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The Use of Assistive Technology in School-Aged Children with Learning Disorders

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By

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Abstract

Assistive Technology (AT) allows children with Specific Learning Disorders (LDs) to adequately access school curriculum. There is a paucity of literature addressing the use, perception of use, and training of students who qualify for AT. The few studies completed suggest that children with AT like their devices and find them useful. The current exploratory study examined the grade level of children provided AT devices, the types of AT hardware and software being used by children with various learning limitations in a school environment, and children’s perception of their AT devices. Archival data collected from school-aged children referred to the Learning Disabilities Association of Windsor-Essex County (LDAWE) was analyzed using descriptive and inferential statistics. It was predicted that grade level, type of AT device, themes of liking, and themes of disliking would predict children’s perception of their AT and the AT training after training sessions. Logistic regressions revealed that children’s perceptions of their AT and AT training were influenced by their grade, device, and Disliking theme, but not Liking theme. Affirmative perceptions of the utility for specific apps ranged from 0% to 100%. In regard to what they liked about their AT, children most commonly responded with themes of “Helpful” (51%), with 8 themes emerging in total. For what they disliked about their AT, children most often responded with themes of “Technical Problems” (31%), with 15 emergent themes. The results of the current study add to the understanding of current practices of AT training and the utilization of AT by children. The findings of the current study should guide AT distributors and trainers in deciding which AT hardware to provide to children with LDs and how to provide training. Additionally, these results can benefit consumers and practitioners in their selections and recommendations of AT hardware.

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Chapter 1: Introduction

The Use of Assistive Technology in School-Aged Children with Learning Disorders

Literature Review

Children with Specific Learning Disorders (LDs) often experience difficulties learning in a classroom setting in comparison to their peers. One method initiated within schools to assist children with special needs is the allocation of Assistive (also referred to as Adaptive) Technology (AT). AT is any tool, product, or device that increases the possibility, or ease, of performing particular tasks (Learning Disabilities Association of Ontario, n.d.). AT devices vary from simple objects like pencil grips to more sophisticated technology such as computers and tablets, the latter of which is the focus of the present study. AT devices allow children with learning limitations to interact with the material in a way that increases understanding, and allows acquisition of knowledge and academic skills (Rapp, 2005). AT has been demonstrated to improve comprehension of academic materials for adolescents with LDs (MacArthur & Haynes, 1995). Furthermore, AT allows individuals with disabilities to have increased opportunities and independence (Garner & Campbell, 1987).

The limited research that currently exists provides evidence of the benefit of text-to-speech software for children with LDs. Using text-to-speech software programs (see Table 1 for examples) has been found to increase reading rates for slow readers, defined as those who read below 78 words per minute (Sorrell, 2007). Sorrel (2007) recruited 12 students to take part in a four-week reading program (45 minutes daily, for four to five days per week). Students participated in the experimental condition (using the Kurzweil 3000 text-to-speech software program) and the condition (unassisted reading), with half of the students assigned to each group initially for four weeks and then exposed to the other condition for the following four weeks. The study was limited by a small sample size and all of the students attending the same rural school in a low economic status area. Furthermore, the students were selected by their teachers as below grade level readers, and did not necessarily have formal diagnoses related to reading difficulties (e.g. LD). Students who were classified as slow readers at baseline had improved reading rates after using Kurzweil-3000 (K-3000).

Text-to-speech software has also been found to improve performance on functional tasks, such as filling out a job application. Chiang and Jacobs (2009) examined the outcomes of a 10-week learning intervention with K-3000 with high school students with learning difficulties in comparison to a control group with no access to K-3000. They measured self-perception ratings and functional task performance (filling out a job application form) before and after the intervention. They found that students in the K-3000 group had a greater increase in self-rating of reading competence and general intellectual ability. The K-3000 students also showed more improvement filling out education and work experience information on the job application task. Students were assigned into either the experimental or control groups based on the classroom they were in (25 students in each group). All students were identified as having learning difficulties by their school board and were on IEPs. Children in different learning categories spend different proportions of their day in special resources (R2: less than 26%; R3: 26 - 59%; R4: over 60%). Interestingly, in the experimental condition children were mostly classified as R2 or R3 learners, whereas students in the control condition were mostly R3 or R4 learners. Limitations of this study included non-random group assignments and important group differences in the four learning categories of the children.

Students with dyslexia who used text-to-speech software for one semester had increased oral reading scores on average of one grade level equivalent (Elkind, Cohen, & Murray, 1993).

Elkind et al. (1993) recruited students (grade level five to eight) with dyslexia to use Bookwise (a computer reader similar to the K-3000 that reads digital text while displaying it visually) for half an hour a day for one semester (approximately 20 – 25 hours total). Students' oral reading was assessed by the Gray Oral Reading Test (GORT-R) both unaided and using Bookwise. Use of Bookwise increased GORT scores by an average of one grade level equivalent (GE) (after correcting for practice effects). More than 70 percent of students had improvements of at least one GE, and 40 percent had improvements of between two and five GEs. Students reported that Bookwise helped them to read hard words and increased their speed of reading. Some limitations of the study were lack of random group assignment (groups were school classes) and small sample size (N = 28).

Students reported that features of text-to-speech software such as repetition of portions of text, embedding their own notes (Chiang & Liu, 2011), adjustable reading speed, text highlighting while reading, audio and visual input, definitions of words, and having headsets to block out external noise all benefitted their reading (Chiang & Jacobs, 2010). AT devices have many academic benefits to students with LDs. Unfortunately, other software types have not been adequately studied.

Students with LDs on average report lower levels of self-esteem than students without LDs (Peleg, 2009; Valas, 1999). The distress experienced from low self-esteem can have a detrimental impact on academic achievement (Di Giunta et al., 2013), and over-all mental and physical health (Trzesniewski et al., 2006). AT has a positive impact on the self-perceptions of individuals with LDs. Students who used text-to-speech software reported higher reading competence and general intellectual abilities after using the AT for 10-weeks (Chiang & Jacobs, 2009), and reported improvements in academic self-perception, reading comprehension, pronunciation, and focus during reading after 6-months (Chiang & Jacobs, 2010). Children have also reported improved reading speed, quantity, and quality (Chiang & Jacobs, 2010), and improved ability to read difficult words (Elkind et al., 1993). AT has also been found to improve self-perceptions of students with LDs who are learning English as a second language. AT software increased student's perception of the speed, and ease, of their reading, and improved self-perception of their spelling, pronunciation, and independent learning abilities (Chiang & Liu, 2011).

Currently, a number of barriers exist that prevent students with LDs from fully benefitting from AT devices. AT devices are not always accessible. In Canada, individuals with LDs had a higher number of devices needed and not available than any other group of individuals with disabilities in Canada (Statistics, 2008). Additionally, individuals with LDs who did have AT devices were more likely to have paid for their own devices than any other group of individuals with disabilities in Canada (Statistics, 2008). The most commonly used aids for children with LDs were home computers (88%). These statistics indicate barriers to accessibility of AT devices for individuals who need them. For those who have access to AT devices, factors surrounding the perception of use, as well as training for teachers to support use, are of importance. One study examined teachers level of AT proficiency and AT training experience; the majority (70%) had no training on the use of AT in the classroom (Chmiliar, 2007). Additionally, the majority (76%) of the teachers surveyed reported either being unskilled or needing support in regard to their knowledge and skill of AT. When asked about barriers to the use of AT in the classroom, teachers endorsed expense as biggest barrier, followed by time to be proficient in the use of AT (Chmiliar, 2007). Without instructors who are able to support the use of AT devices, those children who are fortunate enough to have access to AT devices may not fully benefit from them.

Currently, research on AT is scarce, with the majority of the completed studies examining the impact of specific AT software programs (most commonly text-to-speech software) on academic achievement and focused on a post-secondary or adult sample. Few studies have been completed to date with children, or with various AT software types. Research examining the impact of AT devices on children with LDs is necessary, considering that childhood is the optimal time for children with LDs to begin using AT to adequately access school curriculum. Many of the studies that have been completed have methodological issues (e.g. quasi-experimental designs, no control groups, violations of statistical assumptions for parametric tests, arbitrary tasks to measure improvements, small sample sizes, and significant differences between groups on extraneous factors) or are authored by AT producers.

