THE UNIVERSITY OF WARWICK

**Original citation:**
Foss, Jonathan G. K., Cristea, Alexandra I. and Hendrix, M. (2010) Continuous use of authoring for adaptive educational hypermedia : a long-term case study. In: IEEE International Conference on Advanced Learning Technologies (ICALT 2010), Sousse, Tunisia, 5-7 Jul 2010. Published in: 2010 IEEE 10th International Conference on Advanced Learning Technologies (ICALT) pp. 194-196.

**Permanent WRAP url:**
http://wrap.warwick.ac.uk/47425



**A note on versions:**
The version presented here may differ from the published version or, version of record, if you wish to cite this item you are advised to consult the publisher's version. Please see the 'permanent WRAP url' above for details on accessing the published version and note that access may require a subscription.

# Continuous use of Authoring for Adaptive Educational Hypermedia: A Long-term Case Study

Jonathan G.K. Foss, Alexandra I. Cristea and Maurice Hendrix
Department of Computer Science
University of Warwick
Coventry, CV4 7AL. UK
{J.G.K.Foss, A.I.Cristea, M.Hendrix}@warwick.ac.uk

***Abstract*—Adaptive educational hypermedia allows lessons to be personalized according to the needs of the learner. However, to achieve this, content must be split into stand-alone fragments that can be processed by a course personalization engine. Authoring content for this process is still a difficult activity, and it is essential for the popularization of adaptive educational hypermedia that authoring is simplified, so that the various stakeholders in the educational process, students, teachers, administrators, etc. can easily work with such systems. Thus, real-world testing with these stakeholders is essential. In this paper we describe recent extensions and improvements we have implemented in the My Online Teacher MOT3.0 adaptation authoring tool set, based on an initial set of short-term evaluations, and then focus on describing a long-term usage and assessment of the system.**

***Keywords - adaptive educational hypermedia, authoring tools***

## I. INTRODUCTION

Adaptive educational hypermedia [1] can provide different information to learners based on various combinations of factors, such as their learning goals, preferences, background, explicit or implicit needs, learning place, tool used in learning (e.g., desktop computer, mobile device [2]), context, environment, network parameters, etc. (this list is not intended to be exhaustive). This is achieved by applying an adaptation strategy [3] to the learning material, and thus carefully (and automatically) selecting the content, information and type of interaction that the learner requires. To do this, the author (often, the teacher, but in some cases, a dedicated course designer) must first divide the content into standalone fragments, annotated with sufficient, semantically rich meta-data [4], in order to be able to be reused in various combinations. Then, the teacher would have to select the personalization strategy (adaptive pedagogical strategy [5][6]) that best suits her students. To ensure the popularity of adaptive educational hypermedia, it is essential that content creation appeals to a wide variety of content authors, so that this process is as simple and as straightforward as possible. This paper briefly revisits the main issues improved in the latest version of My Online Teacher [7], MOT3.0 [8] and PEAL [9] and describes a long-term evaluation and usage case study. This long-term real-life use is important to demonstrate that the gap between idea and practice has been bridged. Unfortunately, in the past, too many systems in the area of adaptive educational hypermedia, were built only till the proof-of-concept point, and real, long-term use was often considered superfluous.

The remainder of the paper is organized as follows. In section II, the MOT toolset is briefly sketched. Section III presents related research. The main authoring imperatives are defined in section IV. Sections V and VI describe the new authoring tool set, evaluated in section VII. Section VIII outlines future research, and section IX draws conclusions.

## II. MOT (MY ONLINE TEACHER)

MOT (My Online Teacher) [10] is a set of authoring tools for adaptive (educational) hypermedia, which has been developed over the past 10 years in various minor and major reiterations. MOT follows the five-layer LAOS [11] authoring framework, which adheres to the 'separation of concerns' principle, especially with regard to separation of content and adaptation authoring. The ***content authoring part of MOT*** focuses on the first two layers of LAOS; the *domain model* and the *goal model*. MOT allows the author to export domain maps and goal maps to a CAF [7] XML file. The adaptation description (the personalized adaptive pedagogical strategy deciding how the content created in the content authoring part is to be used) is defined in the ***adaptation authoring part of MOT***. Adaptation is specified in various ways, but can be exported as LAG [9] files. CAF and LAG files can then be imported into an adaptive delivery system such as AHA! [12] or ADE [13].

## III. RELATED RESEARCH

MOT didn't appear in a void. By the time it started being developed, adaptive hypermedia was an established principle. However, there were significant problems with the authoring tools. One problem was that they were *not flexible enough*, as in the case of Interbook [14], which allowed for easy authoring, but couldn't build much more than a prerequisite structure. Another problem with such authoring tools was that they were *not easy enough for non-experts to use*. AHA! [12] is an adaptive hypermedia system that provides a set of authoring tools to allow the author to create complex adaptation structures. However, the authoring tools (including a 'Concept Editor', a 'Graph Editor' and a 'Form Editor') are not trivial tools. In

other adaptive educational systems developed, such as WHURLE [15], both the adaptation is limited (only adaptation to 3 types of learners possible), and the authoring is difficult (editing of XML files). The TANGOW [16] system presented some interesting, however highly specialized emotion-based adaptation. The WOTAN [17] tool showed promise in terms of graphical authoring, but suffers from a higher level of complexity, and also has issues with scalability.

