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Tanya Elias

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Article abstract

This paper identifies a set of universal instructional design (UID) principles appropriate to distance education (DE) and specifically tailored to the needs of instructional designers and instructors teaching online. These principles are then used to assess the accessibility level of a sample online course and the availability of options in its LMS platform (Moodle™) to increase course accessibility. Numerous accessibility-sensitive plug-in modules are found to be available to Moodle users, though relatively few features were included in the sample course analysed. This may be because they have not been made available to instructors at the institutional level. The paper offers a series of recommendations to improve the accessibility of online DE to learners with diverse abilities, disabilities, and needs.

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70. Universal Instructional Design Principles for Moodle

Tanya Elias

Athabasca University, Canada

Abstract

This paper identifies a set of universal instructional design (UID) principles appropriate to distance education (DE) and tailored to the needs of instructional designers and instructors teaching online. These principles are then used to assess the accessibility level of a sample online course and the availability of options in its LMS platform (*Moodle*TM) to increase course accessibility. Numerous accessibility-sensitive plug-in modules are found to be available to Moodle users, though relatively few features were included in the sample course analysed. This may be because they have not been made available to instructors at the institutional level. The paper offers a series of recommendations to improve the accessibility of online DE to learners with diverse abilities, disabilities, and needs.

Keywords: Universal instructional design; distance education; learning management systems; Moodle

Universal Instructional Design Principles and Distance Education

DE students may face a variety of physical, learning, psychological, visual, and hearing challenges (Moisey, 2004). As well, the nature of contemporary online DE presents other unique types of diversity challenges. Students studying at a distance are often in diverse geographic locations, physically isolated from one another, the institution, and their instructors. Students also demonstrate diversity in their study schedules, timelines, and work and family commitments, all of which affect their availability to study. Moreover, differences exist in their technical skills and levels of online connectivity. Universal instructional design (UID) principles have been developed in order to generate products and services appropriate to the widest range of diversity (Burgstahler, 2001; Council for Exceptional Children, 2005), and it is instructive to examine the extent to which standard online learning management systems (LMS) have made use of these principles.

Burgstahler (2007) describes UID as:

...the design of instructional materials and activities that make the learning goals achievable by individuals with wide differences in their abilities to see, hear, speak, move, read, write, understand English, attend, organise, engage, and remember. Universal design for learning is achieved by means of flexible curricular abilities. These alternatives are built into the instructional design and operating systems of educational materials – they are not added on after-the-fact. (p. 1)

Thus, when online learning is designed using these principles, the resulting products and environments meet the needs of potential users with a wide variety of characteristics. In a graduate course text forum attended by this writer, Baggaley explained,

The ultimate acid test of online software is its ability to cater to users with disabilities. Software which effectively serves their needs could just be the best software for all users. A case in point is *iVocalize*, an audio-conferencing software designed by a disabled designer for others with similar hurdles, which is quite simply the most user-friendly audio-conferencing software I have encountered. (Personal communication, October 8, 2009)

UID features make learning more accessible to learners with disabilities, and these can be useful to diverse learners. In the case of open source learning management systems, these features are openly available for customisation.

Based on the existing principles of UID (Connell et al., 1997; Scott et al., 2002), the current study identified a set of eight UID principles tailored to DE. Only one of the original UID principles (size and space for approach and use) was removed from this list. Otherwise, the existing UID principles and their accompanying definitions required only minor revisions to reflect the types of diversity found among online distance learners.

Eight UID Principles Tailored to Distance Education

1. **Equitable use.** The design is useful and accessible for people with diverse abilities and in diverse locations. The same means of use should be provided for all students, identically whenever possible or in an equivalent form when not.
2. **Flexible use.** The learning design accommodates a wide range of individual abilities, preferences, schedules, and levels of connectivity. Provide the learners with choice in methods of use.

3. **Simple and intuitive.** The course interface design is easy to understand, regardless of the user’s experience, knowledge, language skills, technical skills, or current concentration level. Eliminate unnecessary complexity.
4. **Perceptible information.** The design communicates necessary information effectively to the user, regardless of ambient conditions or the student’s sensory abilities.
5. **Tolerance for error.** The design minimises hazards and adverse consequences of accidental or unintended actions.
6. **Low physical and technical effort.** The design can be used efficiently and comfortably and with minimal physical and mental fatigue.
7. **Community of learners and support.** The learning environment promotes interaction and communication among students and between students, faculty, and administrative services.
8. **Instructional climate.** Instructor comments and feedback are welcoming and inclusive. High expectations are espoused for all students.

