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Use Of Concept-Map Approach In Teaching Energy Resources – An Experimental Study

KEYWORDS: Energy, Resources, Concept Map, Discussion, Understanding. Pre-Test, Post-test, NCF, Achievement score

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ABSTRACT *Energy resources has been put as an unit at secondary level(Class X) to help students learn about different energy resources, their efficient use and conservation. As an alternate to classical discussion method, concept map approach has been used in the present study to teach this unit by using various types of concept maps The effectiveness of this method has been evaluated and compared with discussion method through pre-test and post-test experimental design.The concept map approach was found to be more effective than discussion method in terms of understanding as reflected through achievement scores. Further, in this method learning was more durable. The implications of this method in understanding the concepts and class room transaction has been discussed.*

Energy is the ability to do work. After food and water, energy is the most basic human need. With rise in human population followed by industrialization and the above all with change in human life style, consumption of energy is on rise. Modern economies and cultures are often characterized by their energy production and consumption patterns. With rise in energy consumption particularly fossil fuels, there is environmental pollution leading to rise in temperature, acid rain, global climate change etc. Consequently emphasis is being given to search for, develop and promote non-conventional eco-friendly energy sources. Though sustained efforts are being made by scientists and researchers to meet this challenge, there is a constant need for common people to share with this concern in spirit and action.

Keeping this point in view, "Energy Sources" has been put as a unit at secondary level (Class X) (NCERT, 2006) to make students learn about different energy sources, their use and conservation.

Generally the unit 'Energy Sources' is taught by discussion method in the classroom leading to rote memorization by the learners. As an alternate to this classical method, concept map approach has been attempted in the present study to evaluate its effectiveness in promoting understanding of the concepts associated with energy resources.

The specific objectives of the study are –
(i) to use the concept map approach in teaching the unit and
(ii) to evaluate the effectiveness of this method against classical discussion method.

Conceptual Background

Concept maps were developed in 1972 in the course of Navak's work to understand changes in children's knowledge of science and to promote meaningful learning.

Concept maps are student centred active methods of teaching. It allows students to think deeply, thus helping them to better understand and organize what they learn and to store and retrieve information more efficiently. In this process, new knowledge is linked to the prior existing knowledge to promote understanding rather than simply memorizing the concepts and definitions. Thus, all incoming information is organized and processed in the working memory by interaction with knowledge in the long term memory by interaction with knowledge in the long term memory. This simple tool of concept map serves as a kind of template to help organize knowledge and structure it, even though the structure is built up piece by piece with small units of interacting concepts and propositional frame work. Further concept maps serve as valuable tools for teachers as it reflects information about students understanding. It addresses different forms of learning and individual differences between students.

In the process of concept map development, key concepts are identified and hierarchically arranged. Then concepts are linked with lines having link words creating meaning. No concept map is finished and it needs improvement. Highly sophisticated maps show highly integrated knowledge structure.

In this present study, various types of concept maps looking into curricular needs have been developed after interaction with students to promote understanding of energy resources.

METHODOLOGY

The present study was carried out at JNV, Konark (a CBSE based school) in class X with a sample population of 35 students. The pre-test and post-test experimental design (Best and Khan, 1996) was followed in the present study (Fig.1).

The class students were randomly divided into two groups, each group having 17/18 students. Concept analysis of the unit "Energy Resources" was carried out to list out the major and minor concepts as reflected in the text book. A pre-test was administered with 25 multiple choice type questions to assess their existing knowledge on energy resources before teaching the topic.

The first (control) group was taught about the listed concepts using conventional discussion method without any Teaching Aids. The major and minor concepts were listed on the black board with salient features. One day after completion of the topic, a post-test was administered with 25 multiple choice questions arranged randomly as compared to pre-test.

The students of the second (Experimental) group were given major and minor concepts and were asked to link those with suitable words so as to reflect meaningfully. They were given enough time to think and draw the concept maps. After verifying each map drawn by the students, suitable ones were drawn on the black board and after discussion following active involvement of the students, the concept maps were finalized. Different types of concept maps (Kilic, 2013) such as spider concept map (Fig.2 & 3), the hierarchy concept map (Fig.4), the system map (Fig.5) and Mandela concept map (Fig.6) were drawn looking into concepts and their nature of linkages. Three periods were taken to teach the concepts and draw the concept maps. On the following day, a post-test was conducted using multiple choice objective type questions as said above.

