

A Research Agenda for Assistive Technology Used by Students with Visual Impairments

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Abstract

Assistive technology for individuals with visual impairments has long provided the equalizing effect for which it was intended. Due to federal mandates for the use of scientifically-based interventions for students with disabilities, the question of whether specific assistive technologies are effective in learning has surfaced. The purpose of this research synthesis was to determine the status of scientifically-based interventions related to assistive technology for students with visual impairments. Using a rigorous methodology to locate and analyze the research literature, the synthesis found 397 articles between 1965 and May 2013 that focused on assistive technology within the educational framework. These articles were organized into nine distinct categories. Three categories focus on "research" considered rigorous by the What Works Clearinghouse and the CEC Division for Research standards. Further analysis found that 98 articles fell into these three categories with the majority being descriptive, correlational, and quasi-experimental (N=66, 67%). A subset of articles included single-subject (N=4) and qualitative studies (N=24, 25%). Four articles that met the "golden standard" of experimental research as determined by the What Works Clearinghouse standards. There was evidence that the literature on AT for students with visual impairments is growing with many of these newer articles using stronger methodologies.

Keywords

Assistive technology, visual impairments, blindness, research

Introduction

Technology has always had great potential to have a positive impact. For students with disabilities, the use of specialized technologies has assisted these students participate in education at all levels. Specifically for students with visual impairments, assistive technology devices have provided students with a means to overcome the major obstacles attributed to their disability. Assistive technology (AT) provides equal access to information (in digital and print). It provides resources for independent travel in multiple environments. The examples are limitless. Thus, AT is the "great equalizer" for students with disabilities, especially those with visual impairments.

While there is great promise for AT within education, there is little known about the effectiveness of specific devices on learning. Until recently, most AT was deemed to be effective in educational environments based on either anecdotal evidence, solutions to obvious challenges (providing basic access), or because there were well-known practical applications such as enlarging images on a screen, reading email messages, and money management. Compounding the overall belief that technology improves education is the fact that technology innovation progresses at such a fast pace that it is quite challenging for researchers to test the effectiveness of the technologies in authentic, educational environments.

However, the overall philosophy towards educational research of assistive technology has radically changed recently. Because of the Individuals with Disabilities Improvement Act (P.L. 108-446), Individualized Education Program (IEP) teams are not only directed to discuss the needs for assistive technology devices (as mandated in the 1997 Amendments to IDEA), but to focus on using "research-based interventions" (§1411(e)(2)(C)(xi)). Since AT is considered part of a student's supplementary aids and services, then the inclusion of AT in a student's IEP must

be "based on peer-reviewed research to the extent practicable to be provided to the child" (§1414(b)(6)(B)). With federal law mandating the use of research to make decisions, the need for high-quality research on AT has been elevated.

Since AT cannot be deemed effective in education based solely on anecdotal evidence, the logical first step is to conduct a thorough synthesis of the research literature on educational impact of AT. Therefore, the goal of this research synthesis is to review the research literature on AT for students with visual impairments in order to fulfill the following objectives.

Methodology

This synthesis is a combination of a previously reported synthesis (Kelly and Smith) with a replication of research beyond the scope of the first study. The first study analyzed the research literature within this topic area from January 1965 through August 2009 (Kelly and Smith). The replication study of the original study reviewed the literature during the most recent time period of September 2009 through May 2013 (Smith and Kelly). The resulting "unified" research synthesis encompasses the entire time period from 1965 to May 2013 continuously.

As with any study, definitions of terms needed to be developed to narrow the scope of the research.

- Assistive technology (devices) are "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" (IDEA, 1997, Sec. 602, 20 USC 1401, § 300.5).
- Classroom-based interventions: AT devices and software that provide students with visual impairments access to the common core curriculum and direct instruction in areas of the expanded core curriculum within school classrooms. The study included

studies that a) focused on the use of assistive technology for classroom-based education and b) included participants with blindness or low vision, regardless of co-occurring disabilities, between the ages of 3 and 21 years. The methodology excluded studies that focused on the use of AT “for orientation and mobility, independent living, or augmentative and alternative communication” (Kelly and Smith 39).

- Evidence-based research: the use of scientific research to establish best practices determine by an evaluation of the research.
- Scientific-based research: a research design that determines with the highest degree of probability whether an intervention was the factor that cause the effects. The study used the criteria used by the What Works Clearinghouse as well as the CEC Division for Research standards for scientific-based research across methodologies.
- Effective was defined as "having a positive impact on education" and effectiveness was defined as "the degree to which assistive technology had a positive impact on educational performance" (Kelly and Smith 74).

Five electronic databases were searched using the Boolean search method: EBSCO Education Full-Text, ERIC, Proquest Education Journals, Psychinfo, and Psych Articles. To define the search, the Boolean operator "and" was used while the "not" operator was used to exclude specific terms outside the purview of this study. Articles were retrieved if they included the search terms specified and none of the excluded terms. To see the entire list of terms, refer to Kelly and Smith and Smith and Kelly.

