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TO TEACH**

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## CONCEPT MAP: TOOL FOR ACQUISITION OF MATHEMATICAL KNOWLEDGE DURING LEARNING TO TEACH

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### ABSTRACT

The acquisition of mathematical knowledge can be supported by representing it in hierarchy in the form of concept maps. The network of mathematical knowledge is experienced for prospective mathematics teachers during learning to teach. In this paper the concept map of elementary level algebra is presented showing that how ideas and concepts are connected with the topic, in a well-structured form. Its special fitting as a pedagogical tool for mathematics education is pointed out especially with regard to acquisition of mathematical knowledge. Possible uses of the presented concepts map together with their advantages and limits are discussed. It turns out that concept maps may be the efficient tools for appropriate acquisition of mathematical knowledge.

**Key words:** Acquisition, mathematical knowledge, learning to teach, concept map, mathematical thinking.

### 1. INTRODUCTION

Learning to teach is a complex process that is influenced by a range of factors in which teachers acquire extensive and highly organized body of knowledge. Mathematical knowledge consists of both the knowledge of learning and teaching mathematics. During learning to teach, teachers' knowledge includes both knowledge of mathematics and knowledge of teaching mathematics. Mathematical knowledge has the character of a network, as mathematical objects, i.e. for example concepts, definitions, proofs, algorithms, rules theories are manifold interrelated but also connected with components of the external world. The network character of mathematics may be experienced in the process of acquisition for perspective teachers. The special fitting of concept maps as a pedagogical tool for mathematics education, especially with regard to develop on students' learning, is pointed out and possible advantages are discussed in changing scenario of mathematics education.

### 2. THEORETICAL BACKGROUND

It is well recognized that students' knowledge is influenced by teachers' knowledge. During the past decades, attention has been given to the teacher's mathematical knowledge. Researchers have also focused on prospective teachers' knowledge. Research on teachers' mathematical knowledge for teaching, Lampert (2001) argued on the ability of teachers to deploy a variety of representations of mathematical knowledge in teaching. According to Leichardt (2015) teachers' initial knowledge is gained from their own school experience and from other personal experiences which can be very influential. While different writers have attempted to categorize this knowledge in different ways. Ball (1990) explored the distinction between what mathematics should be known and how it should be organized. Ma (1999) described the "profound mathematical knowledge" held by Chinese teachers including concepts and procedure. Shulman (1986) developed a new framework for teacher education by introducing the concept of pedagogical content knowledge. Shulman believed that teacher education programs should combine these two knowledge bases to prepare teachers more effectively. In 1987 Shulman described seven knowledge bases that identify the teacher's understanding needed to promote comprehension among students but did not mention the aspects of acquiring these knowledge bases that can enhance the teacher's understanding needed to develop comprehension among students and what techniques prospective teachers acquire during their training program.

There is a widespread consensus that mathematics should be experienced by the students in its interrelatedness rather than a collection of rules and facts, especially suited mean for this purpose is to teach them through concept maps. Psychologists introduced concept maps as a research tool, showing in a special graphical

way the concepts are related. This article describes that prospective teachers should learn to represent a mathematical network around a topic in a well-structured graphical way to promote interrelatedness of mathematical concepts in students' learning. Algebra is an important area of mathematics and considered as language used for generalization. Because of generalization and abstraction considered to be a difficult area of mathematics. Empirical research done through this study has revealed that students encounters many problems due to the lack of conceptual knowledge of algebra and might have been the result of learning algebra at elementary level. Therefore, the effort was made to design concept map of algebra. The concept map of elementary level algebra from the Punjab text book board for grade-vi has been designed to show how the ideas and concepts connected with the topic are related to develop on students' mathematical thinking.

