CONCEPT MAPPING AS AN INSTRUCTIONAL METHOD TO ENHANCE ACHIEVEMENT IN SECONDARY SCHOOL PHYSICS

BY

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Abstract

Concepts in physics education underpin a high level of technical knowledge and therefore are crucial to success in many technical disciplines. However, misconceptions in elementary physics are quite common among secondary school students. Therefore, it is important to identify and implement the most effective teaching and learning methods that can reduce instances in physics misconceptions and enhance both short-term and long-term achievement. The concept maps also provide better ways of summarizing concepts learned during the lesson thereby making it relatively easier for the lessons to be reviewed and key points in the lesson reported or reinforced as a required. However, instructional concept maps is an effective teaching and learning tool for developing concepts of electric current in physics.

Introduction

Nigerian economy has faced recession and calls for urgent government restructuring. There is panic on the credibility of the economy as citizens continue to face hardship characterized by hyper inflation. To revive this situation, emphasis must be geared towards prioritizing advancement in scientific and technological knowledgeable human resources. Science is the structure and behaviour of the natural and physical world based on observation and experience (Ezeano, 2006).

Science, technology and science education have vital contributions to the growth, development and survival of mankind. In reviving the economy as planned by the present government, scientists cannot be left behind as science and technology are the benchmark of economy revival and modernization. Any breakthrough in science and technology is deeply rooted in the strength of science education. Physics is a fulcrum subject around which other sciences revolve and requires special attention. Advancement in technologies, information and communication, medical, environmental, crime control and security are feats brought through the knowledge of physics. It is in recognition of this that Egbugara (1986) advanced strongly that specific priority be given to physics for the proper development of scientific and technological programmes of a nation. He warned that backwardness and exploitation by other countries would be the only reward of a nation with poor records in physics. No nation, therefore, wishes to be drawn behind in the field of physics education. Despite this importance of physics in National Development, the subject has serious challenges in Nigeria. The poor performance of physics students in national examinations such as West African Examination Council calls for intervention. The experience of low participation in physics among students at varying levels of learning seems to be global as reflected by Nashon, (2003) in his study of physics teaching and learning in Kenyan classrooms, Mumba, Chabalengula and Wise (2007) who work on the Zambian high school physics and Nigeria is not exempted according to findings by (Egbugara, 1986, Gonzuk and Chaagok, 2001, Adeoye and Okpala, 2005, and Ariyo, 2006). This calls for investigation into factors that impede student's choice of the sciences especially physics. There is generally low enrolment in physics in the country and even those who chose it perform poorly in public examinations, such as Senior School Certificate Examination (SSCE).

Researchers have identified reasons for poor attitude, low enrolment and underachievement in the science to include ill-equipped laboratories, under-utilization of teachers, gender factors and insufficient funding (Meltzer, 2002; Denmole and Adeoye, 2004 and Alebiosu and Bamiro, 2007). The factor of high mathematical or quantitative demands (Onwu and Opeke, 1985, Egbugara, 1986 and Adepitan, 2004) has been identified specifically for physics. Iroegbu (1998) asserted that poor numerical attitude generates lack of confidence in handling numerical problems in physics. Similarly, Meltzer (2002) explained that mathematical ability is positively correlated to achievement in physics.

The attitude formed by a child towards any subject will go a long way to decide and determine the child's choice and achievement in that subject as well as his career choice (Woolnough, Guo, Leite, Womg and Young, 1997). Simpson and Oliver, (1990) identified factors of teachers' attitude, teaching methods and personality, attitude of parents and peers, nature and perception of the subject among components influencing attitude to school subject.

Teachers Attitude: It was discovered that most teachers are in the profession by chance. They consider it as a waiting ground for better jobs, Idoko (2010). "We have not gotten better jobs, we are just passing time" said some of the teachers. Such teachers have no passion for teaching, thereby causing poor performance in science.

