Universal Design for Learning: Critical Need Areas for People with Learning Disabilities

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Abstract: The primary market research outlined in this paper was conducted by the Rehabilitation Engineering Research Center on Technology Transfer to identify critical technology needs for people with learning disabilities. Based on the research conducted, the underlying context of these technology needs is Universal Design for Learning (UDL). The paper will review demographics of the target population, the role of mainstream and assistive technologies within this context, and the emerging concept of UDL in modern education. The study investigates the educational technology industry from various expert perspectives and provides insight into its current state, unmet needs, and future course of action for the adoption of UDL in classroom settings. The intended primary outcome of this research is the facilitation of development and transfer of educational and assistive technology solutions through inclusion of data in marketing materials, business planning, and grant development. However, the benefits of the research include informed policy makers, improved pre-service teacher training, and increased knowledge and awareness of the need for UDL environments.

Key Words: Universal design for learning, Assistive technology outcomes, Learning disabilities, Education technology, Classroom technology

Today's classrooms are comprised of more diverse learners than ever before. Reflecting recent educational and societal movements, over 95% of students with diagnosed disabilities participate in the general education classroom alongside their peers (U.S. Department of Education, 2001). For many education professionals, students with disabilities are seen as an encumbrance as they may need accommodations (i.e., time, technology, or changes in curriculum) to succeed. The hindrance to content mastery is seen as residing within the student and not within the teaching paradigm (McDonald & Riendeau, 2003). McDonald and Riendeau stated that providing a classroom where all students can learn is really more of an issue of "learning diversity" (p. 87) where individual differences are not only expected, but celebrated. This idea is certainly optimistic, but it captures some of the key components of other more popular movements in education such as Universal Design for Learning (UDL) proposed by the Center for Applied Special Technology (CAST, 2006).

This research, conducted at the Rehabilitation Engineering Research Center on Technology Transfer (T2RERC), presents the outlook of experts on current trends and unmet needs in the realm of technologies for education. Although the population of interest was students with learning disabilities (LD), the study was conducted in the backdrop of UDL as an emerging concept to *seamlessly* *accommodate* those with LD in an inclusive learning environment. In doing so, the main focus was to identify *critical needs* in the form of technological solutions and improvements that would facilitate the application of UDL. The study also elucidates carriers and barriers to the advancement of UDL from the perspectives of technology development, pedagogy, and public policy.

Universal Design for Learning

UDL is an approach to instruction, learning, curriculum development, and assessment that, in part, uses technology to respond to a variety of individual learning differences. A central focus of UDL is to promote the development of new curricular materials and learning technologies that are flexible enough to accommodate the unique learning styles of a wide range of individuals, including children with disabilities (CAST, 2006). CAST's co-executive director, David Rose, is quoted as saying:

> A universally designed curriculum is a curriculum that has been specifically designed, developed, and validated to meet the needs of the full range of students who are actually in our schools, students with a wide range of sensory, motor, cognitive, linguistic, and affective abilities and disabilities rather than a narrow range of students in the "middle" of the population (as cited in Hitchcock & Stahl, 2003, p. 45).

The current trends toward innovative teaching methods embrace the idea that classrooms are becoming increasingly diverse. Teaching methods must adapt to reflect this diversity. In any well established system, the introduction of a novel approach meets barriers. Likewise, in the educational system, barriers slow the acceptance of learning diversity and the implementation of UDL concepts.

A curriculum designed with the principles of UDL is by definition appropriate to all students. Students with specific LD will be focused on in this article, as they represent 45% of students with disabilities in today's classroom (Snyder, Tan, & Hoffman, 2004).

Learning Disabilities in Context

A learning disability is a general term used to describe a student with specific learning problems that effect reading, writing, listening, speaking, reasoning, and doing math (National Dissemination Center for Children with Disabilities, 2004). A majority of students who experience learning disabilities have difficulty mastering content in a traditional classroom environment. A key problem for these students is that the preponderance of materials, including textbooks, workbooks, worksheets, trade books, and tests, are provided in inaccessible standard print format that students with LD, and those at-risk of failing in schools, cannot comprehend.

In 2001, the U.S. Department of Education reported that some form of LD affects nearly 5% of children in public schools and that an estimated 2.9 million students currently receive special education services for learning disabilities (National Center for Learning Disabilities [NCLD], 2004). Recent data from the U.S. Department of Education estimates that 2.7 million students between the ages of 3 and 17 years have a specific LD and were served by an individualized education program (IEP) during the 2003 school year (Ideadata.org, U.S. Department of Education, 2004). Alarmingly, this data also indicated that an estimated one-third of children are *at-risk* for academic failure and continue to struggle with some form of undiagnosed LD (Shaywitz, 2003). Given the high unemployment rate (76%) and dropout rate

(27.1%) for students with LD, this is a serious concern that can and should be addressed through a supportive learning environment for all children (Bridges to Practice, 2002; Hurst & Hudson, 2001; National Institute for People with Learning Disabilities, 2007; U.S. Department of Education, 2001).

