Collaborative Authoring of Adaptive Educational Hypermedia by Enriching a Semantic Wiki's Output

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Abstract. This research is concerned with harnessing collaborative approaches for the authoring of Adaptive Educational Hypermedia (AEH) systems. It involves the enhancement of Semantic Wikis with pedagogy aware features to this end. There are many challenges in understanding how communities of interest can efficiently collaborate for learning content authoring, in introducing pedagogy to the developed knowledge models and in specifying user models for efficient delivery of AEH systems. The contribution of this work will be the development of a model of collaborative authoring which includes domain specification, content elicitation, and definition of pedagogic approach. The proposed model will be implemented in a prototype AEH authoring system that will be tested and evaluated in a formal education context.

Keywords: Adaptive Educational Hypermedia, collaborative authoring, Semantic Wikis, communities of interest.

1 Introduction

Adaptive Educational Hypermedia (AEH) Systems provide adaptation of navigation and presentation of educational resources. AEH systems envisage navigation functionality that enables personalized access to educational resources; navigation is implemented on a hyperspace layer, which in turn relies on a knowledge space layer [1]. However, developing knowledge space is not simple and it is time consuming. In addition, courseware is usually non transferable and non reusable [2]. Some research has been done to address the problems by developing generic authoring systems, for example MOT [2-4], based on LAOS authoring model [5, 6] that can be delivered by many AEH systems like AHA! [7] and WHURLE [2, 8].

On the other hand, given that AEH systems rely on large knowledge bases and subject expertise, it would make sense to develop them collaboratively. The Adaptive Learning Environment (ALE), FOSP and LAOS [9, 10] are some models of collaborative authoring established in past research. The models support collaboration works on domain related knowledge for adaptive learning.

Nowadays, with the popularity and success of Web 2.0 and Wikis for authoring documents, the collaboration paradigm shifts to decentralized authoring by online communities [11]. Semantic technology then extends Wikis to Semantic Wikis that are able to support ontology engineering, knowledge management and learning environment development [12, 13]. Previous research has demonstrated the use of Wikis and Semantic Wikis in educational settings, for example Wiki for developing learning spaces [14], Semantic Wiki for collaborative academic writing [15] and SWIM, a Semantic Wiki for Mathematics [16].

This paper reports the early work of PhD research on developing a collaborative authoring model for the knowledge spaces of AEH systems by utilizing a Semantic Wiki. I will first discuss the problems of authoring AEH and the challenges that can be addressed by Semantic Wikis in Section 2. Section 3 will put forward the research questions that motivate the PhD research and Section 4 will present the progress that has been made. The future work of the research will be presented in Section 5.

2 Problems of Authoring AEH

Authoring AEH systems is a complex process. Brusilovsky divided authoring into three steps including structuring the knowledge space, structuring the hyperspace and connecting both spaces [1]. Other research suggested similar steps [2, 10, 17].

The First step, which concerns with structuring the knowledge space, covers the development of pure domain related content that describes the domain concepts, relationships among concepts, and concepts' attributes. The knowledge space construction also involves the development of a user model that is usually introduced as an overlay model. In addition, it includes authoring pedagogic information consisting of learner profiles and learning objectives. The Learning objectives are expressed in the combination of learning goals, constraints, adaptation rules and all other information relevant for delivering adaptation and personalization.

The next steps of authoring, structuring the hyperspace and connecting it with knowledge space, are complex processes as they develop learning content for all concepts in knowledge space. They may involve developing educational content, and also linking concept and content elements by applying pedagogic principles to provide navigation. The links have many-to-many cardinalities, thus enabling learners to access any content element from a concept and vice versa. Content and navigation delivered to students are based on links, learning goals and constraints, learners' profile, and adaptation rules.

Considering all processes described above, authoring AEH could be improved in two different ways. First, the involvement of communities in collaborative authoring of knowledge could provide for a larger volume of educational material described in community-agreed terms. Second, the enhancement of existing collaborative authoring tools to support AEH knowledge space construction could allow developers to focus on the development of additional features only instead to developing collaborative authoring environments from scratch. The development process could thus focus on enriching the output of the collaborative authoring tools by adding pedagogy related knowledge.

3 Proposed Research

This PhD thesis will research the enhancement of Semantic Wikis to support collaborative authoring of knowledge spaces in AEH. The objective of this research is to provide a model of organizing learning knowledge that can be adaptively reused and repurposed to support AEH. The proposed collaborative authoring environment is divided into 2 subsystems. The first one supports collaborative authoring of domain related knowledge by a community of interest using a Semantic Wiki; the general public can also participate in content development. The second one enhances collaborative authoring with pedagogy related knowledge by enriching the output of the first subsystem; this subsystem is intended for use by teachers.

Research Questions. Listed below are the research questions that motivate this PhD research.

1. How can users collaborate to define the elements of the knowledge domain and the relationships between them, e.g. the parts that are pre-requisite to other parts? How can a Semantic Wiki be linked to the above knowledge domain definition so that users can collaborate of the production of content? Which level of granularity of content is most appropriate?
2. From a given knowledge domain, how can different pedagogic approaches be defined?
   - Are there barriers that prevent teachers from collaborating and agreeing pedagogical approaches for authoring AEH?
   - Can such a system be compatible with current standards? (IMS Simple Sequencing, IMS Learning Design or other?)
3. How can we implement personalized delivery of learning resources in AEH taking pedagogy into account? Can such pedagogy related knowledge grafted to standard delivery technologies?

