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THE CONCEPT MAPSAS A TOOLTO EVALUATE HOW TO PRESENTCONCEPTS INTEXTBOOKS

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Abstract

Textbooks should be designed in such a way that students achieve the discovery of relationships between concepts. In fact, when preparing learning materials, educational experts must prepare the conditions in such a way that at least pursuing students are able to achieve meaningful learning goals in this paper, we intend to investigate the method of writing a textbook by depicting conceptual maps. It seems that if we can depict a concept map by observing the method of arrangement and commitment tothe kind of relationships that are intended for students within the context of textbooks, we could access the knowledge organization of authors of the book in the desired topic. We believe that concept maps can be used as a tool to evaluate how to present concepts in textbooks. In this article, in addition to training steps of depicting a standard concept map, we specifically attempt to evaluate the writing style of content of textbooks in our country on the topic of basic electrostatic by conceptual maps.

Keywords

Physics Education, Thinking Approach Of Textbooks, Meaningful Learning, And Concept Map

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1. Introduction

Depicting concept maps was first proposed by Novak in the United States. This idea had been designed based on the psychological perspective of David Ausubel. The main idea in David Isobel’s theory of meaningful learning is learning through linking concepts and new topics to the concepts and topics contained in the conceptual framework of a learner (Shu-Nu Chang 2007). From then on, professor Novak made all his efforts to explain and apply this idea to the educational processes. Further studies showed that conceptual mapping can be utilized as a proper tool in achieving educational goals for curriculum development, training, following up the process of learning, evaluation, showing the student's prior knowledge, summarizing the learned material, note-taking, helping to study, scaffolding, increasing understanding, establishing educational experiences, teaching critical thinking, supporting collaborative learning and organizing content along with other methods (Cañaset al. 2007 - Kinchinet al.2000 - Hay et al8002.).

With conceptual maps, information and concepts can be collected in a summarized note taking, without main points and fundamental concepts to remain unconsidered. Visual presentation allows students and teachers to realize information without dealing with lots of words and word combinations. In this method, the concepts are usually in closed circles and with related communication lines, and the type of communication between the surrounding concepts is specified using communicative words. A concept map consists of concepts that have been efficiently linked together with appropriate communication words. In general, it shows us how the concepts together make sense(Novak et al. 2006).The smallest meaningful unit of a conceptual map is a proposition which contains two related concepts that are related to each other using a communication words (Shu-Nu Chang 2007).

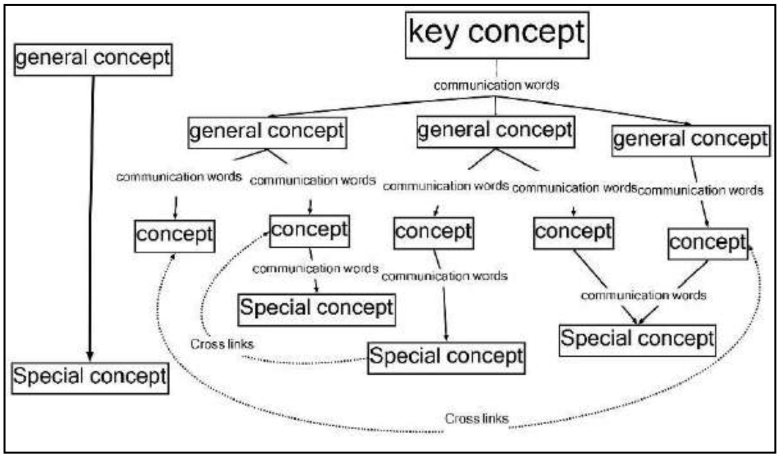

Figure 1: *explaining the structure of concept mapping*

2. The importance of meaningful learning materials

Kinchin et al. (2000) released a completely different approach in analyzing a conceptual map by making some changes in the method of depicting a conceptual map (Kinchin et al.2000). They divided concept maps into three categories of spoke, chain, and network. In this classification, academic achievement is created only when the conceptual framework contained in the structure of student's mind changes from the spoke structure to the network structures and chain pattern represents rote learning (Kinchin et al .2000- Hay et al8002.).