Learning Disabilities Association of Windsor-Essex County

The Learning Disabilities Association of Windsor-Essex County (LDAWE) is charitable not-for-profit organization that strives to help individuals of all ages who have LDs and those who support them. They achieve this by providing information and programming, as well as advocating on their behalf. The LDAWE currently offers a service providing AT training to individuals in the community. The LDAWE has a partnership with two local school boards to provide training for all students that have school supplied AT as part of an educational accommodation. Students that are referred to the LDAWE for training by the local school boards either have an official diagnosis that impacts academic performance (e.g. Specific Learning Disorder) or have been identified as having an exceptionality, based on the Ministry of Education criteria. The designation of having an exceptionality includes students that are unable to access the mainstream curriculum because of behavioural, communicational (i.e. LD), intellectual, physical, or multiple impairments. The majority of students (91%) referred to the LDAWE by the local school boards for AT training have LDs. The AT training is funded by student's Special Education Amount (SEA) claims. The SEA provides each eligible student with AT hardware (laptops, Chromebooks, or iPads), selected AT software programs (see Appendix A), and training (up to 10 hours of initial training, and up to 5 hours of supplementary training; see Appendix B).

The Present Study

Although current evidence suggests that AT devices are useful for children with LDs, there is a paucity of literature assessing perceptions of AT training, and the type of AT hardware and software used. This is despite school boards in Ontario acquiring costly funding for AT devices for children with special educational needs. This has been done without research examining which AT devices and software are actually being utilized by children and which are useful in the classroom. Considering the high expense involved and the implications for learning, research on best practices is essential. There were a number of factors addressed with the available database. The archival data consisted of surveys created by the LDAWE and completed by children after training sessions. The current study examined the ages of children provided AT devices, the types of AT hardware and software perceived as being useful by children with various learning limitations in a school environment, and children's perception of their AT devices. The current study aimed to increase the understanding of current practices of the distribution and utilization of AT. Although limited in scope, the archival data available addressed three main research questions currently unaddressed in the literature:

1. What factors influence children perceiving training as enjoyable, helpful, and useful, and being interested in learning more?

2. Which apps (or features) do children think will help make their school work better?

3. What do children like (and dislike) about their AT?

Although there is no past research on children's perceptions of their AT and AT training, the opinions of professionals working with children with AT provide anecdotal evidence accounts that age and device type influence children's perceptions. Additionally, it would be likely that children that have more positive qualitative responses would also have more positive perceptions of their AT and AT training. It was predicted that grade, type of AT device, liking theme, and disliking theme would predict children's perception of their AT and the AT training after training sessions. As there was no prior research addressing children's perceptions of AT software or devices, there were no a priori hypotheses about which features children would endorse as making their school work better, or what children would endorse liking (and disliking) about their AT.

Chapter 2: Method

Participants

Archival data was collected by the LDAWE from school-aged children (N = 656, grades 2 - 12) referred to the LDAWE by two local school boards. The children resided within the city of Windsor, Ontario or the surrounding Essex County. The children were assessed as having LDs (or exceptionalities) and received AT supplied by the school boards to provide the opportunity for academic success.

Materials

Surveys (see Appendix) were developed by LDAWE and include the child's grade and school board attended. Additionally, questions assessed the software programs the child perceived as helpful, and the child's attitude toward training and the AT. Difference survey forms were used for each AT device type and included the apps (or programs) relevant to that device. The AT supplied included hardware (Chromebooks, laptops or iPads) and 34 apps (or programs) utilized by the local school boards over the period of the study.

Procedure

All surveys were completed between February of 2013 and April of 2016. The surveys were completed either through an interview format or independently by the children (depending on reading and writing abilities) after AT training sessions with LDAWE were completed. The first training session took place initially after AT was supplied; the second training session was 8 – 10 weeks later, after children had the opportunity to get used to the AT. The LDAWE conducted the training sessions for each child in their school. The data was collected at various elementary and high schools that are part of the Windsor-Essex Catholic District School Board and the Greater Essex County District School Board in Windsor, Ontario.

Statistical Analysis

Data from anonymous surveys was coded and analyzed using Microsoft Excel and IBM SPSS 21. Descriptive statistics were analyzed, including the proportion of students from each school board, frequency of children at each grade level, and proportion of AT hardware type (laptop, Chromebook, or iPad). The proportion of children that thought each program would make their school work better was analyzed for 33 programs.

Open ended survey questions ("What do you like most about your [AT type]?" and "What do you like least about your [AT type]?") were qualitatively coded for emergent themes. The first author coded all of the responses and a second rater coded 30% of the qualitative responses to establish interrater reliability. A common standard for qualitative research with large sample sizes and without complex qualitative datasets is to have a second coder code 20%

of that data (Syed & Nelson, 2015). For both liking (percent agreement = 61.93, $\kappa = .76$) and disliking (percent agreement = 83.25, $\kappa = .69$) themes there was substantial agreement (Viera & Joanna, 2005).

Inferential statistics were analyzed using multinomial logistic regression to examine the proportion of variance accounted for by the AT device type (laptop, Chromebook, iPad), Grade group (2-3, 4-6, 7-8, 9-12), theme of liking, and theme of disliking on outcomes of each DV after the training sessions. The DVs were: enjoyed AT training (Q1; yes, maybe, no), thought AT training was helpful (Q2; yes, maybe, no), AT training was a good use of time (Q3; yes, maybe, no), and interested in learning more about AT and apps (Q4; yes, maybe, no).

Missing data for each variable (grade, training, board, Q1-4) ranged from 0% (Q2 and Q3) – 2% (Grade). Little's MCAR test was significant ($\chi^2(38) = 79.54$, $p < .001$) indicating that the data did not appear to be missing at random. Other variables were not included in analysis because they were gathered through the use of separate forms (school board), were stored separately (year) contained in separate folders, or were informative non-responses variables (response to qualitative questions). Due to the large sample size and minimal amount of data missing, data was not removed or inputted.

Chapter 3: Results

School Board

Roughly two-thirds of the surveys were completed by students from the Greater Essex County District School Board. According to the news article, "Local School Boards Exceed Enrolment Expectations" (Waddell, 2014), the survey distribution is roughly proportionate to the enrollment of each school board This is roughly proportionate to the enrollment of each school board. There were 6 surveys that did not indicate the school board attended.

Table 1

Proportion of Students from Each School Board

Board	n	Percent	Valid Percent
WECDSB	243	37.0	37.4
GECDSB	407	62.0	62.6
Missing	6	0.9	

Grade

Of the completed surveys, the grade with the highest proportion of children was grade six. As grade level decreased and increased, the number of children steadily declined. Grades four to six are considered an ideal time to identify children who would benefit from AT and begin to provide devices and training. Earlier identification is not as common, and often older children who would benefit from AT have been identified at younger ages. To facilitate analyses, the grades were divided into groups, comprised of primary (grades 2 – 3), intermediate (grades 4 – 6), senior (grades 7 – 8), and high school (grades 9 – 12). Nearly half of the students were in the intermediate grades, followed by senior, high school, and primary.

Table 2

Proportion of Children at Each Grade Level

Grade	n	Percent	Valid Percent
2	5	0.8	0.8
3	33	5.0	5.1
4	77	11.7	12.0
5	98	14.9	15.3
6	132	20.1	20.6
7	108	16.5	16.8
8	87	13.3	13.6
9	63	9.6	9.8
10	18	2.7	2.8
11	15	2.3	2.3
12	6	0.9	0.9
Missing	14	2.1	

Table 3

Proportion of Children in Each Grade Group

Grade	n	Percent	Valid Percent
2-3	38	5.8	5.9
4-6	307	46.8	47.8
7-8	195	29.7	30.4
9-12	102	15.5	15.9
missing	14	2.1	
totals	656	99.9	100

Year

The number of surveys completed was highest in the 2013/14 school year, with all other school years being roughly equivalent. Within the GECDSB, there were fewer surveys completed within the 2012/13 school year (n = 43, 11%) and similar numbers of surveys completed in the 2013/14 (n = 130, 32%), 2014/15 (n = 133, 33%), and 2015/16 (n = 101, 25%) school years. The difference is accounted for by the WECDSB. There was a much larger number of surveys completed during the 2013/14 (n = 112, 46%) school year than the 2012/13 (n = 88, 36%), 2014/15 (n = 4, 2%), and 2015/16 (n = 39, 16%) school years. In 2013/14, the WECDSB switched from primarily providing laptops to primarily providing iPads. Thus, retraining of students who were given new devices likely accounted for the larger number of surveys completed that year.

