Co-authoring personalised educational content: teachers’ perspectives

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Abstract. In this paper we investigate how authoring activities of adaptive educational hypermedia content may cultivate e-learning content development skills, and promote reflection on learning design issues. Developing content for adaptive educational hypermedia systems is a demanding task that engage authors in self-explanatory activities and deep investigation of resources that correspond to learners’ multiple profiles and confront to specific learning design principles implied by the authoring tool. In this paper we present an empirical study where teachers worked in groups and used INSPIRE Auth to author content for INSPIRE and review content developed by peers. The strategies they used, the benefits they recognised and the difficulties they faced in this process, are described. The possible implications for extending the design of INSPIRE Auth are briefly discussed.

Keywords. Authoring tools, personalisation, adaptive educational hypermedia, knowledge representation, peer review

Introduction

Authoring tools aim at decreasing the cognitive load involved in various design steps of a learning environment. To this end, authoring tools explicitly represent the design of the learning environment and guide authors in controlling its main functionalities. Especially, in an adaptive hypermedia system, a final product of the authoring process is the internal representation of knowledge and information in a special form that is understandable and manageable by the system [1]. Authoring content for adaptive hypermedia educational systems is a quite demanding task, where learner modeling and adaptive functionalities of the system should be also considered. The development of authoring tools for personalised learning is a well developed research area that has already produced a variety of approaches for specifying and prototyping software solutions and content authoring [2] [3]. Main challenges, especially in the area of technology enhanced learning and learning design, remain the pedagogically sound development of designs and the teacher-practitioners’ engagement in the learning design process [4] [5]. Existing authoring tools have several

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limitations in assisting teachers understand the implications of learning theories when designing instruction [6].

In this paper, we argue that the authoring process itself, might prove a useful learning experience for cultivating skills for learning design. Authors using an authoring tool, learn about the domain knowledge by designing instruction for their learners [7]. Thinking about the appropriate content and assignments, authors engage in self-explanatory activities and as a consequence, better learning results are obtained. It is also suggested that through engaging learners more systematically in authoring their own works they [8] (a) develop critical-thinking skills as authors, designers and constructors of knowledge and (2) learn more for the process than they do as knowledge recipients. In the SimQuest project [9] students work on activities that involve authoring domain models, whilst AnimalWatch tutor [10] is an authoring tool for students for authoring arithmetic word problems for their peers.

In the research presented in the paper we investigate the authoring process of adaptive educational hypermedia systems and particularly the content authoring process from teachers’ perspective. Adaptive content authoring is approached as an opportunity for cultivating skills for designing e-learning content, and promoting reflection on learning design issues such as the importance of learning activities in actively engaging students, or the need to provide a learning workflow to support effective learning. An empirical study has been conducted where an authoring environment was used for learning by doing. Teachers, that were also students, worked in groups in order to develop content for INSPIRE and used the INSPIREAuth tool to author the content and review content developed by peers. Teachers’ strategies and perspectives on the particular learning design approach are investigated and implications for the design of the authoring environment are discussed. Preliminary results provide evidence about the potential of the content authoring process in cultivating learning design skills.

The paper is structured as follows. In Section 2 we investigate the range of necessary skills for authoring content. Then in Section 3, we present the authoring tool INSPIREAuth and several functionalities that guide the authors through the authoring process based on the learning design implied by INSPIRE. The empirical study and preliminary results are described and discussed in Section 4.

1. Authoring content for adaptive educational hypermedia

The domain model of an AEH is usually represented as a network of domain concepts [1]. The concepts are related with each other forming a kind of semantic network which represents the structure of the subject domain. Thus, developing the domain model of an AEH system demands the identification of the domain concepts and their interrelations, i.e. the knowledge space needs to be structured. Moreover, content pages need to be designed for the domain concepts and linked to form a network of hypermedia pages with educational material, i.e. the hyperspace needs to be structured and linked with the knowledge space. The above processes are usually guided by the design of the AEH system.