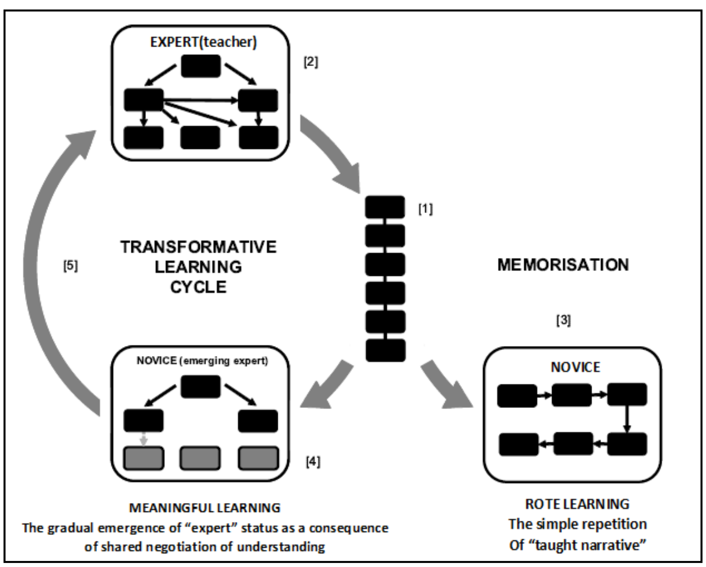

Figure 2: *A model of teaching and learning (Hay ET al*8002 *.).*

Research shows that some teachers tend to use lecture method to present content simply and continuously. This teaching - learning method does not reflect the extent and quality of received understanding by students. As a result, students, rather than being engaged in the construction of new concepts and finding connections between them, often prefer to memorize the taught content(Hay et al8002.).Researchers showed that teaching through using the lecture method for large number of people (in particular) could lead to rote learning. This is because giving a speech requires that teachers turn a complex network of knowledge into a simple narrative and in form of linear chains to be able to express them. These chains are opened during lectures; however, there is often no correct and clear understanding with regard to concepts that are shaped in a student's mind for the first time. Therefore, attentions have been drawn to appropriate delivery through a lecture along with power point method. However, the overall result would not guarantee access to meaningful learning. That is why students choose the chain and rote learning instead of focusing on the relationship between the concepts that arises from a correct understanding. This induces students that the contents have a single answer and rules and regulations should be maintained (Hay et al8002.).

In these circumstances, it seems that the existence of meaningful learning materials can play a significant role in creating meaningful learning in students. As a matter of fact, textbooks should be developed in a way that leads students to explore the relationship between concepts. The realization of this goal requires a careful planning by authors of textbooks. Educational experts, when preparing learning materials, must prepare the conditions in such a way that at least pursuing students are able to achieve meaningful learning goals. Novak considers the existence of meaningful learning materials to be one of the significant factors in the formation of meaningful learning. This means that a learner needs to know that the information he learned today is related to the little information he learned in the past, and new knowledge for a learner must be proportional to the prior learned knowledge and cognitive concepts as well as certain statements (Novak et al. 2006). Educationalexperts can depict a conceptual map from their desired concepts prior to writing different parts of the book, and then set and develop content based on the depicted concept map.

3. How to depict a conceptual map?

The first step in preparing a good conceptual map is to answer this question "How to depict a conceptual map?" Here we are going to train the procedure of depicting a standard conceptual map based on the criteria expressed by Canas & Novak (2008(.

Step 1: to prepare a conceptual map, first asking a central question is recommended. In fact, the goal is to answer the question by putting concepts next to each other. The central question should be asked in such a way that urges the drawer of a map to get to thinking about the relationship between the concepts. He must think about what he knows about the subject. It seems that questions that need to be explained and argued usually lead to a better map. For example, in the context of basic electricity, the central question can be asked in this way: "what do you know about the source of electricity?" or "describe how the property of negative charge (positive charge) is emerged around a neutral atom."

Step 2: identifying key concepts is of particular importance. It is recommended to specify 10 to 20 concepts at this step that are related to the central question, and put and list them in the stopover that is on one side of the page (or the screen in a computer) and then try to sort the concepts out in an initial classification and classify them based on a special issue from the most general to the most detailed concept. However, this prioritization can be changed in each step. In fact, the purpose of this work is to encourage the learner to classify, infer, synthesize and evaluate, and finally hypothesize what he knows. Synthesizing and evaluating are two activities that Bloom considers as the highest levels of cognitive thinking(Bloom 1956).

In this step, you are in the brainstorming condition; thus, to see whether what you have written is correct or incorrect do not stop your mind. Irrelevant things that you have written might later be used or might not be used at all.

