A Technology Toolkit to support accessibility of formative e-assessment for disabled students

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Abstract

This paper illustrates how problems with accessibility and ease of use of electronic formative assessment tools can be overcome by the judicious use of assistive technologies and presentation modes to enhance teaching and learning for disabled students and those with specific learning difficulties such as dyslexia. Where formative assessments are used to enhance teaching and learning to meet the needs of students, it is important to work in an inclusive environment to support diverse personal preferences and skills. Positive responses to e-assessment can only be achieved if a toolkit of support and guidance is available to both students and developers.

Based on research carried out during the Joint Information Systems Committee (JISC) funded e-assessment in Higher Education (EASiHE) project (a case study of a Modern Languages module using QTI, mobile QTI, accessibility, and Web 2.0 tools) and LexDis project (which involved the participation of 30 disabled students), it has been possible to bring together the concept of ease of use and accessibility in practical terms when addressing the issues of the use of assistive technologies with computer based online assessments or e-assessments. As has been noted by the authors of the JISC funded project 'Scoping a Vision of Formative e-assessment' (Pachler et al 2009) "technology does not in itself bring about formative effects". Formative e-assessment, the authors argue, "is better understood as multiple processes involving technologies to greater or lesser degrees, where evidence is generated about a learner's state of understanding relative to desirable goals and

where individuals are enabled to take actions which bring about changes in learners' skills, knowledge and understanding, or in teachers' pedagogical practice". Omitted is the additional impact that assistive technologies such as screen readers, alternative input devices and magnification may have on the student's ability to cope with the e-assessment process.

Blake and William (1998b) found that formative assessment may help students with specific learning difficulties (including dyslexia) even more than it helps other students, and that this type of assessment allows students to identify gaps in their current knowledge (Boston, 2002). There is also some evidence that certain groups of disabled students can access online assessments with greater ease and that dyslexic students find these assessments less stressful compared to paper-based assessments, as less spelling and punctuation may be required (Ricketts and Wilks, 2002). Sloan and Walker (2009) added that "electronic assessments also offer the potential for visually impaired students to customise the display of assessments to suit their accessibility requirements, while those with more severe impairments can access the same assessment in all audio (through a screen reader) or tactile (through a braille display) formats. Flexibility in data input supports people for whom a physical disability would make written tests difficult or impossible."

However, issues remain around time constraints and the amount of additional time offered to students when taking e-assessments, should they require assistive technologies, as many existing guidelines are for paper-based examinations. Organisations often offer an additional 25% time, but this is not always beneficial in e-assessments (Ball and Wilks 2002). This paper does not intend to discuss timings or question types, but evidence exists shows that students prefer to work through questions in any order (Peat and Franklin, 2002) and this can be achieved with both QMP and Hot Potatoes.

Difficulties with navigation, the use of graphical content, audio, video and interactive participation have also been mentioned by Sin et al (2004) and confirmed by some LexDis participants who continued to describe the strategies they used to overcome these difficulties.

The use of such strategies will be described in this paper alongside the relevant evaluation technique, to ensure that the e-assessment tools used on the EASiHE project were as accessible as possible.

Students' Use of Additional Technologies to Support Their Use of E- Assessment

Some students may wish to alter the presentation of an e-assessment, they may need different coloured backgrounds, increased letter spacing, different fonts, or be using their own technologies with the e-assessment. These assistive technologies need to be available at all times and compatible with all aspects of the assessment; for instance, the reading aloud of questions as well as typed answers and flexible navigation through questions.

Assistive technology has been described as "any product or service designed to enable independence for disabled and older people" (FAST, 2001) but recently,

products and services that were not designed with disability in mind have come under the banner of assistive technologies (Seale et al 2008). Specialist technologies have been developed to enable the blind and those with visual impairments to access online materials using complex screen readers. These tools can read all aspects of computer interaction and are labelled by the Royal National Institute for the Blind as 'Access Technologies'. Some applications solely read text on a screen, for those who have specific learning difficulties. Specialist input and output devices such as switches for onscreen keyboards and refreshable Braille displays would also be classified as Access Technologies. If one considers these tools as the most specialist items provided to students to access their e- assessments, these could be seen as sitting on the top of the assistive technology triangle. The next level may contain the personalisation and desktop changes students wish to make, which may be equally important when discussing access to online tests. None of these layers are mutually exclusive. In fact, most students participating in the LexDis project made use of each level of assistive technology described.