Table 4

Proportion of Surveys Completed Each Year

School Year	n	Percent
12/13	134	20.4
13/14	245	37.7
14/15	137	20.9
15/16	140	21.3

AT hardware

Overall, the majority of students were provided with laptops, followed by iPads and Chromebooks. When considering allocations of AT, there were differences accounted for by the school board the student attended, $\chi^2(2) = 193.13$, $p < .001$. The GECDSB does not provide Chromebooks to students, and the majority of students receive laptops, with a small proportion receiving iPads. For the WECDSB, the proportion of students allocated laptops and iPads is similar, with fewer students being allocated Chromebooks. Trends in the type of AT hardware allotted have changed over the span of four years, $\chi^2(6) = 222.56$, $p < .001$. In the 2012/13 school year almost exclusively laptops (n = 126) were provided to children (with the exception of 5 iPads allotted by the WECDSB). Laptops were still predominantly used by the GECDSB in 2013/14 (laptops = 129, iPads = 1), 2014/15 (laptops = 124, iPads = 9), and 2015/16 (laptops = 75, iPads = 26). Within the GECDSB, there has been a greater proportion of iPads provided each year as compared to the previous year. Within the WECDSB, trends moved toward predominantly providing iPads in 2013/14 (iPads = 92, laptops = 20). In 2014/15, the WECDSB opted to start providing Chromebooks instead of laptops (iPads = 1, Chromebooks = 3). In 2015/16, they exclusively provided Chromebooks to students (Chromebooks = 39).

Table 5

Proportion of Children Allocated Each Device Type

Device	n	Percent	Valid Percent
Laptop	480	73.2	73.2
iPad	134	20.4	20.4
Chromebook	42	6.4	6.4
Missing	0	0.0	

Table 6

Proportion of Children Allocated Each Device Type within Each School Board

Device	Laptop (%)	iPad (%)	Chromebook (%)	Total
WECDSB	103 (42.4)	98 (40.3)	42 (17.3)	243
GECDSB	371 (91.2)	36 (8.8)	0 (0)	407
Total	480 (73.2)	134 (20.4)	42 (6.4)	650
Missing	6	0	0	6

Training

Overall, the majority of training was initial training. The survey forms used during the 2012/13 and 2013/14 years did not have space to record whether it was initial or supplemental, therefore most of the training for those years is assumed initial. There were some surveys (n = 13) completed during the 2013/14 year where it was specifically indicated that the training was supplemental.

There were differences in the proportion of training that was initial, supplemental, and assumed initial by year, $\chi^2(6) = 642.07$, $p < .001$. In the 2012/13 school year, all of the training was assumed initial (n = 134). The proportion of supplemental training rose each year, with supplemental training accounting for 5% in 2013/14 (assumed initial = 232, supplemental = 13, initial = 0), 13% in 2014/15 (initial = 110, supplemental = 16, assumed initial = 0), and 36% in 2015/16 (initial = 88, supplemental = 50, assumed initial = 0).

There were differences between the typical amounts of time it took to train students on the different AT hardware types, which was partially due to the software programs that students were trained to use. For the GECDSB, the typical amount of training time for laptops is 5 hours for initial student training, 3 hours for initial classroom training, and 7 hours for supplemental student training. For iPads, the GECDSB allots 3 hours for initial student training, 3 hours for initial classroom training, and 3 hours for supplementary student training. The reported times are guidelines and do vary based on student needs. In total, GECDSB students who were allotted laptops get two more hours of training initially, and four more hours of supplemental training than students who were allotted iPads. These differences in training time may be due to iPad programs being more intuitive for users.

There were differences in the proportions of students that received supplemental training accounted for by the AT device they were provided, $\chi^2(4) = 113.38$, $p < .001$. For students given laptops, 15% of training was supplemental (initial = 129, assumed initial = 268, supplemental = 72). For iPads, 5% of the training was supplemental (initial = 28, assumed initial = 98, supplemental = 7). For Chromebooks, all of the training was initial (n = 41). The discrepant proportion of children receiving supplementary training may be due to one of two factors. It may be accounted for by the yearly differences in the allocations of each device. None of the supplemental training was for Chromebooks, which may be accounted for by Chromebooks only being introduced in the 2014/15 school year. Another explanation may be the ease with which students can master the device and its software programs. This finding may indicate that there is a greater level of difficulty involved in learning to use the laptop hardware and software, in comparison to the iPad hardware and software. This is further supported by the differences in the amount of time it takes to train students on laptops This finding may suggest a higher efficiency of training for the iPads in comparison to laptops.

Table 7

Proportion of Initial and Supplemental Training

Training	n	Percent	Valid Percent
Initial	198	30.2	30.8
Supplementary	79	12.0	12.3
Assumed Initial	366	55.8	56.9
Missing	13	2.0	

Perceptions of training

Responses to survey questions regarding perceptions of training were generally very positive. A large majority of students indicted that they thought training was helpful, enjoyed training, and felt it was a good use of their time. Additionally, approximately two out of every three students indicated that they were interested in learning more about their AT.

Table 8

Students' Responses to Survey Questions

Question	Yes (valid %)	Maybe	No	Missing
Q1: I enjoyed training.	586 (89.7)	54 (8.3)	13 (2.0)	3
Q2: I think training was helpful.	613 (93.7)	37 (5.7)	3 (0.5)	2
Q3: I feel that training was a good use of my time.	534 (81.7)	95 (14.5)	25 (3.8)	2
Q4: I am interested in learning more about my device and apps.	433 (66.3)	155 (23.7)	65 (10.0)	3

Perceptions of the helpfulness of specific Apps

Applications and programs differed in how helpful students perceived them to be in helping with school work. The range of affirmative responses was 100% to 0%, indicating that students' had preferences for some apps over others. The number of student responses for each app differs (see Table 9), which is due to different apps being applicable to different AT devices and difference student concerns. Some apps on the surveys were paired with another similar app (e.g. ClaroPDF or neu.Annotate+ PDF, see Appendix); see Table 10 for student responses. See Tables 11 and 12 for text-to-speech and speech-to-text applications.

Table 9

Responses to if Apps Will Make School Work Better (all Years)

App	Device	n	Yes (%)	Maybe (%)	No (%)	N/A
Google Drive	C	41	39 (95.1)	2 (4.9)	0 (0.0)	0
ClaroPDF	I	13	12 (92.3)	0 (0.0)	1 (7.7)	0
Presentations	C	39	36 (92.3)	3 (7.7)	0 (0.0)	0
Documents	C	41	37 (90.2)	4 (9.8)	0 (0.0)	0
ExplainEverything	I	99	85 (85.9)	11 (11.1)	3 (3.0)	3
iPad Dictation Feature	I	125	107 (85.6)	15 (12.0)	3 (2.4)	9
iPad Speak Selection Feature	I	122	104 (85.3)	11 (9.0)	7 (5.7)	11
iWordQ	I	132	112 (84.9)	19 (14.4)	1 (0.8)	1
WordQ	L	448	371 (82.8)	57 (12.7)	20 (4.5)	25
Smart Ideas	L	367	294 (80.1)	62 (16.9)	11 (3.0)	108
Microsoft Word	I	28	22 (78.6)	4 (14.3)	2 (7.1)	2
Read&Write	C	41	32 (78.1)	7 (17.1)	2 (4.9)	0
Prizmo	I	98	75 (76.5)	19 (19.4)	4 (4.1)	4
Dragon Naturally Speaking	L	449	336 (74.8)	71 (15.8)	42 (9.4)	26
Smart Notebook	L	215	160 (74.4)	43 (20.0)	12 (5.6)	255
Mindomo	C	30	22 (73.3)	7 (23.3)	1 (3.3)	11
Gmail	C	36	26 (72.2)	9 (25.0)	1 (2.8)	5
Popplet	I	31	22 (71.0)	8 (25.8)	1 (3.2)	1
Premier Literacy	L	307	208 (67.8)	86 (28.0)	13 (4.2)	2
Neu.Annotate	I	96	65 (67.7)	23 (24.0)	8 (8.3)	7
Microsoft OneNote	I	12	8 (66.7)	3 (25.0)	1 (8.3)	18
VoiceNote II	C	39	25 (64.1)	11 (28.2)	3 (7.7)	0
Kurzweil 3000	L	47	29 (61.7)	12 (25.5)	6 (12.8)	191
Cam Scanner	I	28	17 (60.7)	10 (35.7)	1 (3.6)	2
Inspiration Maps	I	9	5 (55.6)	1 (11.1)	3 (33.3)	0
Tools4Students	I	8	4 (50.0)	1 (12.5)	3 (37.5)	0
Calendar	C	38	18 (47.4)	13 (34.2)	7 (18.4)	2
Idea Sketch	I	13	6 (46.2)	3 (23.1)	4 (30.8)	18
Clicker5	L	167	77 (46.1)	51 (30.5)	39 (23.4)	302
Pages	I	5	2 (40.0)	0 (0.0)	3 (60.0)	0
iBooks	I	35	5 (13.3)	3 (8.6)	27 (77.1)	0
BookCreator	I	10	1 (10.0)	3 (30.0)	6 (60.0)	3
Keynote	I	4	0 (0.0)	1 (25.0)	3 (75.0)	0

