ASSISTIVE TECHNOLOGY INSTRUCTION WITHIN A CONTINUOUSLY EVOLVING TECHNOLOGY ENVIRONMENT

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The movement toward greater availability of online education in the university setting creates challenges for design, development, and implementation of online courses, particularly those focused on the educational use of technology as content. This article is structured around a central theme of designing and implementing hybrid online courses that have a curricular focus on the use of assistive technologies (AT) to increase educational outcomes of students with disabilities, and to enhance our understanding of the role of technological transience in special education and related disciplines. Specifically, this article explores transience and intransigence as related to assistive technology itself, to technology implementation in the public school classroom, and to postsecondary distance education. *Intransigence* is used here to describe factors that work in the opposite direction of technology transience. Intransigence imparts "drag," and counters the increasing imperative to recognize and respond to technological transience. Technology will advance with its inevitable transience (Aytac & Wu, 2013; Babbitt, Kahhat, Williams, & Babbitt, 2009). Impediments (or intransigence) play a significant, often challenging, role in planning, implementing, and evaluating distance education. Transience and intransigence will be addressed in relation to several dimensions of learning and human performance that must be addressed in distance education: content knowledge, attitudes, and practices.

INTRODUCTION

The Individuals with Disabilities Educational Improvement Act (IDEA, 2004) is the core legislative program governing federal, local and state assistance for special education and related services in the United States. This legislation requires that a student's need for assistive technology (AT) be considered in the development of the student's Individualized Educational Plan.[1] This stipulation in federal law necessitates the inclusion of foundational knowledge, principles, and practices of assistive technology in all preservice teacher education. It further stipulates the professional development for individuals who are already employed as teachers. Significantly, assistive technology does not exist as an easily differentiated area of the realm of technology.

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A definition of assistive technology first appears in U.S. law in the Technology-Related Assistance Act of 1988 (P.L. 100-407), and subsequently was adopted in the IDEA (1990) legislation. An assistive technology device is "any item, piece of equipment or product system, whether acquired commercially or off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (20 U.S.C. § 1401(1)). As such, AT is defined in relation to both individuals with disabilities and outcome benefits, i.e., improvement of function (Wise, 2012). The term *disability* includes developmental disabilities (i.e., whose cause is genetic or an outcome of a developmental condition), and acquired disabilities (i.e., as a result of trauma, illness, or disease).

Interestingly, despite the significant evolution of technologies, (e.g., computer hardware and software applications, software programmable portable devices, apps in mobile devices), the term "devices" has remained unchanged since its adoption in 1988. In an effort to improve understanding of the compensatory outcome benefit of AT (and deemphasize the "device-ness"), a working definition has been proposed defining AT to be "a tool that allows a person with disabilities to do a task he or she could not do without the tool at the expected level of performance" (Parette, Peterson-Karlan, & Wojcik, 2010; Parette, Peterson-Karlan, Wojcik, & Bardi, 2007). In this definition, *tool* supplants *device* and emphasizes that tools are used as technology to enhance functioning by people in general and provide a "performance boosting" benefit. This definition also provides a measurable reference point for the outcome of AT tool use, that is, "the expected level of performance."[2] Unlike medical technology whose purpose is to improve or sustain health through diagnosis of, prevention or treatment of a condition that could lead to reduced functioning (Wise, 2012), the purpose of assistive technology is to improve function or performance in everyday life activities a person engages in all functional life contexts (Peterson-Karlan & Parette, 2008; Wise, 2012).[3]

The mandate to consider the student's need for assistive technology in schools arose from the larger movement to establish the rights of persons with disabilities to have access to the same public places, programs, and services as other individuals without disabilities. In the United States, it resulted in the Americans with Disabilities Act (ADA).[4] In the European Community and in other countries (e.g., Israel), there has been parallel development of legislation and programs to "create an even playing field," with special emphasis on "e-accessibility," i.e., accessibility to information and communication technologies (ICT) (Schreuer, Keter, & Sachs, 2014).[5] Countries and territories of the Asian Pacific have agreed to policies establishing rights of persons with disabilities; however, progress in achieving access to ICT and implementation of assistive technologies have been hampered by cultural, economic, and educational factors (Ratliffe, Rao, Skouge, & Peter, 2012).

Assistive technology, as a multidisciplinary field (engaging and encompassing education, vocational rehabilitation, rehab engineering, physical and occupational therapy, speech-language pathology, special education), has no one agreed upon taxonomy of the areas of functioning to which AT applies. However, the areas of functioning that are common among taxonomies include both basic human abilities and more complex cognitive processes and functions. Table 1 provides an overview of the human abilities and functions that can be supported by AT. In general, impairments to basic human abilities inhibit functioning in a wide range of activities of daily living such as dressing and personal hygiene, domestic living, shopping, food preparation, community transportation, use of community services, et cetera, and important job-related activities that sustain employment. Impairments in executive functioning inhibit our ability to manage personal, educational, or professional affairs. Reading and writing are complex cognitive processes that are at the heart of the educa-

TABLE 1
Areas of Human Ability and Functioning Supported by Assistive Technology When Impaired

Area of Human Ability or Complex Cognitive Function	*Functional Outcome*	*Description*
Physical	Manipulation	Ability to physically manipulate objects and things
	Mobility	Ability to move from place to place without assistance, such as walking, running, crawling, hopping, etc.
	Positioning	Ability to move into or out of or to maintain positions of the body such as sitting, standing, kneeling, laying, etc
Sensory	Sensation and perception	Ability to sense, perceive, discriminate among visual, auditory, and tactile information for the purposes of establishing meaning
Language and speech	Communication	Ability to make oneself understood to a listener using phonological, morphological, semantic and syntactical knowledge or skill
Executive function	Personal management	The ability to organize and manage personal materials (objects), time and events (schedules, calendars, appointments, etc.), tasks (e.g., to do lists), and procedures (e.g., the steps for completing tasks) (Parette, Wojcik, Peterson-Karlan, & Hourcade, 2005)
Reading	Text comprehension	The ability to use scanning, decoding and word and passage comprehension for the purpose of acquiring and using information from printed text
Writing	Text production	The ability to use planning, organization, text transcription, editing and revising for the purposes of producing text (e.g., notes, lists, short responses, text passages, compositions, etc.)

tional process and are critical to postschool economic success (Anderson, 1985; National Commission on Writing, 2003, 2006; "NCTE Position," 2015). AT supports the comprehension and use of information in text or the ability to compose accurate, coherent, and meaningful written text (Anderson-Inman & Horney, 2007; Edyburn, 2000; Peterson-Karlan, 2011; Peterson-Karlan, Hourcade, & Parette, 2008).

