Online Course Designs: Are Special Needs Being Met?

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Abstract*: This study establishes a theoretical basis for an extension of a previous typology of design elements of online courses to include elements specifically impacting students with disabilities. The prevalence of these special design elements is then examined from the results of a survey of existing online courses. It was found that these courses do generally include design elements necessary to meet the basic needs of students with disabilities, but that as more students with more sophisticated needs enroll in online courses, the design of these courses must further evolve. Specific design and research recommendations are made.*

Keywords*: Online Education, Distance Education, Online Courses, Special Education, Special Needs, Instructional Design, Physical Disabilities, Cognitive Impairments, Learning Disabilities*

INTRODUCTION

Online education takes place in a computational environment. Like in traditional environments, this allows flexibility in presentation styles, choice of multimedia, and designs that accommodate physical and cognitive student needs. These attributes are particularly appealing to those attempting to meet needs of students with disabilities because the delivery medium potentially creates learning environments where disabilities become transparent. Federal

legislation requires students with special needs — cognitive disabilities, physical challenges, or emotional problems — be educated in the "least restricted environment," allowing participation in regular educational experiences to the greatest extent possible. It is possible to meet the guidelines of this legislation in online courses, but critical that designers learn methods to ensure the greatest level of accessibility possible.

Internet use is growing at a rapid rate with some industry estimates predicting worldwide use surpassing one billion individuals in 2005 (Meyen et al., 2002). Complementing this growth is an increase in the popularity of online education.

> The total dollar value of all e-learning products and services was estimated at $7.1 billion for 2000. Although this amount was less than 1 percent of the $740 billion spent on education and training of all types in the United States, e-learning is one of the fastest growing sectors of that market, and the total dollar value of all e-learning products and services is projected to reach $40.2 billion by 2005. (Thompson, Ganzglass, & Simon, 2000)

This growth is occurring at all levels of education. Thirty-six percent of all public kindergarten through twelfth grade school districts in the United States are offering distance education options and 72% are planning to extend those offerings in the future (National Center for Educational Statistics, 2005). This percentage accounts for 222,090 students in U.S. public high schools who are enrolled in distance learning courses, about 47% of which are using asynchronous computer-based methods, or online courses (National Center for Educational Statistics, 2005).

Like their peers, individuals with special needs enroll in these courses (Burgstahler, 2005; Meyen et al., 2002). The Report of the Visual Schools Forum even recommends an increase in virtual school options for disabled students working from home (Center for Digital Education &

U.S. Department of Education, 2002). However,"[p]eople with disabilities are among the least considered in the… context of online learning" (Kinash, Crichton, & Kim-Rupnow, 2004). This is particularly disconcerting because twenty percent of all students have a disability (French and Valdes in Kinash et al., 2004), and so this substantial subset of the total population is being potentially excluded from full participation in online education.

Guidelines exist that outline means for accommodating individuals with special needs into online courses. However, many courses still present barriers to this population (Burgstahler, 2004; Edmonds, 2004). This is true in part because many designers believe erroneously that assistive technologies alone can remove all access barriers (Burgstahler, 2003, 2004). Burgstahler (2004) argues that "[d]esigned correctly, distance learning options create learning opportunities for students with a broad range of abilities and disabilities. Designed poorly, they erect new barriers to equal participation in academics and careers." It, therefore, is the responsibility of online course designers to address the needs of students with disabilities in the course development phase, intentionally creating courses that accommodate individuals spanning a plethora of personal needs and styles.

To help designers address these needs, researchers must provide a clear listing of the instructional design elements necessary to meet the needs of students with special needs. Though these elements exist within the literature, they do not exist in a comprehensive format and they seldom address needs related to cognitive disabilities. It is also important to determine whether designers are already accommodating students with special needs in their courses. To address these issues, this study answers the following research questions:

- Which online course design elements provide barriers or supports for students with special needs?

- To what extent are online course designers addressing issues that are potentially beneficial or problematic for students with disabilities?

STUDY CONTEXT

This study focuses on secondary-level online courses designed using a "virtual classroom model" (Hannum, 2001), a model in which the teacher and student are geographically-removed from one another.

> The virtual classroom model uses technology to create an online classroom that comes very close to duplicating what is possible when instructors and learners are physically in the same training room. Instructors and learners communicate in real time by desktop video conferencing, assignments and class notes are distributed on a Web site, interactive multimedia materials are shown as lecture supplements, and learners can discuss issues in real time chats or in asynchronous discussion forums. The virtual classroom… model leverages the Web for providing distance education. This model represents a stand-alone alternative to traditional training. (Hannum, 2001)

This model assumes that the design and development of most instructional materials occurs before students enroll in the course. Therefore, the focus of this study will be on elements appearing during the course design phase, those elements noted in works of instructional designers including Gagné (Gagné, Briggs, & Wager, 1992; Gagné & Medsker, 1996; Gagné, Tennyson, & Gettman, 1991) and Dick and Carey (1996) and in instruments including the "Instructional Design Elements of High School Online Courses," or IODE (Keeler, 2003b).