### 3. CONCEPT MAPS

Understanding Mathematics is a mélange of knowledge which involves the substantive knowledge of mathematics, knowledge of nature & practice of mathematics and the knowledge of connections. Shakoar, A. (2010) described that a teacher who acquires learning as understanding can develop systematic ways to develop their students' thinking. In theoretical perspective the prospective teachers connect new ideas to prior knowledge for understanding learning, it needs an attitude of mind that views learning as an active, socially shared and constructive process by the learners. Teachers should learn mathematical knowledge to connect prior knowledge of mathematics to new concepts by drawing concept map about the topic in a well-structured graphical way and produce supportive learning environment. Concept map designing demands the conceptual and procedural understanding of the particular topic which require a great deal of understanding mathematical knowledge. In the training program prospective teachers should acquire the knowledge of assembling the topics of content of mathematics, from individual component to the top of the topic. It provides the easiest way to make understanding of mathematical knowledge for the prospective teachers because many ideas of smaller topic are related with the larger. In Figure concept map of sixth-grade Algebra has been designed, showing the interrelatedness of variables, terms, algebraic expressions, algebraic sentences and types of open sentences and the solution of equation. If teachers want students to construct, clarify and integrate mathematical ideas by interacting with their environment, mathematical experiences must be carefully planned. In balance teaching approach, teacher delivers instruction according to the student's level of understanding so that there is no chance of misconception in students learning. Teachers who use balance approach find systematic and effective ways to identify and develop their students thinking (Shakoar, A.2010). Teachers should understand not only how children learn, teachers must guide, not direct, children's learning so that they can construct their own mathematical knowledge.

The focus of recent research into the learning to teach was to enhance prospective teachers' understanding of mathematical knowledge through concept maps, algebra of grade-VI was taken as an example. Secondly, to explore the concept maps as an adequate tool for learning and the mode of acquisition of mathematical knowledge the beneficence of their usage had been investigated. Entekin (2012) reported in a research that teachers may use concept maps to introduce many concepts in mathematics class and may propose ways of integration of the single concept.

### 4. RESEARCH DESIGN

Qualitative research design was used for exploring the knowledge of elementary algebra by concept map. The preference was given to qualitative design because the natural setting is the direct source of data (Frankel & Walled, 2003). In this study the researcher went to observe participants and to collect data in their natural setting. Since this research was intending to enhance prospective teachers' understanding of mathematical concepts for learning to teach, exploring the adequacy of idea of concept maps as a tool and possible uses of it in mathematics education. As Creswell, (2003) supports this idea by saying, "This study is "concerned with the process rather than out comes or product" (P145).

Case study as the research method was adopted; this allowed the researcher to explore the tool for learning mode during the acquisition of mathematical knowledge. A case study is particularistic because it focuses on specific phenomenon such as program, event, process, person, institution, or group.

#### a. Sampling and Sampling procedure

A sample in a research study is a group on which information is obtained" (Frankel & Walled 2006, p92). The participants were from the three campuses of university of education district Lahore. Moreover, other characteristics of the participants were: it included those who were studying in the B.Ed. (General) course; Qualified at least 1<sup>st</sup> semester of B. Ed program; mathematics is imperative in this program; all had a bachelor degree; and had designed fifteen lessons for teaching, at least five lessons on topics of algebra of sixth-grade. These

boundaries led to follow Maxwell's (2016) suggestion of using purposeful sampling when persons are "selected deliberately in order to provide important information that [cannot] be gotten as well from other choices" (p,70).

#### **b. Instrumentation**

To explore the adequacy and usage of concept maps of Algebra, three instruments, questionnaire, check list of class room practice and interview were designed to collect the data from 100 prospective teachers. The questionnaire consisted of demographic characteristics, rating on five point Likert scale and an open ended question for suggestions. The questionnaire included three aspects of mathematical knowledge consisting on sub parts. Modes of acquisition for the aspects of mathematical knowledge were developed in the questionnaire. Classroom practice of pre-service teachers was observed through a checklist. Checklist consisted of 12 questions related to the modes of acquisition of mathematical knowledge. Another checklist of interviews was consisted on the 12 questions related to the modes of acquisition of mathematical knowledge. Rating of responses of the 100 participants from both checklists were taken on dichotomous technique (i.e. Yes=1 and No=0).

#### **c. Validity and Reliability**

Validity of the measuring instrument was established through expert's opinion.

Reliability of the instruments was established through pilot testing of the instrument. The questionnaire was administered to the respondents (5% of the sample) other than respondents included in the sample. To indicate the extent to which the responses on the items within a measure are consistent, internal consistency using Cronbach's alpha ( $\alpha$ ) being the most widely used reliability measure. In the light of the calculated coefficient and the remarks of the respondents, the instrument was improved before launching for data collection. Test of reliability produced an overall alpha value of 0.901, which is considered good for social science research (Field, 2005; Rizvi & Elliot, 2005).

#### **d. Data Analysis**

Collected data were converted into numerical form and then descriptive statistics were used to analyze the data. On the basis of observation taken from questionnaire and checklists of class room practice and interview, the special fitting of concept maps as a pedagogical tool for mathematics education is pointed out especially with regard to acquisition of mathematical knowledge. The adequacy and possible uses of the presented concept maps together with their advantages and limits were discussed.

