Extending Authoring for Adaptive Learning to Collaborative Authoring

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Abstract. Research on learning systems has led to the development of Adaptive Educational Hypermedia (AEH) systems that offer students adaptive learning and free exploratory lessons. Developing learning spaces for AEH, however, requires a lot of effort due to the complexity of the learning resources, consisting of learning content, domain knowledge and pedagogical knowledge, which are completed with adaptation rules. Current authoring tools for adaptive learning present drawbacks in terms of the reusability of their output and their collaborative work features. In this paper, a proposed collaborative authoring approach for developing adaptive learning resources is presented. The advantages of the proposed approach lie in the application of a collaborative method; the use of a learning standard, IMS Learning Design, for reusability and extensibility reasons; and the repurposing of learning materials available in existing open content systems.

Keywords: collaborative work, Adaptive Educational Hypermedia (AEH), domain knowledge, pedagogical knowledge, adaptation.

1 Authoring Tools for Adaptive Learning

Adaptive Educational Hypermedia (AEH) provides adaptation in learning. It controls learning adaptively and supports students in free exploration during lessons. Despite the advantages of such tools, the development of adaptive learning resources has remained a challenge. To gain adaptation, adaptive learning systems need to maintain knowledge spaces which consist of three elements: domain-related knowledge, pedagogical knowledge, and learning content [1]. A previous paper identified four problems in authoring for adaptive learning systems: usability, interoperability, efficiency and collaboration [2].

The implementation of collaborative authoring for adaptation support still remains an issue. One question in this area is how adaptation support can be collaboratively authored by a group of teachers or instructional designers. Current authoring tools support learning resources being developed through work by one or more authors. However, rather than enabling collaborative work completed through communication and coordination among authors, such tools support object reuse. The following table presents a comparison of three authoring tools for adaptive learning: AHA! [3], MOT

[4], and GRAPPLE Authoring Tool (GAT) [5] in terms of knowledge space structure, adaptations supported, output format, delivery tools, and the CSCW features they provide.

Table 1. Comparison of AHA!, MOT, and GAT

Criteria	AHA! Editor	MOT	GAT
Knowledge space	-Domain Model/Adaptation Model -User Model	-Domain model/DM -Goal model/GM -User model/UM	-Domain model -Concept relationship type model/CRT -Conceptual adaptation model/CAM -User Model
Adaptations supported	Content-based adaptation: adaptive navigation, adaptive presentation	Content-based adaptation, learning-flow based adaptation	Learning flow-based adaptation
Output format	Hyperdocuments in XHTML files with adaptation rules embedded	CAF/Common adaptation format	GRAPPLE Adaptation Language/GAL
Delivery systems	AHA!	WHURLE AHA!	GRAPPLE
CSCW features	-	-	-

From the table, it can be concluded that none of those three authoring tools support collaborative work. In addition, they manage resources in their own formats, which makes it difficult to deliver them to other Learning Management Systems (LMS) or Players; however, transformation functions can be used to overcome this problem.

This short paper presents an approach for collaborative authoring for adaptive learning systems. The remainder of the paper is organised as follows: Section 2 deals with the reasons why collaborative work is needed for authoring adaptive learning resources; Section 3 presents the proposed approach for collaborative authoring of adaptive learning resources. Finally, Section 4 presents conclusions and future work.

2   Why Collaboration?

There are some reasons why collaboration is needed in authoring adaptive learning resources. First, adaptive learning needs domain knowledge with learning materials, pedagogical knowledge with adaptation rules, and a learning model; developing all of these would be very time consuming. Previous research has studied the complexity of effort that teachers make to develop learning resources. Working individually on this takes a large amount of time because teachers need to have knowledge on all topics of the courses, have expertise in instructional design, and know how to use the authoring tools [6, 7]. Therefore, it is better for teachers to work collaboratively in a group.

Secondly, object reuse, as presented in existing authoring tools for learning resources, is not an appropriate approach for group work. Group work does not just involve dividing work into a set of tasks, allocating people to work individually on the

tasks, and, at the end, integrating all the produced objects. Authors should be aware of what other authors do and how their work might be appropriate to other authors' work. Previous research studies [8-10] have proved the need for communication among instructional designers when developing learning resources. These studies found that teachers get more benefit from discussing their work with colleagues than from learning theories on instructional designs.