In developing this list of DE-related UID principles, two prime questions arose:

- 1) What strategies and tools are currently available to implement the principles?
- 2) Are available tools and strategies being used currently to enhance efficient accessibility?

Methodology

The above principles and a review of accessibility-related product lists and literature (Adaptive Technology Resource Centre, 2010; Special Needs Ontario Window, 2010; Resource Support Centre, n.d.; Council for Exceptional Children, 2005) generated 40 categories of online course accessibility for the study (see Table 1).

Table 1

Universal Instructional Design Principles and Categories of Online Course Accessibility

UID principle	Categories of online course accessibility
Equitable use	1) All content online 2) “Anywhere Anytime” 3) Translator
Flexible use	4) Mind maps/diagram displays 5) Conferencing tools

	<ul style="list-style-type: none"> 6) Video/audio presentation tools 7) Slide presentation tools 8) Video/audio assignment tools 9) Links to additional information 10) Choice of study topics/ assignments
Simple and intuitive use	<ul style="list-style-type: none"> 11) Resume course 12) Simple interface 13) Direct link to new posts 14) Easy-to-navigate menus 15) Books 16) Searchable forums 17) Searchable content 18) Mobile interface 19) Text-only interface 20) Offline resources
Perceptible information	<ul style="list-style-type: none"> 21) Screen preferences, font size, masking, colours 22) Screen/document readers 23) Text-to-speech 24) Screen/cursor magnifiers 25) Transcription 26) Captions
Tolerance for user error	<ul style="list-style-type: none"> 27) Ability to edit after posting 28) Confirmation before sending assignments 29) Warnings when leaving course site
Technical and physical effort	<ul style="list-style-type: none"> 30) Voice recognition 31) Word prediction 32) Built-in assistive technologies 33) Limited use of external links 34) Embedded multimedia/ assistive technologies 35) Browser capability checker
Learner community and support	<ul style="list-style-type: none"> 36) Study group 37) Links to support services
Instructional climate	<ul style="list-style-type: none"> 38) Involvement in discussion forums 39) Regular email contact with students 40) Availability for one-on-one consultation

A sample online course was then examined in relation to its current level of accessibility in these categories. The course was Introduction to Educational Technology, an online graduate course at Athabasca University (AU) in Canada, delivered using the popular open source LMS, Moodle™. The student population of the sample course was comprised of adult learners with diverse abilities, learning styles, schedules, and geographic locations. This study reviewed the course site and its learning materials and included interviews with students and the course teacher during the fall 2009 semester. Analysis of the course website's features was encouraged by the instructor in the interests of improving the site via formative evaluation. At the time of the analysis, version 1.92 of Moodle was being used at AU; since then, it has been upgraded to version 1.97.

Using the same accessibility categories, the wider range of features available in Moodle, though not necessarily used at AU, was considered. The Moodle.org website indicates that there are currently over 49,000 registered Moodle sites in 210 countries with over 34 million users (Moodle, 2010). As an open source product, Moodle is flexible in its customisations, and its use is limited by the knowledge, learning, resources, and innovative spirit of its users rather than by the proprietary rights of vendors (Weber, 2003). Batpurev et al. (2009), in a study of Moodle's use in Mongolia, found that its feature-richness was one of Moodle's best attributes. In April 2010, the Moodle.org community site offered 632 modules and 131 themes for customising various facets of the learning environment. The current analysis assigned each module to an accessibility category based on a reading of the summaries of each module and theme. It is emphasised that the quality of the modules was not assessed. Moreover, the Moodle (2010) site carries the following disclaimer:

WARNING: Please be aware that some of these items have not been reviewed, and the quality and/or suitability for your Moodle site has not been checked. The modules here may have security problems, data-loss problems, interface problems or just plain not work. Please think carefully about maintenance before relying on contributed code in your production site, as some of this code may not work with future versions of Moodle.

Therefore, the current analysis does not attempt to assess the actual quality of the Moodle modules or to encourage the use of specific modules or themes. It provides instead an overall impression of the types and number of available modules in order to illustrate the potential for improving access to online course platforms generally.