### **5. DISCUSSION**

On the basis of finding from the class room observation on checklist shown in table 1 and 2, the adequate measures of concept maps as a pedagogical tool for prospective teachers' understanding of mathematical knowledge were drawn as;

- The hierarchical structure of concept maps confirms to the general assumption that the cognitive representation of knowledge can be acquired in a hierarchically structured way.
- Mathematical knowledge may be organized in concept map according to the content of mathematics.
- Concept map resemble on the whole a tree showing links between concepts of different topics in accordance with the interrelatedness of mathematical knowledge.
- Relations between mathematical objects around a topic may be visualized by concept maps in a structured way that corresponds to the structure in mathematics.

#### **Uses of concept map in Mathematics education**

Some of the most important uses of concepts map that might be profitable in mathematics education are listed below.

- Concept map helps to organize information on a topic.  
The special structure of concept map allows organizing hierarchically structured Mathematical knowledge. A clear concise overview of the connectedness of mathematical objects around a topic supported the learning with understanding during acquisition.
- Concept map facilitate meaningful learning.  
Concept map may facilitate the problem solving abilities of prospective teachers and aided as a tool for organizing and understanding mathematical knowledge.
- Concepts map a powerful tool for developing on students' learning.  
This helps the teacher to plan effective lessons by taking into account what a learner already knows.
- Concept map may serve as a memory aid.



Acquired knowledge by pictorial representation of concept map may be grasped at once, and due to its unique appearance committed well to one's memory and recalled faster.

- Concept map may be used for revision of topics.  
At the end of a topic a prospective teacher can construct a concept map, as repetition and in order to get a lasting and well organized overview of this topic.
- Concept map can be used as design of instructional materials  
Concept map useful tool for prospective teachers to organize a lecture on a topic and aided in planning instruction to increase their own understanding of the subject matter.

#### Limitations

- It has to be considered that designing of concept map demands efforts that needs deep understanding of mathematical knowledge.
- It may sometime have the confusing effect for those who are not mathematically equipped.
- Concept map is an individual's graphical representation of topics. As different people have different associations with the same topic they also draw different maps. The rights grasped of the relations represented in map afford the right associations to the used key words.

#### 6. CONCLUSION

The knowledge of mathematics includes the concepts, facts, and the relation among them, also their acquisition requires the conceptual and procedural knowledge. Conceptual knowledge is rich in relationships. It can be thought of as a connected web of knowledge, a network in which the linking relationships are as important as the discrete pieces of information. Hebert & Lefebvre, (1986) defines, a piece of information is part of conceptual knowledge only if the holder recognizes its relationship to other pieces of information in the form of concept map.

Algebra is significant as a part of Mathematics that its foundation must begin to be built in the very early grades. For relational understanding the concepts of Algebra and use of Algebra as a tool to use it in real world situations it is important that the teachers should develop students' algebraic thinking. Conceptual understating of the interrelatedness of the topic in Algebra, must be incorporated throughout the entire Mathematics curriculum which is shown in bar graph.

Since concept maps were not invented as educational tool during learning to teach mathematics, but it turns out that concept mapping may be useful for the enhancement of prospective teachers' mathematical knowledge. Concept mapping have been rarely used in mathematics education. However, feedback from the prospective teachers in training of algebra was full of enthusiasm.