Teaching of Science by Incompetent Hands: Some of the teachers who teach science have the basic scientific knowledge, but they are not trained to teach. They are trained in content of different disciplines of science while science teachers are trained in both science content and methodology. The science teacher is trained to make correct choice of method, media and how to apply them to impact knowledge to their students properly. A large percentage of the implementers of science education curricula (teachers) are not competent to teach science especially physics. The competent ones are few and inadequate. Training in science is different from training in science education. This means that the assumption that a Ph.D in experimental science for instance, is adequate preparation for a science teacher is wrong. This process is making round peg in square whole. Because they are not rained to teach, they may not make appropriate choice of method, media and how to apply them to achieve instructional goal. In so doing, students lack interest and perform poorly in sciences especially physics.

The above explains that teachers

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identifying gaps in knowledge. That is, it can be used to help learner know what they have learned and what they still do not understand. By matching correctly new knowledge to their own Schemata, eventually learners will achieve a deeper understanding of the knowledge. Analysis of learner constructed concept maps identify conceptual area on which a student should concentrate and to consider appropriate 'remedial' programmes to meet individual needs.

Theoretical Overview

This study was guided by the Paget's constructivist learning theory (Linda 2002). The essence of constructivism is that learners individually build and discover their own knowledge. It is not, therefore, the teachers' role to change children's ideas, rather it is to support and enable children to actively change their own ideas in the light of evidences. Learners are seen as active participant in their learning and not as passive recipients of information (Duffy and Cuning, 1996). In practice it means that students learn through experiencing information and reflecting on those experiences.

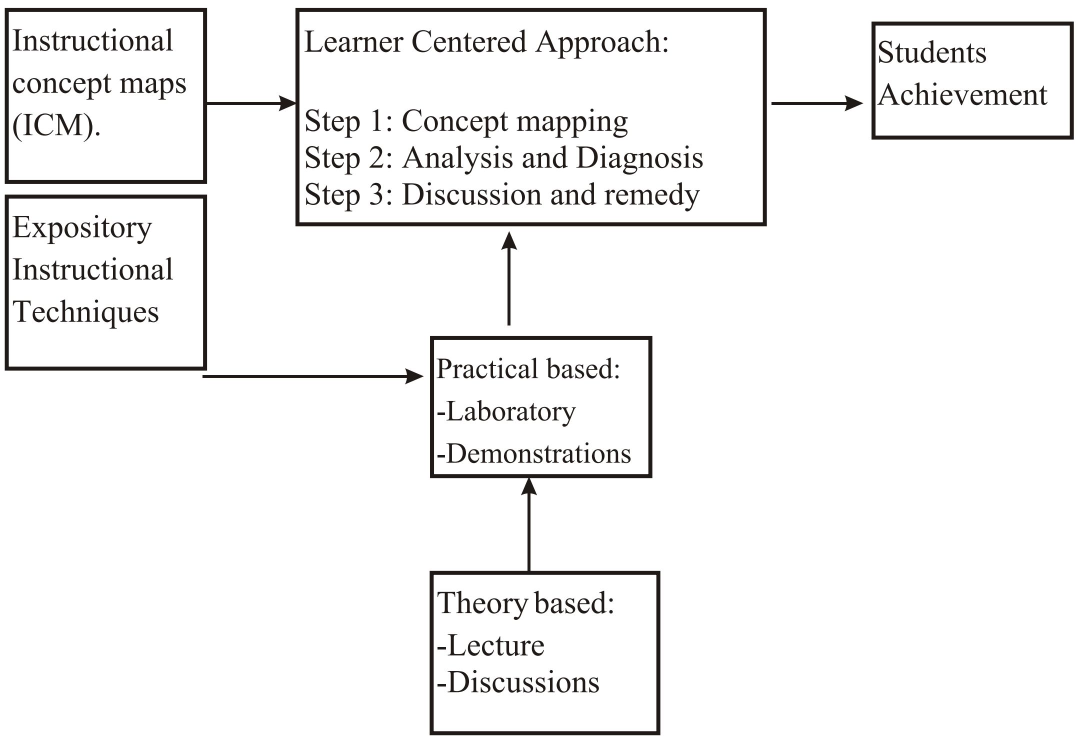
Novak's original work on the constructivist approach to teaching and learning (Novak, Godwin and Johansen, 1983) states that new knowledge should be integrated into existing structures in order to be recalled and retain learning.

Jonassen (1996) stated that students show some of their thinking when they try to represent something graphically. Additionally, it has been shown that in subjects using concept mapping students perform better develop their critical thinking ability and develop better retention.