Note. C = Chromebook, I = iPad, L = Laptop

Table 10

Responses to if Apps Will Make School Work Better (2015/16 school year)

App	Device	n	Yes (%)	Maybe (%)	No (%)	N/A
iBooks	I	3	3 (100.0)	0 (0.0)	0 (0.0)	22
Google Drive	C	38	36 (94.8)	2 (5.3)	0 (0.0)	0
Presentations	C	36	34 (94.4)	2 (5.6)	0 (0.0)	0
Documents	C	38	34 (89.5)	4 (10.5)	0 (0.0)	0
Mindomo	C	22	19 (86.4)	2 (9.1)	1 (4.5)	11
WordQ	L	68	57 (83.8)	9 (13.2)	2 (2.9)	7
iPad Speak Selection Feature	I	18	15 (83.3)	2 (11.1)	1 (5.6)	8
Popplet	I	25	20 (80.0)	4 (16.0)	1 (4.0)	1
Read&Write	C	38	29 (76.3)	7 (18.4)	2 (5.3)	0
iPad Dictation Feature	I	23	17 (73.9)	6 (26.1)	0 (0.0)	3
Microsoft Word	I	22	16 (72.7)	4 (18.2)	2 (9.1)	2
Smart Notebook	L	33	24 (72.7)	8 (24.2)	1 (3.0)	41
Smart Ideas	L	47	34 (72.3)	11 (23.4)	2 (4.3)	27
Gmail	C	34	24 (70.6)	9 (26.5)	1 (2.9)	4
Dragon Naturally Speaking	L	71	50 (70.4)	14 (19.7)	7 (10.0)	4
Neu.Annotate	I	23	16 (69.6)	6 (26.1)	1 (4.4)	1
Microsoft OneNote	I	9	6 (66.7)	2 (22.2)	1 (11.1)	15
VoiceNote II	C	36	22 (61.1)	11 (30.6)	3 (8.3)	0
Cam Scanner	I	23	14 (60.9)	8 (34.8)	1 (4.4)	1
Premier Literacy	L	73	39 (53.4)	31 (42.5)	3 (4.1)	2
Idea Sketch	I	12	6 (50.0)	2 (16.7)	4 (33.3)	13
Calendar	C	36	16 (44.4)	13 (36.1)	7 (19.4)	2
Clicker5	L	12	5 (41.7)	7 (58.3)	0 (0.0)	61
Kurzweil 3000	L	2	0 (0.0)	2 (100.0)	0 (0.0)	71

Note. C = Chromebook, I = iPad, L = Laptop

Table 11

Responses to if Apps Will Make School Work Better for Paired Apps (all Years)

App Pairs	Device	n	Yes (%)	Maybe (%)	No (%)	N/A
Pages or Keynote	I	97	91 (93.8)	5 (5.2)	1 (1.0)	0
Premier or Kurzweil	L	114	100 (87.7)	11 (9.7)	3 (2.6)	12
Inspiration or Tools	I	89	77 (86.5)	11 (12.4)	1 (1.1)	0
BookCreator or iBooks	I	89	70 (78.7)	14 (15.7)	5 (5.6)	0
ClaroPDF or Neu.Annotate	I	6	4 (66.7)	1 (16.7)	1 (16.7)	0

Notes. C = Chromebook, I = iPad, L = Laptop. The apps included in this table were not used during the 2015/16 school year

Table 12

Responses to if Apps Will Make School Work Better for Text-to-Speech (all Years)

App	Device	n	Yes (%)	Maybe (%)	No (%)	N/A
ClaroPDF	I	13	12 (92.3)	0 (0.0)	1 (7.7)	0
iPad Speak Selection Feature	I	122	104 (85.3)	11 (9.0)	7 (5.7)	11
Read&Write	C	41	32 (78.1)	7 (17.1)	2 (4.9)	0
Prizmo	I	98	75 (76.5)	19 (19.4)	4 (4.1)	4
Premier Literacy	L	307	208 (67.8)	86 (28.0)	13 (4.2)	2
Kurzweil 3000	L	47	29 (61.7)	12 (25.5)	6 (12.8)	191

Note. C = Chromebook, I = iPad, L = Laptop

Table 13

Responses to if Apps Will Make School Work Better for Text-to-Speech (2015/16 School Year)

App	Device	n	Yes (%)	Maybe (%)	No (%)	N/A
iPad Speak Selection Feature	I	18	15 (83.3)	2 (11.1)	1 (5.6)	8
Read&Write	C	38	29 (76.3)	7 (18.4)	2 (5.3)	0
Premier Literacy	L	73	39 (53.4)	31 (42.5)	3 (4.1)	2
Kurzweil 3000	L	2	0 (0.0)	2 (100.0)	0 (0.0)	71

Note. C = Chromebook, I = iPad, L = Laptop

Table 14

Responses to if Apps Will Make School Work Better for Speech-to-Text (all Years)

App	Device	n	Yes (%)	Maybe (%)	No (%)	N/A
iPad Dictation Feature	I	125	107 (85.6)	15 (12.0)	3 (2.4)	9
Read&Write	C	41	32 (78.1)	7 (17.1)	2 (4.9)	0
Dragon Naturally Speaking	L	449	336 (74.8)	71 (15.8)	42 (9.4)	26
VoiceNote II	C	39	25 (64.1)	11 (28.2)	3 (7.7)	0

Note. C = Chromebook, I = iPad, L = Laptop

Table 15

Responses to if Apps Will Make School Work Better for Speech-to-Text (2015/16 School Year)

App	Device	n	Yes (%)	Maybe (%)	No (%)	N/A
Read&Write	C	38	29 (76.3)	7 (18.4)	2 (5.3)	0
iPad Dictation Feature	I	23	17 (73.9)	6 (26.1)	0 (0.0)	3
Dragon Naturally Speaking	L	71	50 (70.4)	14 (19.7)	7 (10.0)	4
VoiceNote II	C	36	22 (61.1)	11 (30.6)	3 (8.3)	0

Note. C = Chromebook, I = iPad, L = Laptop

Qualitative Themes

Open ended survey questions ("What do you like most about your [AT type]?" and "What do you like least about your [AT type]?") were qualitatively coded for emergent themes of liking and disliking respectively. For themes of liking, nine themes emerged (see Table 16). Approximately half of the students described liking that their AT helps them in some context. Within those nine themes, subthemes emerged within the *Helps* (see Table 17), *Ease of Use* (see Table 18), and *Fun* themes (see Table 19). For the *Helps* theme, the subthemes were not mutually exclusive. There were eight students who identified their AT being helpful for reading and writing, and two students who identified it being helpful for research and writing.

A z-test revealed some liking theme differences across devices, specifically between iPads and laptops, $\chi^2(14) = 36.33$, $p = .001$. Students with iPads (11%) were more likely to respond with themes of their device being fun than students with laptops (4%). Students with laptops (54%) were more likely to respond with themes of their device helping them than students with iPads (39%). Students with iPads (24%) were also more likely to respond with themes of liking programs on their device than students with laptops (15%), all *p*s < .05.

For disliking themes, 15 themes emerged (see Table 20) with 31% of students indicating that they disliked a technical problem they experienced with their device. Within those 15 themes, subthemes emerged for *Lack of Ease* (see Table 21), *Lack of Fun* (see Table 22), and

Technical Problems (see Table 23). Of particular concern psychosocially, were themes of *Stigma* and *Have to Use*. Although these two themes had very low response rates, they were explored for student grade level. Themes of *Stigma* were found in the responses of students in grades 4 (n = 3), 6 (n = 2), 7 (n = 1), and 8 (n = 2). Themes of *Have to Use* were found in the responses of students in grades 3 (n = 1), 5 (n = 1), 6 (n = 1), 7 (n = 2), 8 (n = 1). This pattern may suggest that some students in the intermediate and senior grades may have concerns about how their use of AT is perceived by others.

A z-test revealed some disliking theme differences across devices, $\chi^2(30) = 72.28$, $p < .001$. Students with laptops (9%) were significantly more likely to respond with themes of *Lack of Ease* than students with Chromebooks (0%). Students with laptops (20%) were also significantly less to respond with themes of *Nothing* than students with iPads (36%) and Chromebooks (38%). Students with iPads (11%) were more likely to respond with themes of problems with *Programs* than students with laptops (4%). Students with laptops (36%) were more likely to respond with themes of *Technical Problems* than students with iPads (16%), all *p*s $< .05$.