## IV. MOT3.0

MOT3.0 was created to respond to the functional and usability issues of its predecessor, MOT1.0. Amongst the new features in MOT3.0 are a redesigned layout, new importing features and a new HTML editor. More details about these new features can be found in [18].

## V. PEAL

Whilst MOT is to be used by the content author, PEAL is to be used by the *adaptation specification author*, which can be a different person altogether. PEAL thus needs a more programming-savvy author. However, its outputs can be used by content authors without any such programming knowledge, by simply reusing personalization strategies. PEAL allows *syntax highlighting for programs*, contains a *wizard*, allows for both *strategy reuse* as well *code fragment reuse*, and contains a *public* and a *private* place for saving strategies. These features allow for collaboration, and are intended to assist programmers in creating their strategies.

## VI. EVALUATIONS

The MOT3.0 authoring toolset was initially evaluated with two groups of students at the Politehnica University of Bucharest in March 2009, who compared the system with its previous version. Results of this evaluation are reported in [18]. These evaluations were relatively short (a few days of interaction with MOT3.0 and MOT1.0, then completing questionnaires). After these evaluations, the feedback was taken into account, and the system was updated. This new updated version was then used by a group of 34 students at the Computer Science Department of the University of Warwick, studying a course on "Dynamic Web-based Systems". The duration of their exposure to MOT3.0 and PEAL was the whole first term (October to December 2009). The students had to create an entire adaptive course, by developing their own content (using MOT3.0) and their own strategies (using PEAL), as part of their effort towards completing the course.

- Exercise 1: *Simple steps with the content authoring tool MOT 3.0*, including tasks such as *browsing and searching domain/goal maps; editing, copying and linking between domain/goal maps; assigning labels and weights to goal maps; and exporting goal maps as CAF files.*
- Exercise 2: *Complex labeling, usage and creation of strategies in the PEAL tool, using the LAG language:* Students were required to perform the complete process of creating static content, labeling it, and applying at least one strategy. They then converted the output to an adaptive lesson, by uploading their content and strategies to AHA! [12]. They had to repeat this process until the course adaptation behaved according to their design.
- Exercise 3: *Integration of used techniques with multiple strategies and usable course content*: H*ere stud*ents were asked to add at least two mor*e* strategies with at least one original strategy.

Finally, the students were asked to create a portfolio of *four adaptive courses*, created with one or two content descriptions (domain maps) based on their chosen topics; three or four goal maps (here, appropriate labels, weights, etc. were important); and four adaptive strategies.

Whilst working on the coursework, students were encouraged to provide feedback on the suite of authoring systems that they were using. The feedback methods were *direct feedback* (during breaks) and a *course forum* with threads for each of the authoring tools.

### *A. Usage of MOT*

When we look at the actual domain and goal maps created by the students and compare them to those created in previous years with MOT1.0, we can see a clear improvement. Many strategies created relied upon the use of a small number of weights and labels, present in a few concepts only. Especially the 'start' and 'end' labels for the first and last concepts to be presented were popular. The number of concepts created varies among groups, but on average students have created between 5 and 10 concepts, a few of these with between 3 and 5 sub-concepts. Overall this suggests that the use of MOT3.0 has improved the created content.

### *B. Usage of PEAL*

Many students used the example strategies[1]as templates. Especially popular were slight modifications to the *depth-first* and *breadth-first* strategies, adding conditions to show certain labeled concepts before their natural order. More innovative

[1] http://prolearn.dcs.warwick.ac.uk/strategies.html

examples include strategies based on the classic *beginner–intermediate–advanced* strategy, which contains 3 levels of knowledge, and only shows concepts according to the user's current level. Students extended this to a more general strategy catering to larger numbers of knowledge levels, or a strategy where 75% knowledge is enough to progress to the next level. There was also an extension to the *visual-verbal* strategy, with an extra *textual* preference, while verbal is interpreted as a preference for spoken text.

The types of strategies created were similar to the strategies created in previous years (without PEAL). However, the number of more complex innovative strategies, differing from the available pool, created, was higher than on previous occasions (the same module was run last year with a similar assignment using the previous version of the tools). Specifically, a number of strategies were created around the notion of a learning goal, represented as the sum of knowledge levels of visited concepts, and decreased knowledge for revisiting concepts. Another group created a 'Mixed Revision' strategy, designed to help students revise. In this strategy, text attributes are initially hidden, but keyword attributes are shown. If the user revisits a particular concept (suggesting that s/he is unfamiliar with the concept), the text is shown for further revision. Another interesting strategy was one for device adaptation. The description noted that while the students implemented it as an *adaptable strategy* (i.e. user-driven), with settings that allowed the user to select the current device, they commented that they would have liked to be able to get this information (automatically) from the AHA! delivery system. This suggests that options for device adaptation would be perceived as a useful extension.