An ancestral search using the same parameters was conducted with the articles retrieved from the database search. A manual search for articles related to the assistive technology topic of interest was also implemented on The *Journal of Visual Impairments & Blindness (JVIB)*,

Insight: Research and Practice in Visual Impairment and Blindness (named *AER Journal: Research and Practice in Visual Impairment and Blindness* prior to 2011), *the Journal of Blindness Innovation and Research (JBIR)* and *the British Journal of Visual Impairment*. The final step in the search process was to examine the reference lists of all articles. The reference lists were searched and additional articles that met the general search criteria were retrieved (Kelly and Smith 76).

All of the articles that were included through the exhaustive search procedures met the general criteria for inclusion in this analysis, and any that did not were excluded. The articles identified for inclusion in the study were classified into the same nine distinct categories Kelly and Smith (76) used to present the results of the synthesis of the AT literature from earlier time periods. Then the articles that utilized a research methodology (experimental, correlational, descriptive, single-subject, and qualitative) were categorized further using the Council for Exceptional Children Division for Research conceptual groupings for evidence-based research. For further clarification within the replication of this classification system, research articles were specifically identified along with any research articles that were single-subject design or case studies.

Discussion

The literature review synthesis of AT used for educational interventions for students with visual impairments encompassed 48 years. During that time, there were a total of 397 articles that met the criteria for inclusion for analysis. Between 1965-2009, there were 256 while the 2009-2013 time period had a total of 141 articles. As seen in Figure 1, there has been a gradual trend upward the majority of the articles published after 1980. Between 1980 and 1989, the average number of articles published on AT for students with visual impairments was 4 articles

per year. However, publication of AT articles began to trend upward beginning in 1990. In the 1990's, the average article published per year went up to 6.4 article per year with peaks of 10 (1990) and 12 (1999). The first decade in the new millennia (2000-2009) found a sharp increase with 15.1 articles being published per year with a peak of 27 in 2005. The trend continued upward after 2009 with the average between 2010-2012 being 39.3 articles per year with a peak of 61 in 2012. Please note that 2013 was purposely removed from this analysis as it was only part of a year, but it has 16 articles published in five months.

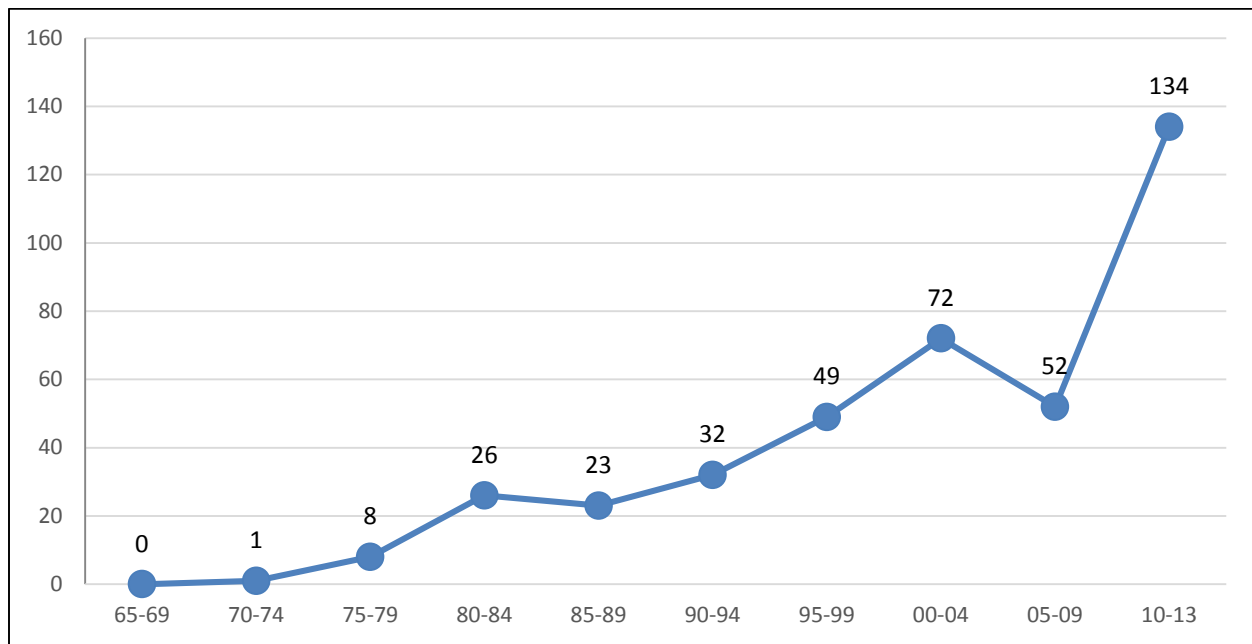


Fig. 1. Number of Articles on AT for Individuals with VI Published (5 year bands).