Step 3: classify the concepts based on an initial guess. Write concepts that you think are so close togethernext to each other.

Step 4: transferring the concepts from the current hierarchical stopover to a conceptual map and choosing the best linking words to link concepts lead to a greater possibility of combining and linking of relationships between concepts and making good statements. Attempt to answer and explain the primary question by choosing the best linking words and the direction of the arrows towards the communication lines.

Step 5: When the concept map is expanded, trying to add new concepts and to find cross relations between two concepts in different parts of the map will be a very useful activity. Finding cross relations leads to the creation of creative thinking.

In the end, refer to the map in a period of time and attempt to review it each time. Add more comments, thoughts and intentions that constantly come to your mind. Changes in the structure or content and displacing and adding concepts to the map should be done in such a way that results in a clearer map and a better structure of overall building of the map.

4. Depicting a conceptual map based on the context of textbooks

In this section and next section we intend investigate the method of writing textbooks by depicting a conceptual map. It seems that if we can depict a concept map by observing the method of arrangement and commitment to kind of relationships that are intended for students within the context of textbooks (in accordance with the same principles that students comply with when drawing concept maps), we could access knowledge organization of authors of the book in the desired topic. We believe that a concept map can be used as a tool to investigate how to write and examine the relationship between the existing concepts in a textbook.

To this end, the ninth grade physics textbook of our country (titled physics and lab - first grade in high school - academic year print) was selected in the topic of electricity. Sixteen-year-old students are the audience for this book. They have already become familiar with the operational definition of an electric charge and the attractive force between the fabric and the balloon in previous grades through some simple experiments and have seen working with an electroscope. Moreover, they have already made some simple electric circuits. Some of the objectives of teaching electricity in the ninth grade have been shown in the table below.

Table 1.1: *presentation of some goals of teaching electricity in the ninth grade in high school*

Knowledge and skill purposes	Attitudinal purposes
- A student must know the role of an electric charge in static electricity phenomena. - Uses methods of rubbing, contacting, and inducing in charging objects. - Understands the concept of electric potential	- Considers the efforts of physicists regarding electricity to be important. - Realizes the role and importance of static electricity and electric current in life. - Feels responsible for consuming energy and

difference. - Knows the generator as creating a potential difference at both ends of a circuit. - Expresses Ohm's law along with the interpretation of results of experiments and applied it in solving problems.	tries to be thrifty.

After careful study of the above mentioned book on the desired topic and identifying key concepts, selected sentences were put in a table. Then, we depicted the concept map though using the rules of depicting concept maps (which is described in Section 3) and the selected contents in the table above, (Fig. 3 to 8). The result of this activity was depiction of two conceptual maps with the focus on both static and current electricity (Figures 8 and 9). It should be noted that the book does not specifically use the terms "static electricity" and "current electricity" at this grade. Therefore, the central concept of "electricity" has been selected in the both maps. In the end, the depicted maps were reviewed by the consultation of two experienced teachers holding master degrees in physics. Then, we analyzed the finalized concept maps qualitatively. Qualitative analysis of the conceptual map was carried out based on the qualitative proposal of doctoral dissertation by Mr. Majidi at the University of Helsinki, in Finland in the field of comparison of the knowledge structure of it.

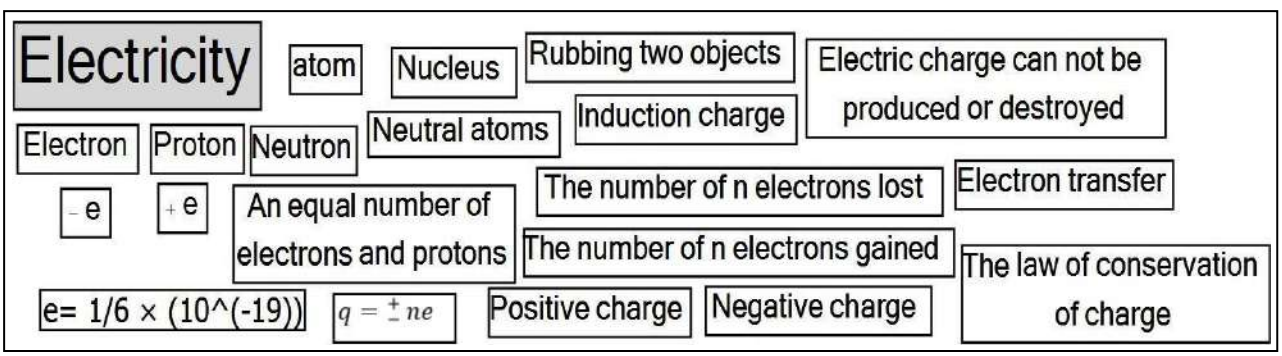

Figure 3: *The first step in depicting a concept map. Writing key words related to the central question, regardless of the relationship between each of them*