Formative Evaluation Results and Recommendations

A substantial number of assistive technologies and multimedia options have been integrated into Moodle modules. It was determined that a series of standard product features (v. 1.7 and above), as well as 121 modules and themes, have the potential to enhance the accessibility of online courses. The features and modules were identified as meeting 79% of the UID accessibility

criteria relevant to online learning. Relatively few accessibility-related Moodle modules were integrated into the sample online course, which demonstrated implementation of only 26% of the accessibility categories. This was due to the limited availability of these modules in the default Moodle platform made available to instructors institutionally (Baggeley, personal communication). Most of the categories represented in the sample course related to the application of pedagogical strategies using standard Moodle features.

Based on these findings, a series of recommendations for supporting the implementation of the UID principles for DE has been developed, relating to the customisation and use of LMS technologies. The recommendations emphasise the integration of pedagogical strategies and technical tools in online education in order to meet the diverse abilities, disabilities, and needs of online learners more efficiently.

Equitable Use

According to the UID principles for DE, course design should facilitate equitable use. The design must be useful to and accessible by people with diverse abilities and in diverse locations (Table 2).

Table 2

Availability of Moodle Modules Serving the Equitable Use Principle

Equitable use	Available in Moodle?	Used in sample course?	Number of modules
All content online	Y	Y	Standard feature
“Anywhere Anytime”	Y	Y	Standard feature
Translator	Y	N	4

Recommendations.

- Put content online. Online files should be directly accessible by screen reader, text-to-speech, and screen preferences programs, which make content more accessible, and eliminate the need to adapt textbooks.
- Provide translation. Language barriers present a problem for many learners. The incorporation of translation modules can help learners for whom English is a foreign language. Four Moodle modules incorporating Google translation features were identified.

Flexible Use

UID principles relevant to DE also prescribe flexible use. Course design should accommodate a wide range of individual abilities, preferences, schedules, levels of connectivity, and choices in methods of use (Table 3).

Table 3

Availability of Moodle Modules Serving the Flexible Use Principle

Flexible use	Available in Moodle?	Used in sample course?	Number of modules
Links to additional information	Y	Y	Standard feature
Choice of topics/ assignments	Y	Y	Standard feature
Conferencing tools	Y	Text only	22
Audio/video presentation tools	Y	External only	15
Slide presentation tools	Y	External only	4
Audio/video assignment tools	Y	N	8
Mind maps/ diagram displays	Y	N	5

Recommendations.

- Make synchronous sessions optional. Asynchronous delivery allows students the flexibility to set diverse study schedules. Synchronous activities can be offered as options, or scheduled in small groups to meet scheduling needs. In addition, recordings of synchronous sessions can be made available to students who cannot attend live sessions. Students can also be given choice with respect to the content studied.
- Present content and accept assignments in multiple formats. Multimedia tools can be used to present content and assignments in multiple forms, providing the learner with flexibility and choice. Graphical representation of concepts using mind maps and diagrams increases the flexibility in use and is an excellent and available method to increase content accessibility. Learners with sensory disabilities, learning disabilities, and diverse learning styles can all benefit from content presented in redundant forms. These tools, however, should be integrated directly into the LMS (an issue revisited under the tolerance for error principle). Thirty-two Moodle modules are available currently to enable a variety of multimedia presentations.
- Offer choice and additional information. Offering links to additional information and choices of assignments and topics of study allows learners to be more active participants in the process. It also allows them to meet course requirements in a way that is best suited to their individual abilities, disabilities, and needs.

Simple and Intuitive Use

In accordance with UID principles for DE, unnecessary complexity should be eliminated and course design should be simple and intuitive. The sample course demonstrated a typical weakness of the Moodle interface, the need to scroll through long lists to reach current information, such as new discussion posts. (Table 4).

Table 4

Availability of Moodle Modules Serving the Simple and Intuitive Principle

Simple & intuitive	Available in Moodle?	Used in sample course?	Number of modules
Searchable forums	Y	Y	Standard feature
Books	Y	Y	3
Searchable content	Y	N	2
Easy-to-navigate menus	Y	N	19
Simple interface	Y	N	8
Direct link to new posts	Y	N	6
Resume at log-off place	Y	N	3
Mobile interface	Y	N	3
Offline resources	Y	N	2
Text-only interface	N	N	0

Recommendations.