Concept Teaching and Learning

To a teacher, teaching students how to think is more important than just conveying information to them. Concepts in any subject are the basic building blocks for thinking in order of hierarchy. Arends (2009) agreed that concept learning is more than simply classifying objects and ideas and deriving rules and principles. They provide the foundation for the idea networks (Schemata) that guide our thinking. One important aspect underlying concept teaching comes from the field of human development. This shows that the process of learning concepts begins at an early age and continues throughout life as people develop more and more complex concepts, both in school and out (Piagent, 1963; Starkey, 1980; Benjafield, 1992; Barsalou, 2000; Tharp and Entz, 2003). Students come into classrooms with a variety of prior experiences from which they have formed conceptions, or schemata, about the physical and social worlds (Arends 2009). Sometimes, these conceptions are accurate and at other times, they misrepresent reality. Misconceptions cannot be changed by simply presenting new information. Instead, change requires teaching process that enables students to become aware of their existing Schemata and help them to develop new concepts and reformations of existing ways of thinking. Concept teaching approach is a key determinant for understanding these Schemata and enhancing meaningful learning. Novak, Mintzes and Wandersee (2000) stated that rote learning occurs when the learner makes no effort to relate new concepts and propositions to prior relevant knowledge he/she possesses.

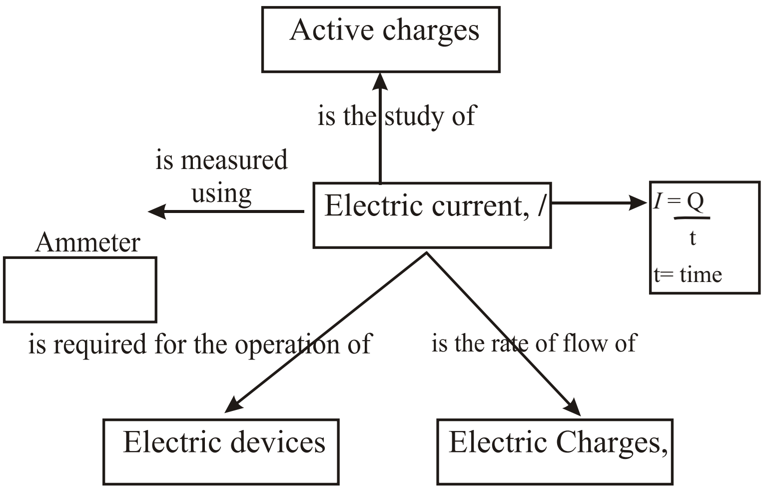
When students are presented with innumerable bits of information to be recalled, it is difficult for them to consider how each bit of information relates to what are very important determinant of enrolment, achievement, and good attitude towards school subjects. Teachers constitute the pivot upon which schooling rotates (Alebiosu and Bamiro, 2007). The teacher is a consultant, guide, mentor, inspirator and moderator (Krejstar, 2004). His use of innovative instructional strategies stands a higher chance of positively influencing the attitude of the learner to the subject. Since teachers play vital role in students choice of subject, any negative attitude towards a certain subject makes learning or future-learning difficult (Guzel, 2004). Hence when students are positively inclined towards a subject they tend to do well in the subject. Developing students' attitude towards science is the most important purpose of science education and apart from students, teacher's attitude towards science and science teaching is also important (Guzel 2004). Adepitan (2004) remarked that the problem of understanding concepts in physics is not only common among students, it is also peculiar to teachers. Consequently, Grober and Jod (2010) suggested the use of self study, problem-oriented learning and remote laboratory/web site experiment while Adeoye and Okpala (2005) advanced the systematic assessment procedure. Invariably, instructional strategy and teaching method are important determinant of attitude to science (Orji, 1998, Meltzer, 2002 and Alebiosu, 2006).



Concept map showing two instructional techniques. Instruction concept map (ICM) and expository instructional techniques both includes practical base (Laboratory).