Table 16

Liking Themes

Theme	n	Percent
Helps – the device is helpful for school work completion	331	50.5
Programs – positive aspects of a specific program	112	17.1
Ease of use – aspects of the device that make it easy to use	78	11.9
Fun – enjoyable aspects of using the device	38	5.8
Possession – positive expressions of having their own device	30	4.6
Blank – no response	28	4.3
Internet – being able to use the internet for work or enjoyment	15	2.3
Everything – expressions of liking everything	12	1.8
Not sure – expressions of not knowing what is most liked	5	0.8
Nothing – expressions of not liking anything about the device	4	0.6
Other – responses that were atypical and/or did not fit into a category	3	0.5
Total	656	100.0

Table 17

Subthemes of Helps

Theme	n	Percent
Writing – device helped with their writing	139	40.8
Reading – device helped with reading	21	6.2
Research – device helped with conducting research or getting ideas online	15	4.4
Organization – device helped with staying organized or organizing ideas	10	2.9
Other - responses that were atypical and/or did not fit into a subcategory	156	45.8

Table 18

Subthemes of Ease of Use

Theme	n	Percent
Accessible – device was easy to access	18	23.1
Portable – device was easy to transport	11	14.1
Versatile – device was useful for many things	10	12.8
Keyboard – keyboard was easy to use	8	10.3
Speed – device and programs loaded and ran quickly	4	5.1
Touchscreen – touchscreen made device easy to use	3	3.9
Other - responses that were atypical and/or did not fit into a subcategory	24	30.8

Table 19

Subthemes of Fun

Theme	n	Percent
Games – playing games on the device was enjoyable	8	21.1
Creativity – using the device to be creative was enjoyable	6	15.8
Other - responses that were atypical and/or did not fit into a subcategory	24	63.2

Table 20

Disliking Themes

Theme	n	Percent
Tech – technical problems experienced with the device	202	30.8
Nothing - expressions of not disliking anything about the device	159	24.2
Blank - no response	71	10.8
Lack of Ease – aspects of the device that made it difficult to use	49	7.5
Programs - negative aspect of a specific program	33	5.0
Other - responses that were atypical and/or did not fit into a subcategory	31	4.7
Lack of Fun – disliking that there was no opportunity for enjoyment	20	3.0
App Errors – applications and programs did not work properly	18	2.7
Internet Problems – issues with not be able to access internet	18	2.7
Confusing – frustrations with not understanding how to use the device	17	2.6
Not Sure - not knowing what is most liked	13	2.0
Stigma – feeling singled out or negatively judged for using the device	8	1.2
Have to Use – feeling a lack of choice about when or if to use the device	6	0.9
Redundancy – overlapping programs that do the same thing	6	0.9
Missed Class – disliked missing class time to do training	3	0.5
Everything - expressions of disliking everything	2	0.3

Table 21

Subthemes of Lack of Ease

Theme	n	Percent
Transporting – difficulties with transporting the device	29	59.2
Typing – difficulties with typing on the device	6	12.2
Other - responses that were atypical and/or did not fit into a subcategory	14	28.6

Table 22

Subthemes of Lack of Fun

Theme	n	Percent
Games – not be able to access games on the device	11	55.0
Other	9	45.0

Table 23

Subthemes of Technical Problems

Theme	n	Percent
Slow – the device or programs being slow to load or lagging	95	47.0
Instability – having the device or programs crash or glitch	27	13.4
Battery – having to keep the device plugged in or the battery dying	12	5.9
Mouse – difficulty using the mouse or mouse pad	9	4.5
Printing – difficulty printing from device	9	0.0
Small – device is too small	6	3.0
Keyboard – difficulties with using the keyboard	5	2.5
Old – device is too old	4	2.0
Cords – device has too many cords	3	1.5
Headphones – difficulties with using the headphones	3	1.5
Touch screen – difficulties with the touch screen	3	1.5
Other	26	12.9

Logistic Regression

Multinomial logistic regression was utilized to examine the proportion of variance accounted for by AT type (laptop, Chromebook, iPad), Grade (4-6, 7-8, 9-12), and qualitative themes from the open ended survey questions (nine for liking and 16 for disliking) on responses to each dependent variable (DV). The DVs were: enjoyed training (yes, maybe, no), thought AT training was helpful (yes, maybe, no), felt AT training was a good use of time (yes, maybe, no), and interested in learning more about AT and apps (yes, maybe, no). Since the factors in the model were not continuous, the assumptions of linearity of the logit and multicollinearity could not be assessed.

Q1: "I enjoyed training"

The initial model revealed that a significant proportion of the variance in responses to "I enjoyed training" was accounted for by the predictors, R^2 (Cox & Snell) = .09, R^2 (Negelkerke) = .17, Model $\chi^2(42) = 61.30$, $p = .027$. Due to issues of singularities in the Hessian matrix, non-significant predictors were removed (AT device, Grade, and Liking themes) and some categories of the significant predictor of disliking themes were removed (Themes of: *App Errors*, *Lack of Fun*, and *Internet Problems*) or merged (*Confusing* and *Lack of Ease* merged into *Difficulty*, *Stigma* and *Have to Use* merged into *Indignity*). Logistic regression revealed that children whose responses on what they disliked most about their AT were related to having to use their device or feeling stigma associated with using their device were 11.67 times more likely to respond "No" than "Yes" to "I enjoyed training." compared to children who responded in the comparison category (Themes of *Everything*, *Nothing*, *Not Sure*, *Redundancy*, and *Missed Class*, or *Blank*), $\beta = 2.46$, $SE = 0.88$, $p = .005$, R^2 (Cox & Snell) = .03, R^2 (Negelkerke) = .05, Model $\chi^2(2) = 18.40$, $p = .018$.

Logistic regression also revealed that children whose responses on what they disliked most about their AT were related to having to use their device or feeling stigma associated with using their device were 5.83 times more likely ($\beta = 1.76$, $SE = 0.71$, $p = .013$) to respond "Maybe" than "Yes" to "I enjoyed training." compared to children who responded in the comparison category. Children who responded with themes of the AT being difficult to use were 3.57 times more likely ($\beta = 1.27$, $SE = 0.41$, $p = .002$) to respond "Maybe" than "Yes" to "I enjoyed training." compared to children who gave comparison category responses. Finally, children who responded with themes of technical issues were 2.0 times more likely ($\beta = 0.68$, $SE = 0.34$, $p = .046$) to respond "Maybe" than "Yes" to "I enjoyed training." than those in the comparison category, R^2 (Cox & Snell) = .03, R^2 (Negelkerke) = .05, Model $\chi^2(2) = 18.39$, p = .018.

Table 24

Logistic Regression for Q1

	β (*SE*)	95% CI for Odds Ratio		
		Lower	Odds Ratio	Upper
No vs. Yes response				
Intercept	-3.96 (0.41)			
Difficulty	-0.03 (1.09)	0.12	0.97	8.24
Programs	0.56 (1.10)	0.20	1.75	15.02
Stigma/Have to use	2.46 (0.88)**	2.06	11.67	65.94
Tech	-0.12 (0.71)	0.22	0.89	3.58
No vs. Yes response				
Intercept	-2.86 (0.24)			
Difficulty	1.27 (0.41)**	1.60	3.57	7.96
Programs	0.15 (0.77)	0.26	1.17	5.27
Stigma/Have to use	1.76 (0.71)*	1.45	5.83	23.43
Tech	0.68 (0.34)*	1.01	1.97	3.82

*p < .05, **p <.01,

Q2: "I think training was helpful"

Logistic regression did not reveal a model that significantly accounted for the variance in responses to "I think training was helpful", R^2 (Cox & Snell) = .05, R^2 (Negelkerke) = .14, Model $\chi^2(42) = 35.67$, p = .744.

Q3: "I feel that training was a good use of my time"

The initial model did not reveal a model that significantly accounted for the variance in responses to "I feel that training was a good use of my time", R^2 (Cox & Snell) = .08, R^2 (Negelkerke) = .12, Model $\chi^2(42) = 53.70$, p = .107. However, since the initial model revealed that AT Device was a significant predictor ($\chi^2(4) = 12.58$, p = .014) and indicated problematic factors, this model was further refined. Due to issues of singularities in the Hessian matrix, non-significant predictors (Grade, Liking theme, and Disliking theme) were removed and categories of AT Device were merged (iPad and Chromebook). Logistic regression revealed that children allocated Laptops are 4.45 times more likely to respond “No” than “Yes” to “I feel that training was a good use of my time” compared to children allocated iPads or Chromebooks, $\beta = 1.49$, *SE* = 0.74, $p = .045$, R^2 (Cox & Snell) = .01, R^2 (Negelkerke) = .01, Model $\chi^2(2) = 6.12$, $p = .047$.