- Simplify the interface. The Moodle interface could be simplified by offering a series of buttons that link learners directly to the following: 1) the current week of study, 2) new discussion posts, and 3) the last log-off place. No scrolling would be required. From this simple interface, students could quickly and easily navigate course sites using organisational options in available Moodle modules to simplify access to content via collapsible menus and tabs. Finding information in course sites could also be improved by using enhanced search features. Although searchable discussion forums are a standard feature in Moodle, searchable course content is not comprehensive. Such improvements would be beneficial to those with sensory disabilities and attention and memory problems, as well as to distracted, busy adult learners generally.
- Offer text-only, mobile, and offline options. The current Moodle interface and other course resources are effective for online learners with fast Internet connections. In areas that lack high-bandwidth connections, however, Moodle's loading speed creates a barrier to access. Some Canadian learners, such as those in the sample course and millions of potential learners in developing countries with low-bandwidth conditions, are restricted to dial-up Internet service (Baggaley, 2007; Batpurev et al., 2009). Simplified and

mobile interfaces are currently available in Moodle. Although a text-only interface was not located among the modules and themes of the Moodle website, open source software (e.g., Webble) is available to translate websites into text-only interfaces. The existence of these open source products demonstrates the ability to increase accessibility by simplifying and improving the intuitiveness of course sites. Learners struggling with low levels of Internet connectivity might also benefit from course materials in offline formats (Batpurev et al., 2009).

Perceptible Information

Screen and font preferences, text-to-speech, screen readers, captions, and screen/cursor magnifiers can ensure that all learners have access to perceptible information (Table 5).

Table 5

Availability of Moodle Modules Serving the Perceptible Information Principles

Perceptible information	Available in Moodle?	Used in sample course?	Number of modules
Screen preferences, font size, masking, colours	Y	Limited	3
Captions	Y	N	3
Text-to-speech	Y	N	1
Screen/document readers	N	N	0
Screen/cursor magnifiers	N	N	0
Transcription	N	N	0

Recommendations.

- Incorporate assistive technologies. Although external assistive technologies can be used in conjunction with online course materials, these tools should be integrated into the LMS itself, according to the principles of UID (Council for Exceptional Children, 2005). Many of these features already exist in multiple Moodle modules and themes.
- Add captions, descriptors, and transcriptions. Video- and audio-conferencing can present a significant obstacle to accessibility. Moisey (personal communication, November 20, 2009) indicates: “You can go over the recording afterward if you need to...and you can boost the volume, but other than that, there is really no way of making it more accessible” for students who are hearing impaired. Poor connections and language barriers can be exacerbated by LMS features. A conferencing system with transcriptions would help to make conference recordings more searchable for all users. Captions and transcription, for which no existing modules were located in Moodle during this analysis, are available in

other open source software (Resource Support Centre, 2010) and should be considered in order to improve the accessibility of online course platforms generally.

Tolerance for User Error

UID principles also minimise hazards and adverse consequences of errors in software operation by designing learning environments with a tolerance for error (Table 6).

Table 6

Availability of Moodle Modules Serving the Tolerance for User Error Principle

Tolerance for error	Available in Moodle?	Used in sample course?	Number of modules
Ability to edit after posting	Y	Y	Standard feature
Confirmation before sending assignments	N	Text only	0
Warnings when leaving course site	N	Text only	0

Recommendations.

- Allow students to edit their posts. Incomplete and incorrect discussion posts can be accidentally uploaded by students. If they have been composed outside the Moodle site, their appearance can change after being uploaded. Allowing learners to correct such mistakes is essential because it supports learner confidence in the use of the technology.
- Issue warnings using text and sound. Resources used by users outside the course website might not be as benign as those within the course site. Notes in the course materials should identify and warn students about potential risks. Leaving the course website without logging out, for example, can expose users to security risks, especially if they are required to enter personal information to access the online software. Students who are less technologically aware can be vulnerable to identity theft, phishing, unwanted marketing, and computer viruses. Text-only warnings about such risks and critical announcements about assignments can be overlooked by students, and their importance could be stressed by the use of images and sound. A pop-up window and “ping” sound to warn students that they are about to leave the course site, for example, would make the site more error-tolerant.

Technical and Physical Effort

Ideally, online learning should require a low level of technical and physical effort compared with on-campus learning. Issues related to physical effort, however, should still be considered when designing online learning (Table 7).

