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The Impact of Using Conceptual Maps on the Development of Creative Thinking of Students

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Abstract
The topic of this study will be the impact of using concept maps on the development of creative thinking of students. This study needs to be conducted because of the stimulation to examine the aspects of incorporating concept maps in teaching mathematics, as well as show the effect on the creativity of students. This paper will demonstrate the ways and techniques of concept mapping in teaching mathematics to help in motivating students for innovation and creativity inspired and influenced by the comprehensive meaningful learning.Concept maps serve the education process in introducing measurement tools to assess learners and access their issues in the knowledge representation and conceptualization. Concept maps by graph of nodes and relationships can represent the concepts for any given domain as well as to measure the declarative knowledge of individuals. Concept mapping is beneficial tool in teaching mathematics. The results showed the usefulness if incorporating concept map in teaching mathematics and its positive effect on creativity of students.
Keywords: Mathematics teaching, concept maps, concept mapping, teaching methods, creative thinking

1. Introduction

Concept mapping tools involve variants known under other names: argument mapping and mind mapping. Concept maps use diagrammatic and graphical relationships showed in verbal description not just words. These structured diagrams present comprehensive and clear illustration to facilitate the understanding of sophisticated topics like mathematics (Davies, 2011). The way of showing and presenting content using various diagrams and graphics is called a concept map (Baralos, 2009).

Concept maps enable students to absorb the concepts, the domain they belong to, and the relationships among them (Davies, 2011). The essential role of teachers is to present their suggestions and comments of the explanations showed in a concept map (Mwakapenda, 2003). According to Simper, the use of concept maps can lead for creative development and clear creative communication (Simper, 2014).

A concept map may come in the structure of a hierarchical tree with super-ordinate and sub-ordinate relations to show the primary, secondary, and tertiary ideas. The root of the tree normally is a concept, word, or phrase that contains an important question need to be answered (Davies, 2011).

In traditional learning and teaching of mathematics, the instructional strategies that the teachers use often reveal low achievement of learners. The presentation of course material or lesson content is a major problem faced by teachers, instructors, and professors although of having many years of experience (Baralos, 2009).

The scholar community is interested in concept map strategies as diagnostic tools instead of traditional tests used in the process of evaluation student's learning (Sultan, 2014). The presentation of course material or lesson content is a major problem faced by teachers, instructors, and professors although of having many years of experience. The change of the material content is hard but the way that it is presented in can be flexibly changed (Baralos, 2009).

When schools use concept maps in the classrooms, they will open the opportunity of having a dynamic, effective, and interactive education. This also allows the students to be more creative not just passive listeners and learner.

1.1 Theoretical framework

The motivation for the conducting this work and evaluating concept maps in teaching mathematics came from the main goals of education. Concept map is a powerful tool that is used to facilitate meaningful learning and to help in organizing and structuring knowledge.

Figure 1 shows the difference between rote learning and meaningful learning with respect to creativity. To foster meaningful learning and separate it from rote learning, concept maps is one of the most fundamental goals. Concept map meets the conditions of meaningful learning by integrating to enhance meaningful learning by introducing content in clear way supported with examples.

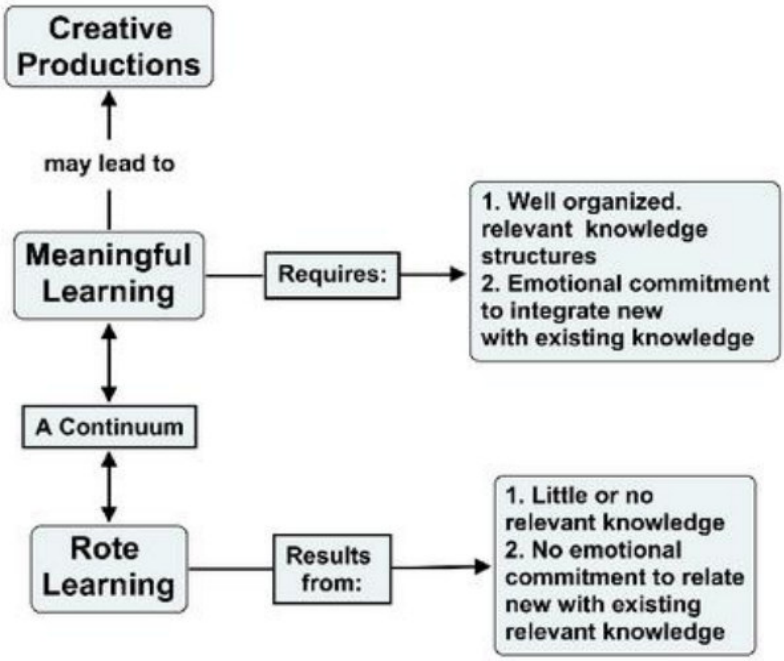

Figure 1: Learning can be highly meaningful to rote learning (ALshammari, 2015).