Closer scrutiny of the Figure 1 within the historical context related to technology provides insight into the reasons for these trends. Between 1965 and 1979, there were a total of eight articles published and four of those were in 1979 alone. The early 1980's saw the advent of the personal computer within education along with advancements in electronic devices. In the early 1990's, another spike in seen in articles published as computers became more sophisticated,

more inexpensive, and the internet was starting to blossom. Major strides in technology took place in the early 2000's with the invention of iOS products (the iPod was released in 2001), smartphones, tablets, Bluetooth-enabled devices, increased wireless internet connectivity, and overall increases in inexpensive technologies that are "universally-designed".

Deeper analysis of the 397 articles finds some major themes regarding the type of research methodology utilized and the rigor of the research. The 397 articles were separated into nine distinct categories (see Kelly and Smith; Smith and Kelly). Of these nine categories, only six used a methodology that met the standards for evidence-based research established by the CEC Division for Research. Due to space limitations, these three categories will be synthesized. Within these three **research** categories, there were a total of 98 articles from 1965 to May 2013 (25%). For a full listing and analysis of all the categories, see Kelly & Smith and Smith & Kelly.

Qualitative Research Design

Qualitative research attempts to gather a deep understanding of behavior and determine the undergirding reasons for the behavior (Shank 12). In these reviews, 24 articles (6% overall, 25% of all **research** articles) were categorized as qualitative research, including multiple case studies. There was a wide range of topics and distinct methodologies used in these 24 studies. Interventions included technology such as audio recordings, vision aids, videophones, screen readers, magnifiers, iPads, and other high-tech to low-tech devices. The types of studies and the participants varied across the studies, thus each study must be reviewed independently to determine if the intervention may have potential for positive educational intervention for students

Quasi-experimental, Correlational, or Single-subject Designs

Twenty-four articles were categorized as having a research design or method that did not include an intervention, control group, and comparison group. The majority of these articles were

correlational studies that used large data sets (such as the NLST2) or quasi-experimental studies that did not follow the rigorous standards of the What Works Clearinghouse. Five articles (1.2% of all articles or 5% of all **research** articles) were classified as single-subject research studies.

The single-subject research included a research design or method that demonstrated experimental control within a single participant or small group of participants (Kennedy 19). For low incidence populations such as visual impairments, single-subject designed studies are a mechanism to complete rigorous studies on individual or small groups of students with similar visual impairments. The five studies used different types of single-subject designs, but all consistently focused on the impact of assistive technology.

Experimental Group Design

Four of the 98 research studies (1.5% of all articles or 4% of all **research** articles) used experimental design as defined by the What Works Clearinghouse to research the effectiveness of using AT. There were only four studies identified by the analysis that included a research design with sufficient data to determine the effectiveness of an intervention with an intervention, control group, and comparison group (LaGrow; Koenig & Ashcroft; Kapperman, Sticken, & Smith, "The Effectiveness of the Nemeth Code Tutorial" and "A Follow-Up Study"). LaGrow examined how reading rates were affected by the use of a video magnifier. Reading rates were positively impacted when a video magnifier was used. Koenig and Ashcroft assessed how writing rates and accuracy were affected by the use of an electronic Perkins Braille. There were no significant differences when the electronic and regular Perkins Braille was used.

Kapperman et al. ("A Follow-Up Study") was a replication, follow-up, and continuation of the original study by Kapperman et al. ("The Effectiveness of the Nemeth Code") that evaluated the long-term effectiveness of the intervention. In both instances by Kapperman et al.,

the studies evaluated the effectiveness of a tutorial installed on a BrailleNote for learning the Nemeth Code of braille mathematics notation. Each of the two Kapperman studies showed that treatment groups had significantly greater growth in both math reading and math writing than the control group. These two experimental studies identified by this exhaustive review of the literature documented the effectiveness of assistive technology designed specifically to help braille students learn Nemeth math symbols.

Conclusions

This research synthesis set out to determine a baseline of understanding of scientifically-based research on AT for students with visual impairments within the educational context. The synthesis located 397 articles that were published between 1965 and May 2013. Of those 397 articles, only 98 were determined to fall within a "research category" (single-subject, qualitative, descriptive, correlational, quasi-experimental, or experimental). Of the remaining 299 articles, 215 (72%) were articles that did not have a research design or method (product reviews, theoretical articles) and the remaining 82 (28%) had validity issues (insufficient data reported, issues with participants, etc.).

While there were only four articles that met the highly rigorous standards for experimental design as defined by the What Works Clearinghouse, this research did shed light upon some positive movements within the field. First, the sheer number of published articles has grown over time even with the challenges of conducting AT research. Beyond the increase of numbers of articles published, types of research that uses research methodologies is increasing. The use of single-subject designs and rigorous qualitative methods are slowly building a foundation of research to build upon. As the field continues to evolve, it can be hoped that

researchers, practitioners, and AT developers will work more collaboratively to develop and research AT innovations for students with visual impairments.

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