As far as the content authoring process is concerned, first of all, authors need to modularise the content into reusable educationally meaningful elements (allowing the system to re-use them under different contexts and learners’ profiles) and design the hypermedia representation. To this end, the author needs to determine the learning
outcomes, analyse the content and modularise it into primitive components (concepts) which reflect the main topics of the domain and are physically and conceptually connected and interrelated. Then, the author needs to develop educational material for the domain concepts. In this process the author should take into account that the content will be used by a variety of learners. Thus, the author should develop educational material for the domain concepts in multiple formats and present information from multiple perspectives allowing those with different, for example, knowledge level or style, accomplish learning tasks in different ways. Critical characteristics of the educational material are the degree of interactivity and the learner control opportunities offered. To this end, skills on using or developing content for the Web are helpful, including information retrieval and designing activities using multimedia representations or computer simulations.

2. INSPIRE Auth: authoring adaptive content

INSPIRE [11] offers personalised courses and support to learners by offering adaptive navigation advices based on learners’ individual characteristics (adaptive navigation support technique) and personalised versions of the educational material pages with alternative sequencing of the modules involved based on learners’ learning style (adaptive presentation support technique). The notion of learning goals that learners select to attain is used in order to build a hypermedia structure that provides an overview of how the relevant content fits together. Learners are invited to interact with the educational content provided for a goal in order to gradually [12] (a) speculate on newly introduced ideas by answering to introductory or self-assessment questions, following instances of the underlying concepts and real-life analogies, studying the theory, (b) become able to apply the underlying concept to specific case(s) by undertaking experimentation activities, working with computer simulations or microworlds, studying hints on the theory that concentrate on specific outcomes, solving small problems, (c) find a new generality, principle, procedure by accomplishing specific tasks in the form of small projects.

INSPIRE Auth supports authors to use the authoring cycle as a conceptual framework for thinking about the structure and content of the domain knowledge based on the learning design implied by INSPIRE. The aim is to provide authors with a design approach for building a hypermedia perspective of the domain taking into account learners’ needs and preferences. Instructors and learners are authors in INSPIRE Auth with different rights.

A form-based functionality has been developed to guide authors in the content authoring and evaluation process. Moreover, several visualisations of learners’ current state and progress support instructors in identifying students’ needs, preferences and strategies, and accordingly evaluate or revise the content. The authoring tool offers different functionalities to instructors and learners. They are both allowed to develop their own content following a specific learning design. However, instructors have full access to the content of INSPIRE, whilst learners are able to update and delete only their own content. Moreover, both are allowed to preview and evaluate content developed by peers. To this end, a peer review functionality is provided through which authors are allowed to (i) act as reviewers of educational content, submitting a special review-form, (ii) receive reviews of their content and revise it accordingly.
Currently, INSPIREAuth supports authors through the different stages of creating content for an AEH system [1] (a) structuring the knowledge, i.e. the domain model, (b) structuring the hyperspace, i.e. a network of hypertext pages with educational material, (c) connecting knowledge with educational material consisting of multiple representations that match learners’ varying needs and styles. Several tools and forms are provided to support authors in designing content based on the instructional framework of INSPIRE and define specific parameters of system adaptation [13].

Structuring the knowledge. The domain model of INSPIRE consists of learning goals and concepts. The domain model is a natural framework for goal modelling which is simply a target subset of domain concepts to be learned; learning goals are composed of a sequence of elementary sub-goals called layers each one composed as a set of concepts to be learned. Thus, the knowledge space is formed by a set of learning goals and concepts. Concepts are related to each other through prerequisite links and grouped in layers from the more general ones to the more specific. INSPIREAuth offers a variety of tools and forms for authoring and structuring the components of the knowledge space (goals, concepts) such as the tools for goal and concept management (see Figure 2), the forms for goal and concept authoring.

Connecting knowledge with educational material. The enhanced concept-based hyperspace approach [1] is used for connecting the knowledge space with the hyperspace forming the information space. Following this approach, multiple pages describing the same concept are connected to this concept in the information space and hyperspace. Each concept has a ‘hub’ page in the hyperspace which is connected by links to all educational material pages related to this concept (the same stands for the goals; the goal introductory page is connected by links to all concept ‘hub’ pages related to this goal). In the case of INSPIRE, each outcome concept is associated with: (a) an introductory page presenting the scope and learning objectives, (b) three types of educational material pages which correspond to the Remember, Use and Find levels of performance [12] (consist of a variety of knowledge modules: activities, examples,
exercises, assessment questions), (c) an assessment page, and (d) a summary page. This way, a role is assigned to each page link distinguishing several kinds of connections between concepts and pages and supporting system adaptation. For example, INSPIRE distinguishes the level of performance that a page supports and graphically annotates the educational material pages to reflect the progress of a learner.