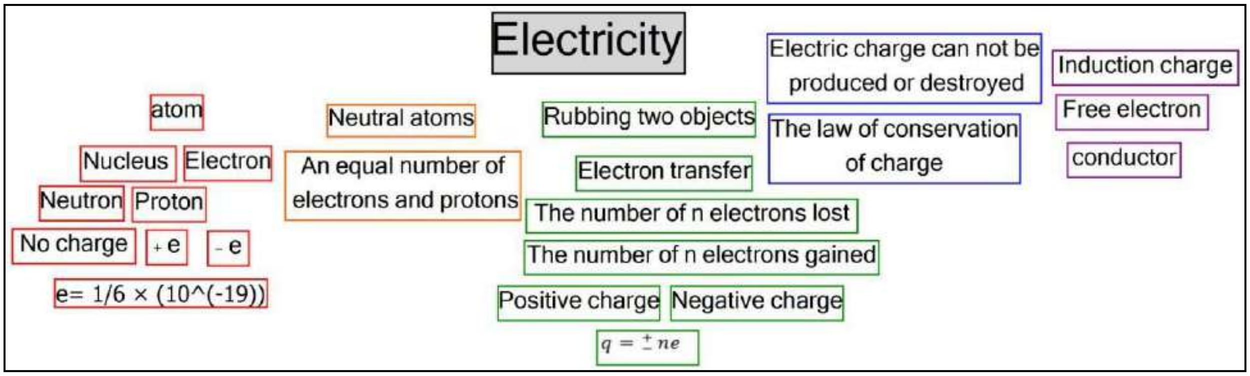

Figure 4: *The second step in depicting a concept map. Thematic classification of key words with observing hierarchy and importance of each of the concepts*

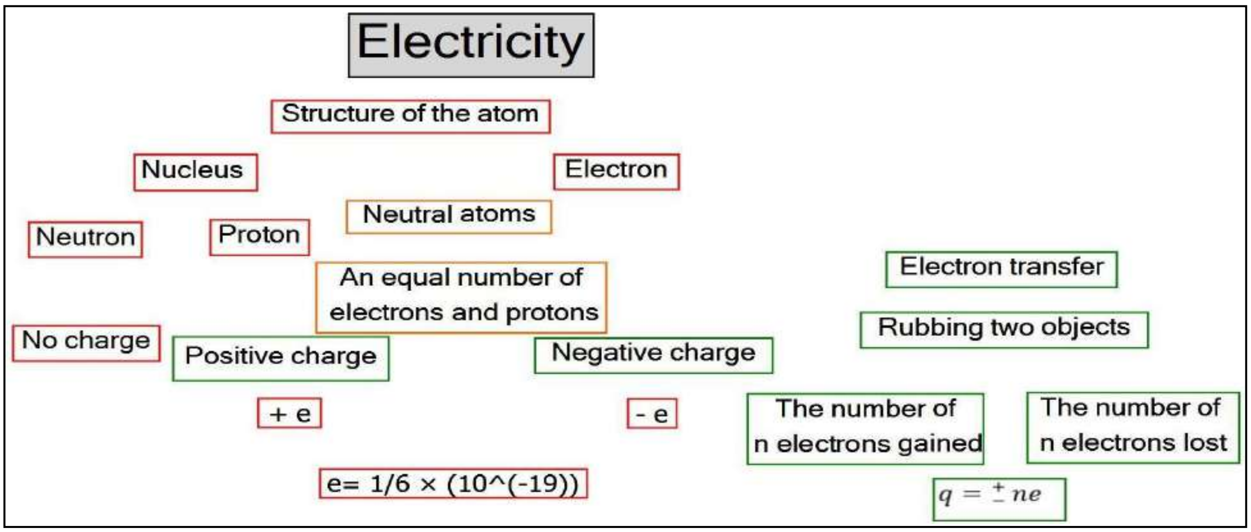

Figure 5: *The third step in depicting a concept map. Transferring concepts from the hierarchical stopover to a conceptual map*