Table 25

Logistic Regression for Q3

	β (*SE*)	95% CI for Odds Ratio		
		Lower	Odds Ratio	Upper
No vs. Yes response				
Intercept	-4.31 (0.71)			
Device	1.15 (0.74)	1.04	4.45	19.11
Maybe vs. Yes				
Intercept	-1.83 (0.22)			
Device	0.14 (0.26)	0.69	1.15	1.89

Q4: “I am interested in learning more about my device and apps”

The initial model revealed that a significant proportion of the variance in responses to “I am interested in learning more about my device and apps” was accounted for by the predictors, R^2 (Cox & Snell) = .13, R^2 (Negelkerke) = .16, Model $\chi^2(42) = 87.04$, $p < .001$. Due to issues of singularities in the Hessian matrix, non-significant predictors (AT Device and Liking theme) were removed and one category of Disliking theme was removed (*Have to Use*). Categories of *Missed Class* and *Redundancy* were merged (*Wasted Time*). The final model included two variables Dislike theme ($\chi^2(18) = 31.82$, $p = .023$) and GradeGroup ($\chi^2(6) = 17.05$, $p = .009$), R^2 (Cox & Snell) = .08, R^2 (Negelkerke) = .10, Model $\chi^2(2) = 52.62$, $p = .001$.

For grade, logistic regression revealed that children in grades 4-6 were 2.86 times less likely ($\beta = -1.05$, *SE* = 0.36, $p = .003$) and children in grades 7-8 were 2.43 times less likely ($\beta = -0.89$, *SE* = 0.38, $p = .021$) to respond “No” than “Yes” to “I am interested in learning more about my device and apps.” in comparison to children in grades 9-12. Additionally, children in grades 2-3 were 3.23 times less likely (β = -1.17, *SE* = 0..59, *p* = .047) and children in grades 4-6 were 1.79 times less likely (β = -0.58, *SE* = 0.28, *p* = .037) to respond "Maybe" than "Yes" to "I am interested in learning more about my device and apps." in comparison to children in grades 9-12.

For disliking theme, logistic regression revealed that children who responded to "What do you like least about your AT" with themes of *Wasted Time* were 7.78 times more likely (β =2.05, *SE* = 0.87, *p* = .018) to respond "No" than "Yes" to "I am interested in learning more about my device and apps." compared to children who responded in the comparison category (Themes of *Have to Use*, *Everything*, *Nothing*, and *Not Sure*, or *Blank*). Additionally, children who responded with themes of technical problems were 1.86 times more likely (β = 0.62, *SE* = 0.23, *p* = .007) to respond "Maybe" than "Yes" to "I am interested in learning more about my device and apps." compared to children who responded in the comparison category.

Table 26

Logistic Regression for Q4

		95% CI for Odds Ratio		
	β (*SE*)	Lower	Odds Ratio	Upper
No vs. Yes response				
Intercept	-1.41 (0.34)			
App Errors	1.10 (0.63)	0.87	2.99	10.30
Confusing	0.35 (0.81)	0.29	1.42	6.86
Ease	-0.57 (0.77)	0.13	0.57	2.55
Fun	0.57 (0.81)	0.37	1.77	8.58
Internet	1.19 (0.62)	0.98	3.29	11.12
Programs	0.61 (0.60)	0.57	1.84	5.96
Stigma	1.02 (1.15)	0.29	2.77	26.09
Tech	0.37 (0.34)	0.74	1.44	2.79
Wasted time	2.05 (0.87)*	1.43	7.78	42.32
Grades 2-3	-0.85 (0.62)	0.13	0.43	1.45
Grades 4-6	-1.05 (0.36)**	0.18	0.35	0.70
Grades 7-8	-0.89 (0.38)*	0.19	0.41	0.87
No vs. Yes response				
Intercept	-1.01 (0.27)			
App Errors	-1.16 (1.06)	0.04	0.31	2.49
Confusing	-0.44 (0.79)	0.14	0.65	3.02
Ease	0.52 (0.37)	0.81	1.68	3.47
Fun	0.95 (0.51)	0.95	2.59	7.08
Internet	-1.10 (1.05)	0.04	0.33	2.62
Programs	0.73 (0.43)	0.90	2.07	4.78
Stigma	1.11 (0.79)	0.65	3.03	14.17
Tech	0.62 (0.23)**	1.19	1.86	2.90
Wasted time	1.25 (0.84)	0.67	3.48	17.97
Grades 2-3	-1.17 (0.59)*	0.10	0.31	0.98
Grades 4-6	-0.58 (0.28)*	0.33	0.56	0.97
Grades 7-8	-0.08 (0.29)	0.53	0.93	1.62

*$p < .05$, **$p < .01$

Chapter 4: Discussion

Research Question 1: What do children like (and dislike) about their AT?

Grade, device, and disliking theme all were factors that influenced children's perceptions of training, while the liking theme was not an influential factor. The disliking theme was the only factor that influenced perceptions on more than one question (Q1: "I enjoyed training" and Q4 "I am interested in learning more about my device and apps"). In general, children who were older, had laptops, felt that training was a waste of time, or who disliked aspects of their device pertaining to emotionally unpleasant experiences, practical issues, or redundant programs/features tended to have less positive perceptions of training.

The factor that influenced whether children enjoyed AT training was what they liked least (or disliked) about their AT. Specifically, children who reported disliking aspects that were emotionally unpleasant or practically challenging tended to enjoy training less. Children who disliked aspects of their device related to feeling like they had to use it ("Sometimes I do not need to use it but I am made to") or feeling stigma associated with using it ("I don't like using it in front of the whole class") were less likely to enjoy AT training. Children who felt like their device was difficult to use ("The difficulty, I don't get it") or experienced technical problems with their device ("Sometimes it loads really slowly and sometimes it freezes") were also less likely to enjoy AT training.

No factors influenced whether children found training to be helpful. The overwhelming majority (94%) of children found training to be helpful. Due to the lack of variance in responses to this question, it was not surprising that there was not an appropriate model to account for differences.

The factor that influenced whether children found training to be a good use of their time was AT device type. Children who had iPads or Chromebooks were more likely to perceive training as a good use of their time. This finding may be influenced by the fact that children with iPads found their devices to be more fun and like the programs more than children with laptops. Students with laptops also found their devices to be more difficult to use than students with Chromebooks, and to have more technical problems than students with iPads. The difficulty students experienced using their laptops, as well as the perception that laptops are not very fun likely influenced children's perceptions of the usefulness their training time.

The factors that influenced whether children wanted to learn more about their AT were their grade level and what they disliked about the device. Children in elementary school (grades 2-8) were more likely to want to learn more about their AT than children in high school (grades 9-12). Perhaps due to their age and having more exposure to technology, older children did not feel like they needed to learn more about their AT. Additionally, some of these older children may have been completing retraining (they had previously used a different device and were training on a new device), and therefore had some experience with the same or similar programs. Children who perceived their time being wasted or the device having some redundancies ("It takes away time from class" "Useless apps that I never use") or who experienced technical problems with their device were less likely to want to learn more about their AT.

Research Question 2: Which apps (or features) do children think will help make their school work better?

The proportion of children responding "Yes" to specific apps making their school work better ranged greatly (0% to 95%) across the different apps over all the years of the study. Due to the different presenting difficulties of the children (LDs with difficulties in reading, writing, math, or other), the different hardware types, and changes within the school boards there are different sample sizes for each application depending on what that child was trained on using.

The apps with the most positive response rates overall (over 90%) were Google Drive, ClaroPDF, Presentations, and Documents. Of these four programs, three are used on the Chromebook (Google Drive, Presentations, and Documents), and one is an iPad programs (ClaroPDF). Not surprisingly, three of the four most positively endorsed programs (Google Drive, Presentations, and Documents) are used regularly by all students in the WECDSB for completing, submitting, and presenting school work. However, ClaroPDF, a text-to-speech software program, was also endorsed very positively. In addition to presenting text aloud, ClaroPDF allows users to highlight and underline text, make annotations, notes, and comments, and insert images and shapes on PDF documents. Although the sample size for ClaroPDf was very small (n = 13), this program seems to be perceived as useful for the majority of users.