This is an important consideration for educators and an opportunity for people developing technology. Many members of this undiagnosed population of children have been identified as *at-risk* for academic failure. According to Thurlow, Sinclair, and Johnson (2002), students at-risk for academic failure "include children with disabilities, students from low-income families and communities, and students with non-European American or non-Asian, single parent backgrounds" (p. 2). They may in the future be diagnosed as having LD or they may simply remain labeled as at-risk and fail. Regardless of whether they are formally diagnosed, the opportunity to address the needs of these children, using curriculum and technology encompassing the UDL philosophy, must be capitalized upon. Failure to provide these children with appropriate support academically and technologically will ensure that schools do not meet the Annual Yearly Progress (AYP) outlined in the No Child Left Behind Act of 2001 (Thurlow, Sinclair, & Johnson). Students with a LD and those labeled at-risk for failure are also likely to leave the school environment without a diploma or certificate of completion, placing them at a greater risk of facing significant obstacles after leaving the secondary education environment (Grumline & Brigham-Alden, 2006). These risks include incarceration, unemployment, or underemployment (Thurlow, Sinclair, & Johnson). The opportunity to assist these students though UDL classroom technologies provides technology developers with new business opportunities.

By modifying how information is provided, educators can ensure that all students can access information in ways that are understandable to them. Many children today have grown up with technology. Leveraging their knowledge of technology provides an opportunity for efficient and effective instruction in school environments (Peterson-Karlan & Parette, 2005).

Role of Technology

In order to understand the role of technology in today's schools, it is first important to understand the difference between what is defined as assistive technology (AT) and what is meant by educational technologies. According to the Technology Related Assistance for Individuals with Disabilities Act of 1998:

> The term "assistive technology device" means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities. [§3(a)(3)]

The term technology in education, or *educational technology*, "consists of a wide range of hardware, software, and technical equipment used in schools to promote learning" (North Central Regional Education Laboratory, 1997).

The boundary between AT and education technology is blurring in American schools. AT devices are often considered to be education technologies when used by students without disability labels. However, in order to maintain funding mandates for students with disabilities who require technology, any technology that is needed by a student with a learning disability to participate in the general curriculum is considered an AT (Edyburn, 2000). In order to overcome such contradictory definitions, the technologies that are of interest to this study are referred to as *classroom technologies*, regardless of whether they are used by students with LD exclusively.

Due to recent legislation and societal trends, many commercial technology developers now include features in their products that enable learners with diverse abilities, languages, and learning styles to successfully use their products. Software features such as changeable displays, text highlighting, keyboard commands, progress monitoring, and speech options are more frequently included in mainstream education technology products. Before this trend began, many of these capabilities were primarily found in assistive technologies; those designed for individuals with disabilities. When a company designs for all using UDL principles, it can also sell to all. This allows the company to take advantage of the larger resources available to American schools for funding technology.

Many companies are embracing the principles of UDL that support the idea that any technology used in classrooms should enhance all students' academic performance. In spite of this industry trend, an artificial distinction remains between what is considered education technology and what is considered AT. As students with and without disabilities learn together in the same classrooms, all students should have the opportunity to benefit from an expanded inventory of well designed classroom technologies.

In a curriculum incorporating UDL principles, technology becomes part of the classroom for all students. It supports the "multiple means of expression, multiple means of representation, and multiple means of engagement" that are core principles of UDL (CAST, 2006). UDL recognizes that all students learn differently and promotes a multi-modal curriculum to ensure that all students have access to the information presented in the classroom (Meyer & Rose, 2000). While technology can and does facilitate access to materials, and supports the offering of learning materials in multiple formats (Montali & Lewandowski, 1996), it cannot ensure that students will actually learn the materials. Rose (2000) reminds us that merely providing access to classroom materials does not immediately translate into access to learning. There is still a need for AT devices in the classroom, because many students with disabilities require the specialized access that AT provides. In fact, some AT can benefit *all children* in the classroom. For example, students who are English language learners can reap great benefits from captioning as they master their second language (Koskinen & Wilson, n.d.). According to the National Captioning Institute (n.d.), "captioned television improves reading and listening comprehension, vocabulary, word recognition and overall motivation to read among students who are learning English as a second language." Children who are learning to read or who are labeled at-risk can also benefit from captioning (Caption First, n.d.). The innovative application of technology, whether AT or simply educational technology, enhances learning for all students whether or not they have a disability.

The T2RERC is a federally funded Center whose mission is to facilitate the transfer and commercialization of innovative technologies to the marketplace to meet the needs of people with disabilities and the elderly. The *Demand Pull* Technology Transfer project at the T2RERC was designed to identify critical technology needs in specific industry segments (Bauer, 2003). Within the segment of educational technology, the project focuses on critically needed technology for children with learning disabilities and, by extension, those labeled at-risk for academic failure.

