

Developing Adaptive Pedagogy with the Adaptive Course Construction Toolkit (ACCT)

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Abstract. A pedagogical underpinning is a fundamental requirement for any learning activity or event. Many personalized eLearning systems, however, focus primarily on adaptive content retrieval based on a user profile and neglect the pedagogical requirements of educational systems. This form of intelligent search and insertion is effective at assembling personalized manuals, but not necessarily suitable for creating pedagogically sound eLearning offerings. This paper introduces a methodology for developing adaptive personalized eLearning experiences and the Adaptive Course Construction Toolkit (ACCT), a tool built on this methodology, for creating pedagogically-based personalized eLearning solutions. The ACCT provides an environment where the course developer can define a subject matter concept space (lightweight domain ontology) and create a customized adaptive course narrative based on modeled pedagogical strategies, the previously defined subject matter concept space and potential learning resource candidates.

1 Introduction

Typically the approach to adaptive eLearning is to perform adaptivity of the content retrieval mechanism based on the user's personal preferences, prior knowledge, etc. The pedagogical considerations in terms of presentation, structure and narrative in some cases is completely absent and in others very weakly applied. In such adaptive eLearning courses where pedagogy exists it is inherently embedded in the content itself making it difficult to reuse or apply different pedagogies across the same adaptive content. This level of inflexibility leads to the development of pedagogically static and restricted courses.

However, eLearning research in the past 10 years has had one constant unambiguous finding; that pedagogy is absolutely fundamental to the success of a course and must be considered first and foremost when developing learning experiences [1]. The adaptivity should therefore support the appropriate selection of pedagogical strategy(s) and then apply adaptivity to the content and activities within the scope of the selected strategy(s). With today's courses built on Adaptive Hypermedia Systems (AHS) it could be argued that pedagogy is less directive in ensuring the overall ex-

perience of the course and much greater effort seems to be expended on accurate selection of subject areas.

This paper argues that next generation adaptive eLearning systems will increase their effectiveness when the adaptivity is applied to the selection of an appropriate (personalized) pedagogy and to the activities, communication and content within pedagogical elements of the course. This leads to adaptive pedagogically-driven eLearning where the pedagogy is central to the learning experience (i.e. not accidental) and where the power of adaptivity enhances the effectiveness of the pedagogy.

2 Adaptive Course Construction Methodology

During the development of an adaptive online learning experience, without the support of an appropriate tool, several key processes must be realized as illustrated in Fig. 1. Firstly we must identify the goals and objectives of the course. These goals and objectives will form the base requirements and initial evaluation scale of the evaluation process. When we are happy with the specified course goals and objectives we must identify and select the appropriate pedagogical strategy(s) for the course based on the goals and objectives. Next we must model the knowledge domain within which the course will reside. Once the subject matter area is recognized and described it can be applied to the chosen pedagogical strategy(s). The next logical phase is to begin the content selection and grouping process whereby the appropriate learning resources are grouped with the pedagogical elements. The customized pedagogical strategy can now be made adaptive by applying the appropriate adaptivity to the pedagogical structure based on the goals and objectives of the course, the selected content of the course and the pedagogical strategy(s) of the course. The next phase of the development process is to test the semantics and the functionality of the adaptive course by verification through the Adaptive Personalized eLearning Service (APeLS) [2]. This cyclical approach supports an expandable course construction process.