THE CHALLENGES OF TECHNOLOGY AND ASSISTIVE TECHNOLOGY USE IN SCHOOLS AND DISTANCE EDUCATION

Maintaining both current and emergent content and educational practice of assistive technology (AT) for course development involves both the "here and now" and the "what will be." Given technological advancements, undergraduate participants in an early sequence AT course likely will not be seeing or using the specific examples provided in course content when they enter the schools as teachers in three years hence. Teachers and AT professionals in schools today need to know what AT devices are outdated, what is current, and what AT may be in the future. One considerable difficulty in determining the state of advancement and change is the lack of predictive trends for AT for persons with disabilities. While the "NMC Horizon Report: 2014 K–12 Edition Preview" (2014) is a contemporary and recurrent source for identifying and predicting emerging tech trends and their potential for adoption into education, comparable sources for tech adoption by persons with disabilities or by schools serving them do not currently exist. The most recent disability-related technology trends report in the United States is from 2006 (Vanderheiden & National Council on Disability, 2006). Technological transience is a key consideration in consumer markets and advanced economies, bringing to light issues of lifespan and replacement (Aytac & Wu, 2013; Babbitt, Kahhat, R., Williams, E., & Babbitt, 2009). Simultaneously, technology advancement in education can prove intransigent, with issues related to technology adoption and replacement and institutional timelines out of step with technology in today's culture and society.

HOW HAVE TRANSIENCE AND INTRANSIGENCE IMPACTED AT DEVELOPMENT?

The state of AT, including the cost, availability, ease of implementation, and use has evolved quickly and dramatically since its first uses in schools in the 1970s when it might have been referred to as an "adaptation" or "accommodation" and was largely in the form of physical objects or hardware devices. The general state of technology development has provided exceptional benefit for AT development and implementation—and new challenges. General advances in device development include microprocessor chips, synthesized speech technology, memory storage, dynamic digital displays (screens), and battery size/power. In conjunction with cost reductions, these technological advances have impacted AT development as has convergence into small, smart, connected mobile devices. A part of convergence is the emergence of affordable, powerful, flexible, touch and voice controlled apps. However, as will be discussed, this has generated some new problems for AT, in both course design and delivery and in preK–12 school adoption and use.

General trends in device development have positively impacted several areas of AT. The size and weight of portable communication devices, together with advances in dynamic displays, provide more "computing power-per-dollar" in cost. Speech generating augmentative and alternative communication technology, in conjunction with dynamic displays can be download from public app stores for installation on consumer tablets and other mobile devices, increasing the availability but also the transience of AT; developers that could not afford to create hardware can now engage in lower cost app development. Device size, weight, computing power, and cost and app availability have impacted a wide range of AT, including visual image enlargement systems, auditory enhancement systems, and Wi-Fi control of household systems using smart devices. AT systems that translate printed text into speech evolved from dedicated desktop devices to apps on a smartphone.

Technological development has also led to significant applications to the cognitive complexities of executive functioning applied to personal management (time, schedules, events, calendars, tasks, procedures) for those with cognitive and intellectual disabilities (de Joode et al., 2010; Gillespie, Best, & O'Neill, 2012; LoPresti, Mihailidis, & Kirsch, 2004). Technology has been very successful in supporting, enhancing, and improving the personal management of students with intellectual disabilities, independent of their ability to read printed information or to require extended verbally prompted instruction (Ayres, Mechling, & Sansosti, 2013). Rapid development occurred in the use of visual, nontext images to support completion of tasks and engagement in sequences of step-by-step action. Advances in speech synthesis cost and availability enabled audio and speech to be added to digital personal management tools at low cost. As the production, editing, and use of digital video became cost effective and easy to do, personal management tools using videos on portable DVD devices, laptop computers, and handheld computers (e.g., PDAs) became part of the tool systems for supporting students' performance of multistep tasks in activities of daily living (personal or home care) or in preparation for and performance in community-based employment (Cihak, Kessler, & Alberto, 2008; Davies, Stock, & Wehmeyer, 2003; Mechling, Gast, & Fields, 2008; Van Laarhoven, Johnson, Van Laarhoven-Myers, Grider, & Grider, 2009; Van Laarhoven, Kraus, Karpman, Nizzi, & Valentino, 2010). Digital personal management tools offering image, audio, and video options are now available as apps for smartphones and tablet computers. In addition to students with intellectual disabilities, many ubiquitous tools for personal management as well as educational apps for managing assignments are available for use for students with learning and behavioral disabilities. Finally, features that might have been viewed as “technology for disabilities” are now ubiquitous features of tablet and smartphone mobile devices, including voice control, text-to-speech screen output, and word prediction for text entry among others, reflecting the continuing trend toward the convergence of devices into tablet and smartphone hardware with relatively low-cost apps and easy distribution and installation.

The move toward app technology on mobile devices speeds development and availability but also speeds technology transience. In the schools, rather than these newer and technologies supplanting and replacing older ones, use of the older technologies persist. This is an example of intransigence within the overall system of educator professional development, administrative leadership, and technology decision making in a time of budget limits and decreasing funding of public schools. With AT apps, version intransigence creates challenges for content and application design. The use of in-app upgrades from the free but “lite” (features are not present or are present but not functional) to the paid fully featured version and the existence of concurrent, multiple versions of apps are challenges for both the public schools and for distance education. As an example, I have encountered free, “lite” versions of an app being offered in the same app store as multiple paid versions with similar but not identical version names and similar but not identical features. Standards that prohibit upgraded “versions” from being separate products that continue to be sold, do not exist in the app marketplace. The challenge for AT course design is to develop “consumer awareness education” within the course content regarding app content and multiple “versioning.”