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Two weeks after teaching, again a test was conducted with short answer type questions to assess how far the students have understood and remembered the concepts taught. In each test, the average score in percent was calculated and the result has been depicted in Fig.8 & 9. Design of the study has been presented in Fig.1.

Result and Discussion

The non renewable energy sources provide the majority of the world's energy supply. It has been predicted that there shall be acute energy crisis at the global level in the coming 50 years and it will be a difficult task to supply energy to each and every new work besides making it environmental friendly. Present school going child being tomorrow's citizen, there is an urgent need to help him/her realize the crisis and motivate for efficient use of the present supply besides conservation of resources for the future.

In teaching, the characteristics of an ideal source of energy such as cheapness, easy availability, tussle free conservation and free from environmental pollution were explained in spider like concept map (Fig.2).

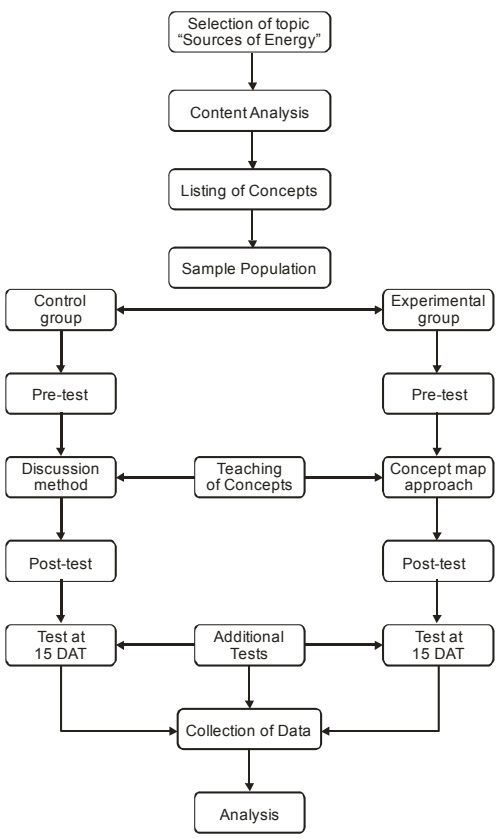

Fig.1: Conceptual Model Design followed in the teaching of "Sources of Energy".

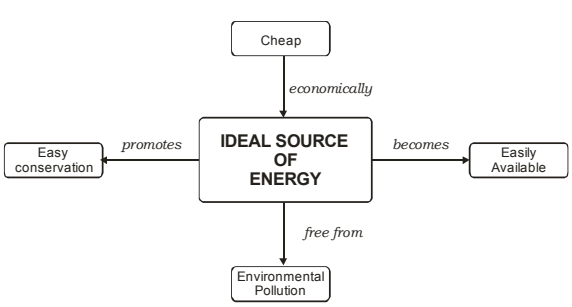

Fig.2: Concept map showing characteristics of an Ideal Source of Energy.

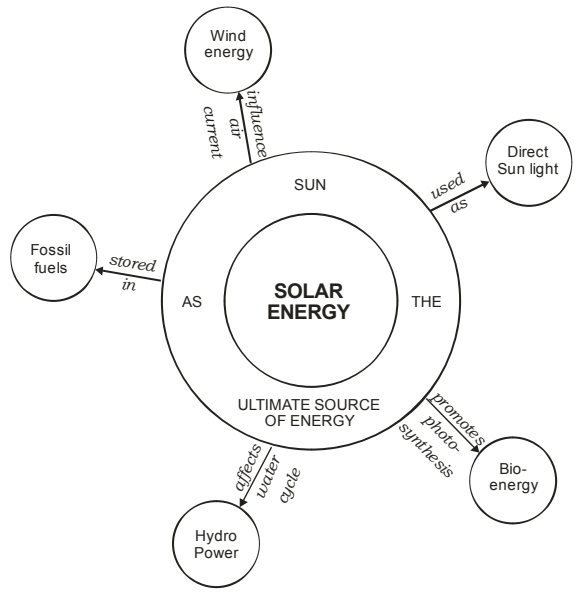

Fig.3: Spider concept map showing "Sun as the ultimate source of Energy".

In teaching the major concept, Sun as the ultimate source of energy, spider concept map was used (Fig.3), various other resources forming the minor concepts was linked into it. The lines linking the major and minor concepts reflect that all different forms of energy such as bio-energy, wind energy, hydropower etc. are derived from this primary source. Nuclear fission acts as the major reason behind energy generation in the sun.

