Concept Maps: Theory, Methodology, Technology
Proc. of the First Int. Conference on Concept Mapping
A. J. Cañas, J. D. Novak, F. M. González, Eds.
Pamplona, Spain 2004

USING A THEMATIC APPROACH AND CONCEPT MAPS IN TECHNOLOGICAL COURSES

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Abstract. In this article we combine the use of a *thematic approach* and *concept maps* to propose a methodological approach for technology courses, in our case, computer networks. The *thematic approach* offers a good way to increase students' motivation and presents a new way of elaborating a curriculum. The *concept maps*, which are the principal tool of the *assimilation theory*, help in the organization of contents, facilitating the process of concept acquisition by learners. These ideas are synthesized in a *Web application* which can be used as an aid or guide for teachers and learners of computer networks to organize and to improve their educational activities.

1 Introduction

In a *traditional teaching approach*, the curriculum is organized by following the classical structure of the programmatic contents of a course in a rigorous way. The contents are previously divided into topics and presented sequentially and in depth to the students.

In a domain with a continuous change of the technological contents, as the computer networks domain, this approach causes some problems. On the one hand, we always have some new knowledge to add into the curriculum. On the other hand, the lifetime of a specific piece of knowledge has been decreasing and its duration lasts no longer than a few years; consequently, we have to worry about the knowledge obsolescence. Furthermore, the high complexity and the great diversity of the contents related to computer networks makes it difficult to select and organize the contents to be taught.

In order to organize the contents, many computer networks textbooks divide the contents based on the "layers" of network architecture, like in (Tanenbaum, 2003). This way of organization largely influenced the teachers of computer networks during the last years. A common approach to explore the contents was to cover the layers in a bottom-up manner, starting from the physical media and finishing with the network applications. Frequently, the network applications were not discussed due to the lack of time and also because they were not considered important.

The rigid pedagogical material of textbooks, associated with the high complexity and the great diversity of the contents, did not motivate the students, imposing great difficulties for them to understand concepts and relate the topics under study with real applications.

With the aim of dealing with these questions, we present in this paper a methodological approach to improve the teaching or learning of computer networks. Our approach combines the use of a *thematic approach* and *concept maps*. The *thematic approach* is presented in the second section, where we emphasize its benefits in helping the selection of the contents and in students' motivation. The *concept maps*, which are the principal tool of the *assimilation theory*, are presented in the third section, where we show how we used them to construct a *knowledge representation* of the computer networks domain to facilitate the process of concept acquisition by learners. In the fourth section we discuss the teacher's role and the *didactic materials*. Finally, in the fifth section, we comment about a *Web application* that synthesizes our approach, which can be used as an aid or guide for teachers and students of computer networks to organize and to improve their activities.

2 The thematic approach

The *thematic approach*, proposed by Freire (1981), suggests that learning activities must be developed around *generative themes* that are part of the students' cultural environment. These *generative themes* increase students' motivation and allow them to extend their knowledge about the subject, including social and political factors that can contribute to form complete citizens with critical minds.

The appeal imposed by the new technological systems, in particular over the young people, and the discussion about the "impacts" of technology on society are two important requirements to select the *generative*

themes to anchor the educational process (Delizoicov et al., 2003). This idea is close to the suggestions of the movement known as Science, Technology and Society (STS), which studies the origins, nature, and social impacts of science and technology.

According to Delizoicov, et al. (2003), a *thematic approach* presents a "rupture" in the way curricula have been elaborated, since they are strongly based on the scientific and technological contents, and organized in a rigid and systematic manner. In a dynamic domain, with a lot of contents, the *thematic approach* is a good criterion for helping in the selection of contents.

If we take into account our domain of interest, computer networks, we can see that the Internet matches the requirements to be selected as *generative themes*. The Internet, after the emergence of the *World Wide Web*, got into the homes and business of millions of people worldwide. These changes have also been reflected in the people's way of life, where the "Internet access" has been considered, particularly in developing countries, an important point for the "social inclusion".