HOW HAVE TRANSIENCE AND INTRANSIGENCE IMPACTED SCHOOLS AND DISTANCE EDUCATION?

Technology transience, in general, plays a significant, often challenging, role in the design, development, delivery, and evaluation of instruction, both in distance education and in the schools. Apps, operating systems, tablets, laptops, hybrid laptop-tablet, and mobile devices proliferate and evolve quickly. In distance education, the challenge is to revise content and application activities to match versions and system transience, especially when participants are using their own computers across multiple operating systems (Apple, Microsoft and Google Chrome). In schools it impacts technology selection and implementation, both initial selection of devices to support apps and maintaining and upgrading devices and applications. It also impacts professional development, requiring sustained technology professional development, just as significant factors such as the economics of disability, pedagogical content development, beliefs and practices about technology, and integration of AT into educational technologies produce “drag” on the effects of technology transience.

The economics of technology acquisition and use for persons with disabilities may not permit adoption to proceed at the same pace within a consumer technology-driven economy and culture where available technology is transient but the ability to afford technology is relatively intransigent for them. Education and economics plays a considerable role in what we might think of as the "technology profile" of individuals with disabilities: 46% of adults with disabilities live in household with income less than $30,000, compared to 26% for adults without disabilities, and 61% have a high school education or less, compared to 40% of adults without disabilities (Fox, 2011). However, when economic, age, and educational demographic factors are controlled, disability remains a major source of technology access; only 54% of adults with a disability living in the US go online versus 81% of adults without disabilities, and 2% have a disability or illness that prevents them from accessing the Internet (Zickuhr & Smaith, 2012). Those impacted would, in turn, be the schools; districts with more affluent demographics would find pressure to provide the latest in AT due to higher parent expectations for technology availability and use. The education and previous experiences of teachers is also impacted by school district demographics, producing varying and uneven expectations about technology and Internet use.

The pedagogical content, along with effectiveness research, of AT content evolves with different time horizons. Within a quickly advancing technology and media culture, AT evolves and transforms; however, pedagogy and practice advance only as quickly as educational professionals have access to technology and can develop appropriate instructional content and strategies for instruction. National survey research has indicated that AT practice in school lags behind in both understanding and practice (Bausch, Ault, Evmenova, & Behrmann, 2008; Bausch & Hasselbring, 2004; Bausch, Quinn, Chung, Ault, & Behrmann, 2009). Empirical research leading to demonstrated effectiveness is often lacking, as is valid research. Meanwhile, AT continues to develop and expand. With the rate of transience in devices, operating systems, and app content, instruction must be "agnostic," requiring that we teach in-service and preservice teachers about type and function, not specific brand or product of app or device (e.g., a "tablet," and not an "iPad;" voice recognition software, not Dragon Dictate; word prediction, not CoWriter, etc.), as all these technologies will likely continually evolve.

The beliefs and practices about AT in schools have developed on slower timelines than those within culture and society. "Belief intransigence" plays a significant role in this discrepancy. My own graduate students holding both teaching and administrative positions in the schools have repeatedly noted that, in their districts, AT is still seen as expensive hardware systems (e.g., a dedicated $3,000 speech-generating device, or an expensive power wheelchair), which might be called the "myth of expensive AT." Graduate students also report the misbelief that AT is only for students with sensory, physical, or significant intellectual disabilities: AT is still not seen as also benefiting students with learning and academic disabilities who struggle with writing, reading, and math computation. Even where a greater acceptance AT's benefit exists, "funneling" can reduce options for AT to consider for students with disabilities (Parette, Peterson-Karlan, & Wojcik, 2005). "Funneling" occurs when key AT "experts" within a district have knowledge of only certain specific technologies within a category of support function (e.g., specific speech generating devices or apps from among those available). AT course content design, then, must identify and alleviate information funneling through broadening the use of examples and instruction, regardless of existing beliefs. However, and perhaps ironically, technology transience may actually serve as a facilitator of belief and practice change. As technologies originally designed for use by persons with disabilities become increasingly common in our digital culture, schools professionals will become less intransigent about those who might benefit and about real, rather than imagined, cost.

Beliefs and practices about ICT in schools are indeed changing, but not as rapidly as cultural acceptance and use. Curricular advancements, particularly those standards related to technology literacy and applications (e.g., the ISTE Standards Students; the Profiles for

Technology (ICT) literate students; and the Common Core technology integration), have increased the need to consider the ability of students with disabilities to access and use ICT (Peterson-Karlan & Parette, 2008). Emergent research is examining access and use of ICT by students with severe disabilities in their homes (Cihak, McMahon, Smith, Wright, & Gibbons, 2015; Ratliffe et al., 2012; Schreuer et al., 2014) and access to online courses (Betts et al., 2013). These curricular changes parallel a broader definition of 21st century literacy (Allan & Miller, 2005) that includes reading, viewing, listening, writing, and recording in a media culture of print, video, podcasts, images, etc. In many ways, schools are still print-based or, at least, behind the trend toward nonprint media (Rose & Meyer, 2002), while the culture has moved to multimedia information systems. Such changes create a need for teachers to understand and use digital AT tools in the content subject areas for students with learning disabilities, or for others who academically struggle to support acquisition and use of information beyond traditional reading and writing mechanisms. This includes students who need to access information from print and who may still benefit from reading and writing instruction, or who may have reached a point of diminished benefit due to difficult ameliorate conditions (i.e., visual perceptual impairments, dyslexia, graphomotor impairments, and cognitive processing deficits) that affect multiple components within the complex reading and writing processes. However, feedback from special education teachers in the schools who are course participants indicate that, rather than seeing AT as a means to level the playing field for students with disabilities, some general and special education teachers see this as an equity issue, an unfair advantage, or the creation of "tech dependence" ("But what will they do if it fails, or they do not have it?"). Research does exist to counter the unfair advantage argument, providing evidence that AT used in assessment does permit students with disabilities to achieve to their level of knowledge but does not provide any unfair benefit beyond that (Crawford & Tindal, 2004; Ketterlin-Geller, Yoyanoff, & Tindal, 2007; MacArthur & Cavalier, 2004; Thurlow et al., 2007). Such research has led to the integration of "allowable accommodations" or "technology for students with disabilities" as one of the major common core assessment initiatives, PARCC (Davis, 2014; Partnership for Assessment of Readiness for College and Careers (PARCC), 2013; Samuels, 2013). Additional research initiatives have also emerged recognizing the potential of universally designed assessments in measuring cognitive ability and achievement (Almond et al., 2010; Bechard et al., 2010). However, this research has not yet produced a general change in attitude and beliefs and practice concerning AT.

