

An Adaptive Course on Template-based Adaptive Hypermedia Design

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Abstract. The complexity of the design process for adaptive hypermedia is hindering a wider application of this technology. However, the potential of adaptive hypermedia can also provide support to adaptive course authors. In this way, teachers with no knowledge on adaptive systems, user models or formal languages would be able to produce rather complex adaptive courses, starting from course templates automatically selected according to their specific needs. In this paper it is shown the way in which a TANGOW-based adaptive course about adaptive hypermedia design was used to provide support to secondary school teachers.

1 Introduction

It is clear that not everybody learns the same way. Among other features, students can differ, for example, in their previous knowledge, cultural background, learning styles, interests and goals. For this reason, the learning process can be improved by providing to each student the best contents and in the best way to match his/her needs and preferences. In this sense, adaptive educational hypermedia (AEH) [1] has been successfully used in different contexts, and many on-line educational delivery systems have been developed (e.g., Interbook [2], AHA! [3], TANGOW [4], WHURLE [5]). These systems adapt their educational contents to different dimensions of each learner profile, such as: current knowledge level, user goal, educational context (e.g., if they are in school, university, or learning from home), and more recently learning styles [6] in adaptive hypermedia [7].

Several cognitive and educational researchers [8][9] have empirically tested the effectiveness of hypermedia environments on the learning process. For example in the context of adolescent students, most of the times improves have been observed using hypermedia learning environments [10][11]. Even more, some researchers and educators have turned to adaptive educational hypermedia as a potential mean of enhancing students' understanding of complex topics [12].

However, adaptive hypermedia has not been used in the educational arena as much as its potential and effectiveness may suggest. One of the main reasons for this lack of application is the difficulties implicated in creating adaptive courses. As pointed out by some studies [13], adaptive educational hypermedia systems are difficult to design,

set-up, and implement due to the high technical competencies required to master them.

Even when an adaptive system is available and ready to use, there still remains the task of designing and implementing the adaptive course [14]. It is important to consider that the course designer should be an expert in the subject to be taught (typically a teacher), and normally this designer is not a programming expert. However, systems generally require the description of the system reaction to student actions and inputs in a system-specific language. With traditional authoring tools, where the adaptability is obtained by using computer-oriented code, the non-programmer user can feel lost or may find really hard the learn to use the tool. The situation grows further worse if the authoring tool does not provide ready-to-use patterns that exploit frequent adaptive teaching strategies. Therefore, one of the main concerns in the AEH community should be the usability of the authoring tools.

We have come across this type of problems in an experience applying AEH techniques for teaching Mathematics in secondary schools with heterogeneous population [10]. In this context, AEH techniques proved valuable and the results of the experiences were very positive. Nevertheless, when we tried to instruct teachers about the use of adaptive systems, they were not able to develop their own courses, preventing a real adoption of adaptive systems by these teachers.

In an ideal scenario, the only information required from the designer (besides the educational material) would be the student profile and the adaptability the designer wants to provide. In particular, how to implement the rules related to the intended adaptability should be a task for the authoring tool. Consequently, there is a need for authoring tools providing more advanced support to the course design, relieving the designer from the responsibility for specifying every detail about the implemented adaptation. However, taking the responsibility for describing implementation rules out from the designer would also probably means taking out from him/her the control for making use of the full potential of the target hypermedia adaptive system. If a given designer has enough knowledge to specify adaptability rules, he/she may prefer to be able to directly use the system-specific language or formalism.

In this way, it seems difficult to devise a unique solution capable of satisfying everybody needs. Considering that adaptive hypermedia intends to provide solution to this kind of situations, it only seems natural to use an adaptive hypermedia course to guide each designer through the process of creating his/her own adaptive hypermedia course.

With this goal, an adaptive course for teaching to teachers how to design adaptive courses was developed. This adaptive course for teachers (for the sake of clarity it will be called “adaptive tutorial” in contrast with the adaptive course developed by the teachers) was developed in the TANGOW system. It provides each teacher support for defining the relevant features of the student model that should be used for adaptation and, according to the criteria selected by the teacher, it proposes a potential structure for the adaptive course.

Second section of the paper presents a brief description of the process of design an adaptive course for the TANGOW system. Section 3 describes the adaptive tutorial itself, while section 4 explains the results of using the tutorial with secondary school teachers. Section 5 describes the related work and section 6 presents the conclusions.

