TEACHING BY DOING WITH CONCEPT MAPS: INTEGRATING PLONE AND CMAPTOOLS

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Abstract. Learning technologies are increasingly used as a fundamental component of all teaching and learning activities. A mix of methodological frameworks and sophisticated technological instruments is now the standard toolbox of many teachers. In this context, we propose a model of *teaching by doing*, to be used within university courses or professional workshops, which fully integrates in a teaching continuum, the (traditionally distinct) moments of presentation of theoretical concepts and moments of practical demonstration of the topic to be taught. In this model we extend the Ausubel concept maps-based advance organizer in the form of an interactive advance organizer, where concept maps are fully integrated with the application to be taught. We then present an application of this model to a course on the Plone Content Management System, where we developed an integration of Plone with CmapTools for preparing interactive teaching materials and organizing the educational activities. The results demonstrate the effectiveness of this approach, especially in terms of responsiveness, manifestation of interest and willingness to learn on the part of the participants.

1 Introduction

Plone (www.plone.org) is an Open Source Content Management System (CMS) and has quickly become one of the biggest and most successful projects in the history of open and free software, already rich in success stories: Linux, Apache, OpenOfficie.org, the GIMP. At the beginning of 2004, it passed the 100.000 download mark from the plone.org servers. It builds on the well-proven design of Zope (www.zope.org), an object-oriented web application development system. Its ever increasing diffusion makes it a sort of de facto standard for Open Source CMS, to be used inside or outside organizations, both as intranet content server and as Internet collaborative portals. This trend induces increasing needs for training and self-training on this new platform. In 2000, LIASES started to design, develop and deliver (although using traditional tools and methods) different courses on many ICT topics, with a special focus on Zope and Plone.

In our research project, we depart from this approach and base our teaching methodology on concept maps fully integrated with the topic we have to teach: Plone. From Joseph D. Novak: "Concept maps are tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts or propositions, indicated by a connecting line between two concepts". The concept map interface used for our Plone course was constructed using CmapTools, the *knowledge modeling kit* developed by the Institute for Human and Machine Cognition (cmap.ihmc.us).

Concept maps were born out of the constructivist theory of learning, which holds that the learner constructs or builds his/her own knowledge, as opposed to the previous notion of knowledge as something that was acquired through direct transfer from books or experts. In the constructivist theory of learning, information can be acquired, but knowledge is pieced together only through the incorporation of new information or ideas into the framework of the learner's existing knowledge (Cheek, 1992).

Concept maps are used to structure argument forms and express relationships between ideas (Gaines & Shaw, 1993). In education, the use of concept maps has been promoted to investigate a student's understanding of a topic (Novak & Gowin, 1984). The novelty of the concept map-based interface for first-time users raises the question of whether training is required to use concept maps and related representations effectively. The proponents of knowledge maps have suggested that effective processing of knowledge maps requires training in map reading and construction (McCagg & Dansereau, 1991).

The goal of this research project is to integrate special learning technologies (some based on concept maps) into a unique teaching environment aimed to support educational activities. This environment in turn allows another level of integration among (1) presentation of theoretical concepts and (2) practical presentations, for example lessons and exercises or, more generally, theory and practice. From this twofold integration, we propose a model of *teaching by doing*. We then present an application of this model to a course on Plone, where we developed an integration of CmapTools with Plone itself for preparing interactive teaching materials and organizing the educational activities.

The paper is structured as follows: section 2 presents Plone in more detail and section 3 presents the fundaments of concept maps. In section 4 we present the *teaching by doing* model and focus on the integration of different aspects of the teaching process. In section 5 the specific application of this model to a course on Plone is presented, where CmapTools and Plone are integrated. Section 6 concludes the paper and proposes some future directions of research.

2   Plone

From the official presentation of Plone: "Plone is an out-of-the box ready content management system that is built on the powerful and free Zope Application server. It requires minimal effort to set up, is deeply flexible, and provides you with a system for managing web content that is ideal for project groups, communities and intranets". It may be used for building traditional web sites, collaborative portals, intranets, document publishing systems and represents a powerful platform for implementing e-learning platforms (Margarita, 2003) or Learning Management Systems.

