Interactive Conceptual Maps Part of Constructivist Environment for Advanced Physics Teaching

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Abstract

A great challenge for a physics teacher nowadays is to respond to students’ demand to explain advanced science notions used in everyday life to a very young public. The introduction of new and advanced knowledge is enhanced by the creation of constructivist learning environments. It is a fact that students don’t like to study in the way their parents did, so one solution can be a great change in the methods used during physics class, combined with informatics tool created by the teacher. This paper describes how conceptual maps are projected as informatics tools for constructivist environment. They are made using advanced Power Point 2007 notions, combining different type of animation, slide transition and hyperlinks between pages or with external folders. In the same time it is shown how these sequences of learning units can be integrated in lessons and also some examples of combined tools for demo. All those informatics tools can be used as to apply constructivist methods in physics teaching.

Keywords: Constructivism, Informatics tools, Conceptual maps, Physics teaching

Introduction

Unprecedented science and technology development necessitate permanently acquiring of new information and also their thoroughgoing study in a very short time. This fact is perceived both by adults and children. Obviously, there is the psychologists’ job to study the impact of new technologies on human mind, but for us, the teachers this is a real challenge. It is well-known that increasingly younger students are pressing to a point home that science teacher trashes out concepts to be study in college or high school. Some frequently questions may be: “What is a LASER or a LED?” What is Magnetorezitence?” or “How an economic bulb works?” These are only a few questions science teachers are aggregated demand to answer. Ten to one that the answer cannot be evasive, indistinct, misty or vague. By no means will the student be advised to wait till these concepts will be taught in school! Obviously the historical approach of science teaching due to national curriculum is proving unsatisfactory for young generation of students keening on learning quickly and effortless. One solution can be a different approach of science teaching using graphic organizers.

Constructivist approach

We may consider conceptual maps as different forms of diagrams projected to provide visual languages, like a natural language text in that they can be subject to syntactic and semantic constrains with a capacity of representation range from fairly informal to extremely formal (Gaines and Shaw, 1995).
Concept comprehensions

Pedagogical research (Varela et al., 1992) relieves that concept comprehension has to be realised due to a strict independent activities system. These stages are: an initially approach of the concept, the highlight of the main distinctive characteristics; particularising of the characteristic of the concept; the dissent of the concept – the collate of main characteristic of the concept with those previously taught; determining of the concept’s links and connections with others already taught; classifying of concepts; incarnation of concepts.

Applying of concepts by different task solving including creativity ones.

Each of these stages has an essential role in concept forming. Teacher’s task is to organize the contents of knowledge as to simplify information acquisition proper to a certain field as to promote and facilitate knowledge building (Esiobu and Soyibo, 1995).

A proper scientific concept assuming depends on the following conditions: bringing into being the necessarily bases to introduce new concept; bringing into being problem situations to convince students of the necessity of approaching of new concept, for understanding and explanation of a phenomena; the right selection of facts and their analyzing as the students to be able to build in their own knowledge system the new concept; educational packages selection according to students’ thinking level; learning conducting and organizing in all stages; increasing of development and applying of new taught concept.

The increasing of students’ learning results can be assured by the teacher, organizing the contents logically as to confer them meaning and allows them to recognize and analyze some information’s particular characteristics as to use then in beating out the meaning achievement.

In order to develop students’ skills for understand and use conceptual maps at physics classes, there are two directions to follow: learning contents selection and using during different lesson moments conceptual maps models realized by the teacher.

Learning contents selection is necessarily because any conceptual map for teaching use is made for a special subject of a lesson (Ausabel and Fitzgerald, 1962).

Constructivist environment

For the best results in using constructivist methods is vital to design a specific learning environment connected with instructional design.

Wilson identifies that the role of instructional design theory then is to provide a set of principles or concept models to assist teachers and designers in these environments. (Wilson, 1996). He defines a constructivist learning environment as “a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities” (Wilson, 1996).

The great advantage of these models is that they can be replicated over time in a number of instructional contexts (Lefoe, 1998).

The main characteristics of a constructivist environment are that it is inclusive, interactive and responsive and that there is continuous dialogue between teachers and students. The role of the teacher is to facilitate learning rather than to be the source of it. Such an environment engenders cooperative learning and, as far as possible, reflects a democratic organization and management structure that allows students and teachers to share responsibility and decision-making (Aitken and Deaker, 2008).

This constructivist approach maximizes student learning and allows teachers to enhance students’ development to become autonomous and questioning thinkers (Fosnot, 2005).

The exogenous interpretation of constructivism emphasizes the role of direct instruction to help the learner to form their own mental model of the ideas to be learned, supported by activities that
allow the learner to test and further tailor their knowledge representation. These activities could be carried out using a virtual environment that simulates part of the knowledge domain. In some knowledge domains such as science physics the concepts to be learned are abstract and do not correspond to directly to material objects (Winn and Jackson, 1999). Suggest that virtual environments “are most useful when they embody concepts and principles that are not normally accessible to the senses”. Exogenous interpretations of constructivism also emphasize the use of cognitive tools, which help the learner to develop an understanding of concepts. Categories of such tools include concept mapping and graphing tools (Dalgarno, 2002).

**Graphic organizers in constructivist learning environments**

For visualization of information processing of abstract notions in physics is recommended to use graphic Organizers (GO). They are dignifying the layout of different relationships between terms, ideas, problems, factors, causes-effects in a problem rationally needed to approach, how in formations processing is visualized. Graphical representation is the problem’s global image, as an artifact of building and understanding related to the task. These graphic Organizers can be converted in rational, scientific learning procedures in didactic tools facilitating and sustaining the achievement by the student guided by the teacher (Joita, 2008).

