Use of Assistive Technology by Students with Visual Impairments: Findings from a National Survey

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Abstract: This study investigated the use of assistive technology by students in the United States who are visually impaired through a secondary analysis of a nationally representative database. It found that the majority of students were not using assistive technology. Implications for interventions and potential changes in policy or practice are discussed.

Anecdotal evidence and preliminary small-scale research suggest that primary and secondary students who are visually impaired (that is, those who are blind or have low vision) across the United States are not being trained to use assistive technology in public schools to the extent that many professionals assume. The majority of students who are visually impaired attend the same regular public schools, sit in the same classrooms, and have the same teachers as do their sighted counterparts (American Foundation for the Blind, AFB, 2005) and thus are included in regular education as is prescribed by the law. Frequently, however, the textbooks read by sighted students are not available to their classmates who are visually impaired—in braille, large print, or audio form. Smith, Geruschat, and Huebner (2004) found a consistent delay in the delivery of materials to students who use large print or braille materials even though the Individuals with Disabilities Education Act mandates equal and timely access to all information presented in school for all students.

The presentation of less accessible information to students who are visually impaired is both regrettable and avoidable, given the assistive technology that exists today. For example, it is possible for children who are visually impaired to access much of the information presented in school to students who are sighted by using computers that have special software that enables the computers to read aloud or enlarge information that is displayed on the computer screen. Students who are visually impaired can use their computers to listen to or enlarge text-based classroom materials.

Unfortunately, it appears that many students who are visually impaired have yet to benefit from using assistive technology (Abner & Lahm, 2002) even though the assistive technology market is flourishing with devices and software that make the visual world significantly more accessible to individuals with visual impairments. A survey of the use of assistive technology by primary and secondary students with visual impairments in Illinois demonstrated that these students are not receiving the experience they need with assistive technology (Kapperman, Sticken, &

Heinze, 2002). The findings referred exclusively to academic students with visual impairments who read braille or large print and, therefore, were exceptionally inclined to benefit from assistive technology training. As Kapperman et al. noted, "60% of the students who, in the authors' judgment, could benefit from the use of assistive technology were not given the opportunity to use it" (p. 107). It is possible that the situation in Illinois was not different from the situation in other states.

The study

The study presented here investigated the extent to which U.S. students who are visually impaired use assistive technology, the change in the use of assistive technology as time progressed, and several predictor variables that may have played a role in the use of assistive technology. According to the Assistive Technology Act of 1998 (Section 3), assistive technology is any item or equipment that is either acquired commercially or is custom-made that is used to improve or maintain functional capabilities of people who have disabilities. For the purpose of this study, the term *assistive technology* refers exclusively to the high-tech, state-of-the-art assistive technology, such as text-to-speech devices and computer screen-enlargement software, that is used by people who are blind or have low vision. The predictor variables were seemingly salient contextual factors and included measures of mathematics ability, parental involvement, school placement, and school environment.

Variables

Mathematics ability

The measure of mathematics ability assessed whether the difference in grade and mathematics level for elementary and middle school students with visual impairments could be attributed to the use of assistive technology. Students with visual impairments often have problems accessing spatial and visual information presented in mathematics education without the use of assistive technology tools (Dick & Kubiak, 1997). Assistive technology can make inaccessible information, such as three-dimensional and nonlinear illustrations, accessible to these students (Cahill, Linehan, McCarthy, Bormans, & Engelen, 1996) and allow them to master the mathematical skills they have the intellectual capability to learn (Rapp & Rapp, 1992). Mathematics is a context in which the use of assistive technology tools makes otherwise inaccessible visual information meaningful to students who are blind or have low vision and was, therefore, of particular interest for the purpose of the study.

Parental involvement

The use of assistive technology was further examined according to parents' involvement in support networks for families of children with disabilities. A frequently reported benefit of various types of parent-to-parent support groups is informational support (Singer et al., 1999). Parents who reported involvement in support networks for parents of students with disabilities explained the merit of finding, helping, and being helped by others in the same situation (Hancock, Wilgosh, & McDonald, 1990). Parental involvement was assessed as a predictor of the use of assistive technology.