Considering only the technical aspects of current computer networks, the Internet, along with *local area networks*, are the dominant technologies. Many other standards and technologies used in the 1980s and 1990s have been decreasing or becoming obsolete. Thus, a reasonable approach for a modern computer networks course should focus on the *current network technologies* and search for the *fundamental concepts* that allow understanding these technologies. The *thematic approach*, featuring the Internet, is consistent with this assertion.

The approach used by Kurose & Ross (2000) walks in this direction. They innovated with "a top-down approach featuring the Internet", which begins with a global view of the Internet and explores the layers, starting at the application layer and working its way down the layers. According to the authors, the "top-down approach" has several important benefits. It places emphasis on the application layer, which is the high growth area of computer networks. It is a powerful approach to motivate students. It enables instructors to introduce network applications development at an early stage.

However, to be more correct with Freire's ideas, in a *thematic approach*, we should include, along with the technical subjects, themes related to the impacts of the information and communication technology on society. To help the teacher in this task, we are constructing a *Web application*, discussed in the fifth section, where the appropriate *didactic materials* are associated with the *generative themes*.

3 Using concept maps for structuring knowledge

The *thematic approach* consists of relating *generative themes* and concepts, with the themes being the starting point to elaborate the curriculum (Delizoicov, et al., 2003). This process is called *thematic reduction* in (Freire, 1981) and must be based on the *fundamental concepts* that allow giving a global vision of the theme.

In this sense, in a computer networks course, inverting only the way of exploring the layers is not sufficient. It is also interesting to organize the concepts in order to establish a global and structured view of the theme.

The *assimilation theory*, presented by Ausubel et al. (1980), can help in this task. This educational theory describes how the students construct or acquire concepts and how these concepts are organized in their minds. For the *assimilation theory*, learning occurs when new information is obtained from a planned effort by the learner to link this information with some relevant concepts already existing in his/her *cognitive structure*. To accomplish this task, the suggestion is to start learning from the more general and comprehensive concepts and then move towards more specific ones.

In the sequence of studies on *assimilation theory*, Novak (2003) developed the *concept maps*, which are a kind of "graph" used to represent the relationships among a group of concepts. In the *concept map* representation, concepts are represented in a hierarchical way with the most general and inclusive concepts at the top and the more specific ones organized hierarchically in the bottom. For a concept corresponding to a node, it is also possible to build another *concept map* with the objective of refining it.

According to Novak (2003), *concept maps* can be helpful to clearly present the material to be learned, identifying the large general concepts prior to instruction and assisting in the sequencing of learning through progressive and more specific and explicit knowledge.

Concept maps have been used for a variety of educational purposes (Novak, 2003; Cañas et al., 2003). In a domain like computer networks, that has many complex concepts linked in an intricate way, *concept maps* can be of great help to organize and structure knowledge.

The *concept map* of figure 1 shows an example of a knowledge organization describing some general concepts related to the Internet. The rectangles represent the concepts related to this topic. The links show the relationships between the concepts.

