. To clear this concept we will use the cut-outs of rectangles or circles (i.e., plane figures) and put them on each other to make cuboids or cylinder (i.e., solid shapes).

- Then, we will discuss the parameters with which we can specify the plane figure and a solid figure i.e., the concepts of area and volume, perimeter and total surface area and their relationship with plane figures and solids.

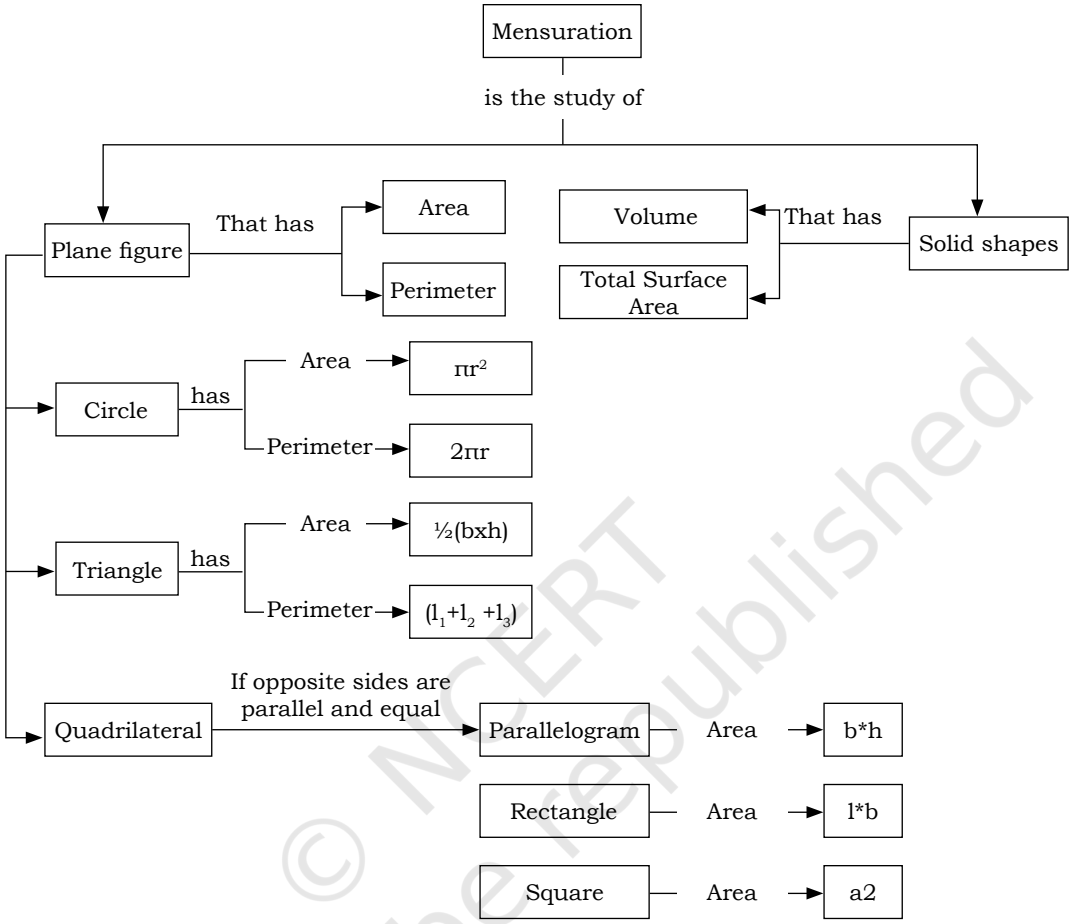
In the final step, we will link the concepts with the help of following concept map for the students so that they can have a foundation for the next lesson and basic layout of the concepts in the form of map.



LESSON 2: LET US RECALL

In this lesson, first of all we will discuss only the concept of basic plane figures leaving the solid shapes and will ask the students to recall the different plane figures that they have learned previously.