2 Designing Adaptive Hypermedia Courses

The TANGOW system, used in the experience with secondary school students, provides a flexible support for the creation of courses with different adaptive features. Courses in TANGOW are composed by tasks and subtasks, and rules describing their composition and triggering their activation. The rules will activate some tasks or others depending on given conditions over the student model. This model based on tasks and rules provides great flexibility and expression power for defining different adaptive conditions [15]. However, such level of flexibility leads to a high degree of complexity in the course descriptions.

The issue of the complexity associated with TANGOW course creation was addressed in some previous works. Some advanced tools, based on novel techniques, were developed for coping with this problem [16], and tested successfully with course designers [17]. Nevertheless, when these tools were tried with secondary school teachers, they did not provide enough support to assist the teachers in course creation.

The secondary school teachers were attending a staff training course named "Multimedia resource creation". In this context, they have already designed teaching material to be accessible through Internet, albeit without adaptation capabilities. They had no knowledge on programming languages, and thereby some difficulties to enter the rules to get the intended adaptability were expected. The teachers were instructed about the concepts related with AEH, its application in education, as well as the concepts needed to create an adaptive course in TANGOW. They were even presented with some examples of courses implemented in TANGOW. Afterwards, they were asked to design an adaptive course, following these steps:

- Firstly, they had to state what they wanted to adapt in the course.
- Secondly, they had to specify the features of the student model that would be taken into consideration for the adaptation process.
- Thirdly, they were asked to design a structure of tasks and subtasks, using pencil and paper, according on the course and student profiles previously defined.

All of them managed to fulfil steps one and two; however, few of the teachers were able to design a usable structure in step three. Most of them did not know how to do it or did it wrongly. A second problem showed up when none of the teachers with properly designed structure managed to implement this structure with the authoring tool. As we were certain that the authoring tools were as intuitive as the underlying model of tasks and rules enabled, it was clear that, at least in that specific context, tools able to hide the complexity of the adaptation model from the teachers were needed.

3 Adaptive Tutorial for Adaptive Hypermedia Course Design

The fundamental idea of this work is that not only students can benefit from an adaptive course, but also teachers. That is, an adaptive hypermedia system can be used to teach the teachers how to design and create their own adaptive courses. This

adaptive tutorial can be adapted taking into account the teacher experience and previous knowledge, as well as those features of the students that each teacher wants to consider for content adaptation (the student model). In this way, every teacher will access a guide to adaptive course creation personalized to the characteristics of the course he/she intends to create.

This concept was extended further by designing the adaptive tutorial in such a way that it both shows the teachers how to create the courses and provides a skeleton for each course. That is, the adaptive tutorial is capable of proposing a structure of rules and tasks oriented to implement the adaptation regarding the student model defined by the teacher. In this sense, the tutorial is based on templates, which encapsulate the knowledge needed to create suitable structures. The tutorial suggests to the teacher the template to choose, according to the student model.

In order to be able to adapt the tutorial to the needs of each teacher and course, the first step is to ask the teacher his/her previous experience with adaptive systems and the dimensions that will compose the student model. With this goal, it was needed to provide a fixed set of dimensions that can be used as adaptation criteria. Nevertheless, it should be noted that the skeleton proposed by the system can be modified through the author tools by the teacher without any restriction. In this way, if a teacher needs to change his/her course for adapting to unanticipated dimensions, he/she has total freedom to modify the original structure.

In previous experiences in the same context, dimensions that had been used for adaptation were Student Level, Learning Style, Language and Pedagogical Strategy. Finally, the tutorial, and the corresponding adaptive course, is adapted according to dimensions defined in table 1.

Table 1. Dimensions considered for course adaptation by the adaptive tutorial

Dimension	Possible values
Teacher previous knowledge	Novice, Medium, Advanced
Student knowledge levels	One, Two, or Three levels
Student languages	One language, Two languages
Student learning styles	None, One, Two, Three, Four dimensions
Pedagogical strategy	Theory before examples, Examples before theory
Course mode	Course, Reference
Exercises	Yes, No

Some of these dimensions are generic in the sense that, for example, the tutorial does not prescribe any concrete learning style model nor limits the resulting course to be adapted to two specific languages.

