An intuitive Authoring System for a Personalised, Social, Gamified, Visualisation-supporting e-learning System

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ABSTRACT

Adaptive Educational Hypermedia (AEH) offers more advanced personalisation and customisation features to the field of e-learning compared to the outdated static systems (where every learner is given the same set of learning materials). AEH can improve the usability of hypermedia, by providing a model of various qualities of a learner and apply this information to adapt the content and the navigation to the requirements of the learner.

However, authoring adaptive materials is not a simple task, as an author may be pressed for time, or simply lack the skills needed, to create new adaptive materials from scratch, and thus any improvements in the reuse of adaptation specification (application of adaptive behaviour rules) is a major help in the authoring process. The aim of this study is thus to expand a personalised, social, gamified, visualisation-supporting e-learning system based on Adaptive Educational Hypermedia (Topolor), by implementing an easy-to-use, intuitive authoring tool and to evaluate it with experts in the field as well as high-school teachers.

Keywords

Authoring; adaptive hypermedia; e-learning; visualisation; look&feel; social learning.

1. INTRODUCTION

Current learning management systems (e.g. Blackboard, Sakai, etc.) still offer a static approach to the delivery of learning materials. This means that every learner is given the same set of learning materials. Adaptive Educational Hypermedia (AEH) provides a personalised and customised approach to the field of e-learning than the outdated static methods. The AEH approach has been shown to be useful, as it displays more relevant content, according to the information stored in various models (user, goal and presentation model). However, a known issue in adaptive hypermedia is the *authoring process*. A literature review [1,2] revealed that authoring is the bottleneck for adaptive course usage. It needs to be improved in terms of interoperability, usability and reuse. This is especially true, as Adaptive Hypermedia authoring is considered to be challenging and laborious. Thus, a hypermedia system should render it easy and natural for the already burdened authors to create adaptive courses.

In this paper, this issue is addressed in two ways: firstly, a simple authoring tool is proposed, for an e-learning system, Topolor, which has already been extensively evaluated in various countries,

in terms of student perception of deliverance [3]. The second approach is to create a similar look and feel to the original system, due to the fact that authors may already be somewhat used to that, as well due to the fact that Topolor itself has been praised in various contexts due to its good design and look and feel – which itself emulates tools familiar to online users. This approach is then evaluated with experts, as well as teachers, and results are reported.

2. RELATED WORK

AHA! [4] was an open source project, with a web-based adaptive engine built on Java servlet technology. It offers authoring through Java Applets with general purpose user-model and adaptation rules. It uses XML extensively and supports a MySQL database. AHA! provides *content adaptation*, by conditionally selecting pages, fragments or objects and *link adaptation*, by conditionally changing the colour of link anchors and adding icons. Although AHA! is known as a powerful system which provides many authoring tools, it is considered complicated for first-time users.

The Grapple Authoring Tool (GAT) [1] has three main components: A Domain Model authoring tool (DM), for creating a conceptual representation of an application domain (or "course"), a Pedagogical Relationship Type authoring tool (PRT), for defining types of pedagogical relationships between concepts and their associated adaptation, and a Conceptual Adaptation Model (CAM) authoring tool (also called 'Course tool') for defining the pedagogical structure of a course. The GAT toolset is set up to allow for very general types of relationships and adaptation rules. Although GAT is a very powerful system, it has many tools which have also been shown to be complex for authors.

The Adaptive Course Construction Toolkit (ACCT) [5] was created to provide the course developer with tools to design, test and deploy adaptive personalised e-learning, based on pedagogical support and instructional design principles. ACCT, similar to its predecessors, also supports 'separation of concerns', for reuse. Like GAT, it uses drag&drop interfaces. The adaptation, however, is to be written in XML (as a narrative). ACCT doesn't allow for test authoring.

APeLS [6] is a personalised e-learning service based on a generic adaptive engine. Authors have evaluated the usability and effectiveness of using the multi-model, metadata-driven approach for producing rich adaptive e-learning solutions that remain content and domain independent. One of the strengths of APeLS is that it can utilise many pedagogical approaches and

models, to produce highly flexible solutions. However, it still asks its authors to use XML to edit pedagogical models, similar to ACCT, and does not provide the addition of adaptive tests.