The purpose of this narrative study is to understand, describe, and develop a concept map framework for the teaching mathematics. At this stage of research, the teaching of mathematics will be generally defined as framework of concept map.

Therefore, this study tries to show the possibility of integrating concept mapping in the teaching of mathematics. It also looks into the ways and methods that can elaborate the process.

The work (Tseng et al., 2013) aimed to investigate the used of concept map in creative problem solving. They suggested that the promotion of student performance can be done though concept mapping. Creative problem solving was given to encourage students in constructing knowledge structure that is visualized by student utterance. Three main issues were discussed in the paper including the quality of student learning affected by the concept map construction, the evaluation of student performance in creative problem solving, and the quality of interaction between teacher and students as well as among students.

The results proved the successful application of creative problem-solving activity was in meaningful high-level learners showed better results in terms of the performance of students when construct concept map. Further, the students were able to initiate better, higher quality creative ideas (Tseng et al., 2013).

The paper of (Flores, 2008) included a review of the current teaching experience at university level mainly in the course of calculus and discussed the use of concept mapping as a teaching tool. Both cognitive and con-cognitive aspects were considered in the review of concept mapping as well as the spatial orientation, logical reasoning and other components of self-concept. The experience of teaching mathematics attempted to show the teaching strategies and the cognitive paradigm of education by introducing a framework for concept mapping in the teaching of mathematics. The activities of teaching mathematics were explained from the perspective of concept mapping to support the learning process in classrooms.

The proposed framework involved an elaboration of the role of teacher to serve the development of mathematical content. The concept mapping of mathematic teaching was supervised by the teacher considering self-concept and graphic representations to get the concepts. The students do an active role not only a passive role to understand the tasks carried out by the teacher that require deep reflection. It enriched the knowledge involvement for teachers, students, technology, and content of material (Flores, 2008).

The paper of (Grevholm, 2008) studied the use of concept maps in the teaching of mathematical concepts. The main goal was to see if the concept maps can serve the research contributions of the conceptual development in mathematics for better understanding of students. The secondary goal was to make sure of the ways can concept maps be useful. The meaningful learning, procedural knowledge, and conceptual knowledge were considered as the most important parts of learning process. The work indicated that the way if studying mathematics influences the development of concepts for both teachers and students.

Moreover, the perception of these concepts might changes the attitudes to mathematics during education and this will impact the outcome of educations. The development and improvement of knowledge for students will contribute in the redesign of education. The author showed that the modeling of mathematics teacher education especially in the form of concept map can professionally identify and show the development of

concepts of the teachers (Grevholm, 2008).

The study (Cañas et al., 2003) is a report and summary of the published literature about the support of concept map to human education and work. The effectiveness of concept mapping was showed in regard of related activities including learning, knowledge sharing, training, performance support, decision making, and knowledge presentation.

More explicit knowledge can progress by the sequence of learning tasks and the development of conceptual frameworks. The relevant prior knowledge becomes easy to remember in any domain of subject matter, and the linking between lessons and their details will be easy to handle and map to the subsequent lessons. Teacher can control the progress of lessons and get the attention of students by motivating them to answer and discuss. Overall, concept map provides an combination of prior knowledge with new meanings (Cañas et al., 2003).

1.2. Research problem

The problem raises from the complexity and the experience requirements. In teaching mathematics, complexity may be higher with respect to the memorability issue. We do not need to fall into the feeling of de-motivation and overwhelming. One more thing, the identification of concepts and the associations in between is not a simple task, but rather it requires a separation of concepts and importance.

This problem becomes more difficult when the material is complicated like mathematical computations that requires the teachers to get feedback of understanding from students (this is called meaningful learning). There have been few qualitative researches that are based on the use of concept map in the education research of mathematics. Therefore, there is a persistent need to investigate the use of concept mapping tool in teaching mathematics.

1.3. Questions

This study is set to answer the following questions:

- What do the concept map in teaching mathematics?
- What is the effect of the incorporating of concept mapping in teaching mathematics on the creativity of students?

Based up on, there is a need for further investigation of the use of concept maps in teaching mathematics and study the leading for creative development.

2. Significance

The importance of concept mapping appeared in the prior research community that attract the attention of interests to invest more researches. Concept mapping enables teachers to show the relational links between related concepts. The findings of this study will be useful for the mathematics teachers by helping them in create new innovative teaching methods of the concept mapping to reveal creativity at students minds.