Research Objectives

In the preliminary phase of the project, extensive secondary market research was conducted to recognize the state of the educational technology industry and to provide a basis to conduct further primary market research to examine unmet technology needs. The output of this study sheds light on the movement towards adoption of UDL in the field of education. The document also lists and describes a vast array of technologies and products in the educational technology that can be classified in four primary domains: (a) computer applications for students, (b) hand-held devices, (c) presentation and media applications, and (d) teaching and instruction tools and training.

In consideration of this scenario, the primary market research conducted in this study had two major objectives: to (a) validate the concept of UDL as a fundamental basis for the development and improvement of classroom technologies, and (b) identify *critical needs* that must be addressed to facilitate the use of classroom technologies in a UDL environment.

The goal of this project is to disseminate this critical information to manufacturers and other technology developers thereby providing them a strategic guide to the market demands and expectations of experts in the field. The expected outcome, as per the T2RERC mission, is the introduction of novel and improved classroom technologies that would benefit people with learning disabilities and those at risk of academic failure.

Method

In order to fulfill the research objective, the study was designed through the active participation of industry experts in the field of educational technology. A series of interviews was conducted with industry experts, including manufacturers, researchers, and practitioners to identify broad categories of critical technology needs. This interview data was used to establish a framework that reflected the current state and emerging trends in the educational technology industry and to categorize critical technology needs as outlined by the experts.

Expert Interviews

Sample. Twenty experts with broad experiences in the field of LD and AT were interviewed. These experts were members and active participants the Assistive Technology Industry Association, who demonstrated prior experience in developing and commercializing assistive or universally designed technologies. Researchers and practitioners qualified as experts if they had significant publication and training histories in research and practice. The sample size and the sample composition (40% manufacturers, 30% researchers, and 30% practitioners) were preset and considered appropriate to optimally address the research objectives.

Interview Protocol and Instruments

All interviews were conducted by two researchers with extensive experience in technology for students with LD, and a notetaker who captured key points of the interviews. The interview protocol was developed over the nine years of conducting the *demand pull* technology transfer (Bauer, 2003; Lane, 1999) and *Industry Profile* (Bauer & Stone, 1999) projects at the T2RERC. The interview protocol consists of three main categories of inquiry: (a) needs identification, (b) state of the practice, and (c) future technologies and products.

Table 1
Generic Expert Interview Questionnaire

Needs Identification
1. What needs are poorly met?
2. Why are these needs important?
3. Who is most affected?
4. In which roles and contexts are these needs most critical?
State of Practice
5. What products now address these needs?
6. What are the strengths and weaknesses of these products?
Future Technology and Products
7. What new or improved products are needed?
8. What research and technology is needed?
9. What barriers delay product development?
10. How might these barriers be overcome?

The questions asked were generic, but were also designed to address specific critical needs in each AT area explored. In order to avoid interviewer bias, the concept of UDL was not addressed in the questions. This approach seemed rational because the focus of the study was not to understand or conceptualize UDL, but to use it as a frame of reference in the analysis to link and describe the identified *critical* and *specific* technology needs. The generic questionnaire is presented in Table 1.

In order to provide a common ground and structure to the interviews, the questionnaire was derived from the Industry Profile on Education Technology (Strobel, Arthanat, Fossa, Mistrett & Brace, 2006), which highlighted the current state, trends, and domains in educational technology. The interview protocol was developed in one month and was reviewed by the Industry Profile project manager, the principal investigator, and the T2RERC evaluation expert.

Interviews were scheduled at the convenience of the experts over a two-month period. Prior to each interview, experts were emailed an explanation of the project goals and a list of the questions that would be asked during the interview period. They were advised that it was not necessary to answer the questions in writing, as the intent was to foster dialogue via the teleconference call with each expert. In order to respect the time constraints of the experts, each interview was scheduled for and conducted in a one-hour time period. The

Table 2
Coding Process: Examples of Codes and Critical Needs in UDL

Raw Data	Code	Critical Need	Frequency
We need tools that can help 90% of the students and that can be adapted to the rest 10%	Customizable technologies for general classroom	Novel technologies	2
UDL technology is mutually beneficial for teachers and students. Teachers' time required for each individual student will be saved and kids love to learn through technologies as well	UDL concept enhances teacher student interaction and is mutually beneficial	Carriers	5
Teachers need to be skilled in assessing students' strengths and weaknesses within an inclusive setting	Application of technologies by teachers for all students is challenging	Barriers	1
Technology needs to be simpler and user-friendly for both students and teachers as well	Need to improve usability and accessibility of current technology	Needed improvements	1

