An Adaptable Personal Learning Environment for e-Learning and e-Assessment

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Abstract: This paper proposes a component model and development framework for an open source Adaptable Personal Learning Environment (APLE), an e-Learning environment which is responsive to an individual learner's needs or preferences and to the environment in which they are working. In this paper we briefly cover three separate areas of the proposed systems: firstly the component model and open source development framework for an APLE itself; secondly the development of adaptive learning objects; thirdly adaptive e-Assessment, based around models for formative assessment and evaluation.

Key words: Adaptability, Accessibility, Virtual Learning Environments, Personal Learning Environments, e-Learning, Assessment

INTRODUCTION

JISC (the Joint Information System Council in the UK) [8] describe a Personal Learning Environment as one that replaces elements of a standard Virtual Learning Environment (VLE) with tools that are personal to the individual learner. These components are typically elements such as communication tools (e-mail and chat), diary tools, content and web browser tools etc. However the actual tools used are chosen by the individual and will probably be drawn from the student's own personal system. The important factor here is that the learner makes the choice not the institution. The e-learning environment becomes a framework for personal tool integration and collaboration and a collection of digital e-learning content.

In this paper we propose to extend this model by adding the concept of adaptability as defined by the IMS AccessForAll group [1],[7]. An Adaptable Personal Learning Environment would facilitate participation by all students including those with disabilities for whom access may currently be difficult or impossible. The framework is focused around the creation of novel interfaces for personal learning, taking as the starting point an existing Virtual Learning Environment (VLE) known as the Portland VLE [4]. It was developed as part of a research project on a symbols-based accessible VLE for the Portland partnership, a large cross institutional European funded initiative. The areas under scrutiny are symbols based interfaces, social software and inclusion and draws on related work with the IMS AccessForAll [6] anonymous Profiles of Needs and Preferences (PNPs). In recent projects, members of the Accessibility Research Centre (ARC) have been involved in three major areas of research: firstly, the development of the adaptive Portland VLE; secondly self adapting interfaces for mobile devices [2], and thirdly a Transformation, Augmentation and Substitution Service (TASS) for the definition of adaptable learning objects [3]. Linking all of these is the concept of personal profiles - often referred to as anonymous profiles of needs and preferences (PNPs).

Profiles can be said to be anonymous in the respect that they are not there to identify the individual’s private details or disabilities but to highlight user requirements relevant to a specific context. These requirements can include absolute needs (those requirements which must be met for the interface to be considered accessible), weak preferences (perhaps relating to a learning style, a preferred font or media augmentation) or anything in between. Profiles enable adaptation of the user interface (perhaps for mobile devices), the delivery of learning objects and personalisation of the learning environment to meet the needs and preferences of the individual. Appropriate standards are also required to establish a framework that enables interoperability between learning environment, devices and learning objects [13]. Currently there are a number of standards which apply to different areas of the framework but they need to be integrated, rationalised and simplified if true interoperability can be achieved in practice.
THE PORTLAND VIRTUAL LEARNING ENVIRONMENT

Our initial research experiences on an accessible VLE within ARC were based on the development of the bespoke Portland VLE [4];[5]. This VLE took a specific and pragmatic approach, based on the specific needs of a small group of severely disabled learners. To some extent, therefore, the Portland VLE might be thought of as a Personalised Virtual Learning Environment (PVLE). Until this VLE was developed it was generally considered unlikely that these students would ever be able to access a learning environment. The Portland VLE relies on the tutor or administrator making the required adjustments to the VLE by selecting elements of interaction according to the learner profile. The profile is partly derived from observations and formal assessment of student needs, although whenever possible students were consulted and mechanisms were put in place to elicit choice.

The Portland VLE interface is personalised to allow learners to have an appropriate screen display, layout and symbol set (PCS, Rebus or Makaton). Interaction between the student and the VLE is facilitated by their preferred input device (e.g. mouse, switch with scanning etc.). In many respects the Portland VLE includes the standard features found in most mainstream VLEs, including a secure login system, communication tools via e-mail or chat, a personal timetable and access to adapted learning resources. However Portland’s unique functionality and features has resulted in an accessible and adaptable learning environment that meets the needs of learners with severe learning difficulties and physical disabilities. While the development of the Portland VLE taught us a number of very valuable lessons, it is apparent that it meets the needs of a very specialist group of students. However the concept of an accessible, adaptable and personalised VLE has a much wider appeal. Consequently over the last two years we have started to look at the concept of a PLE (Personal Learning Environment). The PLE concept (from the UK, Joint Information Systems Council) goes one step further in that every aspect of the learning environment, including the functions of the environment such as e-mail, discussion and calendar are actively selected by the individual. A PLE can be developed from a PVLE if a common set of standards can be identified for component interoperability and the individual is allowed to build up their personal set of functions from available components [12]; [4]. We also wished to build in elements of adaptivity. Consequently the successor concept of the Adaptable Personal Learning Environment was born.