Meyen and colleagues (2002) identify "a broad range of topics that impact e-learning, including message design (e.g., learning object design, richness of media, message redundancy, and feedback), instructional strategies (e.g., cooperative learning and knowledge structures), and instructional systems (e.g., pacing, advice mechanisms and personalized learning systems)." They further state that the "degree to which these instructional design components affect learner performance is often influenced by the learner attributes such as age, gender, learning styles, previous knowledge, and cognitive abilities." This study attempts to provide a comprehensive picture of these elements as they relate to populations with disabilities.

The special needs populations this study addresses include individuals with physical impairments and those with cognitive challenges, such as learning disabilities. The study does not address the needs of individuals with emotional disabilities though we recognize the importance of addressing this topic in later studies. The American Disability Act (ADA) defines an individual with a disability as

> …a person who has a physical or mental impairment that substantially limits one or more major life activities, a person who has a history or record of such an impairment, or a person who is perceived by others as having such an impairment. The ADA does not specifically name all of the impairments that are covered (U.S. Department of Justice, 2002).

The intersection of disabilities and online education is complicated by the fact that the "variability between disability types and even within disability types is… quite pronounced" (Bohman, 2004; Bohman & Anderson, 2004). The online education literature related to disabilities is robust with guidelines relating to accommodating individuals with physical impairments including low vision and blindness, hearing difficulties, and mobility impairments,

but is lacking regarding individuals with cognitive impairments. WebAIM (http://www.webaim.org/) compellingly addresses this void by arguing that there "are far more users with cognitive disabilities than with all other types of disabilities combined (when you include learning disabilities, reading disorders, attention deficit disorders, and other common conditions)" (Bohman, 2004). Rowland (2004) continues by noting there are four times the number of individuals with cognitive disabilities than with blindness, a disorder receiving extensive attention in the accommodations literature. "Cognitive disabilities are the least understood and least discussed type of disability among Web developers" (Bohman, 2004). The current study broadens the understanding of accommodation as it relates to online education by addressing special needs of individuals facing either physical or cognitive challenges.

LITERATURE REVIEW

There is very little research on the intersection between special needs and online courses (Bohman, 2004; Cook & Gladhart, 2002; Kinash et al., 2004; Meyen et al., 2002). Kinash and colleagues (2004) recently completed a review of the literature on this topic and found that of the few research-based studies on the topic, "the source publications are largely conferences and journals within the field of disability studies rather than mainstream educational technology." There are many questions and few research studies to supply answers. In the absence of research-based literature, an extensive collection of checklists has emerged listing various elements for consideration when designing online courses for individuals with disabilities. These checklists (Barstow & Rothberg, 2002; Bohman, 2002, 2004; Edmonds, 2004; Rowland, 2004; Smith, 2004; World Wide Web Consortium, 1999a) are in addition to United States federal laws and non-research-based citations of elements that do not exist in checklist formats.

One leading group in the field of Internet accessibility is the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C). This industry group, founded in 1994, first published its recommended Web Content Accessibility Guidelines (WCAG 1.0) in 1999 (World Wide Web Consortium, 2004). The group's goal is to "develop common protocols that enhance interoperability and guide the evolution of the web," and they are "committed to assuring that the World Wide Web is fully accessible to people with disabilities" (Burgstahler, 2004). They extended their first set of guidelines with a second, updated version (WCAG 2.0) published as a working draft in 2004 (World Wide Web Consortium, 2004). The first version focused on offering a list of "do's and don'ts" for web developers (Bohman & Anderson, 2004). The second version had the goal of offering "Web content that is perceivable, operable and understandable by the broadest possible range of users and compatible with a wide range of assistive technologies, now and in the future" (World Wide Web Consortium, 2004). The focal point turned to "providing broadly applicable principles, rather than isolated techniques" (Bohman & Anderson, 2004).

Another group focusing on the intersection of accessibility and web environments is the Center for Advanced Technology in Education (CATE, http://cate.uoregon.edu/). CATE is involved in two research strands that impinge on online courses. The first concerns Computer-Based Study Strategies (CBSS, Anderson-Inman, Horney, & Knox-Quinn, 1996). These strategies involve the use of outlining and concept mapping software in helping students, especially students with learning disabilities, to successfully cope with daily study tasks such as note taking, learning vocabulary, synthesizing information, and studying for tests. These study strategies are useful for both traditional and online students.

CATE is also involved in the development of "supported text" (Horney & Anderson-Inman, 1999). This is a form of hypertext in which a base text is supported with a variety of resources. These resources include vocabulary support, illustrations, summaries, graphic overviews, supplementary information, and prompts for meta-cognitive reading strategies. They are normally hidden from view until requested by a student struggling to comprehend the base text. Examples of these texts are available at Web de Anza (http://anza.uoregon.edu) and at the Intersect Digital Library (http://intersect.uoregon.edu).

Supported text is an important construct for online education because online courses are multimedia hypertexts. Developing courses using supported text formats provides direct assistance to online students on a “just-in-time” fashion. CATE is experimenting with these formats with the development of an online course targeted at students with learning disabilities. The course teaches students to use Computer-Based Study Strategies (http://www.coolschool.k12.or.us/).