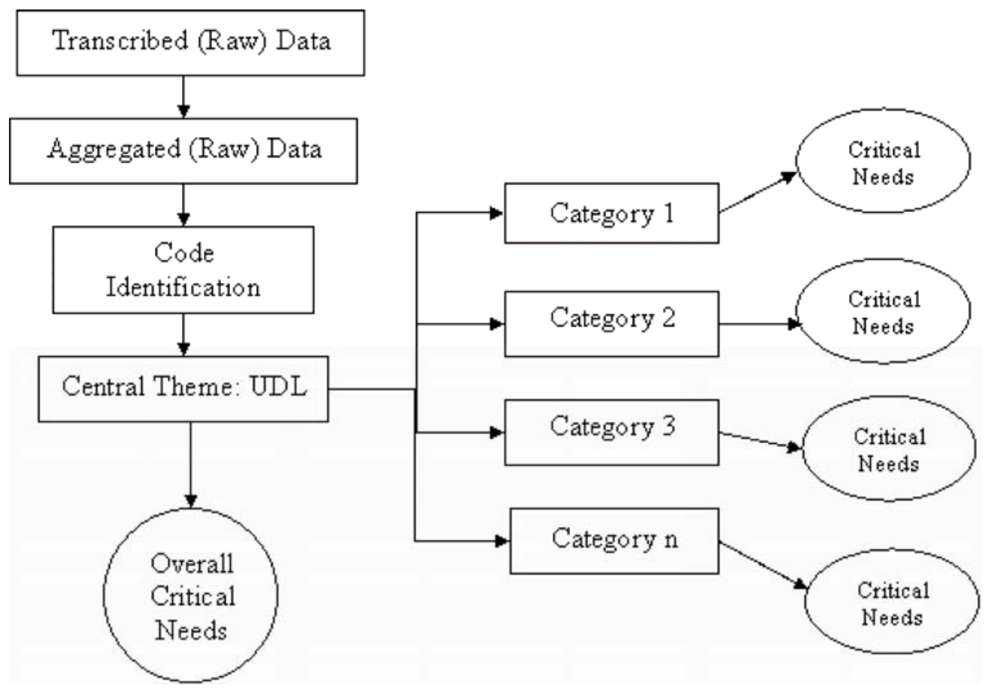
interview sessions were recorded and transcribed for coding and analysis.

Data Analysis

The data from each individual interview transcript was aggregated and all proprietary information (relating to specific technologies) was removed. The aggregated data were analyzed to identify salient themes and critical needs as expressed by the 20 experts interviewed. Based on methods outlined on *content* or *thematic analysis* (Boyatzis, 1998; Krippendorf, 1980; Strauss, 1987), an inductive approach was used to analyze the transcribed data. Inductive reasoning is *data-driven* and is a proven method in qualitative enquiry by which themes, conclusions, or theories are drawn by the researcher based on the identified codes in the data (Boyatzis).

The Industry Profile project manager first reviewed the transcribed data several times to identify open codes, which in this context denoted any piece of perceptible information in the expert statements that highlighted changing trends, expectations and unmet needs in the educational technology industry. The codes were analyzed to validate the central theme of UDL in the interview data. Technology needs relevant to the UDL theme, referred to as *critical needs*, were identified and reported as relating to a *novel technology* and *improvements to existing technology*, and *carriers* and *barriers* for meeting those needs. The frequency of codes (the number of needs and the number of experts expressing a particular need were recorded to reflect their significance in the data. Technology-specific or domain-specific codes in the central theme were categorized as *specific needs* based on their relevance to various areas or domains in classroom technology. In summary, the interview content was conceived as being

Figure 1. Stages in the coding and analysis of UDL based critical needs.



composed of one central UDL (theme) component that embodied the emerging trend and future path of the educational industry with several related sub-themes and categories. The theme and its categories in essence served as a framework by which the expressed technology needs (codes) in the data could be classified into corresponding *components*.

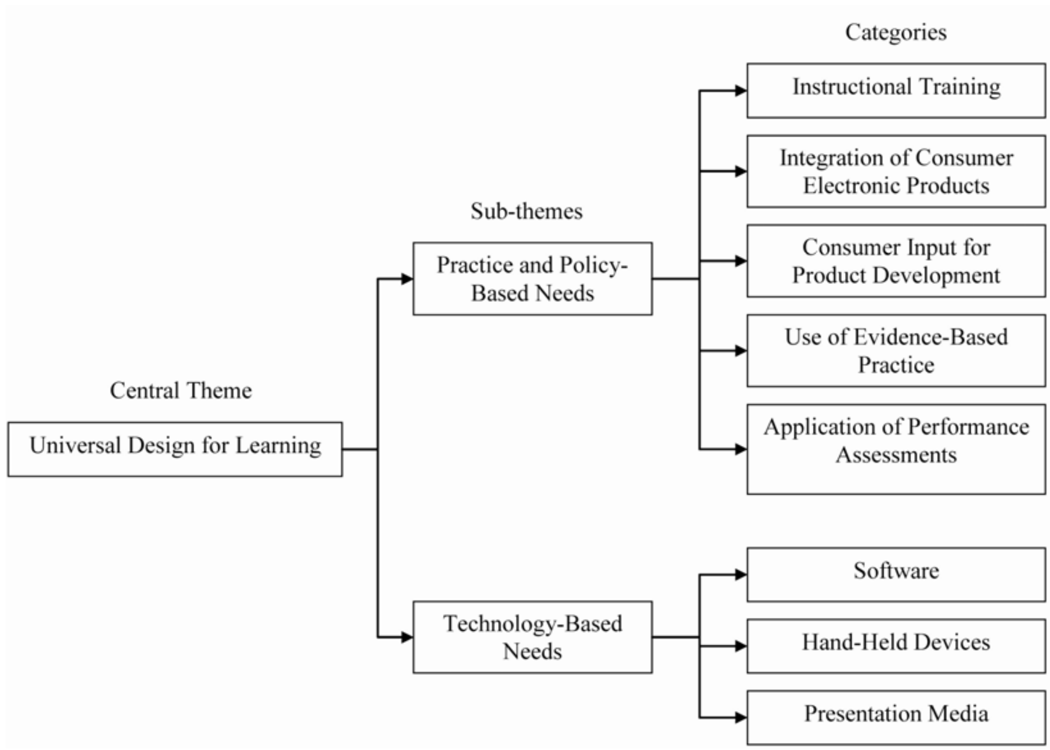
The categories in the theme (components of the framework) were defined and described in order for reliable classification of the identified technology needs. Critical needs that were not specific, but generally vital to the adoption of UDL were listed as *overall critical needs,* while the needs specific to each category of the UDL theme were described exclusive to the categories. Figure 1 illustrates the stages involved in the coding of the data and the analysis of the overall critical needs and category-specific needs. Table 2 presents four distinct pieces of information in the data that were subsequently coded to identify and categorize the critical needs.