Findings during the most recent school year studied (2015/16) were similar. In 2015/16, Google Drive, Presentations, and Documents were among the top four applications. ClaroPDF was not supplied to students in 2015/16, and iBooks was rated positively by all three students trained in its use (note the very small sample size). iBooks allows users to read or listen to eBooks.

The proportion of children responding “Yes” to specific apps making their school work better ranged from 62% to 92% across the different text-to-speech apps. The text-to-speech apps with over three-quarters responding “Yes” overall were ClaroPDF, iPad Speak Selection Feature, Read&Write, and Prizmo. Premier Literacy and Kurzweil 3000 had less positive ratings, with approximately two-thirds of children perceiving them as helpful. Given that these programs are designed to accomplish the same thing (reads electronic text aloud to the user while simultaneously displaying it on screen), these differences provide a useful comparison of the perceived utility of the software by children. In the 2015/16 school year, ClaroPDF and Prizmo were no longer allocated to children. Ratings overall were slightly less positive, with three-quarters of children perceiving iPad Speak Selection Feature and Read&Write as helpful, half of the children perceiving Premier Literacy as helpful and none of the children sampled perceiving Kurzweil 3000 as helpful. Of note, a very small sample (n = 3) rated Kurzweil in 2015/16.

The proportion of children responding “Yes” to specific apps making their school work better ranged from 64% to 86% across the different speech-to-text apps. The speech-to-text apps with the most positive response rates overall (75% and above) were iPad Dictation Feature, Read&Write, and Dragon Naturally Speaking. VoiceNote II had a slightly less positive rating at about two-thirds. These software programs also are designed to accomplish the same thing (transcribes speech into text that can then be edited) and these ratings provide a useful comparison between these programs. Although in the 2015/16 school year ratings were very similar, Read&Write was rated slightly more positively than iPad Dictation Feature.

The results of the current study regarding children’s perceptions of their AT software can assist decision makers (i.e., school boards or other suppliers) regarding which programs children perceive as useful. If children do not perceive the allocated software programs to be useful and will not make use of them, funding for these is not well spent. These differences also speak to which AT hardware may be the most and least useful. When looking at the software ratings for all apps for all years, the top five most highly rated apps are all used on Chromebooks and iPads (none of laptops). Out of the top ten, five are iPad apps, three are Chromebook apps, and only two are laptop apps. For text-to-speech software a similar pattern emerges, with laptops programs (rated fifth and sixth out of six) being rated less favourably than iPad or Chromebook programs.

Research Question 3: What factors influence children perceiving training as enjoyable, helpful, and useful, and being interested in learning more?

Of the eight themes that emerged in response to "What do you like most about your [AT type]?", children most often responded that their device was helpful for the completion of their school work, with half of responses coded into this theme. This highlights that many of the children surveyed do view their devices as being helpful. Nearly one-fifth of children responded by mentioning a specific program, or aspect of a specific program, that they liked or found helpful. Just over one-tenth of students mentioned aspects of their device that they liked (e.g., accessibility, portability, and versatility). Students with laptops tended to highlight the helpfulness of their devices more than children with iPads. Whereas, children with iPads tended to highlight fun aspects or specific programs that they liked in comparison to those with laptops. These findings provide important information comparing laptops and iPads, and demonstrate that both device types have aspects that children like.

Of the 15 themes that emerged in response to "What do you like least about your [AT type]?", students most often responded that they experienced technical problems with their device (e.g., device was slow, crashed or glitched, and needed to be charged frequently), with almost a third of responses falling into this category. One-quarter of students responded that there was nothing they disliked about their device. This positive finding may be exaggerated by children not feeling comfortable or being unsure of saying what they disliked in the presence of the AT trainer. Students with laptops were more likely to respond that their device was difficult to use than those with Chromebooks. Those with laptops were also less likely to experience problems with specific programs and more likely to experience technical problems with their device than those with iPads. Although laptops may experience more technical problems and present some barriers to ease of use, the specific programs seem to have fewer problems. Despite the programs having fewer problems, the ratings of specific apps revealed that many of the children did not perceive many of the laptop programs as useful.

Strengths of the present study

There is currently a very limited body of research examining the use of AT, and no published data on the distribution or training of AT. The current study provided data on the distribution, training, and perceptions of AT by a large sample of 656 school aged children. The sample had a wide age range (grades 2 – 12) and was collected from various schools in Windsor and Essex County, Ontario. Given the various schools sampled from urban and rural areas, with different ethnic and socioeconomic student populations this sample is representative of children within a mid-sized Ontario city and the surrounding rural county who have been diagnosed with LDs or identified as having an exceptionality based on the Ministry of Education criteria.

The current study also included a large number of software programs and allowed for the comparison between three different hardware devices. Furthermore, the time frame of the study allowed for an analysis of how things have changed within the two local school boards in regard to hardware and software programs being allocated to children. Lastly, the qualitative analysis provided an exploration of children's perceptions of their AT, which can be helpful in understanding what factors may be preventing some children from making use of their AT.

Limitations of the present study

One of the major limitations of the current study was the use of archival surveys that lacked information on specific diagnoses or exceptionalities. Future research would benefit from collecting data regarding the child's specific area(s) of difficulty to better understand the perceived usefulness of each software program for different presenting problems. For example, children with reading difficulties would likely benefit more from text-to-speech software than children with difficulties in mathematics. The surveys also lacked information on the child's age (although grade was recorded) and gender. Gender data would be beneficial for future research to collect to determine if there are gender differences in the perceptions of AT. The surveys used in the current study did not include any way to link the data. Considering that children receive initial training and sometimes supplementary training, being able to link the data to ensure independence of observations (in case the same child completed two surveys as part of the study) and to evaluate changes over time by using the linked initial and supplementary survey date would be beneficial in future research.

Another limitation of the current study is the lack of standardization in the administration of surveys. Some surveys were completed through an interview format, whereas others were completed more independently. Some AT trainers scribed the responses for the students (if they had writing difficulties). There were also different methods of completion, some children completed surveys on paper, whereas some completed surveys on their device. Given the lack of standardization, there may have been differences accounted for by how the trainer instructor or assisted the student in completing the surveys (e.g., how they introduced the task or if they provided suggested responses). If the AT trainer was present during the administration, that could also have introduced some demand characteristics, where responses may have been positively biased due to possible discomfort the child may have had providing negative feedback in the presence of a trainer they had just worked with for hours. Future research would benefit from employing standard administration procedures when children fill out surveys.

Another limitation of the current study was missing data. The proportion of missing data was very low with a range of 0.3% to 2% missing for each variable. The missing data did not appear to be missing at random, which was unsurprising due to some AT trainers and children not filling out multiple areas on surveys and some areas (such as grade) being left blank more often than other areas. Future research would benefit from checking surveys to ensure that both the children surveyed and those administering the surveys are filling out all required fields.

Implications

The current study provides the first empirical data of the distribution, training, and perceptions of utilization of AT by school-aged children with LDs. The findings of the current study provide data that can guide AT distributors (e.g. school boards) in which AT hardware and software they purchase and provide for children with LDs. It is not uncommon for those who work with children or adults with LDs to find that they are not using the AT provided for them. It is important to know what hardware devices and software programs are perceived as being helpful, since those perceptions likely influence whether the individual continues to make use of the AT. These findings can also be helpful to individual consumers purchasing their own AT, and practitioners who may recommend specific AT hardware or software to clients with LDs, as there is very little research that has evaluated or compared specific device types and software options.

The current study also shows the positive perceptions children have of AT training. Chmiliar (2007) found that teachers endorsed the amount of time needed to be proficient in the use of AT as the second biggest barrier to AT use in the classroom. Additionally, more than two-thirds of the teachers surveyed had never had any AT training (Chmiliar, 2007). This study provides evidence that AT training is perceived as enjoyable, helpful, and a good use of students' time. It can therefore contribute to establishing best practices in the allocation of AT by supporting the standard of providing training to students and teachers in the use of AT.

Future research would benefit from a larger study examining the outcomes of training, specific AT hardware and software, and perceptions of AT training, hardware, and software on academic functioning and continued device use. Including an initial survey component in a larger study (either after training has been completed or after the AT has been allocated in the absence of training) examining academic achievement using objective measures would add to the AT literature by providing insight into how training, AT hardware and software, and initial perceptions influence both the use of AT over time and its influence on academic achievement. More research is also needed to guide best practices of the distribution, training, utilization, and perceptions of AT given the currently limited body of AT literature.