Currently, integrating AT into educational technology classrooms and distance learning is simultaneously both transient and intransigent. Technology trends are pushing technology integration in schools, which has had a recognized pattern for adoption ("Understanding," n.d.), producing both impetus for change (Bolkan, 2014; "Educational technology," 2013) and giving rise to recognized barriers and intransigence (Norris & Soloway, 2011). The promise of mobile computing spurred by the interest in 1:1 computing (Herold, 2013, 2014b, 2014d) and fueled by the injection of funds into schools as part of the American Recovery and Reinvestment Act of 2009 led schools to complete large scale adoption of either tablet or notebook computer technology prior to having clear plans for digital content acquisition and professional development. The development of digital content, critical to the success of digital education and assistive technologies for literacy, may not be keeping pace with device development in these 1:1 computing initiatives (Cavanagh, 2014; Herold, 2014a, 2014c). There has also been engagement in the education market by large system organizations producing new technology—including Pearson PLC, a large educational publisher that is producing the PARCC computer-based assessments. These opportunities to advance technology integration have created new challenges. Their creation and deployment are in advance of the schools' ability to integrate them; in the 2015 school year, PARCC computer-based testing was delayed due to school district technology infrastructure limitations (i.e., devices and bandwidth). The tools and accessibility features that are provided with these devices represent unexamined effectiveness; for example, no research exists comparing the effectiveness of the Apple or Android word prediction tools with Co:Writer for which effectiveness research with students with disabilities does exist

Learning management systems (LMS) for delivering and managing distance education curricular content and instruction can be relatively intransigent, given the system software and implementation demands, including large-scale technology implementation, and faculty or staff professional development. Beyond deployment, online accessibility of current LMS are recognized as having accessibility problems (see, for example, Web Accessibility for Online Learning). In addition to the reported problems with LMS in conforming to web accessibility standards, it is this instructor's experience that functioning accessibility features available in the web browser or as add-ins may not function when course participants are in the LMS environment. Accessibility features, such as embedded dictionaries, screen simplification to increase readability (e.g., the "Reader" feature of Firefox and Safari), text-to-speech, and screen display modifications may or may not work within the LMS. Another challenge for delivering distance education through an LMS is the very recent emergence of the Google Classroom LMS system for management of classroom content assignments, blogging, discussion, upload and storage, sharing, et cetera within the K–12 school classroom context. This new system may necessitate using two systems for AT distance education, including both the university's LMS to manage the course, and a Google Classroom to emulating the digital classroom to demonstrate accessibility options available to students with disabilities.

CHALLENGES AND OPPORTUNITIES OF ASSISTIVE TECHNOLOGY IN DISTANCE EDUCATION DESIGN

Assistive technology (AT) is not defined by specific technologies, but by the degree to which any technology addresses the functional limitations of persons with disabilities. AT education is about the need to think about using technology "outside the box." The functional nature of AT and its technological transience yields three design factors.

The first design factor, technology scope and transience, requires continually refreshed illustration within the online course content; the examples of what constitutes AT are broad and evolve as technology and human ingenuity advance. The second factor, dynamic technology function, requires that illustrative content depict *how* AT provides compensatory benefit for a student. Text and still image, as might be used in a print or e-text, may be sufficient to show things that are actual devices for daily living and physical abilities, such as, wheelchair, stander, adapted cup, bathtub person lifter, etc., but are not sufficient to illustrate the dynamic function of devices, computer software, and mobile device apps that support sensory, cognitive, or academic functioning. Video is a better medium for designing this content, for example, a "day in the life" video of an adult with intellectual disabilities using AT to support his independent living throughout his apartment and community. Another alternative is dynamic simulation, for example, the opportunity to obtain the perspective of an individual with a visual impairment or disability, such as dyslexia. Dynamic content, however, can be transient and costly. Effective simulations have typically been created by vendors or professional organizations to provide a form of professional development (e.g., from the American Ophthalmological Association, a simulation of visual impairments) or by nonprofit educational organizations (e.g., from a public broadcasting station, a simulation of learning disabilities). The challenge is to continually check and evaluate whether such resources have been removed or abandoned by the creating agencies. The cost of dynamic content development for academic course instructors is prohibitive, especially in light of technology transience; the search for meaningful and well-made video and simulations becomes an ongoing process in course design.

The third factor, technology as problem solving, creates a need for "critical thinking" instruction and assessment. Online quizzes or exams, typically used for concept or fact-based information, can be extended to include brief, limited "application thinking about AT" items. However, course participants cannot fully understand how AT works by viewing descriptive illustrations alone; they must "interact" with the technology in learning activities. Course participants need to more deeply examine AT at three levels: retrospective, prospective, and reflective. Retrospective ("reverse engineering"): Why is a tool considered AT, i.e., what is its compensatory effect on the person's functioning? Prospective: How do I determine what AT a student needs? Reflective: How will this affect my teaching? To achieve this, the AT course design must exist as a blend of online lessons, online application activities, and guided interaction with AT in a classroom-lab setting.