It is one of the most powerful Open Source CMS, thanks to its strong commitment to quality, usability and accessibility. Plone is:

- easy to install. Different click-and-run installers exist, which allow a quick installation of a full-blown CMS in a few minutes
- multi-platform. It runs on many platforms, including Linux, BSD, Solaris, Windows and Mac OS X
- international. The interface has been translated into more than 30 languages, and tools exist for managing multilingual content
- standard. Plone follows standards for usability and accessibility (it is compliant with US Section 508 and with the W3C's WAI AA rating) and web standards like XHTML and CSS
- easy to use. Both user and manager interface are web-based and very friendly. Content managers can add, update, and maintain content through the web
- extensible. Plone can be scripted using web standard tools and Open Source languages and may be extended by creating new content types or service tools.

In our application, we make wide use of the Plone web orientation in integrating it with concept maps, generated in their web form by CmapTools (Cañas, Carvajal, Carff & Hill, 2004).

Plone has some very powerful features like:

- full manageability of users. Through a fine-grained mechanism of roles and permissions, administrators can restrict users to limited zones of the site or to access only specific services and tools
- real-time indexing and cataloging of contents. A built-in search engine allows searches to be carried out in the site, depending on the rights possessed on the different objects
- publication workflow. Each content type may have a separate publication workflow, which defines the different actors, actions and states of the publication process
- cataloguing of documents with metadata. Plone follows the specifications of the Dublin Core Metadata Initiative (www.dublincore.org).

Figure 1 shows the Plone first level concept map we use in the Plone course (see section 5).

3   Concept maps

Conceptual maps are artefacts for organizing and representing knowledge. Their origin lies in David Ausubel's theories about the psychology of learning of the 1960s. Their objective is to represent relations between concepts in the form of propositions. Concepts are included within boxes or circles, whereas the relations between them are explicated by means of lines connecting their respective boxes. The lines, in turn, have associated words describing the nature of the relation that links the concepts (Dürsteler, 2004).

In this context, Joseph D. Novak defines a concept as "a perceived regularity in events or objects, or records of events or objects, designated by a label". The label of a concept is usually a word. Propositions are "statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected with other words to form a meaningful statement. They are also called

semantic units, or units of meaning". Concepts are correlated by relations, boxes and linking lines. Conceptual maps are structured in a hierarchical way, where the most general concepts lie at the root of the tree and, and as we descend the structure, we find the more specific ones. Doesn't this sound familiar? Indeed, like many other things conceptual maps can be represented, where the nodes are concepts and the arcs the relations between them.
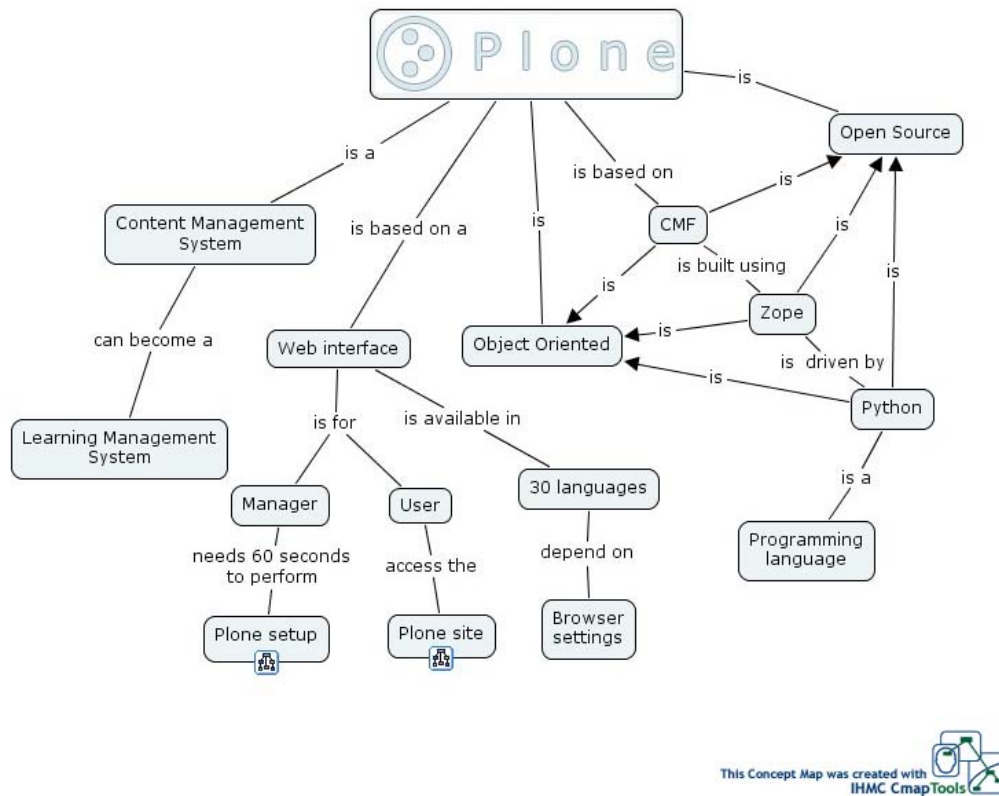

