

Evidence-Based Practice and the Consideration of Assistive Technology Effectiveness and Outcomes

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Abstract: The legislative and policy background for evidence-based practice (EBP) is presented with implications for research on assistive technology (AT) research in general and for the AT consideration process specifically. Requirements for the development of research-based evidence of AT effectiveness are presented as a guide for researchers and developers of AT and for practitioners who use findings of AT effectiveness. EBP as part of decision-making guidelines for AT consideration are presented.

Key Words: Evidence-based practice, AT outcomes, AT decision-making

In today's educational environments, demands for evidence-based practice in assistive technology (AT) decision-making are being articulated with increasing frequency by administrators, policy-makers, researchers, and classroom practitioners (Dugan, Milbourne, Campbell, & Wilcox, 2004; Edyburn, 2003; Hill, 2006; Parette, Peterson-Karlan, & Wojcik, 2005). Owing in large part to legislative influences (i.e., The No Child Left Behind Act of 2001 [NCLB] and the Individuals with Disabilities Education Improvement Act of 2004 [IDEIA 2004]), the term 'evidence-based practice' has become almost ubiquitous in education circles (Detrich, Keyworth, & States, 2007).

NCLB requires that that educational interventions used to improve educational performance are based on scientifically-based research (Odom et al., 2005; U.S. Department of Education, 2003). Education professionals familiar with the legislation are aware that there are more than 100 references to 'research' noted in its text, communicating a clear intent to have school reform efforts focused on educational curricula, instructional strategies, and achievement that are based in research [§1114(B)(ii)]. Similarly, IDEIA 2004 requires that educational interventions with students having disabilities are scientifically-based instructional practices [118 Stat. 2650(B)].

For a decade now, it has been a mandate that AT be 'considered' in the development of the IEP of every student with a disability [20 U.S.C. 1401 § 614(B)(v)], and the use of AT has been implicitly linked to enhanced educational outcomes for students [§616(a)(2)(A)]. Moreover, in school settings, AT is an intervention in that it is applied not only to enhance or improve student access to educational opportunities but also to improve performance in the general education and life skills curricula (Peterson-Karlan & Parette, 2007). Thus, educational law and policy generated from these laws require that AT consideration be based upon evidence of AT effectiveness and that claims of effectiveness arise from scientifically-based research. This,

in turn, requires that we understand what evidence-based practice is, what constitutes an acceptable scientifically-based research claim, and how such evidence and research can inform the process of AT consideration and decision-making.

What is Evidence-Based Practice?

While an entire issue of *Exceptional Children* in 2005 was devoted to evidence-based approaches in special education, there is still no consensus regarding a definition of and guidelines for such practices (Detrich et al., 2007; Odom et al., 2005). As noted by Odom et al., numerous groups have developed standards for evidence-based practice, though there is no agreement across groups regarding the quantity or quality of evidence required. Recent compilations of evidence-based recommendations are observable in the health care industry

(HealthLinks, 2007; U.S. Department of Health and Human Services, n.d.), medicine (Wikipedia, 2007a), nursing (Beyea & Slattery, 2006; Malloch & Porter-O’Grady, 2006), counseling (Chwalisz, 2003), psychology (American Psychological Association, 2005), and early childhood special education (Smith et al., 2003; Strain & Dunlap, n.d.). These recommendations reflect both commonalities and differences in thinking about evidence-based practices.

