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The Adaptive Learning Environment: Customising the System to the Users' Accessibility Needs

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Abstract: Computer-delivered educational material has great potential for customisation to meet the requirements of individual users, in particular students with disabilities. An adaptive learning environment (ALE) is a system which analyses the student's performance at each stage, using the results to generate the next section's content. This has always been the practice in traditional teaching, but is expensive in resources and dependent on the teacher's skills and experience. Automating this process offers consistency of quality and flexibility. This paper discusses how a set of user characteristics relating to disabilities can be recorded on registration to an ALE. It outlines how this profile can be used to modify the interface's appearance, improving accessibility for the user, and investigates how meta-tagging the learning objects in the ALE with accessibility tags can further tailor the material delivered. Finally, the paper discusses the implications to computerised assessment of students with disabilities.

Keywords: Assistive technology, accessibility, adaptive learning environment, ALE, disability, education, learning object, re-usable learning object, RLO.

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1. Introduction

The UK Special Educational Needs and Disability Act (2001)[1] both strengthens the right for students with special educational needs (SEN) to be educated in mainstream schools (integration) and ensures that these students are not disadvantaged (inclusion). These students will bring with them an emphasis on individualised learning; student-centred rather than curriculum-centred. The resource impact for the teaching profession is a very serious issue - the main concern expressed by English head-teachers regarding inclusion of special education needs students in primary schools was that of resource allocation[2].

This paper considers potential problems and advantages for students with disabilities in the increasing use of computer-delivered educational material [8, 9]. The need for student profiles is discussed, and what these might contain, and how profiles could be used to ensure inclusion and aid classroom management.

2. The Adaptive Learning Environment

A Virtual Learning Environment (VLE)[3] is a web-delivered online learning environment with secure access, student tracking, resources and communication tools. An Adaptive Learning Environment (ALE) is a VLE which adapts to the needs of the individual, combining the traditional teaching method of individualised learning with the advantages of a VLE[4]. At the end of each element, the ALE analyses the results, using them to build up the next element delivered. Each element is made up of one or more re-usable learning objects (RLO) which are described by a set of meta-tags, defined in the Sharable Content Objects Reference Model (SCORM) produced by ADL[5]. Currently these do not contain explicit information on accessibility issues, though they do include information on the type of object, e.g. graphic, audio, text.

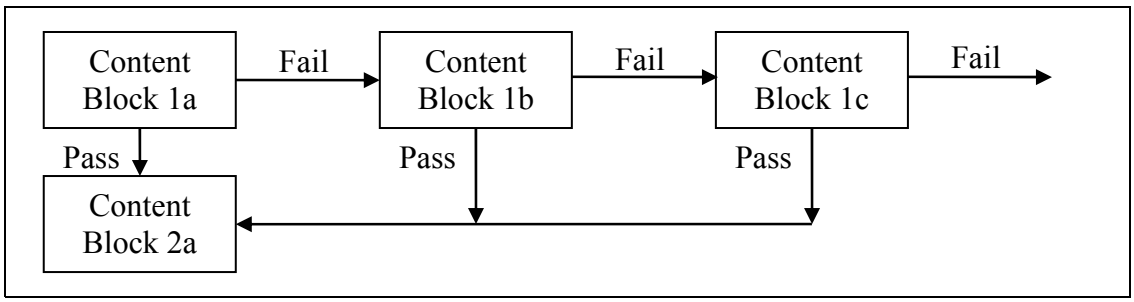

Figure 1. Simple navigation through an ALE-delivered course

Figure 1 shows a simplified flow through an ALE-delivered course. The ALE should contain sufficient flexibility to include an unrestricted number of element extensions and an option to flag the teacher for assistance. The student's progress through the course is recorded automatically on their profile by the ALE, giving teachers immediate access to student marks, and an electronic bookmark so that the student, on starting a new session, is taken to their most recent exit point.

2.1 Problems of the ALE for the student with disabilities

The system depends on the student being able to access the RLOs and complete the tests without access bias. This may present difficulties to the students with accessibility problems. Alternative RLOs will be required in some cases, increasing management and cost. Different students will have different preferences for web-browser set-up, which could be time-consuming for a student without a dedicated machine. The school will also need to

make sure the necessary hardware and software for the course is available for the student, requiring the teacher to manage resources.