Codes that were extraneous to the central UDL theme, if found, were to be analyzed, listed and described separately. To ensure reliability in the analysis, the developed theme and its categories were further refined after review by other members of the research team. Subsequently, the transcribed data was further reviewed by two members of the research team, who validated the existence of the identified critical needs and ensured that they were categorized appropriately within the developed theme.

Results

In terms of participant demographics, the 20 experts interviewed included nine manufacturers of AT or UDL tools. The remaining 11 were six researchers in the field of educational technology and five AT practitioners with experience in school

Figure 2. Sub-themes and categories within UDL.



settings. The findings from the critical needs analysis are discussed below sequentially beginning with the overall critical needs within UDL, and then progressing to the description of the categories and their corresponding needs.

Critical UDL Needs from Expert Interviews

All 20 experts unanimously and overwhelmingly stressed the importance of teaching students in an inclusive environment, the analysis of the interview data indicated. The underlying premise of UDL from the perspectives of new technologies and improvements to existing technologies was clearly evident in varying explicit and implicit degrees.

The primary market data revealed that nearly 92 statements in total reflected the general importance of the need to adopt UDL concept in classrooms. Among those, 37 distinct comments from the experts supported the premise that UDL was imperative to effective instruction and technology integration into today's classrooms. For example, 16 of the experts explicitly stated that the curriculum used in schools should be accessible to all students, using tools such as cognitive rescaling (as defined by Edyburn, 2002), curriculum sharing, and meaningful assessments. Another key comment was that technology tools should be made accessible to 90% of the student body and be adaptable for the remaining 10%.

The central UDL theme was composed of two broad sub-themes: (a) practice- and policy-based needs; and (b) technology-based needs. The *practice- and policy-based* improvements needed to facilitate the

Table 3
Practice and Policy Categories and Representative Statements from the Experts

Category	Exemplars
Instructional Training	Remediate learning problems by assessing the overall organizational approach as opposed to the task- by-task approach. Search engine for teachers to identify appropriate technology as needed. More efficacy studies are needed to validate what teachers should do to intervene with technologies and accommodations. To recognize what technology accommodations children require, performance based assessments should be used. Need for teachers to be creative and open to changing teaching strategies.
Integration of Consumer Electronics Products	Incorporate consumer electronics products as educational tools.
Consumer Input for Product Development	Feedback from teachers and consumers is helpful for developing next generation products.
Use of Evidence-Based Practice	Results from evidence-based practice should be disseminated to teachers.
Application of Performance-Based Assessments	Teachers should be better at using performance based assessment to identify student's strengths and weaknesses in an inclusive setting.

adoption of UDL in schools were related to five major areas: (a) instructional training; (b) integration of consumer electronic products; (c) consumer input for technology development; (d) use of evidence-based practice; and (e) performance assessments. The technology based needs were specific to software, portable devices, and presentation media. Figure 2 displays the sub-themes and their corresponding categories that stemmed from the central UDL theme.

Practice- and Policy-Based Needs for UDL Adoption

There were many practice- and policy-based needs identified by the expert interviewers. These included instructional training for teachers, integration of consumer electronics products into the classroom, consumer input into product development, use of evidence-based practice for classroom technology, and the application of performance-based assessment in the classroom (See Table 3).

Instructional Training

A major portion of the interview data (nearly 100 statements) attested to the needed improvements in training for teachers and administrators to improve the implementation of technology and the delivery of curriculum in the schools. The reasons for these statements varied. Some experts stated that because students are so comfortable with current technologies, teachers must know how to use it correctly to ensure that it is beneficial in the learning environment. Interestingly, four experts characterized teachers as "digital immigrants" and their students as "digital natives." Thus, if teachers hoped to implement technology in the classroom appropriately, they need sufficient training to keep up with their students. Others stated that technology integration was a *carrier* in ensuring that students were engaged in the classroom and in learning.