The overall quality of strategies created was clearly higher than in previous years. While other factors, such as the quality of students and updated training material may have all contributed, it seems reasonable to say that the PEAL editor is responsible for at least part of this improvement.

## VII. Future Work

Using students in their last years of study to evaluate authoring tools is helpful because much of their work consists of gathering and presenting material in front of their peers, similarly to teachers and authors. Clearly, the latter also need to be (and have been) involved in the evaluation process. Still, for comprehensive, long-term evaluations with iterative development, student evaluations are useful, and have highlighted a number of usability issues that needed to be addressed - work which has already started. Further research will also investigate ways of allowing the author to more quickly see the results of applying particular strategies. This could be done by integrating MOT3.0 and PEAL with ADE.

## VIII. Conclusions

This paper has outlined the main features of MOT3.0 and PEAL, and described the procedures used to evaluate the software. This long-term evaluation has provided useful qualitative feedback about the functionality (and stability) required for an adaptive hypermedia authoring system, especially in terms of *ease of use* and *familiarity*. It is important that such tools are released as fully developed software to encourage the widespread use of adaptive hypermedia.

## Acknowledgment

This research is partially supported by the GRAPPLE IST project IST-2007-215434.

## References

[1] P. Brusilovsky, "Adaptive Educational Hypermedia: From generation to generation (Invited talk)," in *4th Hellenic Conference on Information and Communication Technologies in Education*, Athens, Greece, 2004, pp. 19-33.

[2] M. Kravcik, A. Kaibel, M. Specht, and L. Terrenghi, "Mobile Collector for Field Trips," *Educational Technology & Society*, vol. 7, no. 2, pp. 25-33, 2004.

[3] N. Henze and W. Nejdl, "Knowledge Modeling for Open Adaptive Hypermedia," in *AH2002*, Malaga, Spain, 2002.

[4] M. Nilsson, M. Palmér, and A. Naeve, "Semantic Web Metadata for e-Learning - Some Architectural Guidelines," in *WWW2002*, Hawaii, USA, 2002.

[5] D. Dagger, V. Wade, and O. Conlan, "Adaptive Pedagogy with the Adaptive Course Construction Toolkit (ACCT)," in *A3EH*, Eindhoven, The Netherlands, 2004.

[6] E. Melis et al., "Activemath: A generic and adaptive web-based learning environment," *International Journal of Artificial Intelligence in Education*, 2001.

[7] A. I. Cristea, D. Smits, and P. De Bra, "Towards a generic adaptive hypermedia platform: a conversion case study," *Journal of Digital Information (JoDI)*, vol. 3, no. 8, 2007.

[8] J. G. K. Foss and A. I. Cristea, "Adaptive Hypermedia Content Authoring using MOT3.0," in *A3H Workshop, ECTEL 2009*, Nice, 2009.

[9] A. I. Cristea, D. Smits, J. Bevan, and M. Hendrix, "LAG 2.0: Refining a reusable Adaptation Language and Improving on its Authoring," in *ECTEL 2009*, vol. 5794, Nice, France, 2009, pp. 7-21.

[10] F. Ghali and A. I. Cristea, "MOT2.0: A Case Study on the Usefulness of Social Modeling for Personalized E-Learning Systems," in *AIED'09*, 2009.

[11] A. Cristea and A. de Mooij, "LAOS: Layered WWW AHS Authoring Model and their ," in *WWW'03, Alternate Track on Education*, Budapest, Hungary, 2003.

[12] P. De Bra, D. Smits, and Natalia Stash, "The Design of AHA!," in *ACM Conference on Hypertext and Hypermedia*, Odense, Denmark, 2006, p. 133.

[13] J. Scotton, S. Moebs, J. McManis, and A. I. Cristea, "A Case Study on Merging Strategies for Authoring QoE-based Adaptive Hypermedia," in *A3H Workshop, ECTEL 2009*, Nice, France, 2009.

[14] J. Eklund and P. Brusilovsky, "Interbook: An Adaptive Tutoring System," *UniServe Science News*, vol. 12, no. March 1999, pp. 8-13, 1999.

[15] T. Brailsford et al., "Towards a Framework for Effective Web-based Distributed Learning," in *Poster, WWW2001*, Hong Kong, 2001.

[16] R. Carro, E. Pulido, and P. Rodrigues, "Task-based Adaptive learNer Guidance on the WWW," in *Computer Science Report*, Eindhoven, The Netherlands, 1999, pp. 49-57.

[17] M. Freire and P. Rodríguez, "A Graph-Based Monitoring Tool for Adaptive Hypermedia Course Systems," in *AH*, Dublin, Ireland, 2006, pp. 279-282.

[18] J. G. K. Foss and A. I. Cristea, "MOT3.0: Adaptive content engineering for adaptive presentation," unpublished