**Figure 2.** Graphical representation of the content structure organised in three levels: goals, concepts and educational material pages. In this screenshot the content of the first goal has been expanded.

INSPIRE*Auth* offers specific forms for authoring different types of content pages that correspond to alternative levels of performance. These forms prompt the author (a) what should be entered in textboxes that correspond to appropriate knowledge modules of multiple types such as examples, activities, assessment tests, and (b) how these pages or modules should be metadescribed through a set of metadata (general, pedagogical and technical) in order to support copyright issues, reuse of material, and the adaptation mechanism.

Thus, authors are guided in linking the knowledge with the hyperspace: they are stimulated to define a conceptual structure for each goal and the corresponding educational material pages for each concept (see in Figure 1 tools for content pages administration). Finally the functionality of the Information space structure preview illustrated in Figure 2 provides a graphical representation of the information space aiming to support learners link the knowledge with the hyperspace. 

**Evaluating students' current state & progress.** Teachers are provided with information about learners’ profile (learning style & knowledge level on the domain concepts) and multiple representations of interaction data reflecting their global activity compared to the model suggested by the tutor, learning trails, and progress. These representations aim at providing interpretative views of learners’ learning behaviour and support teachers in acquiring a comprehensive image of learners' work, performance, interests and needs [14].
Designing for multiple learners’ profiles is a demanding task, and by providing access to students’ profiles, the aim is to support teachers in identifying learners’ state and progress and accordingly evaluate and revise the content. For example, in Figure 3, information is provided about a student’s interaction with the content of a goal. For each concept of the goal, the area (i) of Figure 3 illustrates: the time spent along with the semantic density of the resource provided by the tutor in the content metadescription, visits along with total number hits on the content, level of performance on different types of questions and the way this was evaluated (automatically by the system or learner defined). Accordingly, area (ii) of Figure 3 illustrates learners’ activity with the relevant educational material pages of different types along with the semantic density of the resource provided by the tutor.

3. Empirical Study

The study performed to investigate teachers’ perspectives about the usefulness of the content authoring process for designing learning using INSPiREAuth. To this end, we aimed at identifying teachers’ (a) strategies in the development of lessons for students of multiple profiles, (b) opinions on the benefits and restrictions of the authoring process, (c) perspectives on the peer evaluation process as a peer support opportunity.

In this study, 22 students (13 females, 9 males) of the MSc in Educational Technology organised by the University of Athens and the School of Pedagogical and Technical Education, participated. The students were attending the course ‘Lifelong learning and ICT’ during the winter semester of the academic year 2008-2009. The students of the particular MSc are preservice (10 students) or in service teachers (12 students) of a variety of disciplines such as language teachers, science teachers, engineer and computer science teachers. The particular group was considered appropriate for the evaluation of the authoring procedure and environment since most of them are experienced teachers working on the public or private education sector.
During the study, students had the double role of students learning about adaptive educational hypermedia systems in an e-learning context but also of teachers and domain experts reflecting on the authoring process and a particular learning design for distance learning. In particular, they worked individually and in groups in order to develop educational material following the learning design implied by INSPIRE and author the content using the INSPIREAuth authoring tool. They also evaluated their peers’ educational material. At the end, they completed a questionnaire evaluating their learning experience, the authoring and evaluation procedure. The forum of an e-class environment of the particular course was used as a helpdesk and a shared space for collaboration.

3.1 Method

Students worked individually and in groups undertaking multiple roles. They initially worked as domain experts developing educational material following a particular learning design. Then they worked as reviewers evaluating their peers’ solutions and the authoring experience (usefulness, support in authoring content). The study took place through the whole semester.

In particular, students’ work organised in three phases as follows.