CONCEPT MAP STRUCTURES USING ELECTRIC CURRENT

(a) Spoke



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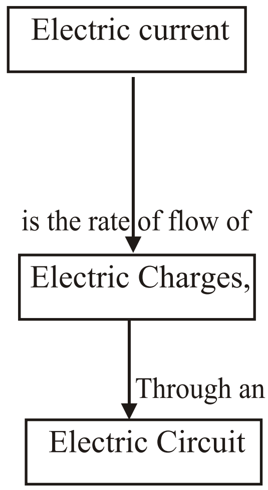
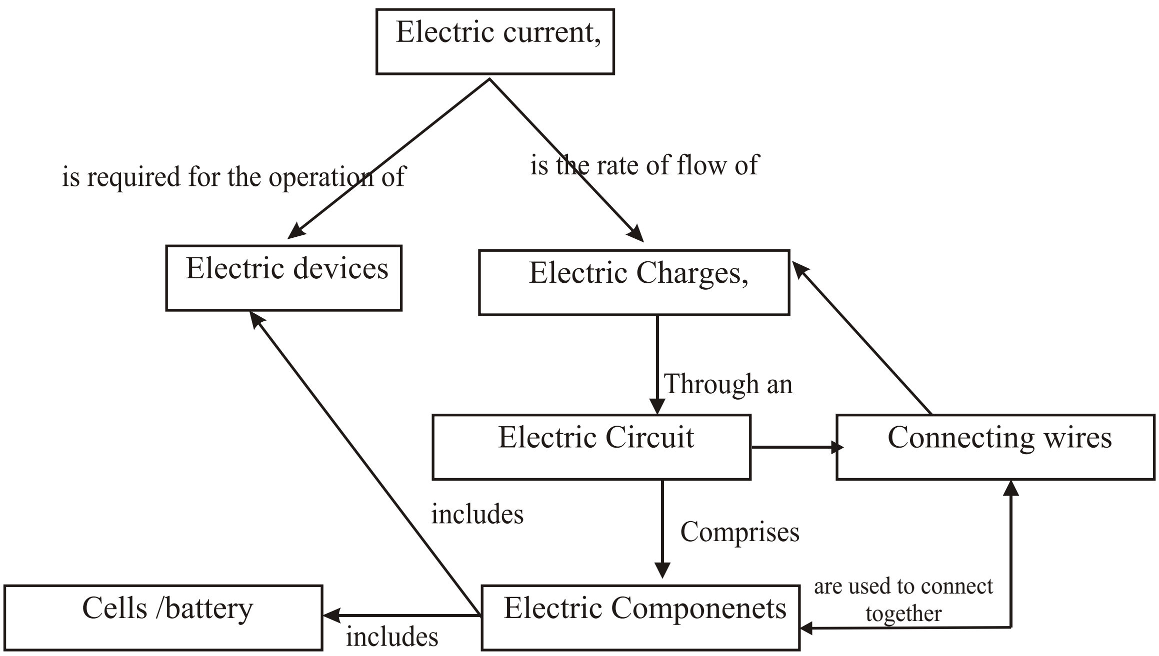
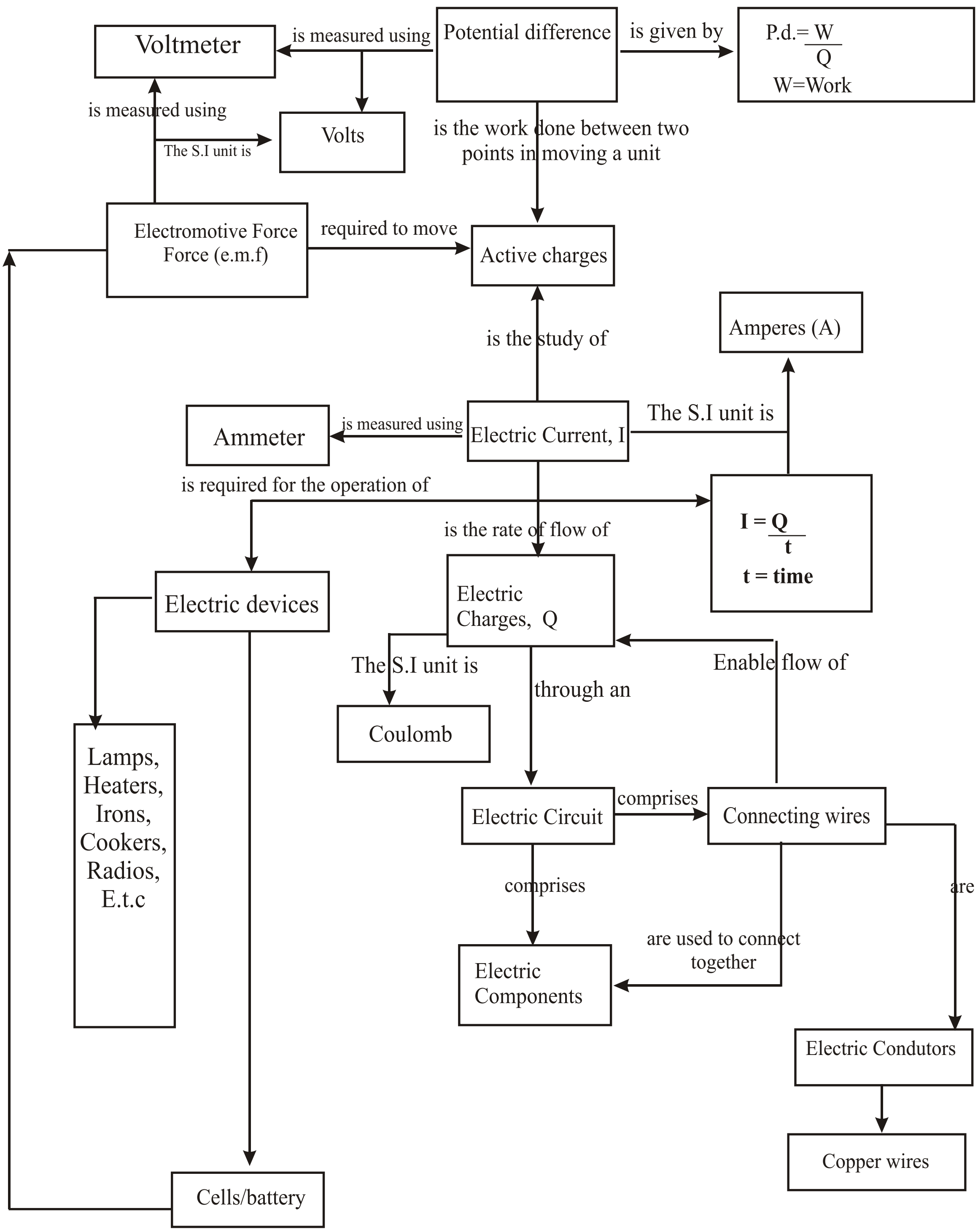