Figure 1. The Plone first level concept map.

Concept maps have several useful applications: they can be adopted in education, in government and business, in industry and the military (Cañas et al., 2003). They provide a new method for organizing and browsing through information and may be an effective navigational tool for hypermedia environments (Cañas, Ford & Coffey, 1994). Because of their graphical nature, concept maps may make desired information more accessible.

In particular, Ausubel (Ausubel, 1968; Ausubel, Novak, & Hanesian, 1978) advocated the use of "advance organizers" to foster meaningful learning. A concept map can be utilized as an advance organizer (Novak & Gowin, 1984; Novak, 1998; Willerman & Mac Harg, 1991). Advance organizer Concept Maps might be constructed by teachers or other experts. The Concept Map advance organizers can then be used in various ways as part of the classroom experience. They might be presented at the beginning of a textbook chapter or other instructional unit, or used as a guide for a lecture that is presented in a class. They might be used to present an overview of multimedia, with links to instructional materials associated with different topics.

A Learning Environment Organizer (LEO) was developed to support computer-mediated courses and provide the learner with a graphical advance organizer (Coffey & Cañas, 2003). It is used to build graphical course representations for computer-mediated instruction. LEO is used to create organizers which represent the topics in a course, their sequence in terms of prerequisite relationships, additional explanatory information about the relationships among them, and links to pertinent instructional resources. This approach is effective and useful both for teachers in organizing knowledge objects and for learners in browsing a self-chosen set of topics in a non-linear fashion.

In the same directions of research followed by LEO, we propose a new approach which overcomes the traditional educational approach, in which theory and practice are separated, and gives life to a *continuum temporalis* based on a *teaching by doing* model.

4   Teaching by doing

A mix of methodological frameworks and sophisticated technological instruments is now the standard toolbox of many teachers. In this context, we propose a model of *teaching by doing*, which fully integrates in a *teaching continuum*, the (traditionally distinct) moments of presentation of theoretical concepts and moments of practical demonstration of the topic to be taught. In this model we extend the concept maps-based advance organizer (Ausubel, 1968; Ausubel, Novak & Hanesian, 1978) in the form of an *interactive advance organizer* (IAO), where concept maps are fully integrated with the application to be taught. Assimilation theory, formulated by these authors, explains how concepts might be acquired and organized within a learner's cognitive structure in a meaningful manner through different strategies. Advance organizers play an important role in the initial and progressive differentiation of learned concepts. If construction of knowledge begins with our observation and recognition of events and objects through concepts we already possess, and if we learn by constructing a network of concepts and adding to them, concept maps-based advance organizers play a fundamental role in the meaningful learning of a given domain of knowledge. Our approach integrates the two aspects that the traditional didactic approach splits: theory and practice, thoughts and actions.

From a teacher's point of view, IAO allows him/her to prepare and organize traditional materials for the course (slides, texts, images) and browse through them using the concept map. But IAO also allows the teacher to integrate interactive sessions of use of the program into the map. For each node of the map, that is for each Plone concept, a resource may be created which opens a real-time session giving access to a zone of the Plone environment, corresponding to the specific topic. In this way, the teacher can browse freely in the Plone site to present related concepts and features. At the end of the practical presentation, browsing of concepts begins again through the concept map.

From a learner's point of view, IAO provides an environment which fosters qualified learning and integrative thinking, avoiding the usual swapping syndrome where students stop to study theory to do exercises and vice versa. Merging these two moments gives a more immediate perception of the knowledge model and the skills to acquire.

