Topic Maps in E-learning:

An Ontology Ensuring an Active Student Role as Producer

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Abstract: Topic maps have been introduced as a HCI-solution within e-learning. One problem when using topic maps is that the student is left in a passive consumer role. The article proposes a topic map ontology, focusing on both students and teachers as active producers of learning resources. The article also discusses how small-scale and large-scale sharing of student-made learning resources can be achieved. Topic maps customize the interface, and the interface should also provide possibilities for online students to share learning resources like "on campus" students do. The article also discusses implications for the online teacher's role and how students could be encouraged to share in an online learning environment.

Introduction

During a semester students produce a lot of written material in the form of notes from lectures, books and articles, mind maps, illustrations, diagrams, checklists, templates, questions and answers etc in addition to e.g. oral presentations. Taking "on campus" courses it is common that the students share notes, experiences and explanations, while this exchange is harder to achieve in an online learning environment.

Topic maps and the semantic web are suggested as HCI (human computer interaction) solutions within e-learning (Dichev et al. 2003). There is, however, the problem when using topic maps that mainly teacher-productions will be available. This article suggests a systematic student production of learning resources and systematically sharing of student-made learning objects within e-learning, also in topic map environments. The article also discusses implications for the online teacher's role and how students could be encouraged to share, in addition to discussing the HCI implications that the reuse of student-made learning objects introduces in an online learning environment. The article introduces an e-learning ontology for the systematic production and reuse of student-made learning objects.

The method used in this study is a qualitative approach, more specifically the Grounded Theory (Glaser & Strauss 1967, Strauss & Corbin 1990) with data collection from brainstorming sessions and depth interviews among the user groups, in addition to requirement specification development and literature review from the fields of pedagogy and educational technology.

Student productions

Most students are eager to share in "on campus" learning situations. They share lecture notes when one student was not able to attend the lecture, they exchange notes from the curriculum, they distribute URLs to interesting websites, they share mind maps and assignment answers. A student typically does this because there is "something in it for me" as well. They know that if they share their lecture notes this time, they will get something back from the receiving student later, so it will be useful for both the giver and the receiver.

In an online learning environment, however, the sharing is not as easy, because you do not necessarily know your fellow students very well and the answer of the question "What's in it for me?" is not clear to neither

students nor teachers. Today, sharing among online students is done through e.g. discussion forums. If online sharing is going to be successful, it must be obvious for the student that “giving now” will mean “receiving later”. If online students are going to share, it should not only be sacrifices and waste of time and energy, but the online students must know that the sharing will be useful for them later.

Being an active producer of learning objects and learning activities the student not only prepares learning objects and learning activities for his fellow students, but the process of making the learning objects is also a valuable learning experience for the producer.

Within e-learning there has been a lot of research on reusable learning objects by making standards like SCORM, IMS, IEEE-LOM etc (Marsico et al. 2005) to ease the reuse of learning objects, but the focus has been on the reuse of teacher-made, not student-made learning objects. This article emphasizes that time and energy for both teacher and students could be saved if sharing was systematically performed among online students.

What to share in an online environment?

In an online environment it is possible to share in both a small and large scale. In a small scale sharing could be performed through a ranking system (where students e.g. rank a learning object, and the system could show the ranking results for other students). The ranking would be interesting feedback to the teacher as well, in the process of reviewing and improving the learning objects. The system could also use the ranking results to give suggestions of other learning objects to the student based on the behaviour of the fellow students, similar to Amazon.com, which has a suggestion list of other books that might be interesting to the buyer (“Costumers who bought this item also bought: … “). An e-learning example could be that the student ranks one learning object high, and the system provides a list of learning objects ranked high by fellow students who also had high ranking score on the same learning object.

In a larger scale we can imagine the online students sharing multiple choice questionnaires, mind maps, screen capture recordings, slide presentations and lecture notes. An incentive to get access to the student-produced learning object repository could be that you need to submit one learning object before you get access to the learning objects produced by fellow students.

The teacher role

McGhee and Kozma defined the new teacher roles in technology supported classrooms to be instructional designer, trainer, collaborator, team coordinator, advisor and monitoring and assessment specialist (McGhee & Komza 2003). This article suggests an additional role as “editor”. Student-made learning objects / learning activities should be quality assured before it is published to the fellow students, and this should be done by the teacher.