Federal law requires online courses be designed to meet the needs of students with disabilities. U.S. legislation mandates that “courses offered online or that include web-based components must allow an equal, effective, and inclusive opportunity for participation to students with disabilities” (Banks, Lazzaro, & Noble, 2003). These mandates appear in several pieces of legislation including the Americans with Disabilities Act (ADA), the Telecommunications Act, the Vocational Rehabilitation Act, and the Individuals with Disabilities Education Act (IDEA). Providing accommodations is a “fundamental tenet of the law” (Banks et al., 2003) which applies to all schools supported by federal funds.

The Americans with Disabilities Act (ADA), passed in 1990, prohibits discrimination based on disability and ensures individuals with disabilities receive equal access to services (U.S.

Department of Justice, 2002). While it does not specify regulations for online courses (Edmonds, 2004), "the U.S. Department of Justice and the Department of Education's Office for Civil Rights have clarified that the ADA applies to Internet-based programs and services" (Burgstahler, 2004). The Department of Justice even "issued an *amicus* brief in a Texas case arguing that the ADA applied to a private Internet site" (Edmonds, 2004). Like the ADA, the Telecommunications Act of 1996 "requires manufacturers of telecommunications equipment and customer premises equipment to ensure that the equipment is designed, developed, and fabricated to be accessible to and usable by individuals with disabilities, if readily achievable" (Architectural and Transportation Barriers Compliance Board, 1998). "Readily achievable," or the corollary "undue burden," refers to an action resulting in "significant difficulty or expense" to an agency (Architectural and Transportation Barriers Compliance Board, 2000). This states, in effect, that online course designers should make every effort, short of excessive expenditures or hardship, to make their courses accessible to students with disabilities.

The Workforce Investment Act of 1998 includes the Rehabilitation Act Amendments of 1998 and Sections 504 and 508. It requires that "agencies that develop, procure, maintain, or use electronic and information technology" ensure the resources are comparable in use for both individuals with and without disabilities (Architectural and Transportation Barriers Compliance Board, 2000). Dating back to 1973, Section 504 of the original Vocational Rehabilitation Act prohibits discrimination by any institutional recipient of federal financial assistance, including schools. It states that institutions cannot "deny individuals with disabilities the opportunity to participate in or benefit from any aid, benefit, or service" receiving those funds (Banks et al., 2003; Edmonds, 2004; U.S. Department of Justice, 2002). To ensure compliance with this expectation, the United States Architectural and Transportation Barriers Compliance Board

developed standards of accessibility for web pages in Section 508 (Burgstahler, 2004; U.S. Department of Justice, 2002). Section 508 provides the only federal regulations specific to information technology accessibility (Edmonds, 2004) and closely aligns with the guidelines set forth in WCAG 1.0 (Architectural and Transportation Barriers Compliance Board, 2000).

These laws complement P.L. 94-142, the Education for all Handicapped Children Act of 1975, renamed the Individuals with Disabilities Education Act (IDEA) in 1990 and reauthorized in 2004 (Karger, 2004). The IDEA "requires public schools to make available to all eligible children with disabilities a free appropriate public education in the least restrictive environment appropriate to their individual needs" (U.S. Department of Justice, 2002). One of the most significant changes to the most recent version of the legislation is the new requirement that individuals with and without disabilities have access to the same general curriculum (Karger, 2004). This expectation also exists within the No Child Left Behind Act (Karger, 2004) and suggests that students with disabilities should have equal access to all courses, including online options purchased by institutions receiving public funds, including public school districts. To provide this equal access, online course designs must accommodate individuals with special needs.

Checklists, guidelines, policies, and legislation are only the beginning of making websites accessible to individuals with special needs. The task, which is not difficult (Bohman & Anderson, 2004), requires forethought and proactive design (Bohman & Anderson, 2004, 2005; Burgstahler, 2003, 2004; Edmonds, 2004). Not only is a proactive approach the "right thing to do" (French, 2002), it can lead to avoiding costly litigation (Edmonds, 2004) or expensive retrofitting of courses (Banks et al., 2003). Accessibility is also accepted as an important feature of well-designed Web pages (Distance Learning Resource Network, 2000; Mills, 2002; Schrock,

2002; van den Brink, 2000), and assists individuals who do not have disabilities (Burgstahler, 2005; Edmonds, 2004; Kinash et al., 2004). In addition to proactive approaches to making websites accessible, web designers should be prepared to respond quickly when requests for accommodations are stated by users of websites (Burgstahler, 2003).

It is sometimes assumed that "text-only" and "accessible" are synonymous. This is incorrect. While text-only versions of courses may be adequate accommodations for some individuals with visual disabilities, it fails to consider individuals with other disability types. "In fact, a text-only version may decrease the content's usability for [some individuals with cognitive impairments], since it removes the visual cues and illustrations that may enhance the content's understandability" (Bohman, 2003). Accessibility implies accommodating a wide audience, allowing users to interact with websites in ways that best suit individual needs and styles, with or without use of peripheral assistive technologies (Northwest Americans with Disabilities Act and Information Technology Center, 2005). While addressing a wide audience may allow a greater number of users with disabilities to access a site, it still may fail to accommodate all individuals' needs (Burgstahler, 2005).