Regarding different sources of energy, the hierarchical concept map was used. First the sources of energy were splited into renewable and non-renewable (non-conventional) sources. Under renewable and non-renewable sources, different sources were included as presented in Fig.4. The characteristic features of each type of source were explained to students.

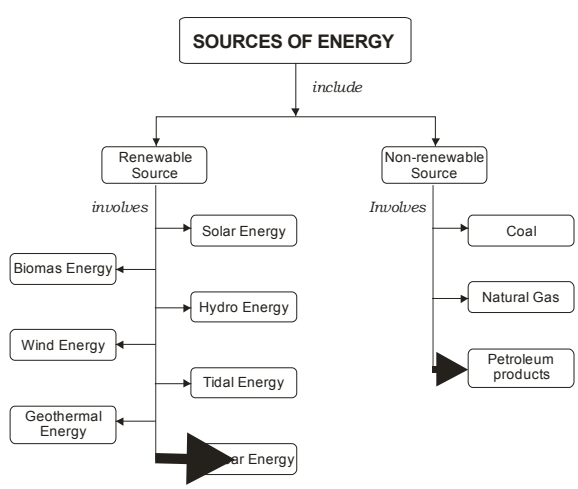

Fig.4: Hierarchy concept map showing different sources of Energy.

For explaining the production and use of Bio-energy, a cheap and non-toxic source, a system type concept map (Fig.5) was used. Students were explained about the structure of bio-gas plant and production process.

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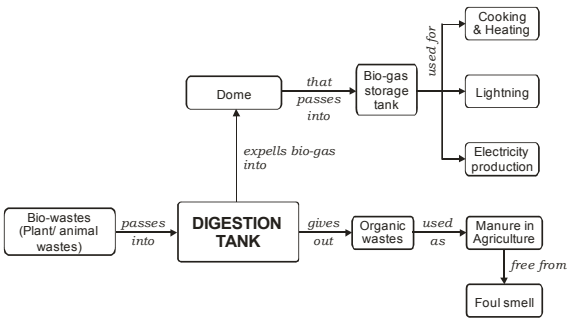

Fig.5: System Concept Map showing production and use of Bio-gas.

Wind power is a clean, abundant, inexhaustible and inexpensive energy source. It is plenty available in certain states of India. Advantages and disadvantages associated with this source were explained through a concept map as depicted in Fig.6.

Currently, most of the world's people remain reliant on fossil fuels such as coal, natural gas and petroleum products produced from dead plants and animals under the earth. These non-renewable energy sources provide the majority of the world's energy supply reaching at about 30% of the total need on the earth. Though, it is an easy source, disadvantages associated with its use include air pollution, acid rain, green house effect and climate change. These were explained by a Flow chart concept map (Fig.7). To reduce the use of fossil fuel consumption, students were explained about the need of using bio-diesel and hybrid vehicles in the transportation process.

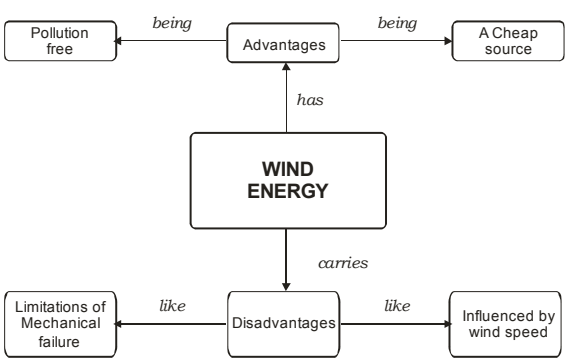

Fig.6: Concept map showing Wind as the energy source.

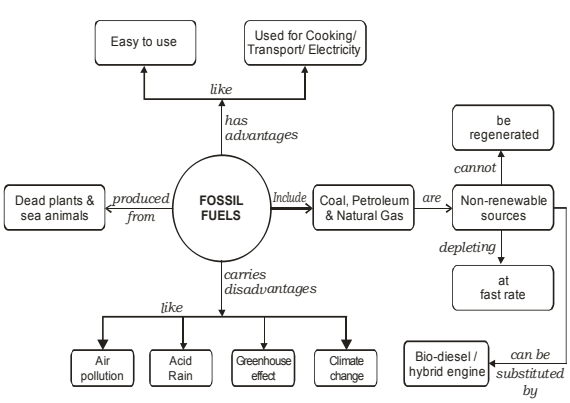

Fig.7: Concept map showing components of fossil fuel, advantages and disadvantages.