1st Phase (duration: two months): Initially, students had to develop content for a goal of their choice. At this phase students collaborated in groups. They had to select two or three main concepts for the specific goal and develop multiple types of content for these concepts following INSPIRE’s design. They initially produced a printed version of the content. Then they used INSPIREAuth to author the content. The main guidelines were to develop material of high interactivity (using simulations, applets, microworlds), promoting learners to explore and investigate the main concepts of the domain knowledge.

2nd Phase (duration: fifteen days): Students worked individually for reviewing content developed by their peers. After the submission of the reviews, students completed an evaluation questionnaire about this learning experience.

Table 1. Evaluation Questionnaire of learners’ content development, authoring and reviewing experience

<table>
<thead>
<tr>
<th>Section A. Content development process</th>
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<tbody>
<tr>
<td>1. Describe the procedure you followed in the content development process based on the learning design of INSPIRE e.g. step by step (like resource collection, concept selection, page development, learning objectives posed), goal &amp; content selection criteria, content structuring, learning approach adopted etc.</td>
</tr>
<tr>
<td>2. Which was the added value in this development process for a teacher or a student?</td>
</tr>
<tr>
<td>3. What was problematic or indifferent in the development process?</td>
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<tr>
<th>Section B. Authoring process</th>
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<tr>
<td>1. Describe the way you used the authoring tool to enter the content in INSPIRE.</td>
</tr>
<tr>
<td>2. Which was the added value in this authoring process compared to the development of printed content;</td>
</tr>
<tr>
<td>3. What was problematic in the authoring process? How you faced difficulties?</td>
</tr>
<tr>
<td>4. In which phases of the project you would need support and ideas exchange with (a) your peers (b) the teacher. Which communication tools would you use;</td>
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<tr>
<th>Section C. Peer review process</th>
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<tbody>
<tr>
<td>1. Describe the procedure you followed in the peer reviewing process</td>
</tr>
<tr>
<td>2. Comment on the suggestion “Students as reviewers should support a high quality result that will impact the products of both learners, i.e. author and reviewer”; Do you agree;</td>
</tr>
<tr>
<td>3. I would prefer to take</td>
</tr>
<tr>
<td>‡ initially the teacher’s and then my peers’ reviewing comments</td>
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<td>‡ initially my peers’ and then the teacher’s reviewing comments</td>
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<td>‡ reviewing comments by particular peers</td>
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<td>‡ the teacher’s reviewing comments</td>
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3.2 Data collection and analysis

The data collected during the study include: (a) messages posted at the forum of the eclass, (b) content & reviews developed by groups, (c) learners’ evaluation questionnaires. The evaluation Questionnaire was organised in three sections (see Table 1): (a) questions about the process of developing content based on the particular design, (b) questions about the process of authoring the content using the INSPIREAuth tool, (c) questions about the process of evaluating the content developed by peers.

Below we present an initial analysis of the questionnaires reflecting students’ strategies when developing content and opinions about the benefits and drawbacks of working on a particular learning design.

3.3 Results & Discussion

*Strategies used through the development of content for students of multiple profiles.* Different strategies in the authoring process of educational content for INSPIRE were identified based on students’ descriptions. Actually most students followed a number of similar steps. Alternative orderings have been observed constituting different approaches to the authoring process. Main steps of the authoring procedure consist: (a) resource exploration, (b) familiarization with INSPIRE and the learning design approach through the guidelines offered or a prototype – a goal example, (c) decide on the goal, main concepts and learning objectives based on the domain, the design specifications, students’ needs or knowledge, (d) content development focusing on multiple representations promoting learner involvement. They search for or develop microworlds that students may interact with, make and test their own hypotheses.

Different approaches can be summarised as follows:

- Most groups explore multiple types of resources, in order to decide on the topic and main concepts, then they studied the design approach and collaborate to develop content based on the proposed principles.
- Other groups first select the topic, and then try to reuse existing content matching the objectives of the proposed approach, such as microworlds, simulations, examples. Then select concepts and set learning objectives. They adapt the content based on the specific requirements. In this case the design approach, was used as a guide for adapting and organising the content.
- A few groups start from studying the design approach, then select topic and main concepts and develop or collect multiple types of content. The content is finally structured based on the design principles.