Forty-one comments regarded the need for training on technology — both technology used for teaching and technology to enhance student performance. For example, 12 comments addressed the need to provide teacher training on accessibility features of current technology. Another 10 stated that teachers needed ongoing training on available technology. Another expressed need was that teachers required specific training on technology that supported math instruction and performance.

As a novel concept (technology), some experts even specified tools that should be created and maintained to make this task easier, such as a database or search engine that would help identify needed technologies. According to experts, this database would include available technologies and a search mechanism that allowed for inputting functional limitations to identify "ideal" technology for a specific student. Experts recommended a number of novel tools that would enhance teacher training, including web-based training tools that would allow for "anytime" training to accommodate teacher's busy schedules. As a barrier that needed to be overcome, experts stated that many school administrators were not supportive of a rigorous training regimen necessary to ensure the appropriate levels of technology literacy in school staff. Others felt that it was the responsibility of manufacturers to provide training to teachers on their specific products.

Eleven experts stated that teachers require training on the implementation of the broad teaching styles that would engage today's students. As a *barrier*, some experts felt that some teachers' unwillingness to be creative and open to changing teaching strategies means that they fail to engage the diverse student population in their classrooms. Finally, 36 expert comments identified the need for training for teachers that would help them accommodate and understand the functional limitations associated with disability labels. They stated that many teachers tend to give the same accommodations to all students with disabilities, despite the difference in the needs of each group. These typical accommodations were identified a (a) extra time to complete work; (b) task break-down into smaller, more manageable pieces; (c) priority seating; (d) color coding materials; (e) providing typed notes; and (f) and reading aloud.

The experts in this study outlined a number of *barriers* to the success of accommodations like those described above in the classroom. The first *barrier* to successful accommodation was an inability to effectively measure the impact of these accommodations. Furthermore, since the accommodations provided to a student in a classroom one year are often not recorded in any meaningful way, it is impossible to replicate that success as the student moves from grade to grade or from school to school. Second, experts stated that many accommodations were seen as 'cheating' by many in the school district and as a result, those who used them were sometimes stigmatized. This barrier was labeled as more an attitudinal barrier than a limitation of the accommodations themselves.

Integration of Consumer Electronic Products

The second theme identified by 14 expert statements was the need to include current, popular technologies (i.e., MP3 players and digital phone technology) in the classroom. Experts stated that these technologies were ideal for classroom implementation because they are relatively inexpensive, simpler, more user friendly, and applicable to a wide range of students. The reasons given to support this statement addressed the reduction of stigma around the use of AT. Experts agreed that many students were concerned with how they appeared to others when using technology that was not normally used by students. Others raised the issue of students' tendencies to abandon AT. Some experts believed that these simple classroom technologies would stimulate and encourage learning in students. However, one of the expressed barriers was the misuse of these technologies while students were supposed to be attending to classroom instruction.

Consumer Input for Technology Development

Consumer input into product design and marketing of new products was the third theme identified by experts with 10 expert interview statements. This was seen as a valuable tool for development due to the knowledge that this generation of children has regarding the use of technology. According to the experts interviewed, school personnel could also offer insight into what the products needed to do to work in the classroom. Consumer input was also seen to be a great benefit to manufacturers who continuously incorporate new product features and functions to improve their products.

Use of Evidence-Based Practice

Experts wanted to see an increase in the efficacy testing of new technology products to ensure that the tools used would be effective in the classroom. Ten experts stated that there was a need to improve research on teaching methods, data collection and analysis, and impact data for varying teaching methods. The experts listed several *barriers* that prevented this research from being conducted effectively. Lack of funding was a barrier, and as a result, small companies face difficulty in conducting research effectively. They also stated that the limited population of students who received services under the Individuals with Disabilities Education Improvement Act of 2004 (IDEIA, 2004) limited the pool of research candidates under the current system. Finally, experts stated that the requirement to conduct evidence-based research delays product introduction.

Application of Performance Assessments

The final issue identified was the need for performance-based assessment for children with disabilities. As a barrier, experts stated that there is currently a lack of meaningful assessment and testing for many students with disabilities because of the methods used to deliver standardized assessment and the exclusion of many classroom technologies in administering these tests. One of the stated needs was school personnel should more adeptly assess the strengths and weaknesses of their students. They also felt that school personnel should focus more on the knowledge gained versus teaching the confines of a standardized test. Experts also stated that performance-based assessments, in a universally designed learning environment, would allow a clearer picture of skill sets versus diagnosis and disability labels.

Some of the expert comments related to instructional training were also tied to performance testing, as assessment and planning were identified as other areas in which teachers required training. While experts were excited about the development of web-based assessment tools, they expressed concern that teachers required additional training on how to conduct effective assessments and how to implement performance-based assessments. The lack of knowledge on how to include classroom technology in assessments and on standardized tests was seen as a major *barrier* to the success of students. Experts also stated that teachers needed additional training on how to write and implement effective IEP and other intervention tools.