> It is impossible to design a single version of Web content that is equally understandable across the full spectrum of disabilities, or even within the spectrum of cognitive disabilities… it is possible to create Web content that approaches the ideal of universal design, even if it doesn't quite succeed in the absolute sense… Web developers should seek to make their content as universal as possible, recognizing that there will always be a small minority of individuals for whom the content will not be fully accessible… If a Web developer seeks to create content that is specifically targeted at users with significant cognitive

> disabilities, the best approach may be to create a graphics-only version that caters to their needs… The truth is that this Web site can easily be made accessible to people who are blind, even though there is no visible text on the page at all. Screen readers will be able to read the alternative text… The addition of text would confuse the target audience (Bohman, 2003).

"Universal design," then, refers to accommodation of the greatest number of individuals within the population of possible users of a course. Most definitions of universal design encourage multiple representations of content in order to maximize access (Bohman, 2004; Council for Exceptional Child in Burgstahler, 2005; Center for Applied Special Technology, 2005; Karger, 2004; Meyen et al., 2002; U.S. Department of Justice, 2002). The most effective means of achieving true accessibility, however, is to perform democratic evaluation with all potential users of the course (Smith, 2004).

METHODOLOGY

This study involved two components: identifying the design elements applicable to special needs populations and reporting the frequencies of those elements in contemporary practice. To identify online course design elements imposing barriers or supports for students with special needs, elements cited by the Architectural and Transportation Barriers Compliance Board (2000) the World Wide Web Consortium (1999b), other legal documents, guidelines for Internet accessibility, and research literature were paired with those in the "Instrument of Instructional Design Elements of High School Online Courses," or IODE (Keeler, 2003b).

While several lists of online design elements exist (Blomeyer, 2001; Boshier et al., 1997; North Central Regional Educational Laboratory, 2001; Reiser, Alfano, & Brooks, 2004), the

IODE provides the comprehensiveness, theoretical basis, validity, and credibility (Keeler, 2003b) needed for the current study. The instrument was designed for mainstream usage and its theoretical basis was derived from instructional literature spanning traditional, distance, and online education contexts. It does not specifically focus on literature related to servicing students with special needs so additional theoretical considerations were necessary before using the instrument for the context of this study. Justifications for inclusion of specific elements in the IODE were revisited in this study by reviewing the intersection of the literature between online education and special needs populations.

The IODE includes design variables from course, lesson, and assessment levels and contains 156 elements and 600 data points. Example screen shots from the instrument appear in Appendix A. By matching elements between this instrument and the literature traversing accessibility and online education, a picture begins to form showing which elements are critical for consideration when dealing with online course delivery to students with special needs. This picture, however, is incomplete. Therefore, after identifying the matching elements, this study further considered the remaining elements of the IODE to determine whether each could potentially impact the selected populations. Following identification of these elements, the conglomerated elements were categorized. The result, appearing as Appendix B, includes each category name and design construct (or element).

Next, the study addressed the frequency with which each selected element appears in online courses. The frequency statistics were derived from a study performed in 2003 (Keeler, 2003a) that involved 22 sample courses, 6 lessons, and 183 assessments from 5 online high schools. Each school was chosen based on its time in existence, reputation (as determined by popularity in the literature), size, and accessibility. Sample schools varied in annual student

enrollments from five hundred to tens of thousands of pupils; they span the United States (two housed in the Pacific Northwest, two in the Midwest, and one on the Eastern seaboard); and, they have different accrediting bodies. Two are large commercial vendors and three are state-based schools. One of the schools focuses on serving students with advanced placement needs, some service students from rural and disadvantaged schools, and others focus on servicing students from a specific state. The 22 sample courses were chosen using a random-selection method biased by specified and stated decision rules (Keeler, 2003a). The courses included at least four from each major subject area (English, mathematics, science, social studies, and "other") and about four from each school. The sample also included advanced placement courses as well as those without this stipulation.

Data collection occurred between August and October of 2003 by a single rater. Using summary layouts available within the instrument, data compilation and descriptive statistical analyses (e.g., frequency percentages) followed the ratings. These percentages, confirmed by the qualitative data collected from subjective elements of the instrument, provide the results for the Keeler (2003a) study. Frequency percentages for the elements identified as critical to the present study were collected from the previous study's results and are analyzed and discussed as they relate to this study's context in the "Results and Discussion" section.

RESULTS AND DISCUSSION

The list of instructional design elements that could impose barriers or provide supports for students with special needs is nearly endless and sometimes conflicts with itself. Burgstahler (2004) notes that there are two basic approaches to designing for accessibility. One involves avoiding certain data or methods; the other requires offering alternative methods, features, or formats. Other web design considerations relating to special needs populations involve

pedagogy, assessment, content, instructional delivery, instructional management, standards and policy (Meyen et al., 2002), accessibility, usability, scalability, technical feasibility, affordability, aesthetic considerations, server technology, markup languages, scripting languages, multimedia formats, and coding guidelines (AccessIT, 2005). To create a manageable list, it is necessary to focus on elements most affecting student ability to participate fully in online courses. For instance, research suggests that student access to grades is important for students within online environments (Clark, 2001). This element may provide some additional benefits to students with special needs, but those benefits would be minimal compared to those gained by students without special needs. For this study, then, the focus was on elements addressed in the literature that make a direct impact on accessibility for individuals with disabilities.