Huge amount of energy is stored in the nucleus of an atom. When the nucleus of a uranium atom breaks into two nuclei or lighter elements, being struck by a neutron (fission process), large amount of energy is released. Though it is a cheap process, uranium atom availability is a difficult process and its utilization produces dangerous nuclear wastes. This was explained by a Mandala type concept map (Fig.8).

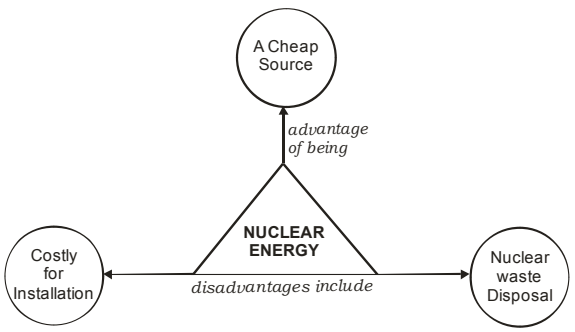

Fig.8: Mandela concept map on Nuclear Energy.

From the comparison of two (discussion and concept map) approaches used in the present study, it was noted that both the groups (control as well as experimental) scored about 37-39% in the pre-test. This showed that students had below average pre-existing knowledge on sources of energy. However, after teaching, the post test result reflected an impressive increase in achievement score. In control and experiment groups, it was 58.6 and 78.7 percent respectively (Fig. 9 & 10). This showed that there was 100% increase in experimental group as compared to 69.9% increase in control group highlighting the effectiveness of concept map approach in promoting students understanding of concepts relating to energy resources. This could be due to childrens construction of knowledge through thinking and reflection (Chang, 1993; Khader, 2005). Their attempt to link the concepts suitably might have helped them in understanding the concepts.

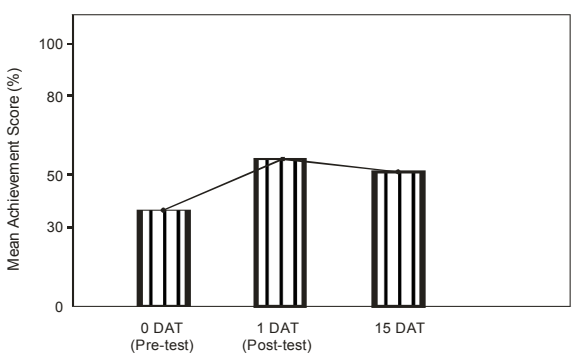

Fig.9: Mean Achievement Score (%) in Pre-test, Post-test and 15-days after Teaching (DAT) by discussion method.

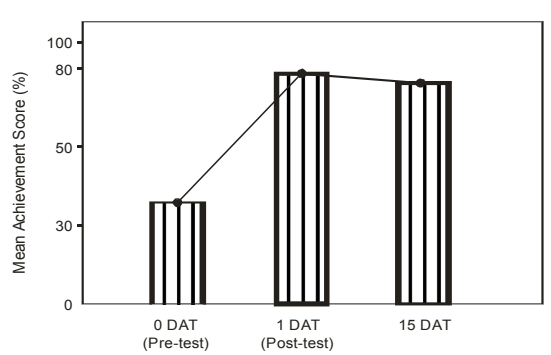

Fig.10: Mean Achievement Score (%) in Pre-test (0 DAT), Post-test (1 DAT) and 15-days After Teaching (DAT) by concept map method.

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From the test conducted 15 days after teaching (DAT) to understand the retention (Satapathy and Dash, 2003) of the concepts learnt, it was found that loss of learning in concept map approach is less (5.4%) than the discussion (14.1%) method (Fig. 10). Though there was a loss of knowledge/ understanding, students were found to remember and retain (Satapathy & Dash, 2003) the concepts better in this method. This could be because of involvement, participation, thinking and reflection by the learners (Phillips, 1998). Kilic (2013) observed that this simple tool of concept map facilitates meaningful learning and creation of powerful knowledge frameworks that not only permit utilization of the knowledge in new contexts but also retention of the knowledge for long periods of time. Specific training to teacher educators and teachers in this type of teaching methods (Khader & Das, 2003) may help in improving classroom transaction. As knowledge and understanding influence attitude that controls action and behavior (Dash and Satapathy, 2004) this understanding of energy issues among students may go a long way in its efficient use and conservation.

As energy use of energy resources and their conservation are important concerns in our daily life, the students shall not only retain the knowledge through this method, but can use it outside the classroom (NCERT, 2005) in daily life situations. Further , this method could be effectively used for teaching of many science and social science unit.

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