Thirdly, imposing collaborative functions in authoring enhances the quality of the both authoring itself and its outputs. Past research studies have indicated that group work produces more meaningful results than individual work. That can be achieved through a consensus which considers all authors' insights and visions [11]. The quality of the process and output is influenced by the number of authors and the collaborative method used within the group [12]. Another advantage of collaborative work for learning is that collaboration allows the possibility of learning resources being continuously updated, thus keeping them relevant to students' needs [13].

Fourthly, the successful implementation of Computer Support Cooperative Work (CSCW) in other areas can be adopted to improve authoring for adaptive learning. Research on coordination methods, for instance, has shown that implicit coordination is suitable for large groups, whereas explicit coordination is more useful for small groups [12, 14]; those have successfully enhanced awareness.

3   A Proposed Approach: Enhancing Authoring by Collaboration

In this on-going research, a new approach to collaborative authoring for adaptive learning resources is defined. The approach is aimed at improving authoring through the use of a learning standard (IMS Learning Design/IMS LD), the reuse of existing learning materials, and the addition of collaborative features. IMS LD is used to enhance the reusability of output. Figure 1 presents the proposed authoring lifecycle based on the IMS LD authoring lifecycle [15], and a collaborative research framework that has been successfully implemented for authoring documents [16]. The proposed approach applies asynchronous distributed collaboration to enable authors to work collaboratively towards a common goal from different places at different times. Although authors do not need to work interactively at the same time, the possibility that authors may sometimes work concurrently must be supported.

Compared to previous authoring approaches for adaptive learning, the novelties of the proposed approach lie in the collaborative features added and the use of learning standards to manage learning resources. The collaborative feature implemented is *Note,* which enables authors to discuss, thus improving the progress awareness of authors [17]. The other feature is *History,* which maintains a record of updates made in the authoring process. This is important for authors as it informs them of what other contributors have done and to which objects during the authoring process. This information can help novice users to understand how the authoring process has progressed. With such features, problems that generally occur when carrying out group work, such as a lack of communication and tracking of history, can be minimised.
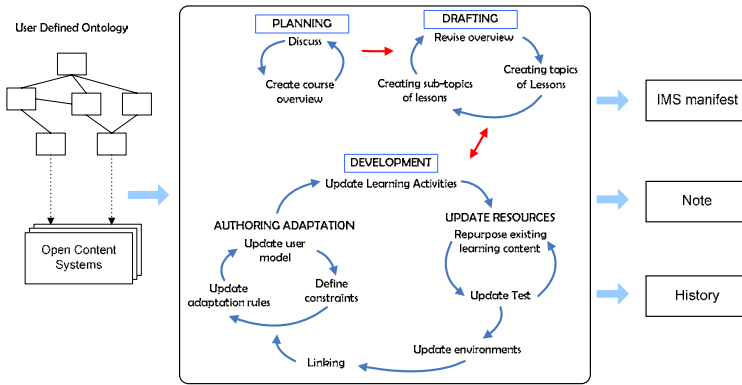
Fig. 1. The Proposed Collaborative Adaptation Authoring Lifecycle

In this approach, teachers are recommended not to focus on creating learning materials; instead it is suggested they use materials from existing open content systems. Teachers need to focus on creating learning activities, learning environments, learning flows, learners, and learning rules; all those objects are structured in an IMS manifest as the main output of the authoring process. Other outputs are Note, which contains all the discussions that occurred among the authors, and History, which records all updates made by the authors.

4   Conclusion and Future Work

A collaborative approach for authoring adaptive learning has been proposed to answer the need for collaborative work. It also considers the use of a learning standard, IMS LD, to enhance reusability. The new approach concerns the improvement of authors' awareness in a small group through the implementation of a collaborative feature, *Note*, and the maintenance of update histories.

The current work includes a prototype development and qualitative evaluation. It extends ReCourse, a currently standalone authoring tool for IMS LD. The extension includes transforming it into a web-based application and adding collaborative features. Future work will include the evaluation of qualitative inquiries, which will involve a number of teachers or experts who have experience in collaborative work or authoring adaptive learning system. For this, case studies will be developed using the enhanced ReCourse to create some topics for a programming course.

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