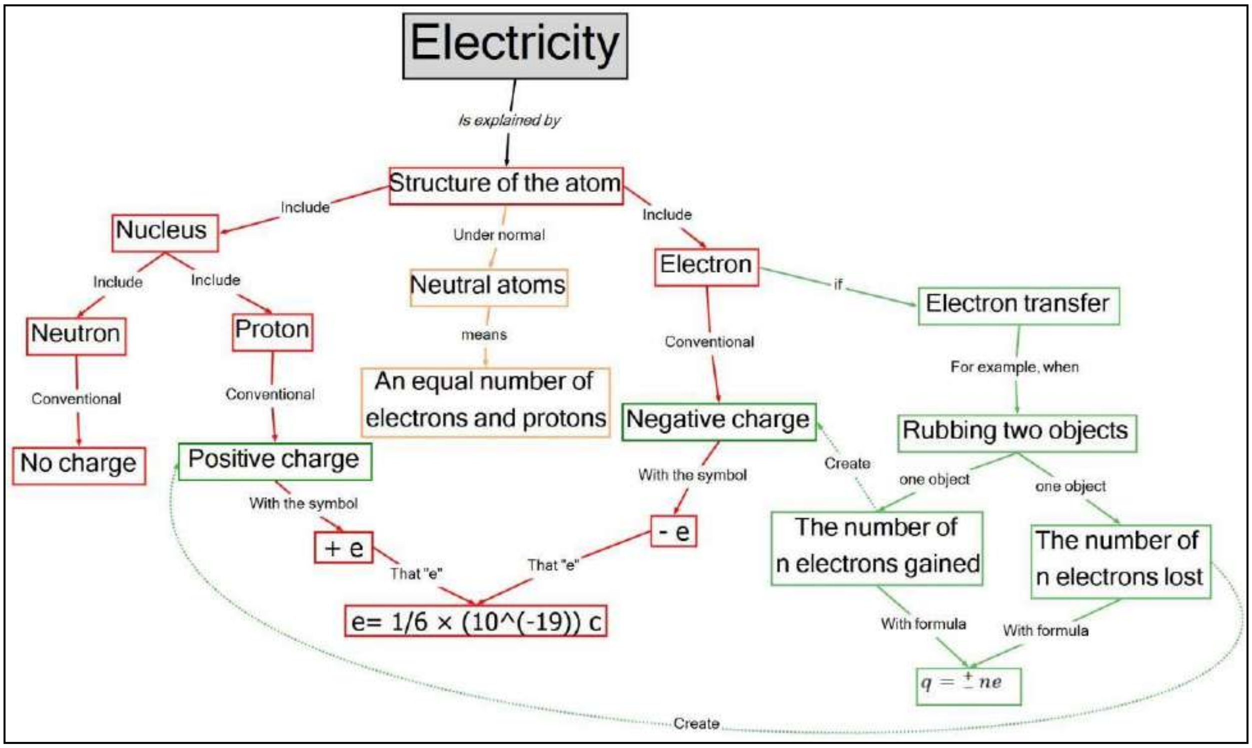

Figure 6: *The fourth step in depicting a concept map. Creating a link between the concepts with appropriate linking words*