After a review of the literature and the IODE, we identified 38 design elements justifiable as critically important to the design of websites for people with disabilities. These elements fall into five categories: focus on disabilities, website design, technologies used, instructional methodologies, and support systems. The categorical schema, definitions for each of the elemental construct, possible responses for each variable, and resulting data for each possible response appear in Appendix C. The sections below describe each category and the elements within it. They also present general results, representative examples of elements in context, and make design recommendations.

Focus on Disabilities

The category "Focus on Disabilities" includes those elements specifically intended to address the needs of individuals with disabilities. Literature and guidelines are replete with recommendations for web designers about accommodation to assist individuals with visual and hearing impairments. These recommendations can be broadly broken into visual

accommodations and hearing accommodations, as was done in the IODE. The literature is also clear about the need to eliminate bias in educational material (Distance Learning Resource Network, 2000; Mills, 2002), including bias that relates to directly to disabilities.

An example of a standard recommendation (see, for example, Architectural and Transportation Barriers Compliance Board, 2001; Bohman, 2002, 2004; Burgstahler, 2004; Rowland, 2004; World Wide Web Consortium, 2000, 2004) is to providing auditory alternatives within individual web pages. If a page includes audio content such as an audio lecture or an alert beep, that content should also be available in a format, such as a written transcript, accessible to individuals who are hearing impaired. This extends to embedded videos containing audio tracks where many guidelines suggest synchronous captioning (Architectural and Transportation Barriers Compliance Board, 2000, 2001; Bohman, 2002, 2004; Burgstahler, 2004; World Wide Web Consortium, 2000, 2004). It also extends to other sounds within pages. For instance, if background music plays as a page is loaded, there should be an alternative that informs the user who cannot hear the music about the musical selection ensuring that individual has an equivalent experience as the non-disabled user.

Data from the Keeler study (2003a) suggests that high school level course designers are in fact including many of the accommodations necessary for access by individuals with hearing impairments — 95% of the sample courses did not provide identifiable barriers to these individuals. Note, however, that audio usage is still uncommon in these courses (Keeler, 2003a). Designers are also doing well eliminating bias in their sites. None of the sample courses included obvious bias against disabilities generally or individuals with disabilities.

A greater concern appears regarding accommodations for individuals with visual impairments. Though the majority of courses, 59%, did not impose barriers, the remainder still

poses difficulties. Some areas of extreme concern include use of pop-up windows (14% of the sample) and use of moving content (12%). Additionally, nearly one-quarter of the lessons in the sample courses failed to provide textual equivalents for visual content. This factor, commonly addressed in the literature (Architectural and Transportation Barriers Compliance Board, 2000, 2001; Bohman, 2002, 2004; Cook & Gladhart, 2002; Smith, 2004; World Wide Web Consortium, 2000, 2004), deserves special attention from online course designers. When static or moving images appear on screen, it is necessary to provide a textual equivalent. This could be as simple as adding alternative text to a graphic, or as complex as describing a painting or figure in detail.

Website Design

The category "Website Design" is broadly focused on the design of websites generally, and on web page design more specifically. "Mouseclicks" and "Design Consistency" consider the whole site — its navigability, link structure, visual consistency, and overall congruence across pages. The website elements focus mostly on visual elements of design — color, "busyness," legibility, and use of visual cues.

Research suggests that websites with "consistent and predictable" navigation patterns assist individuals with special needs (Cook & Gladhart, 2002; Rowland, 2004; World Wide Web Consortium, 2000, 2004). They further note that individuals with special needs are not just interested in the accessibility of individual web pages, but the ability to successfully and fully participate in the entire expected experience of a website (Bohman & Anderson, 2004) (Bohman, 2002, 2004; Cook & Gladhart, 2002). In the case of an online course, this means that all individuals should be capable of learning from the content and participating in the instructional activities and assessments. The experience for individuals with disabilities should not be

substantially different than that of their non-disabled peers. When websites fail to follow consistent patterns, individuals using screen readers may have to relearn layouts for each page and individuals with cognitive disabilities may become easily frustrated.

Frustration might also occur when working with web pages that fail to follow visual design principles such as inclusion of white space (Bohman, 2004; Burgstahler, 2004) and color balance between backgrounds and foregrounds (Cook & Gladhart, 2002; World Wide Web Consortium, 2000, 2004). White space assists in "chunking" content creating a "visual representation of semantic meaning" (Bohman, 2002; Bohman & Anderson, 2005; Cook & Gladhart, 2002; Rowland, 2004; World Wide Web Consortium, 2004). This is particularly important for those with learning disabilities who may use this white space as a form of scaffolding. Likewise, individuals with attention deficit disorders may become distracted by "busy" backgrounds becoming unable to focus on the primary content appearing in the foreground. The goal of the online course designer should be to create web pages that maximize student attention to, and therefore student learning of, the instructional content and materials.