Analysing students’ answers we observed that argumentation inside the groups on the topic, the content structure, educational material, and the design principles, was stimulated by the authoring process. Critical thinking on learning design issues and students’ needs was also recorded. It was mainly focusing on the development of multiple types of content aligned with the students’ preferences and knowledge level, and of authentic activities that promote learner engagement and control. Main considerations in this process were (a) needs and preferences of the target group of students, and (b) the development of a stimulating learner-centered environment where learners work autonomously, interact with the content and control their learning.

Implications for the design of the authoring environment are investigated concern the support that might be offered at the authoring process level or at the development
level, aiming at allowing authors to share or collaboratively develop content, promote argumentation and ideas exchange on critical steps of the authoring process.

**Benefits for designing learning and restrictions of the authoring process.** Students reported as main benefits of the authoring process: (a) the granularity of the design approach for developing e-learning content, (b) the integration of multiple representations in a comprehensive structure, (c) the hypermedia content structure and the content modularity that demands authors to synthesize content to a meaningful whole giving a sense of how all the information fits together, (d) the requirements for developing content for distance learning and particularly e-learning, (e) the need to design for all taking into consideration students’ individual differences, (f) the need for resource exploration in order to develop multiple types of content.

The specifications of the design approach demanding the development of multiple types of representations, interactive e-content, stimulated ideas generation. Moreover, students suggest that this process cultivates skills for developing e-learning content and analysing digital media necessary for e-learning. It also enhances awareness on the content development process since it involves many parameters of content development that were ‘obvious’ such as the corresponding level of performance of each content page, the descriptions of assessment queries including feedback or weights that reflect the importance of each question, or the metadescription of the content including pedagogical parameters like the semantic density of the resources. They also report that the authoring process of personalised content guided them in organising and orienting their knowledge and ideas towards the students’ perspective.

However, several students, although acknowledge the importance of the experience of working on a particular learning design approach in improving their own design strategies, they also suggest that the need to adopt one particular approach was quite restrictive “demanding adaptation of the individual teaching approach to the particular one”. A representative comment was that this approach is ‘useful and restrictive’! They also suggest that the particular approach may support teachers in organising teaching even in the classroom. Students also characterised the authoring tool as a useful tool for teacher training.

Based on the above comments, an important implication for the design of the authoring environment is to introduce flexibility in the domain structure proposed, allowing authors to make their own decisions at particular steps of the learning design approach and reflect their own perspective.

**Perspectives on the peer evaluation process, needs and support offered.** The peer review process was also an interesting experience for students. They worked on the selection of evaluation criteria, and apply the criteria to provide an objective review. Students characterised the whole process quite supportive in cultivating evaluation skills that are necessary for the development or selection of appropriate content (‘The reviewer evaluates the peer work but also his/her own work’). Most students found it as ‘objective’ since it comes from peers sharing the same problems and objectives - just one student argue that she didn’t feel comfortable as a reviewer due to limited experience with the topic and the role. A main advantage of the review process was that it made them consider their student’s perspective, since most of them reported that they ‘evaluate the content initially from a students’ perspective and then as a teacher’. This is due to the double identity of the particular group being students but also teachers. They also reported that commenting on peers’ ideas requires consideration of how the ideas of others work and this process gives fresh ideas. Thus most of the students faced reviewing as ‘an opporunity for self-assessment’ and helpful for both students.
As far as the type of support needed through the authoring process, most of the students report several problems. They mainly need help to resolve different issues at the content selection, content structuring or activity development stages and technical problems when working with INSPIRE-Auth. In both cases, they found quite supportive the opportunity to co-author content working in groups, as well as the e-class forum which played the role of a helpdesk. They seem to appreciate a lot support coming mainly from peers but also from the teacher especially on learning design issues.

4. Conclusions and future plans

Teachers by authoring personalised content using the authoring tool that makes explicit the learning design requirements concerning content objectives and organization, elaborated on several learning design issues and made their own proposals. They characterised the process as quite demanding but also helpful in making them speculate on learners’ needs and elaborate on the subject matter.

Currently, the authoring tool supports teachers in understanding and evaluating the particular design. In our future plans is to extend the tool to allow teachers to construct their own designs and evaluation of these designs.

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