Concept map showing active charges, (which says that electric charges,) Q is the rate of flow of electric current I and $I = \frac{Q}{t}$ where Q is the quantity charge and t is the time taken. The electric current, I is required for the operation of electric devices and the instrument used in measuring electric current is Ammeter, this is the study of active charges. Electric current is the rate of flow of electric charge through an electric circuit.

CONCEPT MAP STRUCTURES



CONCEPT MAP SHOWING THE KEY CONCEPTS INVOLVED IN SUB-TOPIC, ELECTRIC CURRENT AND POTENTIAL DIFFERENCE



Potential Difference is the work done between two points in moving a unit. It is given by $P.d.=\frac{W}{Q}$ W is work done Q is quantity charged.

Electromotive force (e.m.f) that is potential difference is measured using voltmeter. The S.I unit of p.d is Volts. The electromotive force (e.m.f) is required to move active charges. The active charges is the study of electric current, I. An electric/current is measured using ammeter, the SI unit of electric current, I is Amperes (A) and current, I is given by $I=\frac{Q}{t}$ It is the rate of flow of electric charges, Q and is required for the operation of electric devices. The SI unit of electric charges, Q is coulomb. It flow through an electric circuit. The electric circuit comprises connect wires. The connecting wires are electric conductors, they are copper wires made of insulator. The electric components includes cells / battery and is required for the operation of electric devices, examples of electric device are Lamps, Heaters, Irons Cookers, Ratios etc.

How To Build A Concept Map

Concept maps are typically hierarchical, with the subordinate concepts stemming from the main concept or idea. This type of graphic organizer however, always allows change and new concepts to be added. The rubber sheet Analogy states that concept positions on a map can continuously change, while always maintaining the same relationship with the other ideas on the map. Concept map can be build through the following steps

- Start with a main idea, topic, or issues to focus on, Novak J.D. (1998).