Despite this seeming lack of clarity in what EBP might be conceptually, the U.S. Department of Education (2003) is clear in how evidence-based practice works. NCLB calls upon educational practitioners to use “scientifically-based research to guide their decisions about which interventions to implement” (U.S. Department of Education). Interventions are broadly conceptualized to include such things as reading and math

Table 1
Characteristics of Scientific Research from the Education Sciences Reform Act (P.L. 107-279)

Scientific research studies:

- Employ systematic, empirical methods that draw on observation or experiment;
- Involve data analyses that are adequate to support the general findings;
- Rely on measurements or observational methods that provide reliable data;
- **Make claims of causal relationships only in random assignment experiments** [emphasis added] or other designs (to the extent such designs substantially eliminate plausible competing explanations or competing results);
- Ensure that studies and methods are presented in sufficient detail and clarity to allow for replication, or at a minimum, to offer the opportunity to build systematically on the findings of the research;
- Use research designs and methods appropriate to the research question posed; and
- Obtain acceptance by a peer-reviewed journal or approval by a panel of experts through a comparably rigorous, objective, and scientific review.

curricula, school-wide reform programs, after-school programs, and technologies and are criticized for having claims to effectiveness that, while being supported by evidence, is based upon “poorly designed or advocacy-driven studies (U.S. Department of Education, 2003). While NCLB allows flexibility in the type of “reliable evidence of effectiveness” presented [115 Stat. 1597, §1502(B)], there is an emphasis on “rigorous” scientific evidence (U.S. Department of Education).

What Is Scientifically-Based Evidence?

Given its explicit connection to EBP, knowledge of the characteristics of scientifically-based research and methodologies used to produce it are needed by AT developers, researchers who investigate AT effectiveness, and practitioners who must now use EBP. The Education Sciences Reform Act of 2002 established standards for scientifically-based research that include (a) applying rigorous, systematic, and objective methodologies to obtain reliable and valid knowledge to education activities and programs; and (b) presenting findings and making claims that are appropriate to and supported by the methods that have been employed. Table 1 details the seven characteristics of research that would be considered to be rigorous, systematic, objective, and reliable. Noted in Table 1 (with emphasis added) is what has been referred to as the ‘gold standard’ for research design: the ‘random assignment experiment,’ also referred to as the ‘randomized controlled trial’ (RCT). The randomized controlled trial has been cited as being the highest standard for research in medicine, welfare, employment, and psychology (Odom et al., 2005; U.S. Department of Education, 2003). While “other designs” which “substantially eliminate plausible competing explanations for the obtained results” are permissible, the RCT has been emphatically promoted as one of two

key indicators of “strong evidence” of effectiveness with the second being trials showing effectiveness in two or more typical school settings, including a “setting similar to that of your schools/classrooms”(U.S. Department of Education) Randomized controlled trials are studies “that randomly assign individuals to an intervention group or to a control group, in order to measure the effects of the intervention” (U.S. Department of Education) This would mean, for example, that to determine the effectiveness of a text-to-speech (TTS) digital reader on text passage comprehension, a developer or researcher would need to (a) identify a large number of students with reading impairments at a particular grade level, and (b) randomly assign some in the same class to an intervention using the TTS technology, while others are might be assigned to an intervention in which someone reads the text to the student. This would be repeated across all the classes at that grade level having impaired readers. A lesser claim of “possible evidence of effectiveness” is also permitted when closely matched comparison groups are used in lieu of randomized assignment. A closely matched comparison group is created, for example, in the TTS technology study when students who have reading deficits from one or two classrooms, perhaps at one school, are assigned to the TTS intervention while others having the same degree of reading deficit from other classrooms, perhaps in another school, are assigned to the adult reader intervention.

Developing Claims for AT Outcomes and Benefits

It is obvious that these standards for scientifically-based research and claims of effectiveness have great impact upon what AT may be considered to be effective, how the evidence is a claim of AT effectiveness, and what would be included in AT decision-making consideration. There has not,

however, been total acceptance among special education researchers of one ‘gold standard’ research methodology (Odom et al., 2005). RCT addresses only one of three possible questions that can be addressed by research: (a) What is happening? (description); (b) Is there a systematic effect? (cause); and (c) Why or how is it happening? (process or mechanism; Odom, et al.). RCT is a method for determining effectiveness. The Council for Exceptional Children (CEC) Division for Research (as cited in Odom et al.) identified four different types of methodologies are needed to address these questions when developing and evaluating the effectiveness of intervention practices: (a) experimental group (of which RCT is a part); (b) correlational; (c) single-subject; and (d) qualitative. Subsequent work has established rationale, characteristics and standards for group and quasi-experimental (Gersten et al., 2005); single-subject (Horner et al., 2005); correlational (Thompson, Diamond, McWilliam, Snyder, & Snyder, 2005); and qualitative (Brantlinger, Jimenez, Klingner, Pugach, & Richardson, 2005) research methods. Space does not permit a full examination of the purpose served by each approach or the quality indicators associated with each; for further information the reader is referred to the individual articles cited here.