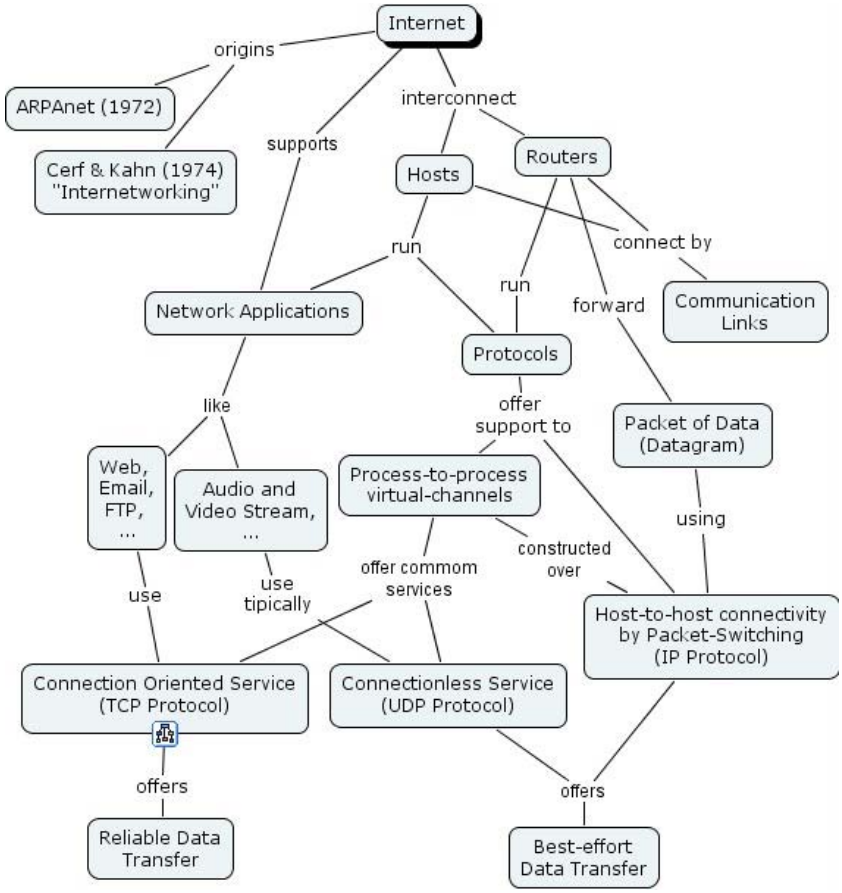

Figure 1. Example of a *concept map* describing some general concepts related to the Internet.

With the *knowledge representation* modeled by *concept maps* it is easier to explore the concepts and technologies in a *general-to-specific* manner, increasing the complexity along the course.

This way of organizing knowledge can also be helpful to solve the conflicts between approaching a theme or topic in scope or in depth, where the hierarchical structure of *concept maps* always keep the subject under study in the whole, avoiding any possible fragmentation. Although, as the *concept map* representation allows both breadth-first and deep-first navigation styles, it still remains to the teacher the responsibility of conducting the learning process.

4 The teacher's role and the didactic materials

According to Delizoicov et al. (2003), the elaboration of *didactic materials* finishes the process of *thematic reduction*. Commonly, the principal *didactic material*s used by teachers are textbooks. However, the teacher is, above all, one that organizes an activity. If the teacher has access to many options of *didactic materials*, he will have more chances to find the most adequate ones, assuming the responsibilities by his choices and adaptations, or creating new alternatives if necessary. Working this way, the teacher can preserve the creative and pleasurable aspects of his educational activities.

In this sense, we developed a *Web application* where the *knowledge representation* of computer networks is linked to a repository of *didactic materials* that could be used by teachers during the development of their

activities. Examples of *didactic materials* included in the repository are: texts for discussions related to *generative themes*; practical activities and exercises, used to illustrate the application of concepts; analogies and theatre acting, used to facilitate the conceptual understanding; and so on.

5 A Web application to help and guide teachers or learners of computer networks

The theoretical discussion developed in this paper has been "compiled" in a *Web application*[1] constructed in order to help and guide teachers and students to organize and improve their activities.

The users can browse on the *Web application*, searching for information, getting help in planning a specific course in computer networks domain or to be guided during the development of a course.

The environment provides access to a *knowledge representation* of the computer networks domain, constructed as *concept maps*, associated with *didactic materials* and other storage information.

Users can also interact with the application by means of tools that allow interactivity. It is possible for users to post suggestions or comments about the information on the *Web* and to discuss with other users about specific themes.

6 Summary

In this paper we presented some methodological guidelines to be applied in computer networks education, stemmed from some modern learning theories. Our methodological approach combines a *thematic approach*, along with the *assimilation theory* and *concept maps. Web application* synthesizes our approach, allowing teachers and learners of computer networks to use this application in order to get some help and guidelines for their work. The application is supported by *concept maps*, a graphical representation of the relationships among concepts, used to model and organize the knowledge of the application domain. With the *concept maps*, the knowledge is organized in a hierarchical way, with the most general and comprehensive concepts on the top and the more specific ones arranged in the bottom of the map. This organization facilitates the developing of learning following a *general-to-specific* manner. *Didactic materials* are also part of the *Web application* and can be used by teachers in their activities.

7 References

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[1] This *Web application* was constructed with the **IHMC CmapTools** from the Institute for Human and Machine Cognition. http://cmap.ihmc.us.