2.2 Advantages of an ALE to the student with disabilities

Because the environment gives spatial and temporal independence, all the material is available all the time. This allows students to review each unit as many times as they want, an advantage for the cognitively impaired student. The teacher can be certain that the material is not subject to copying errors by the student (common in dyslexia) or missing parts due to absenteeism. Provided they have access to the web, the student can work at home and even potentially at hospital, reducing the disruption extended stays can cause to a student's education. The hospital tutor can see exactly where the student is in their studies without time-consuming school consultation, and the student's education is not interrupted while waiting for this information. Much work has already been done on the accessibility of web pages, and there are guidelines available, for example IMS Guidelines for Developing Accessible Learning Applications[6].

Provided the necessary software and hardware are available and set up to the student's preferences, computer delivery offers flexibility and accessibility. By meta-tagging RLOs and the student's profile with accessibility tags and mapping the two, the ALE can present a course tailored to the student's ability without hindrance of inappropriate delivery. A tool to check the RLO requirements against accessibility profiles for students, and create a list for inaccessible RLOs, is required. An advanced search facility for the RLO repository containing accessibility fields should also be created.

Collaborative learning can also be aided by computerised delivery. E-mails benefit many students, giving the same advantages as other written text, enabling communication between groups not previously able to communicate freely.

3. Profiles

3.1 Constructing the profile

Each disability could be recorded, but this would involve an enormous mapping exercise of disability-to-implication to ALE which would not always be useful. A student who is blind, for example, will not necessarily need a Braille display, as other output modes may be appropriate. It would be better to store the system requirements in the RLOs and the user requirements on the profile. It would also be useful for the ALE to store information on what equipment each student needs as an administrative tool for the teacher. In some cases, the equipment might be deemed useful but not essential, for example a dyslexic student might prefer to use a tinted screen yet still be able to cope if such a screen is not available. It is therefore proposed that all adaptive equipment be set by default to 'not needed', but with options available for 'preferred' and 'essential'. A tool should be developed to create a list of special equipment needed for a particular class, assisting the teacher to manage the available resources.

The information stored in a web-browser needs to be stored in the profile, for example font, font-size, font colour, background colour. Sometimes different font-styles are used for emphasis within an RLO. A single-font field within the student profile would be needed.

3.2 Multiple profiles

There may be occasions where it would make sense for a student to have more than one profile. A student may have very different needs when using a personal digital assistant (PDA) to when they are using a desktop, or when they are working with their learning assistant and when they are working alone. More than one account could be set up for that

person, but the student would then have to remember more than one login. Also, if a student is taking a course on a desktop then moves to a PDA, the electronic bookmark would be wrong, and tutors analysing the student's marks would need to group work done on the different accounts. Instead, multi-profiles relating to one account are proposed, defaulting to the last used or a pre-defined default.

4. Example Considerations for Disability

4.1 Visual material

In traditional teaching much of the material is delivered by written material (books / worksheets / blackboard). The printed page is of fixed colour, font and length, expensive to produce, and static. The blackboard / whiteboard are inaccessible, so any information conveyed via the board will need oral delivery or putting into another accessible form. Blind students need printed material converted to Braille or audio, or require an assistant to read it to them.

Students with low vision may require magnification of information on the screen. Sometimes a graphic can lose its sense, or become too pixelated. A field for an RLO unsuitable for magnification is required, and a corresponding need for magnification on the student's profile. In this case, a higher-resolution graphic could be created for the student.

Items should not rely solely on colour. When colour does play an important part, there should be a tag to indicate this, and a matching tag in the student's profile indicating a colour-requirement. The Ishihara colour-test plates (to test for colour blindness) are an example; trying to change the plates to not depend on colour would clearly invalidate them.

Graphics need to contain, wherever possible, textual annotations of similar or equivalent educational value. Figure 2 shows a pie-chart with typical textual descriptions. Although the *Alt Text* description is correct, it is clearly not of the same educational worth as the graphic. It would therefore be valuable for the ALE to contain a tool for producing a list of RLOs which need annotation, with a facility for the composition and checking of such annotations.

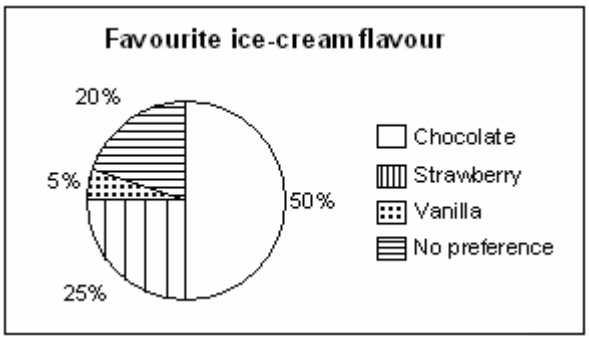

Figure 2(a). Pie chart of favourite ice-cream flavours

Alt Text: A pie-chart showing the favourite ice-cream flavours.