For retrospective analysis, course participants complete an online activity in which they view high quality videos of preschool children using AT in everyday classroom activities and prepare a short essay describing and analyzing how AT supports physical performance in activities of daily living. Course participants describe and compare the physical activity and social interactions in a video of typically developing children engaging in common preschool activities with videos that show preschool students with disabilities using AT in similar preschool activities among typically developing preschooler peers. Participants then describe what the AT is and how it functions for the student to improve outcomes, how it provides compensatory benefit (why is it AT?) and how it affects the student's physical and social interaction with other preschool students.

For prospective analysis, a 2-hour in-class lab focuses on AT for personal technology uses: (a) small group analysis and large group reporting with immediate instructor feedback to examine "why is it AT?" with low cost, physical tools for personal management (e.g., pill boxes with built-in alarms, large print, and/or Braille, small, dedicated audio prompting devices, timers, specialized personal schedules; vibrating alarms, etc.); (b) individual creation of low cost, flexible, printed personalized visual supports using a word processing program and a commercial, specialized database of drawings; and (c) guided exploration of apps on tablets which provide the same functionality, but with increased access to customized digital images, and voice and video recordings personalized to the student.

For prospective and reflective analysis, in another online activity participants watch a video of an adult with cognitive disabilities using a variety of digital mobile and tablet-based apps and then complete blogs about their expectations for persons with cognitive disabilities and how they changed before and after viewing the video. Later, participants review the video and complete an assignment where they are asked to identify specific personal management functions of technology, and then blog about applications of their own smartphone or tablet apps that assist students with disabilities better manage their own time, events, tasks, and procedures.

IMPLEMENTING THE DISTANCE EDUCATION TECHNOLOGY ENVIRONMENT FOR AT COURSES

Challenges to implementing assistive technology (AT) instruction in distance education courses include the types of instructional activities needed (e.g., video, simulations, synchronous and asynchronous discussion, case study projects, direct AT interaction and use), the level of interaction with and evaluation of AT use (e.g., modeling and guided practice and direct assessment of technology "skills," including operation, function, etc.), and, to an extent, technology infrastructure issues accompanying online course delivery (e.g., Wi-Fi infrastructure, consumer bandwidth, multiple Internet browsers, support features of the browsers). I have used blended, or hybrid, instruction as the model of choice for AT instruction involving a multicomponent system of instructional technology (IT) to deliver the assistive technology courses to participants. This system consists of the instructional technology infrastructure and the design and sequencing of content to deliver the AT content and instructional activities.

INSTRUCTIONAL TECHNOLOGY INFRASTRUCTURE

The central technology used to design and deliver assistive technology instructional content at Illinois State University has been a learning management system based on Sakai software and development software to support the creation of web-delivered lessons (e.g., Softchalk). The web lessons for the AT knowledge content were initially developed as a series of "single idea or concept" screens that combined text with images, embedded audio, or links to external websites and video streaming servers, including both commercial and university-based, to create a dynamic information context. The content currently exists as a series of seven lessons each, consisting of 15–20 web pages, each page of which is designed to limit the need to minimally scroll down a page beyond what fits comfortably on a typical laptop screen. This web lesson software also supports the embedding of a variety brief self-assessment learning activities (e.g., crossword, sorting, timelines, flashcard, etc.) that create "active learning" opportunities among the screens and immediate reinforcement of content learning. The web content is housed on a university-owned web server. By keeping the web lesson content separate from the university LMS, creation, revision, and updating of the web-lessons can be accomplished more easily. Also, the web lessons themselves become learning objects available for use within multiple AT content-related courses via URL. In addition, the web lessons are "agnostic" in terms of their compatibility with various LMS, or to changes or updates to the existing LMS. Finally, the SEAT Center, a classroom-lab located on campus, is the final and integral element of the instructional technology AT infrastructure. In the blended course design used for these courses, direct interaction with assistive technology guided and modeled by the instructor is the only focus. All other announcements, including course "housekeeping," participant Q & A about the course or assignments, are addressed strictly through the online course environment.

Design and Sequencing of AT Information and Instructional Activities

A significant challenge with the implementation of the blended course design described here is the control and sequencing of content, activities, and assignments, including assignment deadlines. The sequence through which course participants complete instructional activities is important for the desired educational outcomes. The course is designed around a weekly course "learning cycle." A weekly module becomes visible each Monday morning. Within each weekly learning module, two initial sections provide learning objectives, as well as a set of key concepts and terms for that week. This is followed by a set of sections labeled as "tasks" with an appropriate extension: Task 1—Online Lesson; Task 2—Online Quiz; Task 3—Online Activity; and, where scheduled, Task 4—In-Class Activity. Such a design facilitates an organized, sequential, checklist approach to completion of instructional activities. Timely completion of the sequence of tasks is controlled by having the online quiz close one day (for example, Saturday at 11:00 P.M.) before the online application activity is due (Sunday at 11:55 P.M.), thereby creating more time for "careful consideration" of online activity. The in-class activity section includes an overview of the ATLab content and activities and links to any resources needed to complete the lab; follow-up assignments (e.g., a reflective blog); and instructions for saving digital "products" developed during the labs (e.g., worksheets, print-based tools, audio or video clips, etc.).

MOVING AHEAD WITH ASSISTIVE TECHNOLOGY CONTENT IN DISTANCE EDUCATION

Challenges and opportunities in preparing educators to use technology, including ICT, to instruct students with disabilities who may need assistive technology (AT) to access and succeed in both the life skills and academic curricula, arise from both the transience and intransigence found within AT content. This includes the school context for use of AT with students with disabilities, the school technology context, and the context of instructional technology (IT) to design and deliver distance education related to AT. We list some of these here.