Classical didactics treats knowledge as a river in which the teacher drives his students. We rather prefer to imagine knowledge as a sea where the teacher explores one direction and can suggest other possible paths, by using the underlying concept map. The Plone course where we experimented this model unfolds in two separate moments:

- in the morning, the teacher used the IAO environment to develop the main theme and to show how to use the most important features of Plone;
- in the afternoon, the students individually used the IAO environment as a compass to explore the other routes, to deepen the different concepts and to extend their knowledge to the minor aspects of Plone.

Thanks to integration we have an environment (Figure 2) which promotes meaningful learning and where knowledge can grow: the teacher explains how to use Plone using CmapTools, and at the same time, Plone integration helps the teacher to guarantee a sort of continuum between concepts and practice. The students can immediately experiment what they are studying, without the need to leave their books, move to check if they had got the focus of the arguments and then go back. By using IAO (in this case CmapTools and Plone together), they move freely from one topic to another, with a continuous insight into the theoretical and practical aspects of every topic.

5   The case of the Plone course

We validated this model in a Plone course we organized recently as part of a two-week workshop which brought together fifteen trainers, managers and Information Technology (IT) specialists from different countries to examine and discuss the latest developments in Learning Technology Standards and Learning Management Systems and their impact on the process of designing, developing and managing instructional media and learning environments.
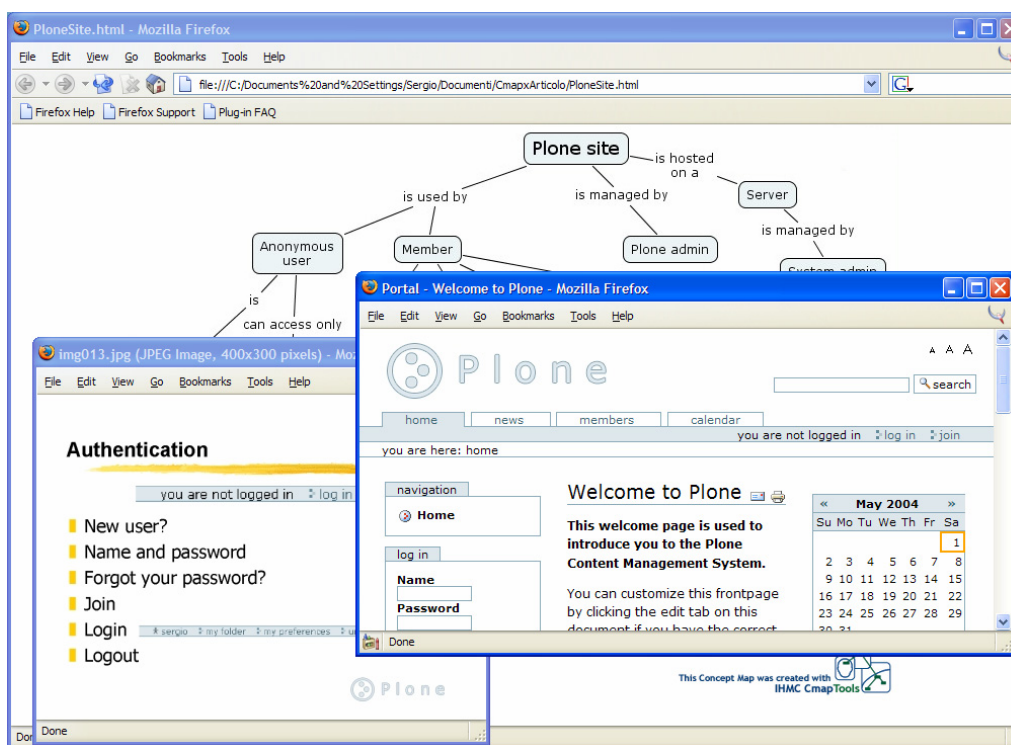
Figure 2. The teaching environment (the concept map, a slide and the Plone site are visible).