Hence, this study will explore the effect of introducing concept mapping in the teaching of mathematics on the creativity of students. Further, the results obtained from this study could open the opportunity form further researches in this field to improve the research contributions. This research fills a gap in the current research and literature review of the incorporating concept map in teaching mathematics and its effect on the creativity of students.

3. Contribution

The contribution of this work is to propose an analysis of the existing research of concept mapping, meaningful learning, and creativity. This research can benefit teachers to use concept mapping in teaching mathematics and focusing on content based subjects. Students will be able to realize content, domain, and the relationships by recognizing a sequence of concept maps. Tow concept maps can be generated teacher-generated maps and student-generated maps.

4. Limitations

There are some limitations of this study including the teaching of mathematics; we do not consider the teaching of any subject else. The features of the research scope also create a limit to this research. Specifically, the main limitations of this research are:

- Available research in the field of concept maps, teaching mathematics and creativity.
- Time constraints due to my work commitment.
- The study of mathematics teaching techniques.

5. Definition of key terminologies

This paper set out that the creativity requires problem solving skills, reorganization, and brainstorming.

Brainstorming is one strategy of creativity that encourage students to participate in teamwork activity of problem solving skill (Neira & Soto, 2013).

Concept map is a term refers to the graphical tool used to organize, visualize, and present the lessons' content. In concept map, the concepts are represented in balloons that are connected by lines that represent the description of the relationship between two or more concepts (Baralos, 2009). In another definition, concept map is a graphic tool that enables students to communicate, present, and link conceptual knowledge to build above current cognitive schemata (Simper, 2014).

Creativity, the ability to create, capacity of creation, is activated to create original, smart, and diverse solutions inherited from the human mind based on the mechanism of searching the transformation of the individual's reality (Neira & Soto, 2013).

Alternatively, creativity is the use of the original ideas and imagination to produce artistic work. Vision, inventiveness, innovation, originality, inspiration, and imagination are all synonyms for creativity (Simper, 2014). Creativity refers to the artistic application relating to clarity, interest, novelty, and understanding dimensions.

6. Methodology

Qualitative approach is a wide, general field of using and understanding the way of collecting data like surveys, documents, etc. to answer some questions and to achieve some objectives. In this research, we will expose the factors, reasons, and effects of the use of concept maps in teaching mathematics in schools in general based on the review of current research in that field.

7. Audience

The audience of this research will be the students, teachers and the individuals or groups have the authority in the ministry of education.

8. Results

After reviewing the literature, useful results can be drawn from. The movement from teacher-generated content to student-generated content enables students to visualize and imagine new ideas and get better understanding (Simper, 2014).

To construct a concept map, the learner is required to draw long-term memory schemas to be able handling new information and replace current cognitive structures with new ones. Graphic organization is simpler than concept map construction.

In educational context, affective learning tools of concept mapping are significantly needed for the following objectives (Simper, 2014):

- Learning support: to support learning as individual or group learning activity tool that can display prior knowledge.
- Assessment tool: to provide a method for scoring and assessment that can test the validity and reliability of concept maps.
- Information organization and presentation: to display and organize key concepts for advance planning, ideas connection, and new instruction provision.

Conceptual maps play a critical role in teaching by utilizing them to serve the arrangement of educational modules and directions. The recognition of the concepts in any subject is a major problem shared by many students. Sometimes the assessment is missing from the learning process and some teachers neglect the creation of comprehensive concept structure to make the concepts easy to understand, easy to learn, easy to remember, and easy to link to other concepts (ALshammari, 2015).

According to ALshammari, the learning and teaching strategies should focus on the teaching of skills too, and the teaching of mathematics should be student-centered and based on inquiry instruction. Concept map strategy is used to organize and show knowledge including concepts and relationships (Huang et al., 2017).

Figure 2 shows the most common principles of concept map theory, and it describes the realization of concepts integrated with the experience and knowledge including reflection, ordering, comparison, clarification, and abstraction of hierarchical and conceptual constructions (Simper, 2014) (Alhomaidan, 2015).