School placement

School placement was examined to address the relationship between the types

of delivery of special education services for children with visual impairments and the use of assistive technology that was documented in the literature. For example, the aforementioned survey of teachers in Illinois showed that "a greater percentage of students (66.3%) used assistive technology in nonitinerant placements ($r = .541$, $p < .001$), or fewer students (27.0%) in itinerant placements used assistive technology" (Kapperman et al., 2002, p. 107). School placement in the Illinois survey referred to the types of service delivery as itinerant, resource, resource or itinerant, or self-contained. Since the majority of students who are visually impaired attend their local neighborhood schools and receive services related to their visual loss from itinerant teachers of children with visual impairments, these results were particularly significant and of interest in the present study.

School environment

The teacher-reported measure of school environment was analyzed to evaluate if the use of assistive technology with students who are visually impaired was an example of an educational experience that was characteristic of schools with more supportive school environments. *School environment* refers to the attitudes, feelings, and behaviors of students and faculty within school systems (Hernandez & Seem, 2004). More supportive school environments are necessary for successful educational experiences and preparations for life beyond school (Noonan, 2004). The use of assistive technology with students who are visually impaired is an example of an educational experience that may be characteristic of schools with more supportive school environments.

Research questions

Data from the Special Education Elementary Longitudinal Study (SEELS, 2003), a large, nationally representative data set, were considered to evaluate the use of assistive technology by students who are visually impaired. The following four research questions were assessed:

1. With regard to academic elementary and middle school students with visual impairments in the United States who read large print or braille and, therefore, were most inclined to have benefited from the use of assistive technology with academic materials, what percentage were using assistive technology during the three measured periods in the 2000–01, 2001–02, and 2003–04 academic years?
2. How did the prevalence of the use of assistive technology by students with visual impairments change as time progressed?
3. How did the trajectories of the use of assistive technology vary according to mathematics ability and parental involvement?
4. How did the trajectories of the use of assistive technology vary according to school placement and school environment?

Method

Source of data

This study was a secondary analysis of pertinent variables from SEELS, a child-focused, large-scale national policy survey that was conducted from 1999 to 2004. The survey was part of a series of seven national assessments commissioned by the Office of Special Education

Programs of the U.S. Department of Education that collectively formed the first national examination of the progress of students who were receiving special education from birth to age 21. SEELS was one of the three child outcomes studies undertaken by SRI International (Godard et al., 2007), and SRI International was the institution that was granted institutional review board approval for the original SEELS data collection.

The SEELS database has the unique capacity to investigate some of the most pertinent survey questions from the perspective of parents, school professionals, and students, since the questions applied to students aged 6–12. As the students made transitions from elementary to middle school during the five-year span of the survey, they were observed in three waves of multi-instrument data collection (Godard et al., 2007). Sampling methods ensured that the cases selected were representative of the population of U.S. special education students as well as each age cohort and disability category. The primary sampling unit from which a stratified random sample of students receiving special education was taken included 245 local educational agencies and 35 state-supported special schools (Godard et al., 2007).

Participants

The same sample of students was observed in three waves of data collection during the five-year data collection period. The data collection for Wave 1 occurred during the 2000–01 academic year, the data collection for Wave 2 occurred during the 2001–02 academic year, and the data collection for Wave 3 occurred during the 2003–04 academic year. During the first data collection period, students were any age between 6 and 12 and in any grade between the first and seventh. Students aged four years between the first and last data collection periods.

Research Question 1 pertained exclusively to academic students with visual impairments who read large print or braille and, therefore, were most inclined to benefit from the use of assistive technology with academic materials. The framework for this question is the same notion that Kapperman et al. (2002) used "to determine the level of use of assistive technology among students with visual impairments (K–12) in Illinois who are academic readers and thus, in the authors' estimation, could benefit from training in assistive technology" (p. 106). Kapperman et al. assumed that academic students with visual impairments were most inclined to benefit from the use of assistive technology. Research Question 1 followed the same assumption and examined the use of assistive technology with students with visual impairments who were generally without other more severely disabling conditions.

Braille readers were identified as students with visual impairments who used braille to read, as reported by their parents in the parent interviews. Parents who reported that their children had a visual disability were also asked the following yes-or-no oral survey question: "Does your child use braille?" This measure was used to identify the participants included in Research Question 1.

Large-print readers were identified as students with visual impairments who used large print to read as reported by their parents in the parent interviews.

Parents who reported that their children had a visual impairment were also asked the following yes-or-no oral survey question: "Does your child use large print?" This measure was also used to identify the participants included in Research Question 1.

Thus, Research Question 1 examined the use of assistive technology by students with visual impairments who read large print or braille during each of the three waves of data collection. Normalized weights were used to account for sample selection biases. Thus, 98 students from Wave 1, 114 students from Wave 2, and 85 students from Wave 3 were included in the analysis of Research Question 1.