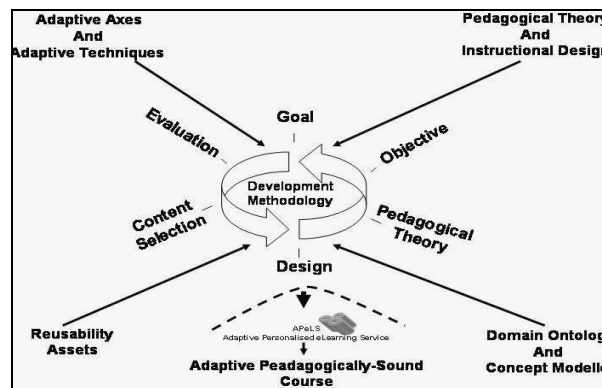


Fig. 1. A Sample Adaptive Course Construction Methodology

3 Creating Adaptive Courses with ACCT

The Adaptive Course Construction Toolkit (ACCT) was developed to address the complex and time-consuming nature of applying the adaptive course construction methodology. The ACCT supplies the pedagogical foundation of an adaptive course developer-support framework. The design-time nature of the ACCT allows the course developer to construct customized domain ontologies to represent the subject matter expert's view of the knowledge domain. It facilitates the design of customized course narratives (the embodiment of pedagogy, abstract course overview and adaptive axes as applied) based on sound pedagogical models. Adaptivity models allow the course developer to create customized adaptive pedagogy through a support oriented drag and drop type association mechanism. The course developer can search for and select learning resources based on keywords, types, modes, contextualized prior usage, etc. The ACCT provides a course verification service, allowing the pedagogically-driven adaptive course to be viewed and verified prior to publication. The ACCT provides a publication mechanism allowing the course developer to export and publish their pedagogically-formed adaptive course.

3.1 Describing the Knowledge Domain

An integral part of a course creation process is the representation of a knowledge domain. Knowledge domain representation allows the subject matter expert to model their understanding and experience of an information domain. The ACCT provides an environment where the course developer can describe the knowledge domain as a collection of abstract concepts with descriptions and usability guidelines and relationship definitions. The ACCT provides the course developer with a set of predefined relationships which can be applied to concept pairs or groupings. The ACCT allows the course developer to create new custom relationship definitions. This flexibility to describe and customize relationship definitions and subject matter concepts during the development of the domain ontology supports the course developer during the initial phase of course production, namely the representation of the knowledge domain.

The ACCT provides an environment through which the course developer can graphically create, edit and distribute these knowledge domain representations. In this way, the ACCT actively promotes and supports the sharing of subject matter expertise between peer collaborators.

3.2 Developing an Adaptive Course

The key process of creating online adaptive learning experiences is the creation of pedagogically sound courses. By using the custom narrative editor the course developer can create a custom pedagogical strategy based on sound and expandable pedagogical models provided by the ACCT (Fig.2). The course developer can choose, customize and create pedagogical elements based on the palette of tools provided by the ACCT. The pedagogical models provided are supported by usability guidelines

and best practice descriptions. As the course developer builds the custom pedagogical strategy for their online learning experience they can specify and assemble learning activities within the supported pedagogical structure. The ACCT provides an interface whereby the course developer can place concepts from their previously defined knowledge domain ontology into this customized pedagogical structure to form a pedagogically sound online course framework (Fig.2). The ACCT allows the course developer to graphically assemble the concepts (both Narrative and Subject Matter) and learning activities of their course.

The ACCT supports the course developer by allowing them to search and select learning resources from multiple remote learning resource repositories (fig.2). The ACCT graphically supports the selection of learning resources by allowing them to be dragged and dropped from the tools palette to the pedagogical course structure.

To make this pedagogical online course adaptive, the course developer must associate Narrative Attributes with the concepts and learning activities of the course (fig.2). By applying these Narrative Attributes to a pedagogical learning structure, the course developer is describing a requirement for certain aspects of the course to be delivered “adaptively”. This ability to apply “adaptivity” to concepts and learning activities uses the approach of Candidacy [3]. When the learning resources are selected they form abstract candidate groups which the adaptive technique, chosen through the adaptive axes rendering process, uses during the reconciliation of the adaptive course.