VASE 2.0 [7] utilises a block-based programming framework called Blockly [8]. Block-based programming offers visual units of work, called 'blocks'. Blocks can be dragged out onto a workspace, where they can be arranged and connected together to build a program. Block-based programming tools are substantially more learnable than text-based programming. They allow for [7]: *forgiveness* - users do not need to memorize programming syntax; *feedback* - to prevent users from making syntactical errors; *real-world metaphor* - blocks look like puzzle pieces, which allow users to understand which blocks can and cannot fit together, via the connector shape. Moreover, in VASE, in principle, any language grammar can be represented. However, VASE only creates adaptive behaviour, and content needs created with other tools (e.g., MOT [2]). Moreover, VASE doesn't allow creation of adaptive questions.

In the following, we describe the e-learning system for which the authoring system described in this paper is created, in order to understand the restrictions and requirements of its creation.

3. Topolor

Topolor [3] is known as a social adaptive personalised online learning platform. It has been used as an e-learning tool for postgraduate students in the University of Warwick's Computer Science Department, as well as abroad, in several countries. The system was developed to create a familiar-feeling online educational environment for learners, with high system usability, based on several hypotheses regarding social features, personalised recommendations and social media interaction features (such as Facebook 'likes'). The system involves a broad range of features, like listing, providing adaptive e-learning contents for the learner, enabling social integration that meets learner's requirements. Screenshot (Figure 1) below shows the 'Topolor Home' and 'Module Centre' sub-systems in Topolor, further briefly described below.

3.1.1 Home page and Facebook-like appearance

The home page contains a left-sided menu that enables the user to check messages, access a list of questions and answers, note list and To-Do list. It also contains a list of recommended learning peers with the ability to communicate with them. Additionally, an information flow wall is provided, allowing users to share contents or comment on any favourite posts. A posting tool is also presented, to enable learner to communicate via several means, e.g., messages, current status notes and questions. This look-and-feel might remind some readers of Facebook, with a good reason – Facebook is something especially the current learner generation is very familiar with, and thus provides them with an intimate feel – in spite of the different functionality –to increase the usability of Topolor [3].

3.1.2 Topolor – Module page

This page provides the learner with topic recommendations, based on the number of tags or topics currently being studied. Mutual peers are recommended, based on the number of questions they have asked, or correct answers given. Learners can send messages

to each other via clicking on a learner's avatar and filling in a pop-up messaging box. They can also comment on topics, or ask tagged questions via Web2.0 tools. Moreover, learner can create, edit, tag and share both notes and To-Do lists. The navigation buttons 'Previous' and 'Next' are used to explore the prerequisite and next topics, based on the recommended path of learning. The 'Take a Quiz' button redirects the learner to the topic-oriented quiz page.
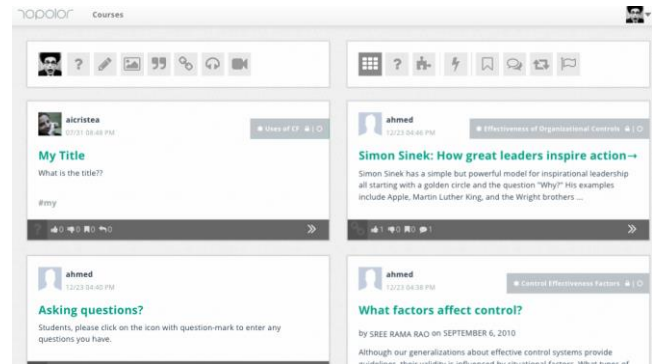

Figure 1. A Screenshot of Topolor

Next, the methodological approach for this paper is presented, for the creation of the Topolor authoring system, and its evaluation.

4. Methodology

The Topolor system was extended, to include an authoring module, to allow authors to create modules, topics and quizzes related to the topics and, indirectly, to the module (course) containing the topics. These quizzes are a means to assess students' knowledge on a particular/specific topic, and could be used for a summative or formative assessment.

The Topolor authoring system was further improved after several rounds of evaluations with experts, with two final evaluations of the system with experts and teachers, respectively, reported here, conducted in April 2018.

The implementation of the Topolor authoring system and its evaluation method for the final round are briefly described below.

4.1 Implementation

The implementation of the authoring system included features to assist the author in creating adaptive content as well as allow for assessment, as explained in the next section.