Research Questions 2, 3, and 4 pertained to a less restrictive sample of students with visual impairments that allowed for an even more substantial sample size necessary for effective multilevel modeling. The measures that identified academic students were not involved in the sample selection for participants who were included in these research questions. Therefore, the use of assistive technology was assessed in these research questions as it pertained to a nationally representative sample of students who were visually impaired with and without other more severely disabling conditions.

The participants who were included in Research Questions 2, 3, and 4 were derived from the same Level 1 and Level 2 samples. Thus, 835 students were included in the Level 1 model and 516 students were included in the Level 2 model who were assessed by the three multilevel modeling research questions.

Data measures

The data that were included in the study were reported by schoolteachers, coordinators, principals, and parents of children with disabilities during either a scripted telephone interview or a mail survey. Teachers of children with visual impairments were included in the sample of teacher-reported measures. The respondents were asked a series of selected-response type questions.

The parents reported on their childrens' use of assistive technology, such as text-to-speech devices or software that enlarges the size of print on the computer screen, in the parent interviews. Parents who confirmed that their children had a visual impairment were also asked the following yes-or-no oral survey question: "Does your child use assistive technology, such as a text-to-speech device or software, to enlarge the size of the print on the computer screen?" The part of this question that refers to text-to-speech devices or screen-enlargement software was included as an example of the high-tech assistive technology of interest in this particular survey question, as well as a more particular example of assistive technology for those who may not have been as familiar with the terminology.

Mathematics ability was the continuous time-varying covariate measured by the discrepancy between a child's grade level and mathematics level. This measure of mathematics ability was computed by subtracting the child's grade level at the time of direct-assessment testing from the child's estimated mathematics grade level provided on the teacher questionnaire. The child's grade level at the time of the direct assessment was provided as a

numeric response ranging from preschool or kindergarten through the 12th grade. Teachers responded to the item on the teacher questionnaire that asked, "On the basis of this student's performance in your class, what is your best estimate of the student's overall mathematics ability?" The computed numeric grade-level discrepancy ranged from 10 years behind grade level to 8 years ahead of grade level.

Parental involvement was the binary time-varying covariate that described whether a parent or guardian or another adult attended any parent meetings, programs, or training sessions for families of students with disabilities as the parents reported during the parent interviews. Parents were asked the following yes-or-no oral survey question during the parent interview: "Have you, or anyone in your family, ever participated in any parent meetings, programs, or training sessions for families of students with disabilities?"

School placement was the binary time-invariant covariate that described whether the student attended a residential or boarding school, as reported by a school coordinator or principal or his or her designee in the school characteristics survey. School coordinators, principals, or their designees were given a survey and asked to mark on the questionnaire next to this yes-or-no item if the school was a residential or boarding school.

School environment was the continuous time-invariant covariate that indicated the degree to which the school climate was supportive of teachers and students, as measured by the extent to which the teacher who provided language arts instruction to the student reported on the teacher survey that the leadership has high expectations of teachers or students, the principal promotes improvement, and the school is a safe place for students. Teachers were given a survey and asked to respond to Likert scale–type questions on the extent to which they agreed or disagreed with the following questions: The school leadership has high expectations and standards for students and teachers, the principal promotes instructional improvement among the school staff members, and this school is a safe place for students. Each of these three items was coded strongly disagree = 1, disagree = 2, agree = 3, or strongly agree = 4. These three items were combined, and response options for this created variable were on a scale of 3–12 (not a positive school environment to a very positive school environment).

Data analysis

Normalized weights were used during the data analysis to address the complex sampling design. Data analysis consisted of a descriptive analysis and multilevel modeling. The descriptive analysis showed the percentage of academic students with visual impairments who used and did not use assistive technology during each of the three waves of data collection.

The second component of the data analysis involved assessing the change in the use of assistive technology during the three measured periods and the contextual factors that may account for the use of assistive technology. Data analysis strategies accounted for the attributes of a binary outcome with the binary logistic application of multilevel modeling. Binary logistic multilevel longitudinal modeling was implemented in Research

Questions 2, 3, and 4. More specifically, Research Question 2 tested the change in the prevalence of use of assistive technology by students who were visually impaired as the years progressed. Research Question 3 assessed how the use of assistive technology varied according to mathematics ability and parental involvement. Similarly, Research Question 4 analyzed how the use of assistive technology varied according to school placement and school environment.