Multiple methodologies are needed, not just because there are multiple questions to be answered but also because research in special education, including AT development and research, is complex (Odom et al., 2005). Additionally, different types of research are needed as a field, such as AT, emerges and develops (Odom et al.).

Complexity of AT Research

Special education research has been characterized as the “hardest to do science given the local conditions that often limit generalization and theory building” (Berliner,

2002, p. 18). As with special education research in general, AT research is inherently complex including the (a) variability of participants (i.e., both types and severity of disabilities) in service settings [20 U.S.C. 1401; §602(3)]; and (b) educational contexts where interventions are to be provided [i.e., for whom an intervention is designed and in what context; Odom et al.; 118 Stat. 2657(29)]. The educational context issue is particularly problematic given that randomization and stratification (critical elements for RCT; Gersten et al., 2005; Mosteller & Boruch, 2002; U.S. Department of Education, 2003) may be difficult, if not impossible, due to heterogeneity of the student makeup in many special education classrooms. Also problematic are issues related to low prevalence rates for certain groups of students (e.g., physical, sensory, severe cognitive or multiple disabilities), and clustering of students in groups (i.e., classrooms may become the units for assignments vs. students; Detrich, 2006; Odom et al.).

Research examining AT development and effectiveness shares the complexities cited above. Methodology other than RCT may better address AT research needs. Carefully constructed single-subject designs employing individuals as their own controls and systematically replicating AT interventions across individuals and/or settings within the same experiment may be more feasible in producing systematic, objective, and reliable data regarding outcomes and benefits than RCT methodology. Designs including multiple baselines across individuals, activities, and settings; alternating treatment designs; and multiple probe designs among others have had a long history in special education research (Horner et al., 2005). Concurrent time series probe designs can produce objective and reliable data concerning long-term effectiveness of AT in supporting student educational progress (Smith, 2000). Such single-subject research designs have

been instruments of rigorous, scientific methodology for over 40 years (Horner et al., 2005) and conform to the characteristics of scientific research outlined in Table 1, with the single exception of RCT design.

Evidence-Based Practice and the Emergence of AT Research

AT development and research have developed over time; technologies, applications of technologies, and their implementation in service settings emerge over time in a logical progression from basic to small-scale applied research to large-scale demonstrations. And as noted above, not all research appropriately addresses the same questions. Descriptions of what is happening often precede demonstrations of (a) whether specific elements cause effects, and (b) how or why these effects occur, and (c) different methods for obtaining this evidence. Emerging fields such as AT use in the school settings may not be able to transition from case study to RCT research without intervening steps. Using science to improve educational or AT outcomes may actually be a continuum of research activities (Odom et al., 2005) which begins with preliminary ideas, hypotheses, observations, or descriptions, and then moves through classroom-based demonstration and design research, and finally culminates in RCT studies. None of these activities is sufficient in the absence of others; all may be necessary for a research-based knowledge base to develop that informs educational practice. In the early stage of description and exploration of specific AT technologies, qualitative research, for example, can be used to describe what is happening when individuals with disabilities, their families, or their educational professionals (a) select and use AT; (b) examine attitudes, opinions, and beliefs about AT consideration, selection and use of AT; or (c) examine personal reactions to types of AT and AT-supported interventions (Thompson

et al., 2005). Single-subject research, as described above, especially systematic replications of AT-supported interventions, can provide evidence of AT effectiveness or efficiency in school and community applications while replications across disabilities which differ in important ways (e.g., autism spectrum disorders, cognitive impairments, learning disabilities) provide evidence of the generalizability of AT outcomes.