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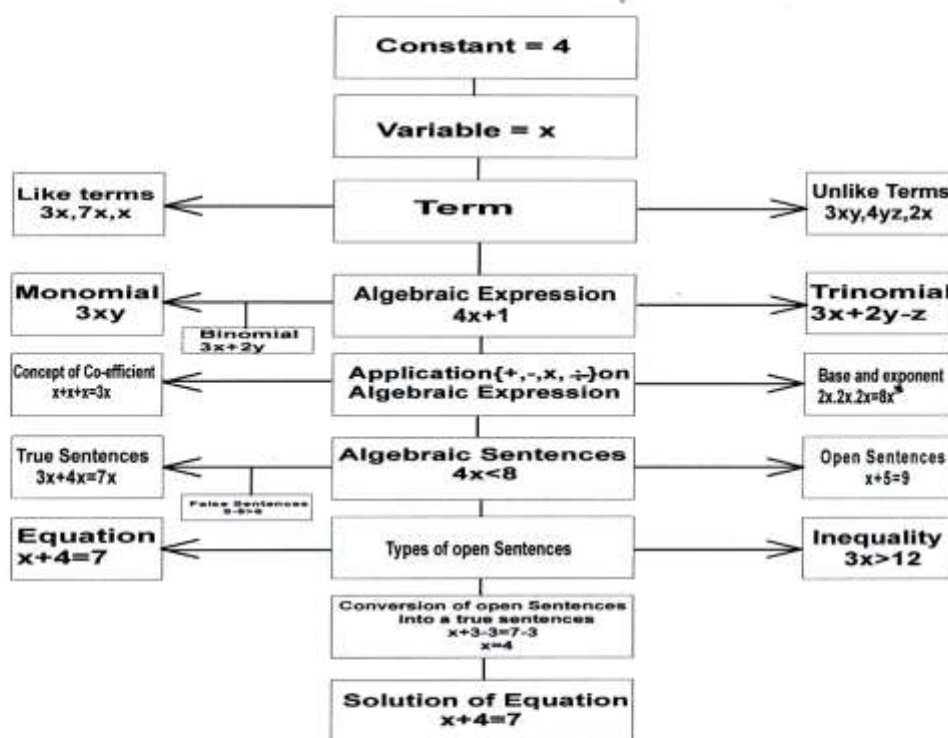
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**Concept Map of Algebra For Class - VI**



**Analysis of Checklist of Interviews for Modes of Acquisition****Table 1**

Frequency and percentage of information obtained through interviews of Prospective teachers during teaching of Algebra at Elementary level (N = 100)

Sr.#	Modes of Acquisition	f	%
1.	Would you think that concept maps are the connection to prior knowledge which helps in understanding a particular topic of teaching of algebra (e.g. Exponent and Base)?	72	72
2.	Would concept maps provide opportunity to think about topic of Algebra helps in understanding?	56	56
3.	Would concept maps work as connection to concrete model to inculcate the understanding in teaching of Algebra?	79	79
4.	Would concept maps provide activities to focus on topic which inculcate understanding for teaching of Algebra?	80	80
5.	Would you like to use it for definition of concepts (e.g. Exponent and Base) to increase understanding for teaching of Algebra?	65	65
6.	Would you think by using it can create examples for the definition of concept inculcates understanding for teaching of Algebra?	63	63
7.	Would concept maps can inculcate the understanding the concept of Exponent and Base.	68	68
8.	Would you think by giving examples about the concept of Exponent and Base make the concept more understandable?	79	79
9.	Would you use it as estimation techniques to help in understanding procedure?	64	64
10.	Would you think the use of concept maps in representations can inculcates understanding about procedure of topic of Algebra?	69	69
11.	Would you think that it is helpful for the use of rule about the procedure helps in understanding for teaching of Algebra?	70	70
12.	Would you think that it is helpful to elaborate the procedure which inculcate the understanding about procedure of topic for teaching of Algebra?	79	79

**Analysis of Checklist of Classroom Observations for Modes of Acquisition****Table 2**

Frequency and percentage responses on checklist for classroom observations of Prospective teachers, about the adequacy and usage of concept maps. (N=100)

Sr.#	Modes of Acquisition	f	%
1.	Concept maps are the connection to prior knowledge which helps in understanding a particular topic of teaching of algebra (e.g. Exponent and Base)	68	68
2.	Concept maps provide opportunity to think about topic of Algebra helps in understanding.	69	69
3.	Concept maps work as connection to concrete model about the topic which inculcates the understanding of Algebra.	74	74
4.	Concept maps provide activities to focus on topic are helpful in understanding.	81	81
5.	Use of definition of concepts (e.g. Exponent and Base) is helpful for understanding.	70	70
6.	Create examples for the definition of concept inculcates understanding.	74	74
7.	Use of Manipulative activities inculcate the understanding the concept of Exponent and Base.	65	65
8.	By giving examples about the concept of Exponent and Base make the concept more understandable.	77	77
9.	Concept maps can be used for estimation techniques helps in understanding procedure.	64	64
10.	Use of concept maps for representations inculcates understanding about procedure of topic of Algebra...	68	68
11.	Use of concept maps for rule about the procedure helps in understanding.	70	70
12.	Ask questions from concept maps inculcate the understanding about procedure of topic of Algebra.	76	76



Preferences of interview and class room observation of Prospective teachers on concept maps