Long Desc: A pie-chart showing the favourite ice-cream flavours. Chocolate 50%, strawberry 25%, vanilla 5%, no preference 20%.

Figure 2(b). Two textual descriptions for the pie chart

4.2 Audio material

For orally-delivered material, students must be able to hear the speaker, or there must be signing provided, or there must be a good line of sight for a lip-reader. The information will often only be delivered once. The ALE allows the student to replay material, either in total or a selected part. As the student will be wearing earphones, the volume can be individually controlled and background noise can be reduced. As for graphics, audio clips should be fully described in the *Long Desc*, either transcribed language or a description of the audio content (for example, the sound of water). In this way, the material can also be made available as text or signing avatars. If the audio-requirements of the student are recorded,

the correct form can be delivered to them automatically. It would therefore be appropriate for the profile to include fields for use of audio and sign-language. An audibility test may be incorporated for some students at the start of each session, of particular use if a student suffers intermittent hearing problems. A field reflecting whether such a test should come up on login would therefore be needed.

The profile should also contain information on the assistive technologies required by students, and the learning object meta-tagged with any assistive technologies it will not work with, e.g. certain flash presentations can only be used with a mouse, so are problematic for the keyboard or single-button user. There may also be problems of dexterity level, and information should be stored on what types of assistive technology the student can and cannot use, and matching requirements for the RLOs.

4.3 Cognitive and physical considerations

The language level of the user should be stored and applied to the interface to suit the cognitive abilities of the student in the same way as language of the user is currently stored and applied. W3C recommends that flashing lights and strobe effects are only used where necessary, and this may be deemed so in a physics demonstration. Therefore a field within the profile should indicate when a student should not be shown an RLO containing strobe effects, and a similar meta-tag on the RLO should be ticked if it does contain such effects.

Physical disability can have implications for computer-delivered education. Use of drag-and-drop, common in flash-delivered assessments, may prove difficult for those with reduced fine motor skills, especially if there are time constraints imposed. Although keyboard equivalents should be used wherever practical, in some cases an alternative RLO will need to be created. Fatigue may require a student to do a lesson in several small sections. With an ALE, this will be possible provided that there are no time-outs or requirements to finish a large section before the electronic bookmark is updated.

5. Student Assessment

To make each assessment test accessible to all students would again be time-consuming and resource-intensive. Because the tests in an ALE are RLOs with the same meta-tagging as other RLOs, the tool checking RLOs will also list tests unsuited for particular students. In some cases optional tests will need to be produced or an alternative scoring used. For example, a test following a field trip may include one question on identifying a bird-song. This would be unsuitable for a deaf student and the ALE must have the flexibility to either substitute an alternative, or bypass this question. (Care must be taken with such decisions, however; deaf students can gain much from a musical education[7].)

The teacher needs to consider carefully what the test is assessing. If the student's colour vision is being tested, amending the Ishihara plates or detail in the text 'this plate shows the number 5' would make the test nonsensical. However, the plate showing a 5 to full- colour vision and 2 to red-green could easily give a false result for a dyslexic student. In this case, an alternative test should be shown. If a particular test needs to be finished in three hours and a student can only physically manage 90 minutes, consideration needs to be given as to whether the test can be split into shorter segments or whether one of the objectives being tested is the ability to perform for three hours. It is therefore recommended that a meta-tag for the test be included indicating whether it can be modified if an accessibility problem is flagged. Whether this should be a binary or text field is an area requiring further investigation, and the maximum time a student can undergo such testing should be recorded.

6. Conclusions

ALEs offer extensive scope for automated course-delivery to students over a wide accessibility spectrum. By development of a user profile, systems can be automatically set up for maximum comfort and usability, and tutors can more easily manage extra hardware and software resources. Adding accessibility meta-tags to the components of the course, and the development of a tool within the ALE to highlight potentially unsuitable RLOs, will enhance accessibility, increase the inclusion of students with disabilities, and produce an efficient means of just-in-time RLO production.

Acknowledgements

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