In summary, it is argued here that, while scientifically-based research is certainly requisite to the development of evidence-based practice, there are methods other than RCT that can provide reliable, valid descriptions of AT (or AT-supported) interventions, examinations of effectiveness, and consideration of how they are effective. For AT developers and researchers, reliable, replicable qualitative, single-subject, or quasi-experimental research with carefully determined dependent variables and consistency of intervention should be used to generate evidence-based practice that is published in peer-reviewed journals such as *ATOB*. Case studies and building- or district-based evaluations of AT effectiveness lacking these characteristics, while initially serving a helpful purpose, cannot be used as standard for evidence-based practice in a maturing field. For educational professionals and families, awareness of the need for evidence-based practice, knowledge of the characteristics of appropriate evidence-based practice, and application of scientifically-based research to AT consideration, selection, and implementation are important goals for professional development and family education.

Evidence-Based Practice and AT Decision-Making Practices: Outcomes and Benefits

Though special education practitioners express interest in evidence-based practices (CEC, 2007), such interventions are used relatively infrequently in classroom settings (Kratochill, Albers, & Shernoff, 2004; Odom et al., 2005) with little guidance being provided to assist families and professionals in choosing among available interventions (Detrich, 2006). Admittedly, the complexity of such guidance is laden with a plethora of embedded issues discussed above regarding the variability of participants and educational contexts

While the debate about evidence-based practice continues, there are still glaring issues about the implementation of such practices by education professionals. Detrich et al. (2007) suggested that there are four pressing EBP implementation issues. These include (a) effective and accessible dissemination of interventions, (b) selection of interventions, (c) initial implementation, and (d) sustainability. Each of these issues is discussed briefly in the following section.

Effective and Accessible Dissemination of Interventions

Given that many researchers in the field of AT are often aligned with university settings, publication in peer-reviewed journals is viewed as a valued and primary venue for the dissemination of knowledge, particularly evidence-based findings. However, these venues may not be an effective dissemination strategy for decision makers (Detrich et al., 2007). Unfortunately, the very nature of the research process is so intensive that findings from a body of work are frequently

distributed across multiple journals. Sometimes these journals are in related discipline databases such that searches in one source (e.g., Psych Info or Academic Search Premier) do not necessarily identify citations of archived peer-reviewed publications archived in other databases (e.g., Social Sciences Abstracts, ERIC EBSCO). Even more perplexing is that the lack of accessibility of peer-reviewed publications is constrained by subscriptions to online journals (i.e., one cannot access the article without subscription or payment for the article). This is complicated even further by the lack of training in conducting searches of varying databases where evidence-based publications may be archived, coupled with lack of training in how to evaluate primary source data reported in the articles (Detrich et al.). Finally, time constraints on the part of decision-makers in intervention settings may be such that reading professional journals is a low priority activity.

To meet the needs of the practitioner for accessible evidence-based practice, a number of Web-based resources have emerged. Table 2 provides a listing of sites and their URLs which provide professionals, consumers, and students with organized information regarding evidence-based practices. Users of such sites must still be aware of and knowledgeable about the difference between summaries of areas of research and summaries of the research itself and the differences in research which has been peer-reviewed and that which has not. For example, LD OnLine (<http://www.ldonline.org/>) contains both summaries of articles which have undergone expert examination (peer review) and those that have not. Peer review assures that there has been evaluation of the reliability of the evidence, the integrity of the treatments or interventions, and the validity of the research claims.