Cognitive and then constructivist approach progressively developed numerous variants of graphic organizers for mental knowledge organizing, enforcing the role of mental structure, indicating the pigeon hole ranking and then advancing of a concept, task, problem. These graphic Organizers become useful tools for understanding, independent or in a group student’s teaching (Joita et al., 2008). Bibliographical references show that there are a lot of models and typologies of organizers and graphical representations for cognitive architecture connected to concepts, theories, learning tasks, and relations between concepts: descriptive, comparative, analogical, diagrams, web layouts, conceptual maps.

**Conceptual Maps for advanced physics concept teaching**

Most of the high school physics teachers are asked to answer some questions over curriculum because the students are very curious to know everything about up to date science discoveries. They don’t have the time to wait until that concept would be taught at the class, so the teacher has to use the most uncommon methods to be understood. A good results solution may be using constructivist environments and cognitive-constructivist methods. Conceptual Map method is designed for knowledge management in the basic teaching-learning process. For illustrating the method we will consider Charge Carrier Transport Phenomena Conceptual Map used to approach and explain advanced physics concepts.

**Designing a Conceptual Map**

Once the subject is established nominating the relevant problem for the students, the teacher is building the objectives as the students acquire interdisciplinary abilities. Then, the main concepts are selected and included in a first level conceptual map, as it is shown in Fig. 1. The title is the main concept to focus on. In this stage we classified the charge carrier transport phenomena and enumerate them. As this will be the interface with the users and the appearance is very important. We decide for a multilevel concept organizing using different colours allotted to the itemized phenomena. The arrows are highlighted using the colour assigned for the concepts in order to conduct students’ logical thinking following the way suggested by the teacher. The layout of this first interface offers the possibility that the users have a general view of the complexity of those phenomena and to be curious to activate the next level.
For each of Thermoelectric, Thermo magnetic and Gavanomagnetics Phenomena we designed a second level Conceptual Map, as it is shown in Fig. 2. This time the layout interface contains all Galvanomagnetic Effects: Hall Effect, Gauss Effect, Nerst Effect and Ettinghausen Effect. Each arrow has a label specifying the way to a short definition, to the physics conditions and to the coefficient formula. It is very important to associate different colours on arrows, concepts, labels and formulas. This layout offers the opportunity to visualize all those concepts with the linking between them.

For a deeper understanding of the concepts we designed third level conceptual maps. The layout in Figure 3 illustrates Hall Effect with all definitions, formulas, figures needed for a better understanding of the concept.

All those examples are made using Microsoft Power Point 2007. The slides can be projected or printed for each student or can be adapted each time it is necessarily.
Interactive Conceptual Maps

To make a usually conceptual map an interactive one is only a matter of creativity, imagination and no advanced programming skills need, only MS Power Point. The conceptual map can be used as a computer interface providing links to, and control of, other materials. Is very important the consistent use of colours as to enhance the visual appearance. The nodes and concepts provide links to other level conceptual maps and files attached as a database. We organized all conceptual maps as different slides in a MS Power Point Show connected with hyperlinks. In Fig.4 is shown how is made the link between the main slide, as first level conceptual map “Charge Carrier Transport Phenomena” and the second level conceptual map “Galvanomagnetic Phenomena” and back. Figure 5 layouts how are made the links between the third level conceptual map “Hall Effect” and both of first and second level of the interactive conceptual map as the hyperlinks between the slides in MS Power Point Presentation. The teacher may also attach files from an external data base such are documents, videos, pictures or other formats.

Figure 4 Including hyperlinks connections between level one and two slides

Figure 5 Hyperlinks connecting slide level 3 with first and second level Conceptual Maps Slides

Integrating Conceptual Maps in constructivist environment

This tool as it is designed by the teacher may be used in a collaborative environment that allows constructivist methods to be putted in practice. The interactive conceptual map tool is an open architecture for integrating with other systems and supports collaborative development both in local area and wide area networks. One of the advantages of using this tool is that any teacher or student can develop a conceptual map for their domain of interest and link between them or with associated materials (Gaines and Shaw, 1995a). Web 2.0 tools may be used. For example a wiki allows to all users to visualize, to critiques and to develop conceptual maps. On the other hand students may use it as many times are necessarily to approach a concept.

Conclusions

The introduction of new advanced notions in science, particularly in physics as a part of experiential and assimilative process is enhanced and encouraged by the creation of constructivist learning environments. Such an environment engenders cooperative learning witch allow
incorporating constructivist activities to allow for a “meta-knowledge” in the subject area, to be more inclusive to all students, not to those who have a great interest in the topic. Interactive tools can be used in teaching, learning and evaluating process and also can be integrated in web 2.0 or multimedia. Conceptual maps have been demonstrated to be an effective means of representing and communicating knowledge. When concepts and linking words are carefully chosen, these maps can be useful classroom tools for observing nuances of meaning, helping students organize their thinking, and summarizing subjects of study. From an educational perspective, a growing body of research indicates that the use of concept maps can facilitate meaningful learning (Coffey, Carnot et al., 2003). Conceptual maps have also been shown to be of value as a knowledge acquisition tool during the construction of expert systems (Ford, Coffey et al., 1996) and performance support systems (Coffey, Cañas et al., 2003), and as a means of capturing and sharing experts’ knowledge (Coffey, Hoffman, et al., 2002).

References