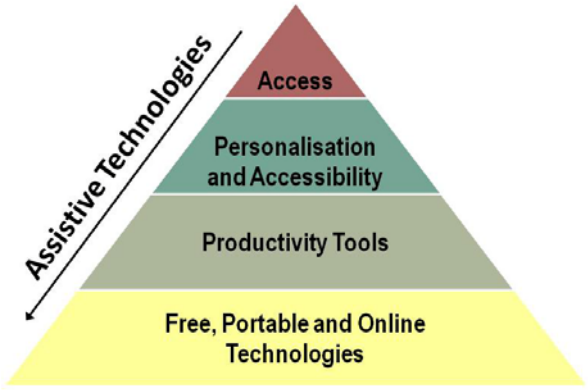

Figure 1. Facets of Assistive Technology

Problems arose when students attempted to personalise their e-assessments on networked computers around the campus. Desktop options, such as screen resolution, background colours and fonts, were not always available.

LexDis participants described how such options were beneficial, and often made these changes to their own computers (Seale et al 2008). To overcome these difficulties, the JISC TechDis Toolbar (Skuse et al 2009) was developed to allow such customisations in any web browser, on any webpage (including assessments), on secured network-based computers. The toolbar may be invoked by any user on-demand (pulled), but can also be provisioned on any website (pushed), making it visible to all visitors.

In the case of QMP and Hot Potatoes it was easier to implement the on-demand toolbar. Changes can be made to the e-assessment templates used for the EASiHE project (Bacigalupo et al, 2010). Once the toolbar was in place, users were able to have selected text read aloud and make various presentation customisations, including changing the colour of text and backgrounds. The text-to-speech worked well with most questions but was unable to render text in typed input fields, unlike

commercial assistive technologies that require installation. The authors felt that this feature was important for proofreading purposes, so it will hopefully be implemented in the future.

Productivity tools were considered in the layer below access and personalisation and included such online tools as the Google Toolbar spellchecker, dictionaries and abbreviation expansion tools or other auto-complete applications. These tools were often browser-specific, so one spell-checker could not be used in multiple browsers. Such tools were rarely available to students unless they were a built-in feature of the browser. Students admitted that they rarely spell-checked their online work due to time constraints and problems accessing their assistive technologies (Seale et al 2008). It was found that the JISC TechDis Toolbar could spell-check most plain text forms but had problems with forms developed using Adobe Flash.

Finally, students may use free, online and portable technologies available on USB pen drives. Although many portable applications and suites exist, some are not accessible, so a menu was developed which allowed suitable customisations to be made and provided a standardised interface (AccessMenu http://access.ecs.soton.ac.uk). These technologies are usually simple versions of some of the more complex assistive technologies. Many of these portable applications offer the extensive features available in commercial products, without requiring installation.

Where inherently accessible questions were presented, most assistive technologies worked well. However, multimedia elements, symbols and drag and drop requirements were detrimental to accessibility and required further evaluation to ensure alternatives could be provided.

Evaluation of E-Assessments for Accessibility Purposes

Developers of online materials have several checks that can be used to evaluate the accessibility of their creations. The World Wide Web Consortium (W3C) Web Accessibility Initiative (WAI) published version 2.0 of the Web Content Accessibility Guidelines (WCAG) in 2008 which covers interactive Web 2.0 type services. Included is support for the accessibility of tools that enable Web content publication; namely the W3C (2000) Authoring Tool Accessibility Guidelines. These tools are often quite complex to use and were not designed for teaching environments or for those who develop assessment materials. Many organisations, such as JISC TechDis (Ball and Wiles 2002) and the British Computer Society, have developed clearer guidelines for the accessibility of e-assessments. A combination of these guides first informed the evaluations carried out by the EASiHE project team with the proviso that "the learner should engage with subject matter [and] not the software. It is vitally important that the system does not end up assessing the student's ability to press buttons in the right order." (Thomas and Milligan, 2003) and "we need to ensure that every step of the way we are letting students know what is ahead of them in as much time as

possible, so potential issues and barriers can be identified, dealt with, and removed or avoided" (Ball, 2006). It was suggested that:

- Before embarking on an e-assessment, a student should have access to information that describes the types of questions that are going to be used with examples of the navigation features used throughout the assessment.

- The student should be able to control any time-dependent features - the chance to turn off time limits or adjust them with warnings of when the time expires.

- Academic rigour cannot be undermined but readability in terms of understandable content and the type of font or text size used is important for those with visual and specific learning difficulties. BCS guidelines advise the use of a sans-serif font, minimum size 12, but students must still be able to resize text.

- Colour contrast levels significantly affect people with visual impairments, so navigation elements should feature differing symbols and/or colours to those used by the browser. High contrast levels may be optional, as they benefit people with visual impairments but detriment the experience of people with specific learning difficulties.

- Keyboard access for those with dexterity difficulties and for students using screen readers is essential. All controls in windows, menus and dialogue boxes must be usable by keyboard alone; navigation between documents and applications should be easy.

- Keyboard focus should never be locked or trapped in one particular area of the page such, as in a rich text editor or media player. Many users benefit from a clear presentation of their current location on a page. This applies equally to e-assessments.

- Items should be presented in a logical order and list elements should be labelled concisely so that screen reader users can hear which parts of the online questionnaire they have reached, and which forms they are filling in before they start writing or selecting answers. Such problems were encountered by at least one LexDis participant.

- Images, videos and audio may require descriptions for both visual- and hearing-impaired students. However, each description must be carefully composed to prevent assessment-based information being given to the students. This may necessitate an alternative form of assessment.

In their evaluation of the authoring tools for QMP, Sloan and Walker (2009) mentioned that not all the features for developing questions permitted the provision of alternative formats for people using assistive technologies. For instance, a system may lack options to annotate images with description, or disallow captioning of video. The EASiHE team also discovered that unless multimedia features were developed with accessible controls allowing keyboard access, such features could cause difficulties for those students who use screen readers or switch access. It appeared at the time of the evaluations that Internet Explorer immediately permitted keyboard-only access, but other browsers first required users to click the multimedia element. Once HTML tags had been added to the player, those who required keyboard access were able to control the sound or video. . If question authors upload audio and video without realising the implications for disabled users, the e-assessment service may be significantly inaccessible, as was found in the version of QMP evaluated. Accessible media players exist, that alleviate this problem.

It was also found that students using keyboard access and screen readers were not always able to make use of features contained within menus in rich text editors, or those used within Web 2.0 Services such as blogs and wikis. Basic text features, such as bold, italic and underline were usable, but lists, images and multimedia features were unavailable when using keyboard-only access. Several wiki systems and blogs were evaluated for accessibility; MediaWiki and WordPress were found to be the most accessible. If access to a rich text editor is not possible, HTML tags can once again be added to ensure total accessibility as was mentioned by a LexDis participant.

The initial checklist provided above was expanded when it was realised that many of the issues seen in e-assessment tools were also found when working online using interactive Web 2.0 services. Students had to work with inaccessible login forms and complex navigation systems on document-sharing and discussion sites. It was decided to develop an online database to allow users to review interactive and social networking services with further guidance. The result was the JISC TechDis funded Web2Access website (http://www.web2access.org.uk) which has fifteen clearly-defined checks that cover both functionality and accessibility issues with links to the Web Content Accessibility Guidelines (WCAG). Any developer can check web pages against the criteria and generate an evaluation report. This provides an insight into which features may cause barriers to accessibilty.