There could also be a problem with a large amount of learning objects that will put the student in a consumer role, which can make him / her passive. Getting access to a large amount of finished notes, mind maps etc may leave the student in a passive consumer role. An ontology of an e-learning topic map is therefore needed for the teacher to systematically organize the student production of learning objects and make them retrievable, in addition to avoiding that the students keep making similar learning objects to already existing ones. The ontology presented in this article will be useful for the teacher in the editor role finding what themes, methods, media types etc are already covered and what topics are still not produced.

The process of producing the learning objects should be as useful as getting access to the produced learning objects. This will mean that the student production of learning objects is not extra work, but part of the learning process. The teacher is not replaceable even if students make many of the learning objects and learning activities. It is important to have one person who knows the subject field and has a pedagogical background. It is also important that the teacher has a bird eye’s perspective of the entire learning environment.

An e-learning topic map

An HCI solution within e-learning could be to use the concept of topic maps, where the information can be shown in several views based on the choice of the user. Topic maps are an ISO standard - ISO/IEC 13250:2003. “A topic map is a technology for knowledge integration, describing concepts and their relations” (Garshol 2006). Organizing documents into a topic map, it is necessary to identify the topics, the topic types, the occurrences and the associations (Pepper 2002). To use topic maps in an e-learning setting it is necessary to design an ontology, and this article presents the initial version of an e-learning ontology.

The student interface

The student interface based on a topic map will allow customized views of the learning objects and learning activities. Examples of the students’ views of the learning objects and learning activities, could be views based on:

- Themes
- Time (the newest learning objects / learning activities)
- Pedagogical methods (Heinich et al. 2002)
- Media type / intelligence (Gardner 1985)
- Proficiency stages (Dreyfus 1998)
- Learning objective (knowledge / skill / attitude / meta learning)
- Student productions of learning object/ learning activities
- Ranking score (the learning objects with the highest ranking scores)
- List of learning object recommended by the system based on behaviour of previous students (the students who liked a specific learning object also liked these learning objects).
- Guided learning paths produced by teacher
- (Free text) search.

A user-friendly, individualized and differentiated interface is an important feature of an e-learning system. Instead of presenting the learning objects and learning activities in one standard interface for all the students, an e-learning topic map could present “many roads to Rome”, addressing the needs of the heterogeneous student group (Kolås 2005).

Why e-learning topic maps?

Dichev et al. (2003) mention many advantages using topic maps, e.g. efficient context-based retrieval, customized views, information visualizations and deeper understanding of the domain conceptual relations. The advantages of a topic map presenting information (e.g. learning objects) are that the user will experience a flexible learning environment and is able to make choices of his / her own on what perspective he/she wants to the learning material.

Information overload for the student is a problem which may occur when we are trying to arrange for an individualized and differentiated learning environment prepared for individual needs when it comes to methods, media, intellectual stages, cultural needs, assessment, and different intelligences in the online learning environment. If nothing else is done other than organizing many different learning objects into folders, the students will not know which learning object to start and which to continue with. “One problem with web portals is how to locate the information you are interested in” (Hjeltnes 2006). This problem also applies to the situation when the students produce learning resources, they must be easily retrievable. There is therefore a need for good HCI-solutions, and topic maps are suggested as one solution of this problem (Dichev et al. 2003).

A disadvantage with topic maps is however the passive student role. The student is able to be active in the sense of choosing the perspective of the information, but there should also be an opportunity for the students to produce information as well. Table 1 lists some of the differences between being an active producer and a passive consumer (Tab. 1). Also in e-learning environments it is necessary for the students to have the possibility of both roles; consumer and producer. Currently the topic maps only provide the consumer role.