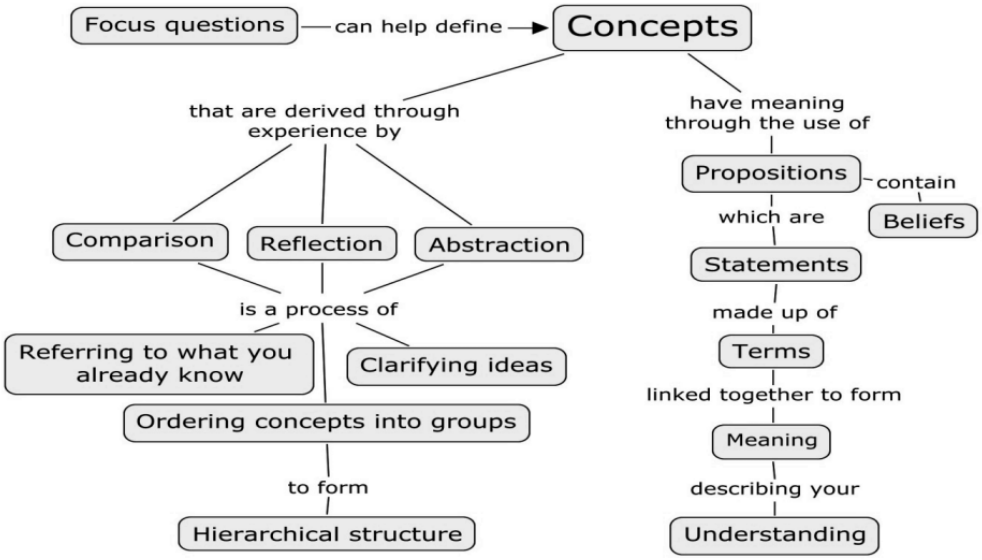

Figure 2: the most common principles of concept map theory

At the root of hierarchical tree of concept map as shown in Figure 1, a focus question could be creative to enrich the process of studying and the corresponding tasks and activities and thus to facilitate the transmission of ideas (Neira & Soto, 2013).

Concept map contains a graphical nodes and links to represent the specification of knowledge concepts and the domain. It shows the semantic knowledge of the relations (ALshammari, 2015).

A cognitive dimension is one of the elements of creativity since it simply starts with integrative settlements to reveal constructed new concepts in a hierarchical structure and encouraged creative relationships between these concept (Neira & Soto, 2013).

The cognitive activities of students can be tested and measured by concept mapping because of teaching mental skills simultaneously with the teaching of mathematics contents (ALshammari, 2015).

To measure creativity, we need to primarily focus on specific cognitive processes including associations creation, broad categories construction and combining, divergent thinking, and simultaneously working on multiple ideas. Creativity tests or measures also can measure motivation and other non-cognitive aspects of creativity, and they can be considered as facilitator for flexibility, positive attitudes, tolerance for independence, and other personal properties (Simper, 2014).

Figure 2 shows the different terms that are used in the teaching mathematics based on concept maps. It includes equations, functions, solutions, rules, instructions, coordinate systems, variables, straight lines, matrixes, etc.

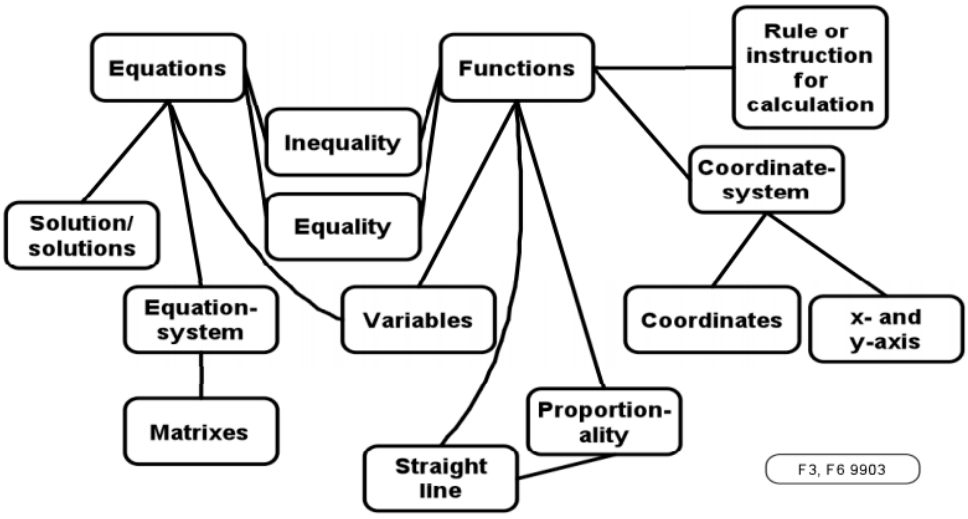

Figure 3: The first concept map of function (Grevholm, 2008).

The creative process in the regard of teaching methodologies is a favor for the creation, discovery, and training new concepts. Moreover, the ability to mediate the content considering the changes on the conceptual structures based on the evolvement of disciplinary knowledge. The student must learn to deal with not only

solving the situations with a particular solution but also the ability to generate problems with multiple possible solutions (Neira, & Soto, 2013).