Specified equations tested the two-level binary logistic multilevel longitudinal model. The unconditional model addressed Research Question 2 and the conditional models addressed Research Questions 3 and 4.

Results

The results were expected to provide precise and reliable estimates of the level of use of assistive technology with text-to-speech devices and screen-enlargement software in addition to revealing which of the analyzed contextual factors are important for the use of and improvements in the use of assistive technology. The results indicated that less than half the academic students who were visually impaired were using assistive technology during each of the three measured periods. Between 29% and 41% of the students with visual impairments who were most inclined to benefit from assistive technology were actually using assistive technology during each of the three waves of data collection. Table 1 shows the percentage of academic students with visual impairments in the United States who used assistive technology by wave of data collection.

An exploratory data analysis was conducted on the measures assessed by the binary logistic multilevel longitudinal modeling research questions. Table 2 displays the descriptive statistics for the Level 1 and Level 2 binary measures by wave of data collection. Table 3 presents the descriptive statistics for the Level 1 and Level 2 ordinal measures by wave of data collection.

Table 1
Percentage of students with visual impairments who used assistive technology, by wave.

Wave	Percentage	*SE*
1	41	4
2	39	5
3	29	5

The ability of the contextual factors to significantly predict the use of assistive technology was indicated by the corresponding log-odds and odds ratios. Table 4 shows the logistic regression results for each of the three binary logistic multilevel longitudinal modeling research questions. The change in the prevalence of the use of assistive technology as the years progressed was not statistically

Table 2
Descriptive statistics for Level 1 and Level 2 binary measures, by wave.

Measure	Level	Percentage	*SE*
Assistive technology use			
Wave 1	1	18	2
Wave 2	1	18	2
Wave 3	1	12	1
Parental involvement			
Wave 1	1	27	1
Wave 2	1	35	1
Wave 3	1	32	1
School placement			
Wave 1	2	1	0
Wave 2	2	0	0
Wave 3	–	–	–

Note: Dashes indicate that data were not collected for that measure during that wave.

Table 3
Descriptive statistics for Level 1 and Level 2 ordinal measures, by wave.

Measure	Level	*M*	SD	Minimum	Maximum
Mathematics ability					
Wave 1	1	−0.94	1.72	−8.00	7.00
Wave 2	1	−1.38	2.19	−9.00	8.00
Wave 3	1	−1.51	2.71	−12.00	7.00
School support					
Wave 1	2	10.41	1.79	3.00	12.00
Wave 2	2	10.33	1.83	3.00	12.00
Wave 3	2	4.80	1.89	3.00	12.00

significant ($p = .989$). Neither mathematics ability ($p = .124$) nor school environment ($p = .971$) significantly predicted the use of assistive technology. However, both parental involvement ($p = .008$) and school placement ($p = .007$) significantly predicted the use of assistive technology. It is noted that the substantial strength of the result that involves the school placement predictor should be interpreted cautiously, since a small proportion of the sample of students with visual impairments was derived from placements in residential schools.

Conclusion

The study found that less than half the students with visual impairments in the United States who were most inclined to benefit from assistive technology had the opportunity to use assistive technology during each of the three measured periods. Between 59% and 71% of the students with visual impairments who were most inclined to benefit from assistive technology did not have the opportunity to use assistive technology. This finding concurred almost precisely with that of the statewide survey in Illinois. Kapperman et al. (2002) demonstrated that approximately 60% of the academic students with visual impairments in Illinois who could have benefited from the use of special technology for individuals with visual impairments were not receiving that opportunity. It is possible that the situation in Illinois was not exceptionally different from that of other states. The finding of the analysis of this nationally representative database can confirm such

Table 4
Log-odds and odds ratios, by measure.

Measure	Research question	Log-odds	Odds ratio
Wave	3	−0.001	0.998
Discrepancy in mathematics grade level	4	0.052	1.053
Parental involvement	4	0.386*	1.472
School placement (intercept)	5	1.739*	5.694
School support (intercept)	5	−0.002	0.998
School placement (slope)	5	−0.354	0.701
School support (slope)	5	0.000	1.000

* $p < .01$.

an assumption and challenge the notion that special education law is implemented effectively.

The change in the use of assistive technology as the survey progressed was not statistically significant. There was a lack of change in the use of assistive technology over the five-year time span measured by the survey. The notion that people with visual impairments struggle year after year with access to information via assistive technology was also supported by Augusto and Schroeder (1995) more than a decade ago: "In spite of technological advances, access to information remains an elusive goal for people who are blind or visually impaired" (p. 9). The disconcerting phenomenon continues today. Consequently, children with visual impairments fall further behind their sighted peers every year they continue not to use assistive technology to experience the benefits of electronic information sharing.