- Teacher previous knowledge: defines the level of assistance/freedom provided by the tutorial.
- Student knowledge levels: through this dimension the teacher defines if the knowledge level of the students will be considered for adaptation; the teacher can define one (no adaptation), two or three different levels for the students.
- Student languages: the course can provide adaptation to the student language, if it can be different for different students.

- Student learning styles: There are several models for learning styles [18], but neither TANGOW nor the tutorial enforces to use a specific model. The teacher can, for example, describe that the course will be adapted to two learning style dimensions; then, during the course instantiation, he/she can specify that these two dimensions will be “visual-verbal” and “global-sequential” [19], or any other two dimensions prescribed by any learning style model.
- Pedagogical strategy: the system let the teacher to choose between two of the most common strategies selected for TANGOW courses.
- Course mode: the teacher might not want to let the students to access to all the information contained in the course from the first moment, but to run along the course guided according to a fixed structure (“course mode”). On the contrary, the teacher may prefer to give the students the option to consult all the information included in the course at any moment (“reference mode”).

The screenshot shows a web browser window with the URL `http://tangow.uam.es/felix/presj/stop=init&course=asistente`. The page content is titled "Course profile" in green. Below the title is a form with the following fields and values:

Assistant language (null)	English
Teacher previous knowledge (null)	novice
Student knowledge levels (null)	Two
Student languages (null)	Two languages
Student learning styles (null)	Four dimensions
Course mode (null)	Course
Exercises (null)	Yes
Pedagogical strategy (null)	Theory before examples

A "Confirm" button is located at the bottom right of the form.

Fig. 1. Initial page of the adaptive tutorial

Fig.1 shows the initial tutorial page, where the teacher defines the features of the course being designed. According to the decisions made by the teacher, the tutorial will suggest the best course template to instantiate and will generate instructions regarding this instantiation. Depending on the student profile, the tutorial will suggest a structure where all the parts are adapted (Fig. 2.a), a structure where only one part is adapted (Fig. 2.b), or a structure where any combination of these parts is adapted (Fig. 2.c).

Once the template is suggested, the teacher loads the corresponding file into the edition tool (Fig. 3). Afterwards, guided by the tutorial, the teacher has to complete the material for each task.



Fig. 2. a) Full structure; b) adaptation to learning styles; c) adaptation to knowledge levels and learning styles.

4 Experience with teachers-authors

The experience with teachers from secondary school was repeated, this time using the adaptive tutorial. Even so it was not a controlled experiment some conclusions can be drawn, as the experience was really positive.

All the teachers were able to design and implement an adaptive course, and all of them found that the suggested structure satisfied all the needs for adaptability of the

required course. Whereas in the first experience several hours of work did not produce any usable course, using the adaptive tutorial some of the teachers were able to make a first version of their adaptive course. Fig. 4 shows one of the designed courses in an early design stage.

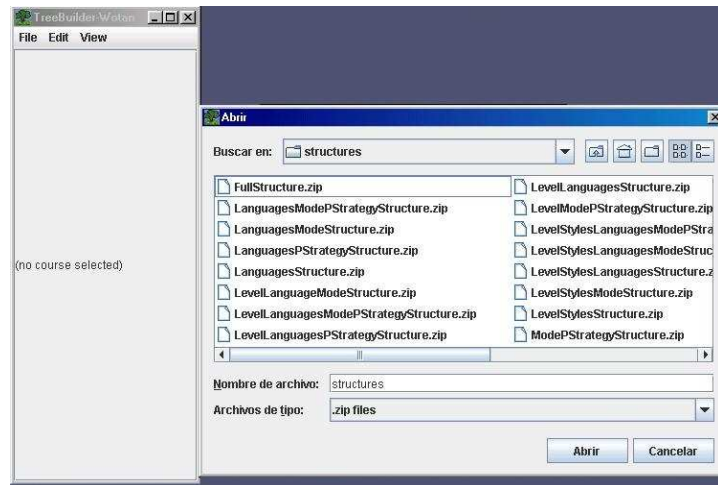


Fig. 3. Loading the suggested structure into the edition tool.

It was also observed that some teachers were able to go beyond the suggestions of the tutorial, by adding their own rules to the proposed structure. This fact leads to two conclusions: a) the tutorial enabled some teacher to reach a level of understanding higher than the one provided by general examples (experience 1). It suggests that the analysis of the structure generated according to their own needs provided them more insight about how an adaptive course should be designed; b) as it was already known, the set of dimensions proposed by the tutorial for adaptation would be insufficient for some teachers. As these teachers were able to use the authoring tool to extend the course for fulfilling their requirements, that is not a real obstacle.