Discussion

Students have access to manuals and guidance on the use of their access technologies and they often learn useful productivity strategies from their peers and academic tutors. However, information about how they should access e-assessments is rare. This is an important case, as students' custom settings are not available on many networked campus computers and additional productivity tools such as spell checkers are not available.

Needless to say, there has been an increase in the number of documents available to developers concerning methods for making e-assessments more accessible, such as those presented by JISC TechDis. However, there appears to be a reluctance to embrace the issues raised by Sloan and Walker (2009) and the authors of this paper. This may be due to the difficulty of providing alternative formats within QMP as the template system is quite complex. Controls for fonts be provided by a knowledgeable developer. Work on captioning and annotating multimedia files is easier through the use of the Synote online annotation service provided by the University of Southampton (http://www.synote.org) and it may be simpler to link to this service when videos need to be part of the assessment criteria.

The University of Victoria Humanities Computing and Media Centre offer their staff some 'hacking' tips for Hot Potatoes, but this requires some coding knowledge of HTML, CSS or JavaScript (http://web.uvic.ca/hrd/halfbaked/tutorials6.php). For instance, drag-and-drop exercises which need to be provided in accessible mode for keyboard users, are made possible by selecting the first part of a question then going to the section where it should be finally positioned, selecting that area and using the enter key to finish the drop movement. Users can be instructed in this methodology and developers need to be made aware that it is possible.

Checklists are available for developers to evaluate the results of their e-assessments and the IMS Question and Test Interoperability Specifications (QTI) define a way of producing assessment information that allows questions, assessments and results to be shared across different computer systems. The challenge related to providing accessible e-assessments for disabled students remains when it comes to measuring the learning outcomes. So although an equivalent assessment should be provided whenever possible there are still accessibility features that might conflict with 'validity constraints' ... "in some cases, accessibility features overcome the threats to validity; in other cases accessibility features can pose threats to validity - you need to know the 'objectives' of the test" (Strobbe, 2006). The QTI example provided shows a picture of the solar system where the student has to place or drag a text marker to the relevant box beneath each planet. Strobbe questions what is being tested; Whether the learner knows the order of the planets? Or whether the learner recognises the planets by their size, colour? The objectives determine the type of equivalent or alternative assessment that should be provided and this remains a concern for many academics providing e-assessments to diverse learners.

Conclusion

Gregg Vanderheiden, presenting at the E-inclusion Ministerial Conference and Expo in Vienna (2008), stated that “somehow we need to figure out how to economically deliver a wide variety of interfaces needed in all the environments and activities that we will find ourselves in". He went on to say, " today many people need special interfaces or features in order to access the information and services on the web due to disability, literacy, ageing [and] many or most of these people cannot afford assistive technologies that are good enough to handle what is now appearing on the

web...". Those participating in the LexDis and EASiHE projects have become aware of the gulf that still exists between the assistive technologies available to students working on formative e-assessments in university computer rooms and the tools available to developers to ensure equivalent or alternative assessments.

On the student side it would appear that an assistive technology toolkit is needed to fit personal preferences and guidance should be available as to where these technologies can be found, how they can be implemented and which ones may be most suitable for the tasks to be undertaken within each e- assessment session.

E- assessment developers need to be aware that the tools they are using may not be providing the most accessible options despite all the guidelines available and that judicious use of alternative formats may be required depending on the type of learning outcome that needs to be achieved.

Those companies developing the tools that allow developers to assemble e-assessments need to make the methods for adding multimedia with alternative formats possible, options to change the way some questions are presented such as the drag and drop system that can be changed to a select and click solution.

Most importantly there needs to be guidance as to how to ensure that alternative formative e-assessments offered to disabled students offer an equivalence of learning outcomes. “Teachers design their instruction to yield evidence about student achievement, by carefully crafting hinge-point questions, for example. These create ‘moments of contingency’, in which the direction of the instruction will depend on student responses” (Leahy, Lyon, Thompson and Wiliam, 2005). It is vital that this direction is not clouded by the barriers imposed by some e-assessment processes.

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