4.1.1 Module (Course) Overview

The authoring system for Topolor needs to be able to create firstly modules. Thus, an interface has been created (see Figure 2) with the following functionality:

- It loads in all modules (courses) the user (author) has created, as well as all topics and sub-topics of that module.
- It displays modules and sub-topics to the user, where each topic is encapsulated by its parent module.
- Users (authors, teachers, module creators) can choose to edit a topic/module, delete it or add a topic/sub-topic, depending on which button they click.
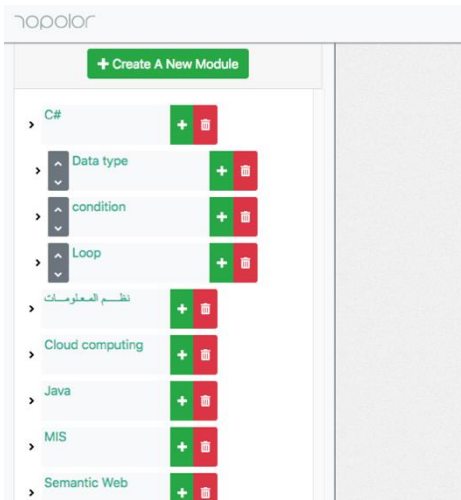
Figure 2. Modules in the Topolor Authoring Tool

4.1.2 Module, Topic and Sub-Topic Design

To emulate the hierarchical structure of content in Topolor, the authoring tool for Topolor has to allow for editing of modules (courses), as well as topics (elements in the courses), sub-topics, etc. The editing interface for a topic (or sub-topic, sub-sub-topic, etc.) is shown in Figure 3, and has the following characteristics:

- The layout of this page changes, depending on whether a module, topic, or sub-topic is being created/edited.
- Users can input a title, content (this can include HTML tags), tags (where they can select from a list of pre-existing tags or create a new tag), and state for topics if they have a pre-requisite and whether it is optional.
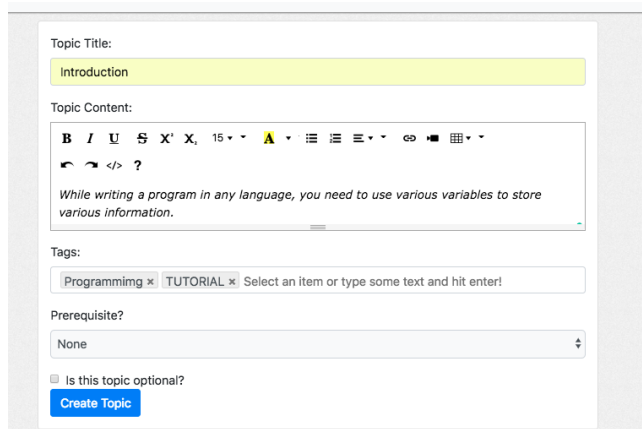

Figure 3. Creating topic and sub-topic in the Topolor Authoring Tool

4.1.3 Quiz Design

Topolor generates adaptive quizzes for each module (course), based on a database of questions that are each related to a given topic (or sub-topic). The authoring system thus had to allow for such quizzes to be created, and properly linked to the topics of relevance. Thus, the authoring interface for quizzes, as depicted in Figure 4, has the following functionality:
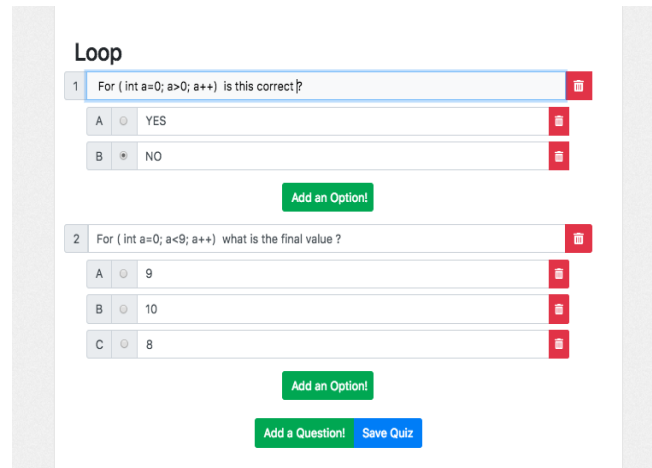

Figure 4. Creating a Quiz in the Topolor Authoring Tool

- It loads in all pre-existing questions for the selected topic.
- Users (authors) can edit existing questions or add new questions to the topic with up as many options as they wish (a threshold of 26 is set by the system, but this can be changed, if necessary).

4.2 Evaluating Usability and Functionality of the Topolor Authoring System

We used a survey, as well as interviews, with eight experts in Adaptive Educational Hypermedia System (AEHS) from two universities, from Departments of Computer Science in the UK and Japan, all experts in online education, as well as experts – or knowledgeable – in adaptive, personalised learning, besides social learning. In total, three professors and five PhD students were invited to participate in this study.