Challenges

- *Technology Convergence*. With AT in particular, the pace of supplanting specially designed device + application systems with apps designed for personal computers or mobile devices is increasingly representing a challenge to content development, especially for a school context where mobile devices may not yet be integrated into or even prohibited from the classroom.
- *Technology Transience*. ICT, IT, and AT are transforming rapidly with new technologies advancing and replacing older technologies, increased universal design for persons with disabilities, and through consumer choices (e.g., text messaging vs. voice or e-mail, social networking choices) supplementing or supplanting each other (e.g, Facebook, Pinterest, Twitter, Instagram, and Snapchat). Transience presents significant challenges for refreshing AT content, for integrating research-based evidence of AT effectiveness, and for supporting recommendations for AT use in schools and classrooms. In addition, multiple device platforms, which perhaps represent a technological diversity, demand agnostic instruction in type of AT tool or practice. Course content design and delivery must account for both what is and is not emerging in AT and in the educational technology into which AT is integrated, including both course participant technology use and school technology implementation.
- *Technology Intransigence*. Slow school technology adoption timelines and competing school technology platforms (for example, Apple iOS and Google Android), adoption challenges content development, as does the ongoing presence of older AT systems, multiple apps that perform the same function, and multiple versions of the same app, and beliefs and attitudes toward technology. LMS intransigence challenges the ability to demonstrate principles of universal design and examples of accessibility features within the environment in which AT content is being delivered.
- *Technology Research*. Significant technological "strategies" (e.g., digital personal management, text-to-speech, writing by speech recognition) require validation of the effectiveness of the strategy but also more systematic evaluation of the technological variants found in apps. Future casting of technologies for persons with disabilities by government or nonprofit foundations, needed for distance and preK–12 educational planning, is seriously lacking.

Opportunities

- *Technology Convergence*. The emergence of the small number of operating systems supported by ubiquitous technology companies and, at least in the present context, a limited number of device types (i.e., small laptops and notebook computers, tablets, and smartphones) represent a stabilizing core infrastructure. This also presents economies of scale for schools and students with disabilities as affordable consumer market devices that can support both educational and AT apps at cost savings and increased availability.
- *Technology Transience.* The advancement of technology for persons with disabilities, despite, or perhaps because of, technology transience, is expanding. The time gap between what is needed and what is available and between what is specially designed for persons with disabilities and what is universally designed is rapidly decreasing. As noted, this presents a challenge for AT course content design, but it also simultaneously presents opportunities. Course participants have increasing access to their own or school district-supplied mobile devices; accessing universal design features or adding apps becomes increasingly possible and affordable, especially free versions. AT labs can therefore become more virtual, relying on tech-supported university classrooms only for more advanced or costly applications and devices.

SUMMARY AND UNANSWERED QUESTIONS

This article has proposed a blended model for AT distance education that employs web-based content, online assessment, and online application activities, combined with face-to-face classroom-lab activities, to deliver instruction. Online learning activities as well as AT labs are designed to reinforce conceptual and factual information, to develop attitudes and beliefs regarding AT, to provide experience in the process of AT consideration, and to engage participants directly with AT and its effects on educational outcomes. Online lessons, online applications (including videos, simulations, and reflections), and AT labs are systematically sequenced to move participants from information acquisition, then to application, to move toward practice and reflection about current and future practice. However, the assumptions and deductions underlying the appropriate AT course design and delivery require validation through qualitative or quantitative instructional research, addressing such questions as: Does this model indeed provide differences that are retained over other courses, such as special education instructional methods? What elements of these AT-centered courses can be effectively integrated into other general and special education courses, and to what effect? How do these AT-focused courses affect practice in the schools immediately or as preservice teachers enter the profession? Technology transience also creates instructional questions, including: How do we best prepare future and present teachers for transience? Does emphasizing type of tool and its function better prepare course participants for implementing AT practices in the schools as compared to focusing on specific tools (i.e., intentional funneling)? Future AT research should turn its particular attention to some of these questions in order to move the field forward in the most beneficial and useful ways.

NOTES

1. An Individualized Educational Plan is a personalized written plan that must be developed for each student with a disability who is eligible to receive special education services in the US public schools. It contains a statement of the students abilities and needs, instructional goals and objectives to meet those needs, statements of the type and amount of specialized instructional and related services that the student requires, and the individualized accommo-

dations and assistive technology that the student requires.

2. For example, using speech-to-text dictation, a student with learning disabilities can transcribe the draft for a five-paragraph persuasive essay at an acceptable level of spelling accuracy without actually writing or typing. Recent advances in medical technology have resulted in one change to defining AT.
3. Increasingly small "bionic," implantable medical devices (e.g., the cochlear implant to imp or rove auditory functioning) required clarification of medical device versus assistive device. As of 2004, IDEA excludes a medical device that is surgically implanted and the replacement of such a device (20 USC §1401(2)). However, schools retain some responsibility when such medical technology is used by students with disabilities. In adhering to the principle of FAPE, it has been established, as a result of federal court interpretation, that, while providing FAPE may not extend to the cost of medical "technology," such as respirators, tracheotomy devices, or cochlear implants, it does require that services not needing a doctor to perform but needed to support the use of the technology in the educational environment (e.g., cleaning and sterilization of a catheter, care of the tracheotomy device, maintenance of the cochlear implant settings, connections or batteries) is the responsibility of the school or district to provide at no cost to the child or family.
4. Under the Americans with Disabilities Act public agencies or any entity providing services to the general public (governmental, commerce, employment, housing, telecommunications, etc.) are held accountable for insuring free and equitable access and must use "reasonable accommodations," which include assistive technology. Unlike the previous Section 504 of the Rehabilitation Act of 1974 that prohibited discrimination on the basis of disability, ADA does not permit the cost of such reasonable accommodations to be used as an excuse not to provide them.
5. Typically, in such countries, implementation is top-down and has been criticized for being less effective as a model for individual change (Schreuer et al., 2014); despite this, the benefits of the use of AT have been highlighted for children with disabilities. For example in Finland, 77% of families with children with disabilities in urban areas reported receiving benefit from AT. In Denmark, with the highest reported levels of participation of children with disabilities in school and after school activities, advocates, the government, and the schools work closely to facilitate the implementation of AT (Wise, 2012).