Challenges. There are certain challenges in the research motivated by the above questions:

1. *Specifying knowledge space elements*.
   The challenge here is on identifying the elements of the domain and pedagogy related knowledge space for AEH and on investigating pedagogic aspects of learning personalization.
2. *Pedagogy in knowledge representation and reasoning*.
   The challenge is on designing the mechanisms for pedagogically meaningful knowledge representation and reasoning in a number of domain. Knowledge representation must deal with the evolving knowledge and content. Another challenge is on designing adaptive rules that are grafted to standard delivery technologies if possible.
3. *Managing communities of interest*.
   The challenge is on developing and managing communities of interest by applying some mechanisms of coordination, negotiation and control on the collaborative authoring activities.

Novelty. The novelty of this research is on the enrichment of existing Semantic Wikis for collaborative authoring of knowledge and content for AEH. The participation of communities of interest, teachers and general public is another novelty of this research.

4   Research Approach and Progress

This work started with an outline of the model of collaborative AEH authoring using Semantic Wikis. The general structure of the knowledge space, contributors and roles is shown in Figure 1. One of the contributors is Communities of Interest which consist of people who are experts on or interested in the subject. They develop the domain related knowledge and content. Other users are public society and teachers. The former can contribute in developing learning content and the latter can generate pedagogy related knowledge.
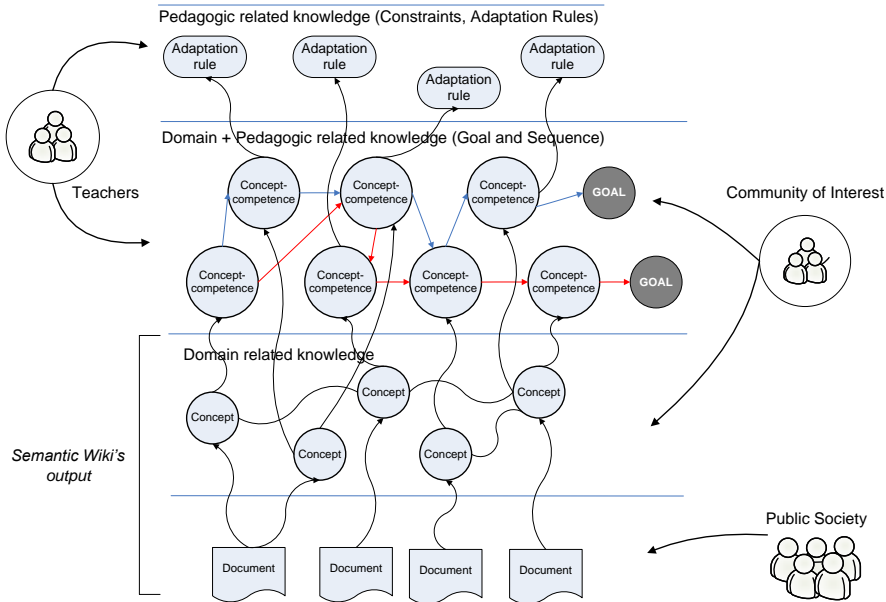

Fig. 1. General Architecture of Proposed System.

The proposed design of the domain and pedagogy related knowledge is based on past research including Brusilovsky's word [1], the AHAM model [6, 18, 19] and other AEH systems like ISIS Tutor [20], AHA! [6, 21, 22] and WHURLE [8].
I propose the domain related knowledge consists of the following elements:
1.   *Concepts*. They represent the topics of the subject.
2.   *Competences*. They express the levels of expertise levels that students can gain. There are many competence theories including Bloom's theory that divides

competences into 6 levels: knowledge, comprehension, application, analysis, synthesis and evaluation [23].

3. *Content*; *representation of learning materials*. It can be in one form of explanation, case study, experiment result, survey data, and the like.
4. *Goals*. They express learning outcomes.
5. *Relationships*; consisting relationships between concepts and content, and also between 2 concepts.

All elements mentioned above will be developed as an enhanced on a Semantic Wiki and then enriched with pedagogy related knowledge consisting of learning paths, adaptation rules, constraints, and learning styles. A student model is grafted in this model in order to support personalization of learning. The user model will be expressed as a stereotype model combined with the overlay map of concepts and competences.

Currently, I am still refining and evaluating the knowledge model, and also investigating the ways communities and teachers can collaboratively develop the pedagogy related knowledge. Collaborative authoring is not a simple task as it involves many aspects known as Kling's c-words [24]. As a next step I intend to investigate implementation technologies including Semantic Wikis. The final step will bring all outputs from the former steps together and build a prototype that will enable experimentation, testing and evaluation.

5 Conclusion and Expected Feedback

This paper details the early work of my PhD research. The idea is utilizing Semantic Wikis for collaborative authoring of knowledge spaces for AEH. This research aims to support personalized learning delivered in AEH. Feedback is sought on the following issues:

1. Comprehensiveness and soundness of the architecture and of the knowledge elements of the proposed system as detailed in Section 4.
2. Managing collaborative authoring processes involving a number of roles as illustrated in Section 4.
3. Testing. What are the most efficient ways to present learners with personalized access? Sufficient systems will need to be harnessed in order to ensure that the collaborative efforts that teachers make may be delivered to learners.

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