Additionally, in order to evaluate the system in a real-life working and learning environment, another evaluation was done with seven teachers (primarily a group of teachers at the High School for Boys in Essex). All participants were asked to use the system, by creating courses, adding topics, sub-topics, quizzes and tags, before proceeding to give their feedback in a semi-structured way.

Specifically, to evaluate the overall usability of the Topolor authoring system, all participants were asked to fill in the well-known System Usability Scale (SUS[1]) questionnaire. Quantitative data analysis techniques were employed to process SUS data. The questionnaire consists of ten questions rated on five-point, where 1 = strongly disagree and 5 = strongly agree, as shown in Table 1. Additionally, to find out if the Topolor authoring system behaves the way it is supposed to, all participants have been interviewed, and asked to answer seven questions, to share their experiences and feelings about the functionality of the Topolor authoring system. Each statement (question) asks about one of the authoring system functionalities, features, tasks in terms of usefulness. Interviewees were also asked to comment on their answers. The list of functionality-related questions is depicted in Table 2 below.

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[1] usability.gov

Table 1. System Usability Scale Questions

	SUS Questions
1	I think that I would like to use this system frequently.
2	I found the system unnecessarily complex.
3	I thought the system was easy to use.
4	I think that I would need the support of a technical person to be able to use this system.
5	I found the various functions in this system were well integrated.
6	I thought there was too much inconsistency in this system.
7	I would imagine that most people would learn to use this system very quickly.
8	I found the system very cumbersome to use.
9	I felt very confident using the system.
10	I needed to learn a lot of things before I could get going with this system.

Table 2. Questions about Functionalities

	Functionality Question
Q1	How does this system compare to your normal planning process?
Q2	Are the questions created with this tool useful for your students?
Q3	Is the content created with this tool useful for your students?
Q4	Is this system generally useful for your purposes?
Q5	What purpose would you use this system for?
Q6	Do you believe this system could be used to create a useful experience for your students?
Q7	How does this system compare to other authoring tools you have previously used, in terms of functionality?

5. Results

5.1 System Usability Scale (SUS)

According to the SUS results with experts, the SUS score for the Topolor authoring system is 81.9 (σ=11.08, median= 86.3).

In addition, the average value of the questionnaire over seven participants in a working environment (teachers in a high school) was 79.2.

Consequently, the usability level is perceived as being excellent, which meets our initial expectations.

5.2 Qualitative Feedback from Experts

In addition, according to the interview data, in the first evaluation, we received qualitative feedback from both experts and PhD students. Overall, the results indicate that the Topolor authoring system is perceived to be feeling somewhat similar, but at the same time being more flexible and easier, when compared to the normal planning process (Q1). For instance, 6 (out of 8) participants have mentioned that this system is easier than the normal planning process. In fact, one of the respondents explicitly mentioned that "it is much more flexible, reaches a wider audience, easy to use". On the other hand, one participant raised the issue of there being no apparent difference between the Topolor authoring system and previous e-learning products he has used. This seemingly negative comment shows in fact that the look and feel of the tool is very similar to other familiar HTML or online course editing products. However, the tool actually creates adaptive material based on gamification, social interaction and visualisation, without burdening the author or making the author feel any additional constraints, when compared to linear hypermedia authoring. Thus, the relatively complex goal is achieved in a simple way.

Additionally, 7 (out of 8) experts agreed that the questions creation tool is very useful (Q2). The qualitative feedback also indicates desiring additional features, where one respondent said *"Yes, however it will be more useful to allow essay questions"*. Currently, essay questions cannot be implemented in the authoring system, due to the restrictions imposed by the delivery system Topolor: as Topolor provides only one type of question (simple choice questions). This is a reflection on all functions which are implemented in this authoring tool, which are dependent on the functions of Topolor. This points to possible improvements of the Topolor delivery system, too, together with the authoring side.

For Q3, 7 (out of 8) experts agreed that the content created is useful for students.

Furthermore, when the participants were asked if the system is useful for their general purpose (Q4), the majority answered "Yes". Some participants added more comments of a positive nature - for instance, one participant explained: "Yes, it will allow students to learn using multiple methods".

For Q5, experts mentioned that they would mainly use the system for creating courses (6/8) and creating quizzes (5/8).

On Q6, all participants mentioned that this system could be used to create a useful experience for students. One participant liked the tools for embedding content from external sources, such as videos.