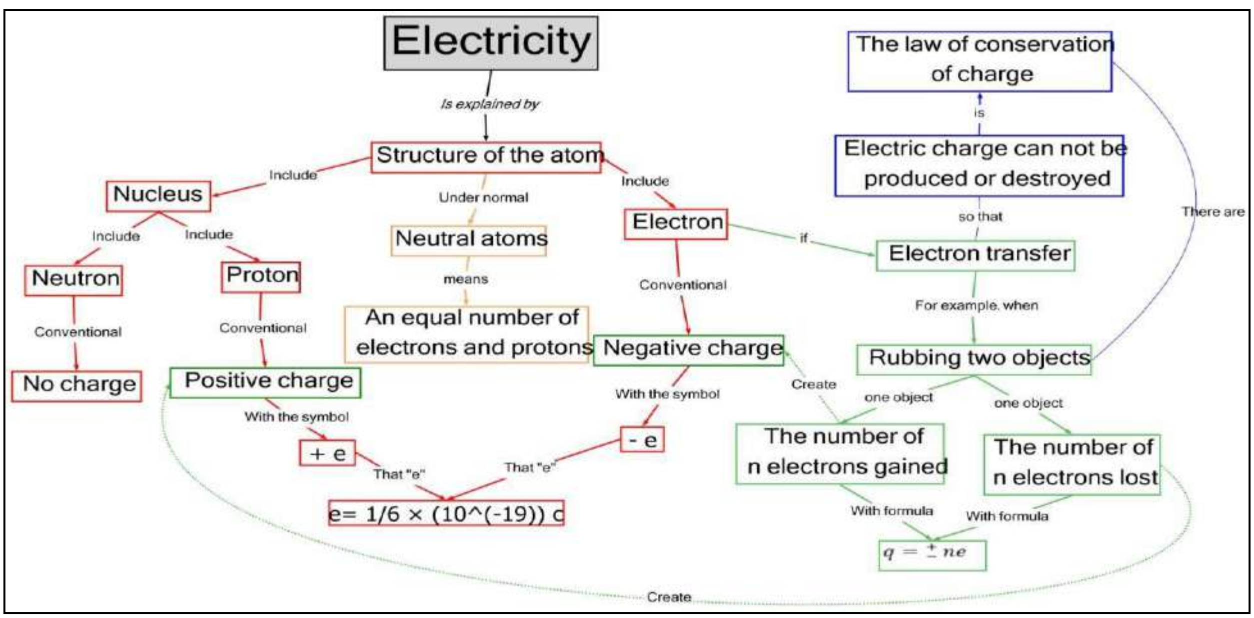

Figure 7: *The fifth step in depicting a concept map. Trying to add new concepts and finding cross relations between two concepts in different parts of the map*

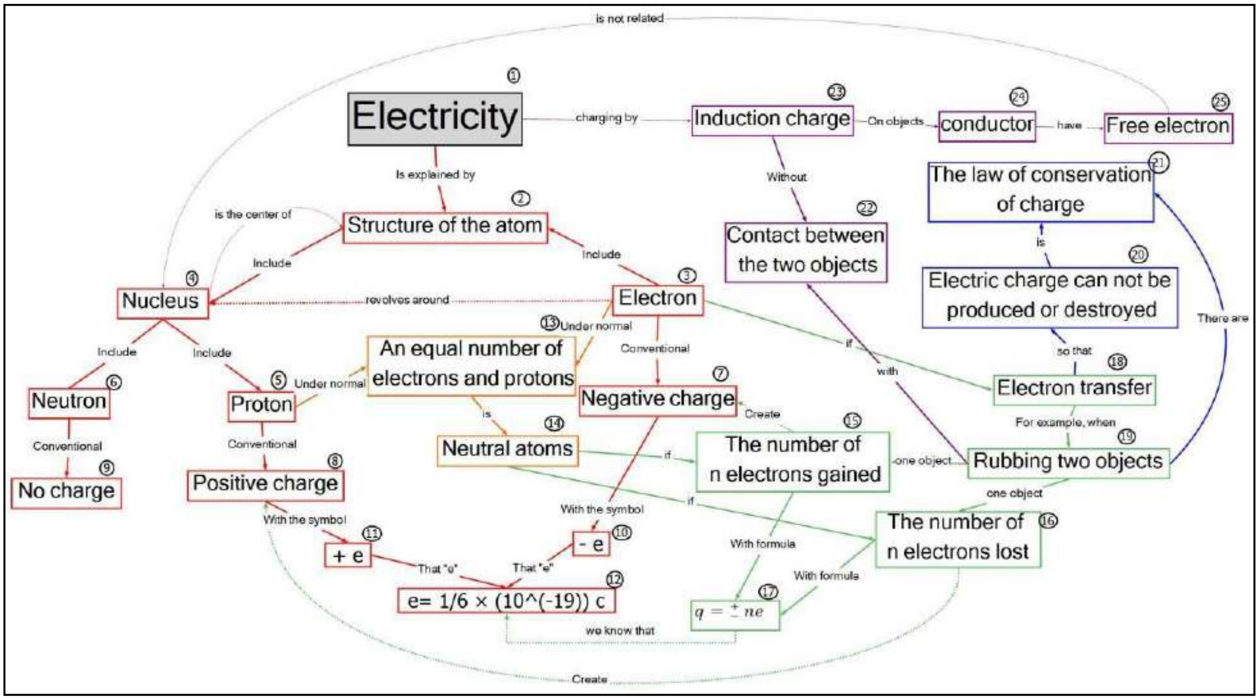

Figure 8: *The step of completing and reviewing the conceptual map. The extracted conceptual map from the topic of static electricity*