REFERENCES

Allan, K. K., & Miller, M. S. (2005). *Literacy and learning in the content areas: Strategies for middle and secondary school teachers* (2nd ed.). Boston MA: Houghton Mifflin.

Almond, P., Winter, P., Cameto, R., Russell, M., Sato, E., Clarke-Midura, J., … Lazarus, S. (2010). Technology-enabled and universally designed assessment: Considering access in measuring the achievement of students with disabilities—A foundation for research. *Journal of Technology, Learning, and Assessment, 10*(5). Retrieved February 5, 2015, from http://ejournals.bc.edu/ojs/index.php/jtla/article/view/1605/1453

Anderson-Inman, L., & Horney, M., A. (2007). Supported eText: Assistive technology through text transformations. *Reading Research Quarterly, 42*(1), 153–160.

Anderson, R. C. (1985). *Becoming a nation of readers: The report of the Commission on Reading.* Prepared by Richard C. Anderson et al., with contributions from members of the Commission on Reading. Pittsburgh, PA: National Academy of Education.

Ayres, K. M., Mechling, L., & Sansosti, F. J. (2013). The use of mobile technologies to assist with life skills/independence of students with moderate/severe intellectual disability and/or autism spectrum disorders: Considerations for the future of school psychology. *Psychology in the Schools, 50*(3), 259–271. doi:10.1002/pits.21673

Aytac, B., & Wu, S. (2013). Characterization of demand for short life-cycle technology products. *Annals of Operations Research, 203*(1), 255–277. doi:10.1007/s10479-010-0771-5

Babbitt, C. W., Kahhat, R., Williams, E., & Babbitt, G. (2009). Evolution of product lifespan and implications for environmental assessment and management: A case study of personal computers in higher education. *Environmental Science & Technology, 43*(13), 5106–5112.

Bausch, M. E., Ault, M. J., Evmenova, A. S., & Behrmann, M. M. (2008). Going beyond AT devices: Are AT services being considered? *Journal of Special Education Technology, 23*(2), 1–16.

Bausch, M. E., & Hasselbring, T. S. (2004). Assistive technology: Are the necessary skills and knowledge being developed at the pre-service and in-service levels? *Teacher Education and Special Education, 27*(2), 97–104.

Bausch, M. E., Quinn, B. S., Chung, Y., Ault, M. J., & Behrmann, M. M. (2009). Assistive technology in the individualized education plan: Analysis of policies across ten states. *Journal of Special Education Leadership, 22*(1), 9–23.

Bechard, S., Sheinker, J., Abell, R., Barton, K., Burling, K., Camacho, C., … Tucker, B. (2010). Measuring cognition of students with disabilities using technology-enabled assessments: Recommendations for a national research agenda. *Journal of Technology, Learning, and Assessment, 10*(4). Retrieved February 5, 2015 from https://ejournals.bc.edu/ojs/index.php/jtla/article/view/1604/1454

Betts, K., Cohen, A. H., Veit, D. P., Alphin, H. C., Jr., Broadus, C., & Allen, D. (2013). Strategies to increase online student success for students with disabilities. *Journal of Asynchronous Learning Networks, 17*(3), 49–64.

Bolkan, J. (2014). Report: 6 trends pushing tech adoption in education. *T.H.E. Journal*. Retrieved from http://thejournal.com/articles/2014/06/25/report-6-trends-pushing-tech-adoption-in-education.aspx

Cavanagh, S. (2014). Industry officials weight strategies for print-to-digital conversion. *Education Week Blogs: Marketplace K-12*. Retrieved from http://blogs.edweek.org/edweek/marketplacek12/2014/06/publishers_plan_for_uneasy_print-to-digital_transition.html?print=1

Cihak, D. F., Kessler, K., & Alberto, P. A. (2008). Use of a handheld prompting system to transition independently through vocational tasks for students with moderate and severe intellectual disabilities. *Education and Training in Developmental Disabilities, 43*(1), 102–110.

Cihak, D. F., McMahon, D., Smith, C. C., Wright, R., & Gibbons, M. M. (2015). Teaching individuals with intellectual disability to email across multiple device platforms. *Research in Developmental Disabilities, 36*, 645–656. doi:10.1016/j.ridd.2014.10.044

Crawford, L., & Tindal, G. (2004). Effects of a read-aloud modification on a standardized reading test. *Exceptionality, 12*(2), 89–106.

Davies, D. K., Stock, S. E., & Wehmeyer, M. L. (2003). Application of computer simulation to teach ATM access to individuals with intellectual disabilities. *Education and Training in Developmental Disabilities, 38*(4), 451–456.

Davis, M. R. (2014). Assistive tech for testing merges into mainstream. *Education Week, 33*(25), 16–18.

De Joode, E., van Heugten, C., Verhey, F., & van Boxtel, M. (2010). Efficacy and usability of assistive technology for patients with cognitive deficits: A systematic review. *Clinical Rehabilitation, 24*, 701–714.

Educational technology: Catching on at last. (2013). *The Economist*. Retrieved from http://www.economist.com/node/21580136

Edyburn, D. L. (2000). Assistive technology and students with mild disabilities. *Focus on Exceptional Children, 32*(9), 1–24.

Fox, S. (2011). Americans living with disability and their technology profile. Retrieved from http://www.pewinternet.org/2011/01/21/americans-living-with-disability-and-their-technology-profile/

Gillespie, A., Best, C., & O'Neill, B. (2012). Cognitive function and assistive technology for cognition: A systematic review. *Journal of the International Neuropsychological Society, 18*, 1–19.

Herold, B. (2013). "1:X computing" aims to tailor digital tools to learning tasks. *Education Week, 33*(6). Retrieved from http://www.edweek.org/ew/articles/2013/10/02/06el-1x.h33.html

Herold, B. (2014a). Big districts pressure publishers on digital-content delivery. *Education Week, 34*(13), 1, 14–15.