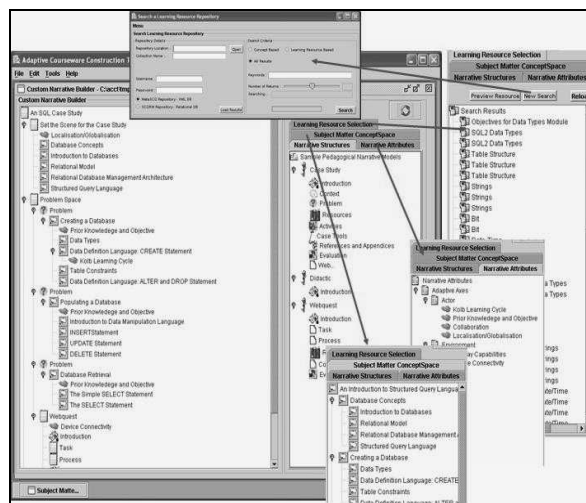


Fig. 2. ACCT Custom Narrative Builder

3.3 Publishing an Adaptive Course

One of the key advantages of the ACCT is its ability to allow the course developer to verify their adaptive course in real time. The ACCT provides a mechanism by which

the course developer can test their adaptive course as a real web application. The ACCT exports a course package and application framework to APeLS (Adaptive Personalized eLearning Service). Included in the course package are the subject matter concept space, the custom narrative model with associated narrative attributes and all other related models, all transforms and class definitions required to run the adaptive course.

Through the ACCT application framework generically defined classes provide varying levels of interaction with respect to the learner and the teacher. It allows the course developer to view the learner model schema, the teacher domain scoping mechanism and the overall adaptive course structure. The produced adaptive course is independent of the content that may be used to render it. This allows for the rapid prototyping of adaptive course structures prior to the availability of the learning content. The ACCT produced course can also interact with physical content. Through the Candidacy architecture the ACCT produced course can adaptively render either concept descriptions or the concepts associated candidate learning resources.

4 Modeling Pedagogy

The ACCT is a pedagogy-driven course developer support environment. The pedagogy that is supplied by the ACCT forms the basis for fully customizable pedagogical strategies. The modeling approach involves the creation of XML models to represent the chosen pedagogical strategies, initially case-study, problem/enquiry, didactic and web-quest. The model contains descriptive information for each of the high level concepts/activities of the pedagogical strategy and suggests a possible sequencing of these pedagogical elements. Through the models the ACCT can provide guidelines on how to use the provided pedagogical strategies, how they might be extended and the types of adaptivity that might be applied. This modeling of pedagogy provides the course developer with a solid foundation on which they can create adaptive pedagogically-driven eLearning in a support-oriented environment.

4.1 Representing Pedagogical Models

Narrative Structures are created to describe how the pedagogical strategy(s) can be realized, e.g. defining types of activities, suggesting possible sequencing of activities, opportunities for communication and collaboration and content selection. They represent the (re)usable elements of pedagogical strategies in a model-based (XML) form. These models can be used as a pedagogically sound foundation on which the construction of adaptive pedagogically sound courses can be based.

The rapid construction of online courses consisting of different “flavors” of pedagogy is facilitated through the use of these Narrative Structures. For example, case based learning, web-quest learning, discovery-based learning and didactic based learning pedagogical models can be combined to form the basis of a customized blended pedagogy. This allows the potential course developer to create customized courses based on “flavors” of the modeled approaches thus actively promoting and facilitating

the reuse of not only learning content but also the strategies and pedagogy behind the delivery of such learning experiences.

4.2 Describing Pedagogical Elements

Pedagogical strategies, typically, can be represented as a series of high-level descriptive concepts representing learning activities to be undertaken. Pedagogical strategies are usually accompanied by a set of guidelines and scenarios intended to strengthen the course developers' confidence in using the strategy(s).

Narrative Concepts facilitate the abstract description of pedagogical elements within a content-independent context. Narrative Concepts allow the pedagogical expert to create and customize elements of pedagogical strategies in the process of creating pedagogically-sound adaptive online learning experiences.

4.3 Enabling Adaptive Pedagogy

To make a customized pedagogy adaptive, Narrative Attributes, which consist of adaptive axes (prior knowledge, learning styles, etc.), adaptive techniques (object inclusion/exclusion, link annotation, etc.) and usability/guideline descriptions, must be applied. The course developer can decide on which adaptive technique(s) is to be applied based on the selected adaptive axes. For example, they could use either object inclusion/exclusion or link hiding in adaptivity based on prior knowledge depending on content granularity.

Through the modeling of adaptivity, Narrative Attributes representing adaptivity based on learner preference, tutor scope preference, learning context and learning device have been created.