Table 7

Availability of Moodle Modules Serving the Low Technical and Physical Effort Principle

Low technical & physical effort	Available in Moodle?	Used in sample course?	Number of modules
Built-in assistive technologies	Y	N	Many
Limited use of external links	Y	N	Many
Embedded multimedia/ assistive technologies	Y	N	Many
Browser capability checker	Y	N	1
Voice recognition	N	N	0
Word prediction	N	N	0

Recommendations.

- Consider issues of physical effort. Long periods of typing can create physical discomfort and reduce hand mobility. Assistive technologies, including voice recognition and word prediction, would help to meet the diverse needs of students, including those who are not normally disabled.
- Incorporate assistive technologies and multimedia, and embed links. Although online course materials can be accessed using external assistive technologies, their use is likely to lead to higher levels of mental fatigue if they are not integrated into the course platform. For example, if the text size in a discussion forum reply box cannot be increased, a visually impaired student may have to 1) increase the size of the text, 2) copy it into external word-processing software, and 3) return to the Moodle site to paste it in the box for uploading. Extensive use of external links and external programs in this way increases the technical effort required by all users. Integrating available Moodle modules to enable the use of sound and video and other assistive technologies built directly into the course site can help to reduce the physical and mental fatigue of online learners.
- Include a way to check browser capabilities. A useful optional Moodle module is a *browser capability checker*. At the beginning of a course, the students can be given a list of required and optional plug-ins and other software to access course materials. The checker then indicates the products correctly installed with a green check mark. Helping

students to identify technological requirements at the beginning of a course could save them from technical frustration later on.

Learner Community and Support

The use of discussion forums in LMS-mediated online courses results in a sense for learners of community and support (Table 8).

Table 8

Availability of Moodle Modules Serving the Community of Learners and Support Principle

Community of learners & support	Available in Moodle?	Used in sample course?	Number of modules
Links to support services	Y	Small font	Standard feature
Study group	Y	Limited	2

Recommendations.

- Provide study groups and tools. The development of a sense of community outside the online class environment, however, can often be limited. Several available Moodle modules enable students to study together and to share marked-up text with one another. Such features can help to develop a sense of purpose and cohesiveness among small groups and can enable learners with diverse needs and disabilities to feel like less of a burden to the group. Developing stronger ties among learners in this way could also create a peer support network for solving technical problems, for example, when no other assistance is available.
- Provide easy-to-find links to support services. Links for students to services, including administration, library, and other supportive services, need to be accessible to online students directly from the LMS in a way not necessary on-campus. Links to these services should be prominently and consistently placed on every course page. Therefore, when considering a simplified interface, course developers should also consider the font size and placement of these links.

Instructional Climate

The UID principle instructional climate concentrates specifically on the impact of the instructor delivering a course as opposed to the course design (Table 9).

Table 9

Availability of Moodle Modules Serving the Instructional Climate Principle

Instructional climate	Available in Moodle?	Used in sample course?	Number of modules
Involvement in discussion forums	Y	Y	Standard feature
Availability for one-on-one consultation	Y	Y	Standard feature
Regular email contact with students	Y	Y	7

Recommendations.

- Encourage instructors to make contact and stay involved. Course instructors must be highly engaged in the discussion forums, and they must make posts that clarify, ask questions, and focus the discussion on important topics in a way that fosters learning and creates high expectations for all learners in an atmosphere of inclusivity. The instructor in the sample course also sent private email announcements to students on a regular basis. Regular contact through the use of group emails, one-on-one email, Skype, and telephone can help to ensure student success and to enhance an online course. Instructor accessibility is an essential component of course accessibility. Clear expectations in terms of comments, feedback, and inclusivity should be set for all course instructors to help them help their learners.

Conclusions

“Inclusive education values diversity. As such, learning materials are designed so that all learners are included – the best way to do so is to avoid erecting barriers” (Moisey, personal communication, November 17, 2009). A wide range of features to reduce barriers and increase accessibility is available for the popular Moodle learning management system. If these are not adequately used in the Moodle platforms provided by educational institutions, an incorrect impression may be gained that Moodle does not provide comprehensive and accessible options. By way of illustration, relatively few of the features fulfilling UID and accessibility goals had been made available for the sample online course examined in this study; and it remains to be seen whether UID principles are being widely implemented in other online courses. Institutions interested in addressing accessibility issues should evaluate and exploit the potential of the LMS products available to them and should invest in training and support for their course designers and instructors on the benefits of implementing UID strategies. Research is required to consider how assistive technologies and solid pedagogical approaches can remove barriers to educational diversity and disability.

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