Herold, B. (2014b). Chromebooks gaining popularity in school districts. *Education Week, 34*(12), 1, 10–12. Retrieved from http://www.edweek.org/ew/articles/2014/11/12/12chromebooks.h34.html

Herold, B. (2014c). Houston district leaders'' interoperability push sparks big reaction. *Education Week: Digital Education*. Retrieved from http://blogs.edweek.org/edweek/DigitalEducation/2014/12/houston_leaders_interoperability.html?qs=digital+content

Herold, B. (2014d). Research drives teacher training for digital reading. *Education Week, 33*(30), 24–

25. Retrieved from http://www.edweek.org/ew/articles/2014/05/07/30readingside.h33.html

Ketterlin-Geller, L. R., Yoyanoff, P., & Tindal, G. (2007). Developing a new paradigm for conducting research on accommodations in mathematics testing. *Exceptional Children, 73*(3), 331–347.

LoPresti, E., Mihailidis, A., & Kirsch, N. (2004). Assistive technology for cognitive rehabilitation: State of the art. *Neuropsychological Rehabilitation, 14*(1/2), 5–39.

MacArthur, C. A., & Cavalier, A. R. (2004). Dictation and speech recognition technology as test accommodations. *Exceptional Children, 71*(1), 43.

Mechling, L. C., Gast, D. L., & Fields, E. A. (2008). Evaluation of a portable DVD player and system of least prompts to self-prompt cooking task completion by young adults with moderate intellectual disabilities. *Journal of Special Education, 42*(3), 179–190.

National Commission on Writing. (2003). The neglected R: The need for a writing revolution. Retrieved from http://www.writingcommission.org/

National Commission on Writing. (2006). Writing and school reform. Retrieved from http://www.writingcommission.org/

NCTE Position Statement on Reading, 1998-2015. (2015). Retrieved from http://www.ncte.org/positions/statements/positiononreading

NMC Horizon Report: 2014 K-12 Edition Preview. (2014). Retrieved from http://cdn.nmc.org/media/2014-horizon-k12-preview.pdf

Norris, C., & Soloway, E. (2011). The 10 barriers to technology adoption. *District Administration, 47*(10), 92–92.

Parette, H. P., Peterson-Karlan, G. R., & Wojcik, B. W. (2005). The state of assistive technology services nationally and implications for future development. *Assistive Technology Outcomes and Benefits, 2*, 13–24.

Parette, H. P., Peterson-Karlan, G. R., & Wojcik, B. W. (2010). Assistive technology and educational practice. In P. Peterson, B. McGraw, & E. Baker (Eds.), *International encyclopedia of education* (3rd ed., pp. 537–543). Oxford, England: Elsevier.

Parette, H. P., Peterson-Karlan, G. R., Wojcik, B. W., & Bardi, N. (2007). Monitor that progress! Interpreting data trends for AT decision-making. *Teaching Exceptional Children, 40*(1), 22–29.

Parette, H. P., Wojcik, B. W., Peterson-Karlan, G. R., & Hourcade, J. J. (2005). Assistive technology for students with mild disabilities: What's cool and what's not. *Education and Training in Developmental Disabilities, 40*(3), 320–331.

Partnership for Assessment of Readiness for College and Careers (PARCC). (2013). PARCC accessibility features and accommodations manual 2013-14. Retrieved from http://www.parcconline.org/parcc-assessment-policies

Peterson-Karlan, G. R. (2011). Technology to support writing by students with learning and academic disabilities: Recent trends and findings. *Assistive Technology Outcomes and Benefits, 7*(1), 39–62.

Peterson-Karlan, G. R., Hourcade, J. J., & Parette, P. (2008). A review of assistive technology and writing skills for students with physical and educational disabilities. *Physical Disabilities: Education and Related Services, 26*(2), 13–32.

Peterson-Karlan, G. R., & Parette, H. P. (2008). Integrating technology into the curriculum. In H. P. Parette & G. R. Peterson-Karlan (Eds.), *Research-based and emerging best practices in developmental disabilities* (2nd ed., pp. 183–214). Austin, TX: Pro-Ed.

Ratliffe, K. T., Rao, K., Skouge, J. R., & Peter, J. (2012). Navigating the currents of change: Technology, inclusion, and access for people with disabilities in the Pacific. *Information Technology for Development, 18*(3), 209–225. doi:10.1080/02681102.2011.643207

Rose, D. H., & Meyer, A. (2002). *Teaching every student in the digital age: Universal design for learning*. Alexandria, VA: ASCD.

Samuels, C. A. (2013). PARCC field tests to lack some accommodations. *Education Week, 33*(11), 6.

Schreuer, N., Keter, A., & Sachs, D. (2014). Accessibility to information and communications technology for the social participation of youths with disabilities: A two-way street *Behavioral Sciences & The Law, 32*(1), 76–93.

Thurlow, M. L., Tindal, G., Powers, R., Lewis, P., Laitusis, C. C., & Breslin-Larson, J. (2007). Research on AT outcomes and large scale assessments. *Assistive Technology Outcomes and Benefits, 4*(1), 12-27.

Understanding the technology adoption curve in education. (n.d.). Retrieved February 12, 2015, from http://al.atomiclearning.com/curve

Van Laarhoven, T., Johnson, J. W., Van Laarhoven-Myers, T., Grider, K. L., & Grider, K. M. (2009). The effectiveness of using a video iPod as a prompting device in employment settings. *Journal of Behavioral Education, 18*(2), 119–141.

Van Laarhoven, T., Kraus, E., Karpman, K., Nizzi, R., & Valentino, J. (2010). A comparison of picture and video prompts to teach daily living skills to individuals with autism. *Focus on Autism & Other Developmental Disabilities, 25*(4), 195. doi:10.1177/1088357610380412

Vanderheiden, G., & National Council on Disability. (2006). Over the horizon: Potential impact of emerging trends in information and communication technology on disability policy and practice. Washington, DC: National Council on Disability.

Wise, P. H. (2012). Emerging technologies and their impact on disability. *Future of Children, 22*(1), 169–191.

Zickuhr, K., & Smaith, A. (2012). Digital differences. Retrieved from http://www.pewinternet.org/2012/04/13/digital-differences/