AN ADAPTABLE PERSONAL LEARNING ENVIRONMENT

Transforming the PVLE to an open source tool, adopting the JISC concept of a PLE and incorporating aspects of adaptability would result in the creation of an APLE that could be used by many other learner groups with particular needs and preferences (Figure 1).

![Figure 1: an Adaptable Personal Learning Environment](image-url)
The two most important aspects of an APLE is firstly the idea that it is to be designed and developed by a community of e-Learning professionals, researchers, tutors and learners as an open source personal environment. A number of approaches will be used ranging from e-mailed comments on the web-based design documents to the use of wikis, social software and on-line contributions. Secondly an adaptable PLE should integrate both content and tools. To achieve this, the framework is based on existing standards for interoperability. However, because many of the standards are complex and mutually incompatible, a level of simplification and license is needed in their application.

It is of fundamental importance that the system optimises user choice and involves tutors and learners in the design of learning tools as well as content. All content, tools and interfaces and every aspect of presentation, layout and operation will become a selection or adaptation of an available component. Where a desirable feature, component or adaptation does not exist, the facility to design or provide that feature or component or simply a request for the component will be generated. This applies to the e-learning content, adaptive e-assessment and the e-learning tutor and user tools. In fact we would also expect the community to have an involvement in defining the framework and commenting on standards where they are able. Consequently, in a very real sense, the APLE framework will be supported by the development of a community of practice based on a range of individuals, with an interest in distributed e-learning design and development.

**TRANSFORMATION, AUGMENTATION AND SUBSTITUTION SERVICE**

The primary purpose of a learning environment, whether personal, virtual or adaptive is to act as a container for content. Without content and learning resources it is useless. However a major failing occurs where there is a mismatch between the available learning material and the learner’s ability to access it effectively. That mismatch can result from any one of a number of reasons, whether that is disability, level of understanding, preferred learning style or any other physical, practical or psychological factor. Inaccessibility can therefore be defined as a mismatch between the learner and their learning. Here we propose a service which can manage this mismatch and provide an accessible resource.

In order to achieve an accessible relationship between the resource and the user, descriptions of user needs and preferences are checked against descriptions of resource components. This process involves a description of a user’s control, display and content needs and preferences being matched with a description of the components of the learning object [3];[13]. According to the AccessForAll metadata overview, Accessible systems should be able to adjust the user interface of the learning environment, locate needed resources and alter resource properties to match the needs and preferences of the user. This may involve the substitution, augmentation or transformation of components of the resource such as changes in sensory modality (see Table 1).

| Transformation | Transformation is the automatic rendering of a learning component in an alternate media, form or style. Transformation may occur where text is rendered visually, as characters, or a sign language, or aurally, perhaps by a screen reader, or transformed into a tactile form as Braille or simply changed in colour, size and other display features. |
| Augmentation | Augmentation involves the optional addition of a feature to a primary resource, for instance a textual caption could be added to a video when required by a user with a hearing impairment or in a noisy environment or a signing commentary (in Makaton or BSL) added. |
| Substitution | Substitution occurs where one learning component is replaced by another equivalent component. For example the visual element of the learning objects with components that match the user’s preferences of vision-free access. Alternatively, an interactive exercise requiring a mouse for operation could be substituted by one that can be controlled using a keyboard or keyboard emulator for a user with a mobility impairment. |

**Table 1: Transformation, Augmentation and Substitution**
For our purposes we propose a transformation, augmentation and substitution service (TASS) which is geared to a limited subset of e-learning applications and contexts. However this can be viewed as a special instance of an AccessForAll service. Our work to date has focused on applying the TASS to learning objects. To make rich online content match individual needs and preferences, this approach requires a basic resource to be created from existing or newly authored components, and the appropriate adaptations (transformations, augmentations and substitutions) need to be identified.

For learning resources to be adaptable, they need to be defined as a hierarchy of learning objects, learning components and media elements, ideally based on predefined learning patterns (Figure 2).

A learning pattern is an architectural design concept also applied in object-oriented programming. In this context it is a mechanism for identifying effective learning structures which can be reused across a variety of learning experiences. Courses, programmes, modules or lessons are broken down into their component learning objects, which in turn are divided into media elements (a piece of text, a question, an image, a video etc.). It is largely at the level of the media elements that the TASS system operates but it can also use its knowledge of learning patterns to recreate a ‘virtual learning object’ based on available resources or alternate patterns. This can be useful, for example, in replacing introductory theory with a practical illustration or exercise for those whose learning styles find this approach to learning more appropriate.