Student as Producer (active) **- producing learning activities / lessons**	**Student as Consumer (passive)** **- consuming learning activities / lessons**
Write text (in a word processor, wiki, blog)	Read text (in a word processor, wiki, blog)
Make a multiple choice questionnaire	Fill in a MCQ
Make mind map	See mind map
Make concept map	See concept map
Make illustration	See illustration
Make slide presentation	See slide presentation
Make aural presentation	Hear aural presentation
Make video presentation	Watch video presentation
Make tutorial	Do tutorial
Make a screen capture sequence	Watch screen capture sequence
Make animation	Watch animation
Make survey	Answer survey
Make database	Use database
Make music	Hear music
Ask question / answer question in FAQ	Read questions and answers in FAQ
Make vote question	Vote
Search for information	Get access to information
Quality assure information	Get access to quality assured information (topic directory, teacher-made website of URLs)

Table 1: Active vs. passive student role

HCI implications

To ensure that a topic map learning environment is not leaving the student in a passive consumer role, the students must get access to the same production tools (for the production of learning objects and learning activities) as teachers do in the online learning environment. It is also necessary for the system to provide an overview for the teacher of what is produced.

One idea is to use the information from the course specification (where the name of the course, the prerequisites, the learning objectives, the course content, the teaching methods and the assessment methods are defined) to create metadata based on this information. This approach does, however, require an e-learning ontology.

The e-learning ontology

A topic map ontology is "the set of privileged topics and their characteristics, including associations between them" (Grønmo, 2006). The e-learning ontology (Tab. 2) covers the different needs of the heterogeneous student group when it comes to different pedagogical methods (Heinich et al. 2002), proficiency stages (Dreyfus 1998), multiple intelligences (Gardner 1985) and taxonomies for affective, cognitive and psychomotor domains (Kratwohl 1964; Bloom 1956; Dave 1970). The e-learning ontology is based on key topics, topic types and associations and occurrences:

Key topics:	**Topic types:**	**Associations**	**Occurrences**
Learning objectives	Knowledge	Is assessed through	MCQ, memory, matching, true/false, short answer, completion, blog, portfolio,
	Attitude		chat log, discussion forum, pre/post survey tool
	Skill		motion sensitive tool, simulator, track tool, log
	Meta-learning		pre-test, post-test, reflection tool
Pedagogical methods	Drill	Is taught through	Multiple choice, drag and drop, match, memory, fill in blanks

	Presentation		Wiki, mind map, concept map, map, slide presentation, video / audio recordings
	Tutorials		Wizards, FAQs
	Gaming		Adventure games, business games, board games, combat games, logical games, word games (Alessi & Trollip 2001)
	Demonstration		Screen capture, animation
	Discovery		Survey, Voting, blog / journal, Search
	Simulation		Physical, Iterative, procedural and situational simulations (Alessi & Trollip 2001)
	Discussion		Chat / IM, SMS, e-mail, forum, Video conference, audio conference
	Cooperative learning		Application sharing, CVE, workspace awareness, shared archive
Learning objects	*(Multiple intelligences)* Visual intelligence	Is produced through	Presentation tool, mind map, concept map, graphics tool
	Verbal intelligence		Word processor, web editor, record audio
	Logical intelligence		Spread sheet, database
	Kinaesthetic intelligence		Simulation, motion sensitive tool
	Musical intelligence		Record audio, midi
	Interpersonal intelligence		Communication, coordination and cooperation tools
	Intrapersonal intelligence		Mind map, hypertext editor
	Naturalistic intelligence		Database, map, hypertext editor
	(Proficiency stages) Novice		Checklist, template, road map, wizard, design pattern
	Advanced beginner		Toolkit, search help
	Competence		Assignment without help, framework
	Proficiency		
	Expert		

Table 2: The e-learning ontology

Conclusions and further work

Instead of an online learning environment with too many unstructured learning resources available, the topic maps will make it possible to find the needle in the haystack, which is the right learning resource for the specific student in a specific situation, to ensure good learning. Topic maps can be a good HCI solution in e-learning, because it customizes the student interface and meet the student's needs in a consumer role. This article has, however, focused on the problem of a passive student role using topic maps. The article proposes an e-learning ontology, focusing on both the teacher and the student as active producers of learning objects and learning activities, to enable sharing among online students.

Further work should include a discussion about copyright issues of student made learning objects. The ontology should also cover cultural dimensions as a factor of the student heterogeneity, but this is not completed at the current time.

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