Keeler's (2003a) survey of high school online courses found that designers are doing an exceptionally fine job in developing consistent site designs and web pages that follow basic guidelines of visual design in regard to white space and backgrounds. All sample sites and pages met expected guidelines. Designers are also limiting the number, types, colors, and styles of fonts they use per page. Researchers (Bohman, 2002, 2003, 2004; Cook & Gladhart, 2002) all support these actions as supportive when attempting to accommodate individuals with special needs.

A more complicated accessibility issue relates to use of graphical images. The results indicate that course designers are regularly including images within their courses. Very few

(17%) lessons did not include any graphical images at all. While photographs were most common (58%), clipart (48%), and diagrams (23%) were also prevalent. Bohman (2003) provides a convincing argument that limiting use of graphic images in favor of text, which may be beneficial for individuals with limited vision or who are blind, may hinder individuals with cognitive disabilities. A person who cannot read due to a visual-perceptual disorder may need graphics to assist in comprehending the text.

> Designers need to be cautious in deciding when to use illustrations. Reading a picture is probably a learned activity that is easier for some than others. Some users skip the pictures; others read only the pictures. Designers must also recognize that visual conventions are not universal and that individuals develop their own mental schema and expectations in interpreting visual information (World Wide Web Consortium, 2004).

Some educators suggest that supplementing text with graphics can only help facilitate comprehension (World Wide Web Consortium, 2004). However, the question remains: "Whose comprehension is being facilitated?" Providing multi-modal cues on a regular basis, as recommended by many (Architectural and Transportation Barriers Compliance Board, 2000; Bohman, 2004; Council for Exceptional Child in Burgstahler, 2005; Center for Applied Special Technology, 2005; Karger, 2004; Meyen et al., 2002; U.S. Department of Justice, 2002), may assist some, while creating barriers for others. Consider a navigational cue that includes text, a graphic, and an auditory cue such as a stop sign reading "Stop" accompanied by an audio alert voicing "Stop" appearing at the end of a form. The multi-modal approach may ensure individuals with a wide variety of disabilities types can access the information, but may, in fact, provide a barrier for an individual who cannot learn well when bombarded with multiple simultaneous

stimuli. The key may be, as Bohman (2004) recommends, identifying the target audience for the course and designing accordingly. This, however, could pose ethical problems. One should not assume that an individual who has a severe reading disability would not be interested in taking an advanced literature course. That individual could potentially participate fully in the course if it were designed for that population. The cost of designing for accessibility, however, may impose undue burden on the funding source for the course.

Technologies Used

Seldom do high school online courses provide only text on a page (Keeler & Anderson-Inman, 2004). Often courses require either use of non-web-based materials (e.g., a camera or a lab kit), web-based technologies beyond simple text (e.g., forms, streaming video), or both. Some of these added technologies pose barriers for individuals with special needs. For example, if a course requires a textbook that is not available in electronic format enabling a screen reader to read it or in audio format for students to listen to it, a person who is visually-impaired or reading disabled may be excluded from the course. Albert Einstein, known for his reading disability and mathematical and scientific genius, might have been excluded from taking an advanced placement calculus course because of his inability to read the text. Another example might be that of individuals with mobility impairments wanting to participate in a creative writing course online. If the course requires extensive use of chat rooms, the student may not be able to actively participate in the course because synchronous communication is difficult for individuals who cannot communicate quickly (Burgstahler, 2004; Cook & Gladhart, 2002). Or, a student with a hearing impairment may want to take a language course to learn to create written interpretations. The student would be blocked from participation if the course required students to engage in telephone or videoconference communications without additional accommodations

(Burgstahler, 2004). Given these potential difficulties, it is important to consider both web-based and non-web-based technologies necessary for students to fully and successfully participate in an online course.

The IODE survey indicates that 41% of the sample courses do not require students to obtain materials beyond what is accessible via the Internet. This leaves 59% with requirements including needs for textbooks (27%), lab kits (14%), videocassettes (14%), software (14%), telephones (9%), microphones (9%), speakers (9%), and audiocassettes (5%). It is the responsibility of the course designer to ensure that both required and optional materials are available in accessible formats and to provide directions to students about how to access those equivalent resources. In the case that equivalent materials are not available or possible, the designer must consider ways to provide an equivalent experience to individuals with disabilities as would be obtained by those without disabilities. The same is true for any optional materials.

Some of the Internet-based technologies commonly used by high school online course designers that could pose barriers to individuals with special needs include the use of threaded discussion forums (36%), downloads (36%), image maps (36%), and web forms (27%). Downloads may pose problems because second-generation artifacts (e.g., non-HTML documents available via the Internet such as Microsoft Word or PowerPoint files) are often not as accessible as first-generation (HTML coded) documents adhering to HTML validity protocols (Edmonds, 2004; Smith, 2004). Likewise, image maps and web forms can be problematic if they do not conform to web accessibility guidelines (Architectural and Transportation Barriers Compliance Board, 2000, 2001; Bohman, 2002, 2004; Cook & Gladhart, 2002; Smith, 2004; World Wide Web Consortium, 2000, 2004).

Other potential barriers are the use of audios and videos. While some researchers recommend that audio should be available for all visual elements (Bohman, 2002; Burgstahler, 2004), this was not the case in any of the sample courses. When audios were included, however, they were usually clearly understandable. As the online course phenomenon continues to grow along with increases in bandwidth, the use of audios will probably also grow and consideration of auditory features will need to be investigated more thoroughly. Frequency of use of videos will probably also increase in the future. Currently, only 12% of lessons include videos with their average length being less than two minutes.