In response to Q7, the majority of those who responded to this question felt that, in term of functionality, Topolor is easier to use than other authoring systems. For instance, one participant said: "*The authoring system is easy to use and the assessment part of the authoring system can be useful, to get feedback on the learning student".* Another respondent said: "*It's relatively straightforward".* On the other hand, two interviewees mentioned that Topolor is similar to other authoring systems, which, as said, further confirms that the tool has similar look and feel to previous tools, although its functionality is different.

5.3 Qualitative Feedback from Teachers

For the evaluation with the 7 teachers of high-school kids in Essex, Q1, comparing the Topolor Authoring System to the teachers' normal planning process, received mainly positive responses. Some teachers were very positive, due to the similarities of processing with their subject (e.g., Economics, where multiple-choice questions are commonly used at all assessment levels). Other positive feedback was that the system provided a platform for students to access content outside of school. An interesting response was that one teacher in particular

could see the tool as being very useful to the school in general, providing the capacity for newly recruited teachers to view Schemes of Work (SOWs) in an easily understandable waterfall format - replacing the current system of excessive physical documents being shared. Another teacher commented on the degree of novelty provided by an online system which will potentially increase engagement. The same teacher also commented on how the system provides flexibility and independence to the student experience. Another teacher commented on the potential for the system to represent a platform for staff cloning content and sharing SOWs, while also providing a 'one-stop-shop' for resources to students.

For Q2, on the usefulness of the questions created, one teacher expressed caution for multiple choice questions (MCQ). Three teachers were positive, one mentioning the applicability to revision purposes, the other for GCSE and A-level training, where MCQs are part of the exam, and the third mentioning the usefulness of such questions as a diagnostic tool.

On Q3 on content usability, one teacher praised the good waterfall effect, with clear subtopics; another one was happy not to have manual content input and to be able to cut&paste or upload pre-loaded files. Another one liked the tools for embedding video content. One teacher was worried that, for Maths, there should be more 'equation' functionality, like graph sketching, entering equations, etc. Another one also was worried that the system was only text-based (which was not the case, but may have been misunderstood that way).

For Q4, teachers mentioned the usefulness for cover-lessons, end of topic exercises, revisions; another teacher praised it for new staff or absent students; another mentioned its potential; the last commenting teacher agreed to the usefulness, but was worried about the uploading time it would take.

For Q5, teachers mentioned that they would mainly use the system for revision (5/7), learning (4/7), distance-learning (4/7). Other usage mentioned was when pupils are ill, away from school, to give them access to material for catch-up; for new staff to see SOWs; and for homework.

For Q6, most replied that this system could represent a useful experience for the students, as it creates a degree of novelty, and may increase engagement, allowing students to learn flexibly and independently; that it would represent a 'one-stop-shop' for materials, also useful for staff cloning content or SOWs; that it would allow for tailor-made revision for Y6 SATs exams. They also praised the 'prerequisite' function, ensuring all students have a base level of attainment, and the layout of the content.

For Q7 on the comparison with other systems, one teacher mentioned it is simpler than current systems, cleaner and less clustered; another said that it is much better than other authoring tools which they abandoned as being far too complicated. Another mentioned using 'moodle' and 'fronter' but not liking them. Another one said it's cleaner and straightforward, simpler than other systems, but still fairly flexible. From the ones that didn't use other systems, one mentioned being keen to try, as a result of this experiment. One teacher however mentioned that such systems are not as user friendly as pen and paper, which never crash or freeze, and that it felt awkward to use online systems.

One also mentioned other systems for their specific topic, such as 'my maths', but were unsure how the current system compares.

The overall response, however, was that the clean and simplistic aesthetic of the Authoring Tool was favourable to existing solutions and likely to result in the system being used over other systems (provided the same functionality can be implemented).

6. Conclusion

In this paper, we have introduced the Topolor Authoring system, and explained how it has been smoothly integrated and linked with a social adaptive personalised e-learning system. This system was designed to be extended with a wider range of authoring tools. The system has been evaluated by a number of experts in the field of Adaptive Educational Hypermedia, as well as group of teachers. In terms of evaluation, both qualitative and quantitative methods were used to evaluate the Topolor authoring system. For example, the System Usability Scale (SUS) was used to evaluate the usability of the system, with results showing a very good level of usability, with a score of 81.9 with experts and 79.2 with teachers.

In addition, functionality evaluation and qualitative feedback shows perceived discrepancies between the Topolor authoring system and other authoring tools. For example, the Topolor authoring system is perceived as providing more flexibility, in terms of authoring for a relatively complex e-learning system, but at the same time, being simpler and easier to use, and having the look and feel of systems the authors are already familiar with.

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