- We will classify the plane figures based on the sides they are made up of. Such as there are three sides in a triangle, four sides in a quadrilateral and we will place the figures that have more than four sides under a topic polygon and a separate section for circle as it has no side.
- Next, we will ask the students to recall the general area and perimeter of triangle and of circle and then we will add the blocks for the circle, triangle and area and perimeter of circle and triangles in the concept map.
- Thereafter, we will discuss the different quadrilateral such as parallelogram, rectangle and square, and the relationship between each other. We will again put this entire concept in the blocks and will link them with the previous concept map and it will look as follows—



Lesson 3: Area of Trapezium

In the third lesson, we will discuss the area of a trapezium. As we know that, the trapezium is also a quadrilateral and we can find the area of a trapezium as the area of general quadrilateral as well. However, we will discuss the area of trapezium separately as sum of the area of triangle and rectangle and we will derive the formula for area of a trapezium as the sum of the area of its constituent rectangle and triangle.

Lesson 4: Area of General Quadrilateral

As per the textbook, the area of general and special quadrilateral need to be discussed in detail we will assign one complete lesson each to the area of general and special quadrilateral.

- First of all, the students are encouraged to draw various quadrilateral and then we will ask them to visualise the quadrilateral as a sum of simpler plane figures such as rectangle and triangle as

students are supposed to know about the area of triangle and rectangle.

- Then, we will discuss the area of general quadrilateral in terms of two constituent triangle and with the help of students we will derive the formula to find out the area of general quadrilateral.

Lesson 5: Area of Special Quadrilateral

- The basic difference between the general and special quadrilateral (Rhombus) is that in special quadrilateral the opposite sides are equal as well as parallel and the interior angles are not at right angles but in the general quadrilateral the sides may or may not be same and they may or may not be parallel.
- We will make this distinction clear to the students and we will proceed to find out the area of special quadrilateral starting with the area of general quadrilateral.

Lesson 6: Area of Polygon

- In this lesson, the students are encouraged to visualise the polygons as made of up quadrilaterals and triangles and to find out the area of same using the area of triangles and quadrilateral.
- We will put this entire concept in the blocks, during the course of each lesson, and will link them with the previous concept map and it will look as shown in the next page.

Lesson 7: Solid Shapes

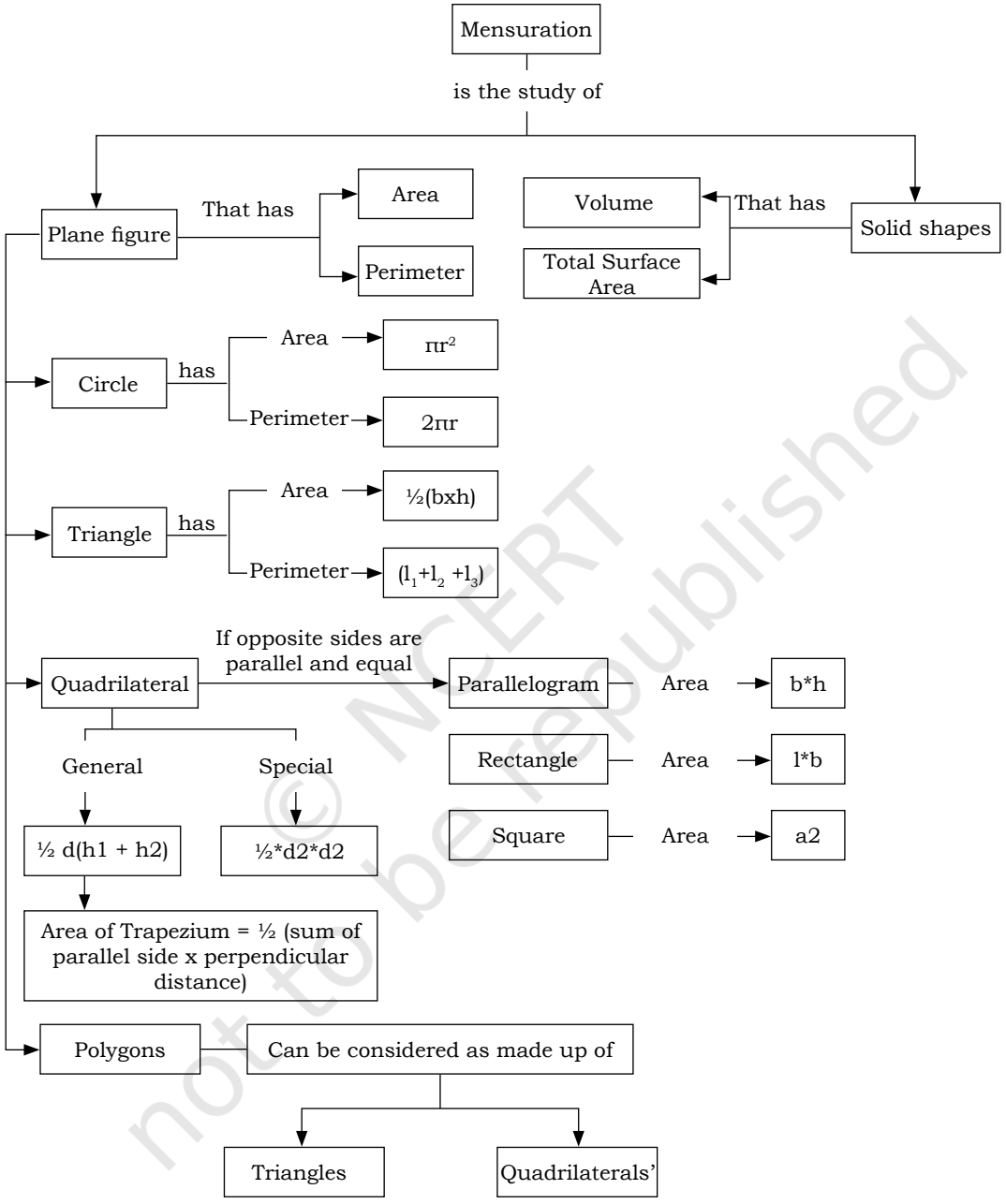
- After completing the plane figures section, we will start the solid shapes section, before starting the solid shape section we will assign one lesson in which we will show how can we create solid (3D) out of the plane figure (2D shape)
- Which plane figure resembles a solid shape when we look at it from different sides, and
- Shape of different objects from day to day life, of which we may need to find the volume or the total surface area, such as pen, pencil, instrument box, briefcase, cakes etc…