Instructional Methodologies

The "Instructional Methodologies" category deals with activities and content students engage with during lesson sessions. It includes assigned activities and assessments, level of communication with peers, readability, available options, timing requirements, and summaries. Should any of these lesson aspects pose a barrier to an individual with a disability, the problem could lead to limited mastery of curricular material, inability to participate with peers, frustration with completing the lesson, a lowered grade, or inability to complete the lesson or course. Lessons provide the content delivery, guided practice, and assessments necessary to adequately learn material. Without complete access at the lesson level, students cannot be successful in the course overall.

Determining the combination of methods leading to the greatest level of student learning in a given lesson is the primary concern of instructional designers. They know that some instructional activities are more conducive to use with certain types of individuals. For example, lectures may work well for auditory learners while demonstrations may be better for visual learners. Similarly, students who excel artistically may perform better on a visual, physical, or

other performance-based assessments than students who prefer highly inter-relational activities such as communications or critiquing. In addition to student preferences, student abilities are a factor affecting student success with instructional activities and assessment types. Though 55% of online courses currently implement simulated lecture-based content delivery (usually in the form of prose), this may be a poor choice of instructional method when instructing students with some cognitive impairments. Group discussions, also commonly used (24% of the sample) may cause problems for individuals who have difficulty expressing themselves in writing, those who cannot physically compete with the typing speed of their peers due to mobility impairments, or those whose mental capabilities require them to take extended amounts of time to complete tasks. Burgstahler (2005) suggests offering students alternative means of communicating with the instructor and one another. Cook and Gladhart (2002) suggest limiting the number of participants in discussion groups. Online course designers must carefully consider the preferences and capabilities of students with disabilities, and do more to provide primary and alternative instruction that accommodates their unique requirements.

One instructional design accommodation method involves providing options for students. When providing options, designers allow students to choose which course modules, instructional activities, or assessment methods to use. For example, students may complete a laboratory experiment and write up the results *or* write a research paper. Should a student have accessibility barriers with one of the options, s/he could self-select the other option. While this allows flexibility to students, it is very uncommon in courses. Less than 20% of the course, lessons, and assessments allow students options.

Another option that should be available for students relates to timed assessments. When there are timed assessments, students should have the option of increasing the time limit

(Architectural and Transportation Barriers Compliance Board, 2001; Bohman, 2002, 2004; Cook & Gladhart, 2002; Rowland, 2004; Smith, 2004; World Wide Web Consortium, 2004). Of the sample assessments, only 10% had time requirements. Some of these were not traditional limits (e.g., students had to observe the location of the sun in intervals throughout the day) and others were timed in order to replicate advanced placement examinations. When traditional timing requirements exist, designers should be aware of potential needs of students with disabilities and provide opportunities for students or their teachers to extend time limits or remove them. Another possibility is alerting the student when the assigned time limit is over, recording the student progress at this point, and allowing the student to continue beyond the limit.

Finally, students should be given the opportunity to comprehend the curricular content. The average reading level of the sample courses was eighth grade with the minimum being fifth grade and the maximum being twelfth. Authors addressing the topic of reading level as it relates to web accessibility clearly argue in favor of developing clear, simple, consistent, simple, grammatically correct language (Bohman, 2004; Bohman & Anderson, 2005; Burgstahler, 2004; Rowland, 2004; World Wide Web Consortium, 2000, 2004). Consider the predicament of a student with a severe learning disability who excels in science, yet has reading difficulties. The student might be excluded from participation in advanced science courses, despite his/her ability to comprehend the scientific content, simply because the reading level is incomprehensible. Online course designers should target textual content at student independent reading levels rather than their frustration levels. This should assist in accommodating most students' needs knowing that some students will need to read using assistive technologies.

Finally, lesson summaries should appear at the ends of lessons (Burgstahler, 2005; World Wide Web Consortium, 2004). Summaries are particularly helpful for students with disabilities

who may have missed a portion of the content because of design errors (e.g., lack of alternative text), assistive technology malfunctions, or inability to focus for extended periods.

Support Systems

The final category, "Support Systems," deals with supports that are both internal and external to the Internet. The internal support exists in the form of "Context Sensitive Help." This element refers to the use of supported text. A button may open a pop-up window revealing a definition, a map of a location, or an American Sign Language (ASL) interpretation. Options to access these supports, appearing with 27% frequency in the sample lessons, assist individuals with and without disabilities in several ways. They help individuals with mobility disorders by placing useful data within a single mouse click; they assist individuals with hearing impairments by giving them access to ASL without the need for a face-to-face interpreter; and, they enable learning disabled students to find definitions of words that may be beyond their reading level. In some cases, these supports help students pronounce words they have only seen in writing, or translate words into their native language. Though the use of this type of resource appears extremely beneficial for a wide array of users, it may pose access barriers to individuals who have difficulties working with pop-up windows or those who cannot manage working with a multitude of options per page.