**E-ASSESSMENT IN E-LEARNING**

Similar approaches have also been tried in adaptive e-Assessment for formative assessment where perhaps the individual concerned feels that they don’t need revision or testing on the easy questions or they are not yet ready to tackle the advanced areas. In this case learners can define a profile based on their current educational experience, knowledge and preferences. The assessment method, adopting standards such as IMS QTI (Question and Test Interoperability) [9], can then take account of this information to present a personalised assessment. Combining the prior experience of the student with the performance on the test will produce an accurate picture of the student’s current understanding and areas for further work. This can be particularly effective where the assessments are built up into a full educational history or an e-portfolio of educational achievements. These are areas of on-going research which are expected to make a significant contribution to the APLE model. A specific approach proposed by a group at TU Gabrovo in Bulgaria takes a very novel approach to e-Assessment.
The group at TU Gabrovo uses a cybernetic model to provide diagnostic feedback in formative assessment, which can help the tutor modify the individual learning experience to the student’s or group’s learning performance. In this model, the system attempts to model the student’s progress based on a mechanism of accumulated averages. This method is commonly used in quality control for process modelling, but is less used in areas which deal with more subjective criteria. However, our conjecture is that this mechanism has a use within our APLE model to help learners and tutors gain accurate information on the learning progress. The tutor can adjust their teaching based on this information and the learner gains very useful formative feedback. This model operates at two levels, that of the individual and that of the group.

An analysis of the learning process leads to the conclusion that it can be modelled as a cybernetic process. The main principles of cybernetic control can be used to develop an optimal and effective learning system [10]. The feedback channels of the cybernetic learning model are used to control the process of learning. The cybernetic approach allows us to apply theoretical and practical expertise in solving technical problems for educational purposes; however, learning is a very specific and specialized process and this means that well-known techniques have to be supplemented by novel approaches. For example, we need to define the identification parameters of the object of control in order to control the process itself. In the case of learning, the object of control is the learner and the identification parameters are the learner’s main learning characteristics. A detailed analysis of these characteristics can then provide diagnostics on the student’s progress and detailed individual feedback to support his learning.

The difficulty here is that learning is a specific process and the object of control – the student – is a complex multidimensional dynamic biological object with fuzzy parameters and an individual nature. For this reason, a traditional, technical approach to the definition of learning characteristics for formative assessment and diagnostic purposes is not really appropriate. We therefore propose a composite approach to definition of the priorities and weighting coefficients of learning characteristics. It uses an objective evaluation of subjective experts’ opinions using rank correlation methods and elements of subjective statistics. In practice, defining the student’s learning characteristics means development of a student model. The suggested approach can be used to create different student models for different cases and styles of learning courses.

Individual diagnostics and supportive feedback to each student is the main contribution of this cybernetic approach to e-Assessment in the context of an APLE. However, the diagnostics of a group of students can also give very useful information on the learning and teaching approach. Common weaknesses and difficulties can be identified to help improve teaching methods. Furthermore, it is arguable that the estimation of students’ satisfaction with a teaching course is essential for evaluating courses and improving their quality. The control of the learning process through formative assessment and diagnostics and providing feedback to the individual learner and to the learning group can help contribute to achieving optimal learning results.

CONCLUSIONS

The APLE framework is focused around the creation of novel interfaces for personal learning taking as the starting point an existing Virtual Learning Environment (VLE) known as the Portland VLE. Central to the project is engagement with and development of a community of practice comprising tutors, developers, students, researchers and administrators. Through this engagement, we aim to develop a set of anonymous personal profiles from which sample interfaces and learning objects will be produced. In addition, an exploration of appropriate standards is required to establish a framework that enables interoperability between learning environment, devices and learning objects. More advanced methods of formative assessment, diagnostics and evaluation also have a place in our model. We expect to explore a whole range of methods, procedures, and approaches to adaptive learning; these coupled with adaptable content and services will
form our final model. In that sense then, the APLE model represents a truly user-centred design for a learning environment founded on a community development approach. The importance of the learner as the central component in our APLE design model cannot be over-estimated. We therefore propose that our APLE model is a valuable contribution to the research in e-learning, e-assessment and learner modelling. However there is still a considerable amount of research required in defining the framework, developing the component modules and populating the model with profiles and adaptive learning objects. For this we rely on an effective APLE community of practice.

REFERENCES


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