Table 4
Technology-Based Needs Categories and Exemplars from the Experts

Category	Exemplars
Software	Teachers must be able to optimize software for the student through the use of a set-up wizard.
	Math software must be more than drill and practice.
Handheld Devices	A wider variety of tools should be available for handheld devices.
Presentation media	Organization of multimedia presentations should be facilitated using graphic organizers in programs, such as Inspiration or Spark Space.

Technology-Based Needs

Experts identified several technology-based needs they wanted to see implemented in classrooms. These included improvements in software used in the classroom, improvements to hand-held devices such as PDA's and MP3 players, and improvements in presentation media used by both teachers and students. Table 4 illustrates identifies these categories and representative statements from experts.

Software

According to experts, there is a tendency to use computer software for the classroom as it is shipped, with little regard to the potential customization that is possible with the application. No expert explained why this phenomenon occurred, but 35 expert comments pointed to the need to develop a set-up feature, or set-up "wizard," that would take the teacher/student through the potential features of a product to determine the optimal set-up for an application. Comments included a list of potential features that should be included on software systems to allow for optimal customization. Features described did not include common accommodations already available (i.e., spell check, auto-summarize, etc.). However, additional features for consideration included: font and background color selection; picture supported text; improved text to speech; improved speech recognition; contextually based word prediction; organizational support; dictionary support; scanning input; and phonetic spell checking.

Experts also stated that they were concerned that accessibility features found in programs such as Microsoft® Word were commonly overlooked despite their availability and easy set-up. They stated that the set-up wizard may not only alert users to the availability of these features, but would also encourage customization of software applications for specific users. Some experts stated that including a set-up wizard with all of the features listed above would be too costly and burden developers. They suggested instead the use of portable features that could be included in a USB drive and given to all students with the personalized accommodations that they needed. Others saw this as an unsuitable solution as students were likely to lose the portable drives.

Although Instant Messaging language was suggested as an input mechanism into software applications, it was a highly contested issue. Some experts felt that it would enable many students to input text more effectively and efficiently, as they are highly socially motivated to use this input system. Others felt that it was a *barrier* and would negatively impact students writing skills.

Experts also stated that there was a need to develop additional math software. They stated that math software needed to offer more than just drill and practice, and should be developed with an eye towards learning and understanding concepts without giving the answers to specific questions. Experts stated that they wanted math software that was geared toward grade 5 and above, as many products were available that addressed basic math skills. Finally, they stated that math software should be interactive to ensure that students were engaged in the lessons.

Handheld Devices

Forty-three expert comments focused on the development of handheld devices (i.e., PDAs and digital phones) that would enhance student learning. Recommended improvements to these devices included increasing the ease of use for K-12 students with disabilities. Experts stated that because students enjoy using these technologies, there would be no stigma associated with their use. The following specific needs were included in the list of needed improvements: (a) wider variety of tools should be made available, (b) alternative input systems should be incorporated into the system, (c) larger buttons should be created, (d) increased display space for text should be made available, (e) devices should be made available at lighter weights, and (f) cost should be reduced.

Many experts saw these devices as easy to incorporate into classrooms activities; however they also had reservations. First, ensuring that all students had access to these systems was seen as a very large barrier to implementation in classroom environments. Second, many comments expressed concern that these devices would give students the opportunity to "play" (i.e., to send instant messages or email) with the devices rather than to pay attention to the teacher.

Presentation Media

Experts identified improvements that should be made to presentation media for the sake of both teachers and students. Sixteen expert comments stressed the need to ensure that the presentation media used should use a multi-media format. Experts stated that presentations that did not employ multi-media could be too difficult for many students with processing disorders that often accompany LD. Many expressed concern over the common use of printed material despite their lack of accessibility.

Formatting issues were identified as a major issue by 13 experts. They identified the need for novel tools that would potentially improve the effectiveness of existing presentation media technologies. These included: (a) tools to improve the clarity of the information presented, (b) tools to improve the timing of presentations, (c) tools to improve the organization of presentations, (d) tools to promote interactivity between the audience and the presentation, (e) tools to improve summarization of important information, and (f) incorporation of concept mapping in designing presentations. Additional comments encouraged the use of the Internet as a tool for presentations.

Experts stressed that no single presentation tool would be effective for all and therefore suggested improvements to several visual presentation media. Projectors were seen as effective tools for presentations in group environments. However, many experts considered their cost to be a barrier to universal availability. They also stated that projectors should have better lighting and should be effective for use in large rooms. Microsoft® PowerPoint was identified as an excellent tool for multi-media presentations and one that appeals to students. They felt the additions of the tools listed above would enhance its usability and ensure higher quality presentations. Interactive whiteboards were also seen as effective tools for multi-media presentations and as being especially effective tools for math instruction. However, the cost of these tools was seen as prohibitive to widespread implementation. Experts also stated that virtual learning environments and video-conferencing should be more widely utilized in schools.