5 Related Work

The main goal of our work is to simplify the authoring process and, in this context, the idea of using adaptation capabilities to support authors is not a new one. Cristea and Stewart [20] propose an approach of semi-automatic generation of AEH, based on the LAOS framework for authoring Adaptive Hypermedia. This approach has important advantages, like the possibility for defining the adaptive course independently from the platform used for delivering it. However, even if it reduces by large proportions the load of work of the course designer, it still requires experienced users, knowledgeable in the creation of adaptive courses. Our focus was to provide support for teachers with very little knowledge on technology issues, particularly, with no knowledge on complex behavior specifications.

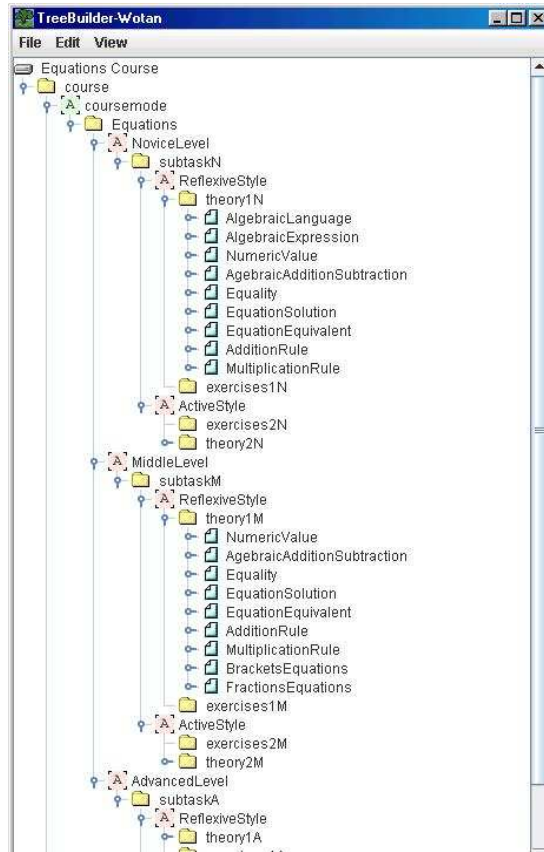


Fig. 4. Example of course designed through the adaptive tutorial.

There also exist some works presenting approaches based on the use of templates. Trnková and Theilmann [21] describe an authoring process based on the concept of advanced learning strategies. The environment implementing this concept allows the authors to create very sophisticated courses based on modern didactical approaches. The downside is that it requires the user to be experienced and with a strong pedagogical background. Less experienced users are advised to use the templates. However, they only consider user experience regarding pedagogy; we, on the contrary, are more concerned with users with little or no experience in the use of technology.

Following a different approach, Passier and Jeuring [22] underline the necessity of feedback in authoring systems. They have planned to define feedback patterns based on ontologies for educational elements such as certain types of questions, examples, definitions, etc. using IMS LD as modeling language.

Regarding evaluation of authoring tools, Dagger and Wade [23] describe an evaluation of a personalized eLearning development environment. This research identified that with this type of environment it is possible for technical and, more importantly, non-technical designers to use and reuse disparate models of personalized

eLearning, composing them to create new personalized experiences. The evaluation proved that non-technical designers can understand how the disparate models are used in concert to produce personalized experiences without having to understand the underlying technologies and representation languages.

6 Conclusions

This paper shows how adaptive hypermedia technology can be used to assist teachers on the designing of adaptive hypermedia courses. It was presented an adaptive tutorial that, based on predefined templates, enables users with no experience on adaptive technology and without knowledge on computer-oriented specifications, to design and implement adaptive courses with advanced adaptation features.

The tutorial relies on a closed set of adaptive dimensions, but it is possible to define a great variety of adaptive courses based on these dimensions. Besides, the system provides the chance for teachers to extend the structure proposed by the tutorial using the authoring tools. Future developments will be oriented to overcome this limitation. More research is also needed on the use of the proposed adaptive tutorial. Particularly, an empirical evaluation will be carried out to get more precise data on its effectiveness.

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