The effect of conducting concept map strategy in the development of creative thinking of students will enhance the skills of students as well as the teacher will make sense of many advantages of incorporating concept map in education. The students will be ready to learn new concepts, participate in the activities, and enjoying in answering (ALshammari, 2015).

To build the concept of creativity and to promote the creativity to the students, some techniques can be used and some definitions have to be known by the experts (Neira & Soto, 2013).

9. Discussion

The correlation between concept map and the development of creativity is still an emerging research problem. Literature review showed the possibility of developing new research to discuss these points.

Interactive learning and meaningful learning throughout the classrooms assists in the development of application and comprehension of content and material presented to the students. The concept map could contain presentations, pictures, scans, videos, documents, internal links, spreadsheets, and many others.

Student can observe, thought independence, discuss, conclude, deduct, and establish relations between concepts. Additionally, student can make decisions based on his/her experience through the use of concept maps. They are called active learning or meaningful learning that include the employment of knowledge in problem solving, the support of creativity, and the development of inventiveness. Furthermore, the extended time consumed by intervention influences the results of the creativity and better performance of students.

Students can be creative and think in creative way in their courses. Problematic situations require students to think in different ways of analysis and proposing solutions. Concept map applies this and transforms the environment of learning to enforce creativity in classrooms for more flexibility in presenting content rather than repeated tasks and procedures that affect the ability of students to generate ideas and then the outcomes of education (Sanchez, 2012).

Principally, the creativity of students can be improved and students will be able to think outside of the box. The teacher can add, change, or remove input from the concept map showed to the students; the concept map is flexible and dynamic.

The relation between concept map and creativity needs to be illustrated here. A creation of narrative plan is like creative writing. The relationship between concept mapping and creativity appears in the elements that allow visualization (transformation) of connections among creativity and meaningful learning. The ability to transform learning to various contextual states to easily uncover, understand, and transfer the solutions is evidence of the meaningful learning (Neira & Soto, 2013).

9.1 Mathematic teaching

Concept map is flexible enough to investigate many aspects in the student learning of mathematics (Mwakapenda, 2003). The hierarchical structure of concept maps is helpful in teaching mathematics since any computational and mathematical equation is resolved based on following structured sequenced steps (Straubel, 2006).

Mathematics teaching should play a crucial role in the development of conceptual and procedural knowledge. Further, the meaningful learning of mathematics does not need only to have knowledge in the subject matter with respect to the concepts and procedures used in, but also it requires sufficient relationships between several concepts to reveal the right created mathematical meaning (Baralos, 2009).

Various ways of representation of information, knowledge, and practical examples in mathematics are applied by concept maps. For example, the calculations in mathematics can be shown in clearer way by presenting complex rules in a spreadsheet to represent these rules. The knowledge behind each rule can be represented also into another concept map (Cañas et al., 2003).

9.2 Mathematic teaching with concept maps

Meaningful learning is fully adopted by creative thinking and when incorporating concept maps, the student can find and solve problems as well as construct concept maps during the mapping process (Straubel, 2006).

One of the main faced problems in employing concept maps in teaching mathematics is that mathematics teaching pays a small attention to the presented mathematical concepts structure. Consequently, the relationships among the concepts cannot be augmented with the mathematical knowledge and skills of students since the teachers and textbooks cannot provide all probable relationships.

The teaching of connection or relationship also leads to not fully achieve the problem solving, proving, reasoning, and mathematising skills. Therefore, the students have to construct their own ways to express the relationships among different concepts regardless how many formulations there are (Mwakapenda, 2003).

10. Conclusion and recommendations

In conclusion, concept maps serve the education process in introducing measurement tools to assess learners and access their issues in the knowledge representation and conceptualization. Concept maps by graph of nodes and relationships can represent the concepts for any given domain as well as to measure the declarative knowledge of individuals. Concept mapping is beneficial tool in teaching mathematics. The results showed the usefulness if incorporating concept map in teaching mathematics and its positive effect on creativity of students.

Concept mapping and creativity affect each other and provide many advantages to students and teachers. The benefits for students and teachers can be gained based on the following recommendations:

- The teacher should make concept maps improve concept construction and clarify misconceptions.
- The teacher should make concept maps serve meaningful learning and active learning.
- The teacher should make concept maps involve clear logical connections between concepts.
- The teacher should make concept maps create solutions based on knowledge.
- The teacher should make concept maps organize and visual format and grouping of thoughts.
- The teacher should make concept maps categorize information and support critical and creative thinking.
- The teacher should make concept maps adopt problem solving, brainstorming, and communication skills.
- The teacher should make concept maps improve and enrich the experience.

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