Another form of support is external to the course. Some online courses (41%) require students engage with an adult other than the online instructor. Other courses offer this support on an "as needed" basis (45%). Support personnel may be parents (0% of the sample), online counselors assigned by the online school (23%), or counselors at the student's home school (41%). The benefit of offering these supports is that students have access to an adult mentor other than their instructor. This mentor ensures the student is making progress in class, provides

moral or emotional support, and acts as a liaison between the student and instructor. The latter point may be particularly helpful in cases where disabilities require interventions unfamiliar to the instructor. A benefit of face-to-face support personnel (occurring in 23% of the sample courses) is that the adult mentor may be able to identify how particular disabilities are negatively affecting a student's success in class and make recommendations to the online instructor. These recommendations could then be forwarded to online course designers allowing them to modify the course as well as make changes to other courses during development or revision.

Providing internal and external support systems is potentially extremely helpful for students with special needs (Rowland, 2004). Online schools may wish to think carefully about which supports they want to offer their students and ensure the supports work effectively once in place.

IMPLICATIONS FOR PRACTICE

It is clear from available guidelines that many methods exist for designing courses that increase accessibility for individuals with special needs. It is also clear from the current study that designers are doing quite well at using these guidelines to meet those needs. There are, however, some areas designers may wish to give special attention as they continue to create and revise courses. Recommendations appear below.

- Eliminate use of pop-up windows or provide opportunities to disengage the windows.
- Provide text equivalents for all visual elements or include a link to a text-only equivalent page.
- Minimize moving content or provide options to turn off moving images.

- Determine the pervasiveness of graphics per page based on the course's target population.
- Ensure that both required and optional materials are available in accessible formats and provide instructions on how to access those equivalent sources.
- Increase frequency of use of audio elements if the course's target population would benefit from this increase, but ensure accessibility for all students.
- Increase student options.
- When timing requirements exist, provide opportunities to extend time limits or remove them.
- Limit use of fast-paced typing requirements (e.g., chats), or ensure the number of students in each peer group interaction remains low.
- Include supported text, but allow users to select which supports they want to be able to access (ASL, definitions, graphics, no supports).
- Extend design principles to second-generation artifacts.
- Encourage use of face-to-face support personnel who have experience working with individuals with special needs.

Designing for Web accessibility requires a proactive approach and continual review and updating of pages (Smith, 2004). Designers must actively manage courses and be ready to adapt them as special needs arise.

LIMITATIONS/BIASES

A major bias of this study is its reliance on the IODE. This source of data was selected because of its comprehensive and theory-based nature and its rich data availability. Because the IODE was developed using traditional, distance, and online education literature and not special education literature, we chose to engage in a thorough review of the literature to ensure the instrument was useful in special education contexts. The result was a finding that some elements identified as important in the literature did not appear in the IODE. One example is "No Auto-Refreshing." A complete list of unrepresented elements appears in Appendix D. Though these elements are important for consideration when designing online courses that will accommodate individuals with special needs, they fall outside of the scope of this study because their frequency data was unavailable. Many of the elements in the unrepresented elements list also appear in the "excluded elements list" of the original Keeler study (2003a) or are suggested as recommended additions. Some reasons for exclusion from the original study included that researchers did not have access to HTML source code, the element was too ambiguous to provide an objective response, assistive devices were not available for data collection purposes, oversight by the author, or literature suggesting the importance of the element post-dates the original study. For the current study, we were unable to identify any source of frequency data for these missing variables. Extending the current study by adding in the unrepresented elements would strengthen this study.

An additional limitation of this study is its generalizability. The Keeler study was designed to be generalizable to large online high schools within the United States that had been in existence for at least five years. It is inappropriate to infer that findings in the current study extend to any other academic level, geographic region, or school type.

Finally, timeliness is a major limitation of studies in the field of educational technology due to rapidity of changes in the field. Data collected in 1993, two years pre-dating the current study, will possibly not represent the current state of the field.

CONCLUSION

The process of designing accessible online courses requires attention to a wide array of variables and consideration of extremely complex and sometimes conflicting needs. In the sample courses, lessons, and assessments examined by Keeler, designers seem to be meeting this challenge by creating usable online high school courses that meet guidelines set forth in the limited research literature in this area.

In addition to the above limitations, there is another. As a typology, the IODE describes the *structure* of online courses, and not their impact on teachers and learners when actually implemented. These limitations suggest a four-part research agenda:

1. An expansion of the IODE typology to include the broadest possible range of online course design elements that might impact students with special needs when taking online courses. This would be based on the experience of online course developers, research into theories of online teaching and learning, and research on the instructional requirements of students with special needs.
2. Complete surveys of a broad range of online courses to identify the prevalence of these design elements in existing courses.
3. Complete surveys of a broad range of students with special needs taking online courses to determine the general level of their achievement in these courses, along with an examination of possible correlations between student achievement and the presence or absence of specific design elements.

4. Develop and implement experimental studies to understand how individual and clusters of online course design elements impact the achievement of students with special needs in online courses, and of the mechanisms by which these impacts operate.

As the field of online education continues to grow, course designers need to exploit the advantages offered by technologies to create courses incorporating accommodations for either the widest possible range of student or specific targeted populations. Systematic research is needed to enable this.