As to course organization, a preliminary introduction to reading concept maps is proposed to the participants, followed by a presentation and collective reading of the main (first level) concept map. This first step serves both as a short tutorial on concept maps and as a gentle introduction to general Plone topics. Subsequently, the IAO tool is constantly used as a browsing tool during teacher presentation and proved to be effective

As to preparation of materials:

- we build concept maps and sub-maps based on the level of deepening we defined for the different course topics
- for the sake of usability and easiness, we define an almost fixed set of four resources associated to each node of the maps:
  1. Slide. The object drawn from traditional presentation containing the information
  2. Inside Plone. The link to the page of the Plone site related to the concept
  3. Link. A link to an external resource (site or specific page) for deepening the topic, mainly a page of the documentation section of the www.plone.org main site
  4. Document. A local document (in PDF format)
- we prepare, and give to the participants at the end of the course, a CD-ROM version of the web maps and associated resources, allowing them to explore by themselves offline and individually deepen the knowledge model and related information.

During the classroom sessions, the teacher is helped by the IAO tool to adapt the presentation to interaction and questions coming from the learners. With respect to sequential presentation tools, the teachers have at their disposal a direct access presentation tool allowing them to jump instantaneously to the live session or to the static content to use for answering the question.

More generally, we avoid typical drawbacks of sequential presentations:

- loss of information about structure of the underlying knowledge model
- difficulties teachers encounter to present the relations among concepts

- difficulties attendants encounter in fully understanding the logical flow of the presentation and the non-linear organization of the presented topics.

After the classroom sessions, students can activate a self-learning process, based on the materials they receive. They can use these materials as-is, renouncing the live sessions but accessing all the other resources, or install on their own personal computer the full package (Plone in our case) and recreate the very same environment the teacher used during the classroom sessions. Students can benefit from this kind of self-learning by searching for other concept maps that may be relevant to the one they are building, and by looking for additional material that could help them enhance these maps.

After some sessions, we observed that some students reached a good level of knowledge on Plone and were able to manage the main concepts. So we suggested that they improve and complete the teacher's Plone maps by incorporating in the maps the information and concepts that were presented as associated resources (mainly slides and links to the Plone site). Although this assignment was "paper-based" (they worked only on a printed version and on the web version of the concept maps, so they cannot directly modify them), we noticed the emergence of spontaneous collaborative learning where the cleverest participants helped the others and where everyone contributed to the map building process with their own knowledge of the different topics.

This framework is also at the heart of the constructivist approach to teaching and learning, which treats learning as "meaning making". The use of such maps serves as a primer for active learning in which students organize their prior knowledge to deal with the present context, and prepare to modify or add concepts and relationships. As a starting point for analyzing a topic, this tool is useful for brainstorming, to spark discussion, and for the teacher to observe and correct existing misconceptions. The learning environment provided by starting a topic in this fashion also conveys to the student that there are alternate frameworks for representing and dealing with knowledge.

The feedback from participants at the end of the course is very positive: they very much appreciated having the possibility to use the same tool (IAO) that the teacher also used; thanks to concept maps, they were able to share their ideas, their problems and solutions. They said that the *teaching by doing* model is effective and successful: during the course, they first become the actors of their learning and after the classroom sessions they can consolidate the knowledge they progressively acquired.

Until now, having to deal with short courses, we did not experiment true forms of cooperative learning neither in traditional form nor based on concept map collaborative building (with the exception of paper-based collaboration). In the future, for longer courses, we want to foster cooperative uses of concept maps and use the CmapServer (Cañas et al., 1993). We are going to focus our attention on students: learning diagrams are central to encouraging students to construct their own worldviews or "mental models" and reflect upon relationships and systems structure. Because students have experiential knowledge about the environment, it is important to use their frameworks as a starting point of learning, using their existing experiential knowledge to acquire the "mental model" as the starting point. This model must lead to the framing of the specific problem in the context of the relevant environmental system.

6   Summary

In this research project, we have proposed a *teaching by doing* model, by performing a two-level integration (1) at a methodological level, between theoretical and practical presentations, and (2) at a technical level, between concept maps-based presentation and interactive use of specific software platforms. This model is based on a tool, *Interactive Advance Organizer* (IAO) that we built and used for fully integrating Plone and CmapTools. We have then shown a successful example of deployment during an instructional course.

The results demonstrate the effectiveness of this approach, especially in terms of responsiveness, manifestation of interest and willingness to learn on the part of the participants. A side effect is the high availability and usability of the post-course material distributed to the students. Trough this experience, teacher and students became actors in a meaningful learning and integrative thinking process that, in the future, will be integrated with concept maps-based collaborative learning activities.

7   Acknowledgements

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