  A helpful way to determine the context of your concept map is to choose a focus question – something that needs to be solved or a conclusion that needs to be reached. Once a topic or question is decided on, that will help with the hierarchical structure of the concept map.
- Then determine the key concepts Find the key concepts that connect and relate to your main idea and rank them; most general, inclusive concepts come first, then link to smaller, more specific concepts.
- Finish by connecting concepts- creating linking phrases and words Once the basic links between the concepts are created, add cross-links, which connect concepts in different areas of the map, to further illustrate the relationships and strengthen student's understanding and knowledge on the topic.

Uses

Concept maps are widely used in education and business. Uses include:

- Note taking and summarizing, gleaning key concepts, their relationships and hierarchy from documents and source materials.
- New knowledge creation: e.g., transforming tacit knowledge into an organizational resource, mapping team knowledge.
- Institutional knowledge preservation (retention), e.g., eliciting and mapping expert knowledge of employees prior to retirement.
- Collaborative knowledge modeling and the transfer of expert knowledge, Novak J.D. (1998).
- Facilitating the creation of shared

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found that primary-grade children are capable of developing very thoughtful instructional concept maps, which they can explain intelligently to others. This observation led the researcher to explore even more the value of instructional concept maps in organizing the instructional material and helping students learn this material.

However, capacity building opportunities and exposure of teachers to challenging tasks for updating their teaching skill and techniques are tools for improving productivity.

Conclusion

One very important factor of effective learning is the strength of what the learner already knows. Propelled by this science educators and researchers have geared their efforts towards understanding the characteristics, strengths and weaknesses of the individual learner so as to design appropriate instructional programmes that will meet his/her needs.

Recommendation

Consequent upon the claim in literature that concept mapping leads to meaningful learning and the findings of the study that the strategy significantly improves learning, it is recommended that physics teachers should embrace concept mapping strategy and other participatory strategies during instruction. By so doing, learners would be guided to learn physics.

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vision and shared understanding within a team or organization.

- Instructional design: concept maps used as Ausubelian “advance organizers” that provide an initial conceptual frame for subsequent information and learning.
- Training: concept maps used as Ausubelian “advanced organizers” to represent the training context and its relationship to their jobs, to the organization's strategic objectives, to training goals.
- Communicating complex ideas and arguments.
- Examining the symmetry of complex ideas and arguments and associated terminology.
- Detailing the entire structure of an idea, train of thought, or line of argument (with the specific goal of exposing faults, errors, or gaps in one's own reasoning) for the scrutiny of others.
- Enhancing metacognition (learning to learn, and thinking about knowledge)
- Improving language ability.
- Assessing learner understanding of learning objectives, concepts, and the relationship among those concepts
- Lexicon development.

Benefits of Concept Mapping

Benefits of concept mapping are as follows:

- Helping students brainstorm and generate new ideas
- Encouraging students to discover new concepts and the propositions that connect them, Novak J.D. (1998).
- Allowing students to more clearly communicate ideas, thoughts and information.
- Helping students integrate new concepts with older concepts.
- Enabling students to gain enhanced knowledge of any topic and evaluate the information.
- It imparts knowledge and skill that are readily applied to problem solving.

Disadvantages

Concept mapping strategy has the following among its disadvantages.

1. It is no beneficial to low ability learners.
2. Many science teachers lack the knowledge for the skills and competence required for effective use of the method.
3. It requires close guidance and supervision of the learners which is often not possible with large classes.
4. It is expensive in terms of resources required for its application.
5. It is not suitable for learners of different age and intellectual development level.
6. It is not suitable for certain science concepts
7. Important concepts and links are often omitted.

SUMMARYs

In an attempt to identify more conceptual based teaching and learning methods, Jonassen (1996) stated that students show some of their thinking when they try to represent something graphically. He investigated the use of instructional concept maps at different stages of learning. Symington and Novak (1982)

Thomas, K.F. & Barksdale – Ladd, M.A. (2000) Metacognitive Processes: teaching Strategies in Literacy Education Courses. Reading Psychology, 21, 67-84.

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