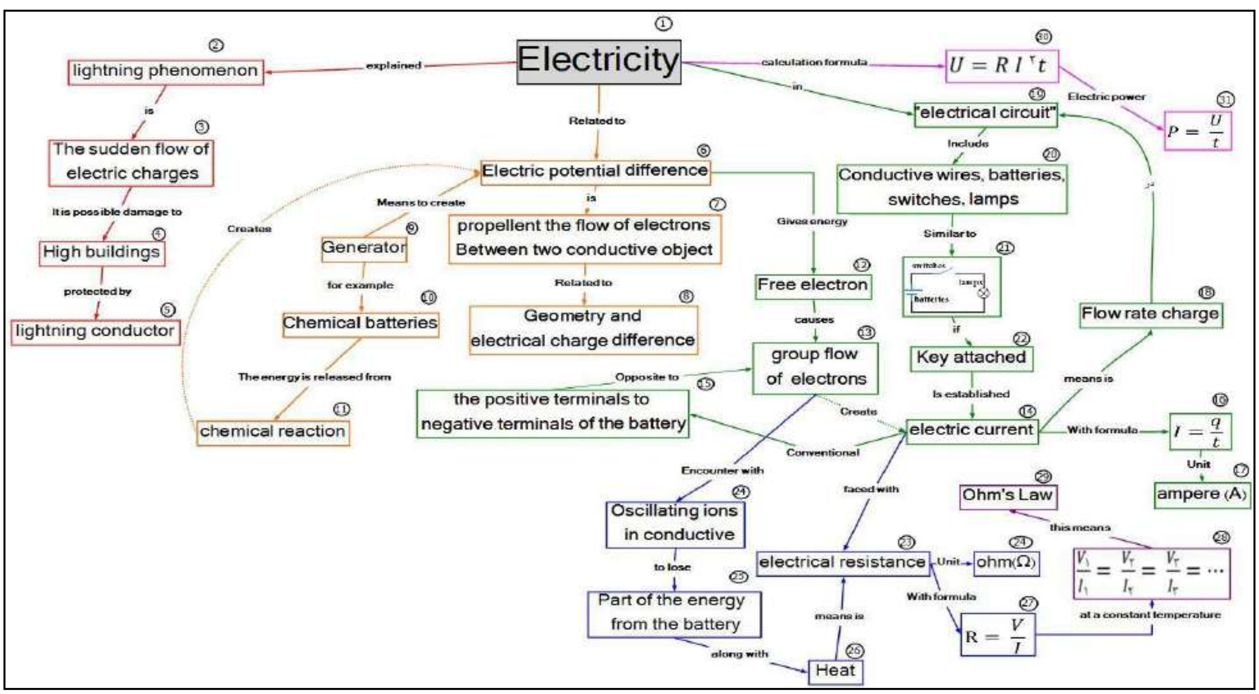

Figure 9: *The extracted conceptual map from the topic of current electricity*

5. Qualitative analysis of concept maps

As it is shown in Figure 8, the conceptual map includes some loops and cycles in the shape of triangle and rectangle. The 1→2→4→9 branch is the only branch that has not been followed and the concepts connection is broken. The textbook authors have emphasized on the key role of electrons in creating electrical loads. According to the above Figure, the electron has one inbound link and 4 outbound links. In addition to explaining the structure of atoms, an electron is directly or indirectly involved in describing the concept of neutral atom, the concepts of negative and positive charges, the disjunction and size of each electrical load. In 3→18→19→15→7and 3→18→19→16→8 branches, it has been tried to highlight how the electrons generate negative and positive charges. The connection of 25 to 4 also shows the way through which the textbook authors linked free electron to the concept of atom structure. The concept of 13 also plays a key role in teaching this textbook. In fact, a detailed description of neutral atom is provided with connecting two branches of 1→2→3→13 and 1→4→5→13.

Comparing positive and negative charges in 1→2→3→7→10→12→11→8→5→4→2 has led to the development of a meaningful ring which is indicative of a visual model from a theoretical concept. It shows how a new concept, i.e. the size of each electrical load (12), can be achieved from two previously-defined concepts of electron (3) and proton (5). The same trend is also observed for comparing the concepts of (23) and (19) with a distinction for the concept of (22). Hence, there is a significant relationship between these 3 concepts. As a matter of fact, the branches show how a concept can be connected to other related concepts. This confirms that the arrangement of the concepts in the branches can demonstrate hierarchical levels and inductive or deductive structures such as knowledge.