The study found that students with visual impairments who have involved parents were significantly more likely to use assistive technology. Children of parents who attended any parent meetings, programs, or training sessions for families of students with disabilities had significantly higher odds of using assistive technology than did otherwise similar students who did not have involved parents. The finding suggests that parental involvement may be a component of the effective use of assistive technology among school-age students with vision loss. The finding also suggests that knowledge and networking provided by parent support groups may arm parents with the information and emotional support necessary to deal with many of the challenges of ensuring that their children are using assistive technology. This is a noteworthy finding for all those who have the ability to connect parents with such salient programs.

Last, the study found that students with visual impairments who attended residential schools were significantly more likely to use assistive technology. That is, the odds of students who attended residential schools using assistive technology were significantly higher than the odds of otherwise similar students who did not attend residential schools. Similarly, Kapperman et al. (2002) demonstrated that assistive technology was used more in nonitinerant placements than in itinerant placements. Since the majority of students who are visually impaired attend local neighborhood schools and receive services related to being visually impaired from an itinerant teacher of children who are visually impaired (Kapperman et al., 2002), the findings are particularly troublesome for the vast majority of students with visual impairments who attend local neighborhood schools who are not as likely to use assistive technology.

Implications

Children who are visually impaired do not have the necessary supports to acquire assistive technology tools or to learn to complete tasks independently with specialized technology without instructors' comprehensive knowledge about assistive technology for individuals who are visually impaired. Although it is not clear how many universities are offering assistive technology course work to some degree in their personnel preparation programs, it is known that no university program offers a specialty in assistive technology in the field of

visual impairment. This is the notion that Kapperman et al. (2002) alluded to in 2002.

Kapperman et al. (2002) suggested the necessity of a nationwide effort to develop an assistive technology specialty in the field of visual impairment that would be similar to the effort that was undertaken to create the orientation and mobility specialty. The findings of the present study support this necessity and indicate that university preparation programs must develop curricula to offer more specialized training in assistive technology for teachers of children with visual impairments (Augusto & Schroeder, 1995).

Furthermore, it is necessary to assess current uses of, trends in, and needs for assistive technology to enable people who are visually impaired to participate more fully in all aspects of digital communication. It is also necessary for future research to establish assistive technology competencies and curricula implemented nationwide. Further study that takes into account the need for assistive technology competencies and curricula can best be geared toward gradually expanding a specialty in assistive technology training for people who are visually impaired that reflects existing, emerging, and ever-changing technologies that are relevant to the field of visual impairment.

It is important to note that the study addressed a highly specialized aspect of the education of students who are visually impaired. Much to the contrary, the SEELS database offers a lot of general information about the characteristics of students who are classified in each the federal disability categories. The data are far reaching in scope and content. Those who conduct a secondary analysis of a database that was conceptualized and implemented by others are limited by research questions that can be asked of a preexisting database that they did not conceptualize or implement. Nevertheless, it would have been helpful if the depth of the information asked of participants with regard to the use of assistive technology was more thorough. For example, it is possible that parents of students who use only braille displays and do not use text-to-speech devices responded negatively to the assistive technology outcome measure because of the "text-to-speech" wording of the question. Consideration should be given to this limitation of the study, especially as it pertains to what could have been even more in-depth wording of survey questions that were intended to fulfill the far-reaching purposes of SEELS.

Ongoing research on technologically advanced applications of assistive technology for those who are blind or have low vision can better ensure the benefits and accessibility of virtual global communities for people with visual impairments. Access to the social networking web sites and mobile devices via text-to-speech devices or screen-enlargement software, for example, is one vital component of enabling students who are visually impaired to connect with others academically, professionally, and socially. Advanced skills with assistive technology can make many of the most popular venues for digital social interaction accessible to children who are blind or have low vision and, perhaps even more important, allow students to adapt their advanced skills to newer technologies as these technologies continue to emerge.

This new aspect of education that embraces the existing, emerging, and ever-changing aspects of assistive technology is ready for immediate attention. If the necessary research was generated and policies were adapted, the education of students who are visually impaired could be reoriented with this emphasis. The success of such a national effort could ensure that many people who are visually impaired are fully included in a society that is captivated by electronic information sharing.

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