5 Related Work

Current Adaptive Hypermedia (AH) systems and authoring tools for AH, in the educational domain, concentrate on developing and providing adaptive content retrieval and display capabilities. To this, adaptive content retrieval/delivery, elements of pedagogy are added in an effort to create online adaptive learning. For educationally effective adaptive eLearning however, the pedagogy must be the focus of development. Once the pedagogy has been customized (i.e. selected and extended if required) based on the subject matter area and learner goals, adaptivity can be applied to the pedagogically sound online course structure to produce adaptive personalized pedagogically-driven eLearning.

Currently, there are a range of tools available to create online pedagogy. For example, the REDEEM system [4] allows the teacher to create pedagogical online courses by describing the structure and flow of the content of the course and also the sequencing of the content. It allows the teacher to divide the course into sections and describe the content that the course will use. REDEEM has been quite successful in construc-

tion courses however it supports no elements of adaptivity and dynamic personalization. From an active learning perspective the LAMS system [5], which is built upon the emergent Learning Design standard (Previously Educational Markup Language EML), allows the teacher to create, describe and sequence learning activities. However, LAMS likewise provides no support for adaptivity of pedagogical structure and content selection.

Adaptive Hypermedia authoring tools are a novel research area specifically in the domain of adaptive educational systems. The LAOS and LAG [6], [7] adaptive hypermedia model hierarchies provide a 5-layer adaptive authoring model for adaptive hypermedia and 3-layer adaptation model respectively. Similarities that exist between ACCT and LAOS are the domain model (knowledge domain representation), and the adaptation model (both use hierarchical relationships between adaptive axes and adaptive techniques). The ACCT differs though by explicitly making the pedagogical model (Narrative) the primary focus of the course development process. Certain Pedagogical elements may be implemented in LAOS through the goals and constraints model, although they would be more focused on curriculum or course scoping.

Due to the complex and dynamic process of authoring Adaptive Hypermedia, the need for author support in creating adaptive pedagogically sound personalized eLearning is evident [8], [9]. The reach and effectiveness of adaptive personalized eLearning systems is also limited due to the cost of application development. The large initial setup cost of adaptive hypermedia is too high for the mass adoption of AHS in education. From current work in adaptive hypermedia [10], [11] in personalized eLearning it is evident that there are two areas of research which need future development, the design of pedagogically sound adaptive courses and the support offered to the course developer during the process of developing pedagogically sound adaptive courses. Pedagogy can be supported by specifying a requirements-based framework in which pedagogy can be described, used, reused and distributed in an effort to actively promote the cost reduction of adaptive course creation. The course developer can be supported by offering structural support and guideline support during the process of creating adaptive and non-adaptive courses.

Based on the state of the art in adaptive hypermedia and online pedagogy authoring, the ACCT will support and provide innovative ways of applying adaptivity to pedagogy to produce personalized eLearning.

6 Conclusion

From our experience with adaptive and personalized eLearning in the past, several key points should be noted. It is critically important that the teacher/tutor be empowered within the learning experience and not disenfranchised. As a blended teaching approach, the adaptive and personalized eLearning does not replace the teacher. It transforms and enriches their role in the learning experience. Adaptive personalized eLearning is a tool which the teacher/tutor can use to increase the potential educational effectiveness of the entire learning experience. Adaptive eLearning is not just about adaptive content retrieval and construction. It is a mixture of pedagogy, domain

knowledge (subject matter expertise) and adaptivity. The production of personalized courses is realized at the concept level not content level. Specific content selection is an aspect of learning experience development that should not concern the teacher/tutor.

The ACCT addresses these issues by empowering the course developer in creating adaptive personalized courses in a blended learning environment. It provides powerful and intuitive mechanisms through which the course developer can use and understand adaptivity and how its application can influence the course delivery process.

Currently, the ACCT is under a trial and evaluation period in both the Centre for Learning Technologies in Trinity College Dublin and the IT and Innovation Centre at Intel Ireland. The trial will involve subject matter experts, pedagogical/instructional design experts and secondary level school teachers.

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