Another point to be mentioned about the arrangement of textbook content is that there was no clear relationship between static and current electricity. According to the conceptual maps depicted in Figure 9, it can be observed that the textbook mostly has a deductive (comparative) approach in explaining concepts of this section since there has been no useful attempt in the second concept map to use two concepts in order to introduce the third concept. Once again, consider both concept maps depicted from the textbook (Figure 8 and Figure 9). In this textbook, no tangible relationship has been established among electrical load, and electric potential difference, conductive object, and non-conductive object. Load flow was first referred to describe the lightning phenomenon. Subsequently, no effort has been made to clarify the exact relationship among potential difference, load, and electric current. As it can be observed in the conceptual map of Figure 9, the authors disregarded the topic after defining the potential difference and defines the concept of current through electronic circuits whose operational definition is tangible for learners. Then, summing up the potential difference and current, "resistance" concept is described. This is clearly observable in the conceptual map of Fig. 9.

According to the writing style of the textbook, the question is whether free electrons do not move if there is no potential difference; whether the movement of free electrons always leads to creating currents; what the electric potential is; why we recognize the potential difference as the cause of the load flow? The textbook does not provide a clear answer to these questions. It seems that the textbook authors tend to convince learners that electric potential difference is something like gravitational potential energy and of energy through making an analogy between gravitational potential energy and electric potential difference. Unfortunately, using this writing style, learners do not recognize the difference between the electric potential and electric potential energy. Electric potential is not dependent on the load. Experience shows that most learners at this grade cannot distinguish between what they refer to as "voltage" in the real world and what the textbook refers to as the "potential difference". One of the reasons might be the way of arrangement and expressing contents used in this textbook.

Once again, consider the concept of 25 in the conceptual map of Figure 8. Later in this chapter, the term "potential difference" can be introduced as a factor which purposefully organizes the free electrons' movement and flow through conveying energy to them. With this type of writing style, suitable condition is provided for the introduction of the "electric drive" concept. Perhaps, if the textbook authors had depicted the concept maps before writing the textbook, they would notice this point. We believe that this approach is more deductive and can better explain the relationship between the concepts. It seems that the absence of the "electric field" concept in the curriculum of this educational grade is another reason for choosing this type of writing style by authors. Learners, while learning the concept of "electric field", will further pursue the above discussion over the coming years.

Considering the above mentioned points we suggest that in order to teach a book, we could draw a standard concept map according to the concepts and subjects presented in that book with regards to the relationship and prioritization between concepts. Then, by analyzing the concept map, one could understand in which parts of the book the subject presentation is enough and leads the student to significant learning. It could also be deter mind that in order to fulfill all educational objectives which parts of the book must be accompanied by additional subjects and examples.

6. Conclusion

Concept maps possess the potential of being used in the preparation of useful educational plans and programs. As it is seen, using this method, we will be able to study the methods for subject presentation. We believe that, if the authors use concept maps before developing the educational materials, they will be more attentive to important concepts and their relationships with other concepts in the process of developing educational materials. In this way, less space is devoted to trivial issues. After explaining and expressing the new concepts for the teachers, learners striving to complete the map connect or disconnect new concepts to their own previous knowledge. Such an active approach will provide a meaningful learning process.

As it can be seen above, concept maps can be used to review and investigate the writing style of a textbook content. Textbooks should be developed in such a way that they lead the audience, while reading, explore the relationship among the concepts through science process skills. To achieve these objectives, however, the roles of the teacher in meaningful learning and teaching principles of physics through exploration are significant.

Using concept maps in teachers' teaching processes, important concepts and their relationship with other concepts are more noticed and less time is possibly spent on trivial issues. This not only leads to the productivity in the classroom, but also increases the learners' satisfaction and motivation to learn.

Finally, as a suggestion, authors can predict a standard concept mapping in certain parts of the textbook. This will direct the learner to have an understanding of the topic. After explaining and expressing the new concepts for the teachers, learners striving to complete the map connect or disconnect new concepts to their own previous knowledge. Such an active approach will provide a meaningful learning process.

This method will be followed by positive results, if negligible cost as well as time is spent for it is implemented. The method of depicting the concept maps can become a powerful teaching-learning practice and more attention should be paid to this topic.

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