Table 2
Web-Based Resources Disseminating Information on Research-Based Practices

Site	URL
What Works Clearinghouse	http://ies.ed.gov/ncee/wwc
Center for Implementing Technology in Education (CITEd)	http://www.cited.org
National Center for Technology Innovation (NCTI)	http://www.nationaltechcenter.org
Tech Matrix	http://www.techmatreix.org
Center for Evidence-Based Practice: Young Children with Challenging Behavior	http://challengingbehavior.fmhi.usf.edu/resources.html
National Early Childhood Technical Assistance Center	http://www.nectac.org/topics/evbased/evbased.asp

Selection of Interventions

Researchers have noted that systems influences impact assistive technology decision making (Parette, 1991; Parette, Brotherson, & Huer, 2000; Parette, Huer, & Brotherson, 2001). Such influences as cost, expert opinion, individual preferences (based on experiences with particular devices), and the effort associated with systems change exert powerful influences on decisions regarding selections of specific interventions. While these influences are indeed practical reality, they are valid criteria only to the extent that they are applied to a range of possible AT solutions for which evidence of effectiveness has been established through scientifically-based research. One might correctly question a decision to provide a student with a preferred, less costly, or readily available AT tool (for which little valid research information is available) in lieu of one that is less preferred, more costly, or which must be

obtained (but for which evidence of AT benefit has been established by an even small body of research studies). Thus, professionals and families must become consumers of evidence of effectiveness when selecting AT during a consideration process and either seek this information themselves or require vendors to provide such information upon request.

Initial Implementation

In making decisions regarding a particular intervention, the question must be asked, “What is necessary to gain practitioner support?” (Detrich et al., 2007). This may present a dilemma in the decision-making process since one’s previous training and experiences may suggest a particular choice of intervention, though pragmatics of implementing the decision with practitioners may result in a very different choice. Decision-makers are often confronted with

the challenging issue of how to effectively train practitioners. It has been recognized that a broad base of competently trained AT practitioners is needed in the field (Parette et al., 2005; Parette, Peterson-Karlan, Smith, Gray, & Silver-Pacuilla, 2006). However, developing such a broad base of effectively trained practitioners is more problematic as there is little guidance for the field. An especially thorny concern is ensuring the fidelity of implementation of evidence-based findings (Odom et al., 2005). If fidelity of implementation is absent (i.e., the specific procedures reported in an evidence-based report of an AT-supported intervention are not followed), unknown effects may be anticipated from what becomes, in essence, an unknown intervention (Detrich et al.).

All too often, decision makers must examine available evidence-based practice reports and decide if the reported intervention can be adapted to meet local circumstances. Detrich et al. (2007) described two inherent dangers when such decisions are to be made. First, if the intervention is changed too much, what is implemented is a different intervention for which there are no data. Second, if the intervention is not modified to accommodate local circumstances, it may not be implemented at all.

Sustainability

Sustainability is defined as “a characteristic of a process or state that can be maintained at a certain level indefinitely” (Wikipedia, 2007b). Detrich et al. (2007) suggest that sustainable programs (a) maintain over time, (b) maintain across generations of practitioners, and (c) are supported with existing resources of system. Wikipedia also notes that sustainability “focuses on providing the *best outcomes* [emphasis added] for both the human and natural environments now, and into the indefinite future.” Unfortunately, evidence-based interventions that are not sustainable

run the risk of being replaced with alternative, ineffective practices. A corollary, then, is that the larger the scale of implementation required of a particular system, the more complex and potentially unsustainable these issues become (Detrich et al.).

Summary

As CEC (2007b) has noted, evidence-based practice, while wanted and needed, is hard to find. In the absence of randomized controlled trials with large numbers of students with disabilities of AT-supported interventions, the consideration, selection, and implementation of AT in school and community settings will need to depend upon AT developers and researchers providing systematic, objective, and reliable data regarding outcomes and benefits based upon research methods appropriate to the participant, context, and evaluation questions. AT developers and researchers will, in turn, depend upon educational professionals and families of students with disabilities who have been informed of the characteristics of valid research and are committed to asking for and using it in AT decision-making. Finally, information technologies will need to be developed and/or sustained to insure access to such information by educational and family consumers.

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