Lesson 8: Cylinder

- After showing the student, how can we build a solid shape out of the plane figure, for example in this case,
  (i) We can build a cylinder with circular discs, or
  (ii) We can build the cylinder with two circular discs and a cylinder.

We will discuss to find the total surface area of cylinder in term of circular disc and rectangular sheet.

- Finally, we will discuss the volume of the cylinder.



Lesson 9: Cuboids and Cube

- In this lesson, we will discuss the total surface area of cuboids and cube. Students will be encouraged to visualise the cuboids and cube in term of plane shapes, in this case rectangles or squares, and to count the number of faces in each of the two solid shapes.
- Next, the student will derive the formula for the total surface area of cuboids and cube in terms of area of squares and rectangles.
- Finally, we will discuss the concept of volume of cube and cuboids.

We will again put this entire concept in the blocks, during the course of each lesson, and will link them with the previous concept map and it will look as follows.

(Note: For the section of solid shapes, we may make use of audio visual teaching aids as well)

Concept Map as an Evaluation Tool

Concept map is not only an effective teaching strategy but it is also an effective evaluation tool for teachers, for measuring the growth of students. It gives an accurate way to evaluate the areas in which the student was not able to grasp the concept clearly. The objectivity in evaluation is also maintained. Students showed positive response in this regard, saying it works as a good aid to memory for revision. It is also good as a lot of things can be said in a few words. Thus, concept map is not only helpful in teaching but also in assessing the learner's understanding of learning objectives, concepts and the relationship among those concepts.

We can make use of concept map as a testing tool as well in;

Formative assessment

In classroom while teaching and drawing, we can use concept map for formative assessment purpose as well. Such as—

- We can ask students to draw the concept map of the lesson of the last day.
- During the mid of the lesson, we can ask the students to draw the concept map for whole of the thing we have learned.
- We can ask the student to draw the various possible concept map or the possibilities for the top we are yet to learn.
- We can ask the students to draw the relation between the different blocks and write the connecting words.

Summative assessment

We can also use concept map effectively for summative assessment as well in the following ways—

- drawing the concept map for a given section;
- fill up the vacant place of formulas;
- linking the different segment of the following map;
- if the concept map is given in the form of numerals instead of

variables, we can ask the students to find the given parameters based on the concept map. For example—

(i) If the area of circle, rectangle, triangle and of other such plane figure is given, we can ask the students to find out the volume of cylinder if we use the given circle and rectangle.

(ii) How many circles and rectangles are required to get desired volume if we wish to make a cylinder of some given volume etc?

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