Experts recommended improvements to the way audio material was presented in classrooms. Specifically, six experts promoted the use of sound-field systems in the classroom. They listed a number of benefits to this presentation media, including: (a) high quality audio output to all students regardless of their location in the room; (b) the ability of these systems to overcome issues such as noise, reverberation, and distance; (c) the ability of these systems to provide sufficient amplification; and (d) the benefits to students with auditory processing disorders. An expressed barrier was that teachers had difficulty maintaining these systems effectively.

MP3 files and players were also recommended as effective tools for the presentation of audio files. Experts identified the ease of conversion of audio files into MP3 formats, the large storage capacity of portable systems, and the ubiquity of the systems as benefits of using this technology in schools. However, experts expressed concern over the possibility of inappropriate use of these systems during class time. They also stated that the headphone technology used with these systems should be improved to increase comfort and prevent damage to hearing.

Discussion

Expert interviews established that needed technology most often contains elements of UDL. The interviews centered on the theme of UDL and identified critical needs for its overall advancement. The underlying premise of the topics addressed during each interview was the need for an educational environment that supported universal design for learning: In other words, an environment that allowed all children to learn in a common environment while allowing students to optimize the educational opportunity by using a variety of individualized tools that fit seamlessly into the classroom environment.

Experts credited the large numbers of students labeled at-risk for failure, which they estimated at approximately 50% of students in the classroom, as the practical reason for including UDL concepts in education and AT applications. Experts often recognized the standardized testing requirements created in NCLB for identifying these children. These children have not been identified as having a learning disability, but still struggle with standardized tests because of poor reading skills and inability to excel in current school environments. Consumers also supported the UDL concepts but emphasized benefits derived from the elimination of stigma around the use of assistive technology.

The most important educational concern, cited by a majority of experts, was for students with an inability to obtain meaning from print. This problem is most pressing when combined with the need for timely access to curricular materials. Participants indicated that the ability of students with LD to advance academically is significantly hindered by delayed access to materials. The overarching need for UDL classrooms and technologies to complement assistive technologies is clear.

This study clearly identified the need for schools, teachers, and students to embrace inclusive educational technology and AT to meet the needs of all students in the classroom. Participants made it clear that the current approach to accommodation is not working for many students. Although there was no formal reliability analysis of the coding, multiple reviews, discussions and iterations of the identified codes within each category by the research team merited the analysis.

Prior to this work, secondary market research was collected on a variety of topic areas and reported in the *Industry Profile on Education Technology: Learning Disabilities Technologies and Markets*. As a reference, the Industry Profile offers an overview of the learning disabilities, demographic and market information, a review of technology, legislation and funding, and appendices that include a manufacturer index, an index of national organizations and associations, and a listing of relevant national conferences. This document can be downloaded from the T2RERC website at http://cosmos.buffalo.edu/t2rerc/. As a continuation of our work on this project, primary market research was also conducted with consumers to examine unmet needs within specific domains of educational technology: reading, writing, and math. The analysis and reporting of this work is currently being carried out and will be published as a consumer oriented perspective of the educational technology industry.

Outcomes and Benefits

In summary, embracing UDL concept in the design, development and use of technologies for education may allow us to overcome the striking paradox of *educational technology* and *AT* by factoring out *disability* and the need for *partial* accommodations. This study adds to the body of knowledge characterizing UDL needs of students and teachers, and the solutions, technological and otherwise, required to meet these needs. Information presented in this article will facilitate the development and commercialization of UDL and classroom technology products to benefit all students, including those with learning disabilities. Study results support the need to incorporate UDL concepts in teacher training, pedagogy, infrastructure, and products. In terms of acceptance, teachers support technology use when all students benefit, while students with learning disabilities prefer technology typically used by all students.

An outcome is a measurable change consequent from a perturbation introduced to a system. In the realm of AT, Edyburn (2003) elaborates that "outcomes may be multidimensional … rather than something that can be captured in a single score" (p. 54). In the UDL context, there are several relevant systems including: governments, post-secondary institutions educating teachers, accrediting bodies for teachers, manufacturers of UDL materials and educational and AT products, K-12 school systems, and K-12 classrooms. Stakeholders within each system may in principle be informed by this study and institute systems change consequent to knowledge gained.

An immediate and demonstrable outcome of this study will be to inform stakeholders of the critical needs identified experts in the field of education. As indicated, thematic analysis of the transcripts and notes collected during the expert analysis resulted in the identification of needs in computer applications for students (including both software and portable device applications); presentation and multi-media applications; and teaching and instruction tools and training. The T2RERC will use this study and the *Industry Profile on Education Technology: Learning Disability Technology and Markets* to inform manufacturers about the critical needs in educational technology as defined by industry experts, and suggest educational and assistive technology product solutions that might satisfy these needs. The current study and the *Industry Profile on Education Technology* will be used to develop strong Small Business Innovation Research (SBIR) proposals, a critical funding source for new product development. In addition, information derived from this study will be used to develop marketing materials, guide business planning, and inform grant development efforts.

Conclusion

The critical need areas identified in this research are based on primary market research with experts in the field of education. Many of the needs outlined in this research may require additional research to fully identify specific technology specifications.

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