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Appendix A

Types of Assistive Technology Software

Type of Software	Description	Specific Programs
Text-to-Speech (Text-to-Voice)	Reads electronic text (including web pages) aloud while simultaneously displaying it on screen. Many include synchronized highlighting, customized voice and rate of speech, note insertion, and translation. Helpful for individuals with reading difficulties and auditory learners.	Kurzweil 3000 Premier Literacy iPad Speak Selection Feature Prizmo ClaroPDF Read&Write
Dictation (Speech-to-Text)	Transcribes speech into text. Uses voice commands to add new paragraphs, punctuation, or emojis, and to execute computer functions. Text can then be edited. Helpful for individuals with difficulty in written expression.	Dragon Naturally Speaking iPad Dictation Feature VoiceNote II Read&Write
Word Prediction	Presents a list of commonly used words from a drop down menu. Desired word can be selected by listening to the listed words. Suggested words are influenced by past word usage and context. Helpful for individuals with difficulty in written expression.	WordQ Premier Literacy Read&Write
Graphic Organizers (Visual learning tools)	Tool for the creation of tables, graphs, diagrams, timelines, and flowcharts to develop, organize, and present ideas, concepts, and information. Many programs provide templates to target specific skills (sequencing, compare and contrast).	Smart Ideas Kurzweil 3000 Popplet Idea Sketch+ Inspiration Mindomo Tools4Students

	Helpful for individuals with difficulty organizing ideas and for visual learners.	
Talking Word Processors	Provide speech feedback as the individual writes (i.e. reads back letters, words, etc.). Some programs have addition features, such as: writing templates, spell checking, picture insertion, sentence building, and confusable word support (helps to choose correct word from commonly confused words).	Clicker 5 Premier Literacy Kurzweil 3000
Text Summarizers	Summarize large chucks of text using language model algorithms. Student determines percentage presented.	Premier Literacy Read&Write
Optical Character Recognition	Converts scanned documents into electronic text that can be edited and recognized by screen readers. Some programs require a scanner; others convert pictures taken with the device.	Kurzweil 3000 (scanner needed) Premier Literacy (scanner needed) Prizmo (converts pictures) CamScanner (converts pictures)
Digital planner and notebook	Organize and store lessons Organize and plan tasks	Smart Notebook
Word processor		Microsoft Word Pages
PDF editors	Read and markup pdfs. Can draw, highlight text, add notes, add photos, add stamps	Neu.Annotate+ PDF ClaroPDF
Note taking app	Can add notes to documents by either typing or writing them with a finger or stylus	Microsoft OneNote
eBook reader	Read electronic books	iBooks
Interactive screencasting white board app	Annotate, animate, narrate, import, and export files	Explain Everything
Presentation creator	Create and deliver presentation Can collaborate with others	Keynote Presentations
Book writing support	Create and publish eBooks	Book Creator
E-mail	Send, receive, and organize	Gmail

	emails	
Time-management organizer	Schedule events and plan tasks	Calendar
File Storage	Store and synchronize files Can share and edit documents, spreadsheet, and presentations	Google Drive
Document organizer	Organize documents	Documents

Appendix B

Assistive Technology Initial Student Training Process for Laptops (GECDSB)

Initial Student Training	
Programs Covered	**Training Time (hours)**
Premier Tools	1
Dragon Naturally Speaking	2
Word Q	1
Hardware, file organization, word processing	1
Total	**5 Hours**

Assistive Technology Initial Classroom Training Process for Laptops (GECDSB)

Initial Classroom Training	
Programs Covered	**Training Time (hours)**
Premier Tools	1.5
Smart Ideas or Clicker 5	1
Word Q	0.5
Total	**3 Hours**

Assistive Technology Initial Student Training Process for iPads (GECDSB)

Initial Student Training	
Programs Covered	**Training Time (hours)**
Accessibility features, organization (Dropbox, One Note, Google Drive)	1
CamScanner, Neu.Annotate	1
iWordQ, Popplet	1
Total	**3 Hours**

Assistive Technology Initial Classroom Training Process for iPads (GECDSB)

Initial Classroom Training	
Programs Covered	**Training Time (hours)**
OneNote	1
CamScanner, Neu.Annotate	1
Idea Sketch	1
Total	**3 Hours**

Assistive Technology Supplementary Training Process for Laptops (GECDSB)

Supplementary Student Training	
Programs Covered	**Training Time (hours)**
Hardware, file organization, word processing	0.5
Premier	1.5
Dragon	1
Smart Ideas	2
Smart Notebook and/or clicker 5	2
Total	**7 hours**

Assistive Technology Supplementary Training Process for iPads (GECDSB)

Supplementary Student Training	
Programs Covered	**Training Time (hours)**
Organization (Dropbox, One Note, Google Drive), word processing	1
iWordQ/Popplet	1
Review – based on student needs	1
Total	**3 hours**

Appendix C

GECDSB

iPad A/T Training: Student Evaluation

(To be completed at the end of Student Training)

To Be Completed by A/T Trainer: Final Training Date: ____________________

Training: ☐ Initial ☐ Supplementary Student Grade: ________

School Board: ☐ GECDSB ☐ WECDSB

To Be Completed by Student:

1.	I enjoyed iPad training.	Yes	Maybe	No
2.	I think iPad training was helpful.	Yes	Maybe	No
3.	I feel that iPad training was a good use of my time.	Yes	Maybe	No
4.	I am interested in learning more about my iPad and apps.	Yes	Maybe	No

I think the following apps (or features) will help make my school work better:

5.	Popplet	Yes	Maybe	No	N/A
6.	Idea Sketch+	Yes	Maybe	No	N/A
7.	iWordQ CA	Yes	Maybe	No	N/A
8.	Microsoft Word	Yes	Maybe	No	N/A
9.	CamScanner	Yes	Maybe	No	N/A
10.	Neu.Annotate+ PDF	Yes	Maybe	No	N/A
11.	Microsoft OneNote	Yes	Maybe	No	N/A
12.	iBooks	Yes	Maybe	No	N/A
13.	Dictation Feature	Yes	Maybe	No	N/A
14.	Speak Selection Feature	Yes	Maybe	No	N/A

15. What do you like most about your school iPad?

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16. What do you like least about your school iPad?

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GECDSB

Laptop A/T Training: Student Evaluation

(To be completed at the end of Student Training)

To Be Completed by A/T Trainer: Final Training Date: ____________________

Training: ❑ Initial ❑ Supplementary Student Grade: ________

School Board: ❑ GECDSB ❑ WECDSB

To Be Completed by Student:

1.	I enjoyed laptop training.	Yes	Maybe	No
2.	I think laptop training was helpful.	Yes	Maybe	No
3.	I feel that laptop training was a good use of my time.	Yes	Maybe	No
4.	I am interested in learning more about my laptop and apps.	Yes	Maybe	No

I think the following apps (or features) will help make my school work better:

5.	Premier Literacy	Yes	Maybe	No	N/A
6.	Kurzweil 3000	Yes	Maybe	No	N/A
7.	Dragon NaturallySpeaking	Yes	Maybe	No	N/A
8.	Smart Ideas	Yes	Maybe	No	N/A
9.	WordQ	Yes	Maybe	No	N/A
10.	Clicker 5	Yes	Maybe	No	N/A
11.	Smart Notebook	Yes	Maybe	No	N/A

11. What do you like <u>most</u> about your school laptop?

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12. What do you like <u>least</u> about your school laptop?

____

____

WECDSB

iPad A/T Training: Student Evaluation

(To be completed at the end of Student Training)

To Be Completed by A/T Trainer: Final Training Date: ____________________

Training: ☐ Initial ☐ Supplementary Student Grade: ________

School Board: ☐ GECDSB ☐ WECDSB

To Be Completed by Student:

1.	I enjoyed iPad training.	Yes	Maybe	No
2.	I think iPad training was helpful.	Yes	Maybe	No
3.	I feel that iPad training was a good use of my time.	Yes	Maybe	No
4.	I am interested in learning more about my iPad and apps.	Yes	Maybe	No

I think the following apps (or features) will help make my school work better:

5.	Inspiration	Yes	Maybe	No	N/A
6.	Tools4Students	Yes	Maybe	No	N/A
7.	Explain Everything	Yes	Maybe	No	N/A
8.	iWordQ CA	Yes	Maybe	No	N/A
9.	Pages	Yes	Maybe	No	N/A
10.	Prizmo	Yes	Maybe	No	N/A
11.	ClaroPDF (or neu.Annotate+ PDF)	Yes	Maybe	No	N/A
12.	Keynote	Yes	Maybe	No	N/A
13.	Book Creator	Yes	Maybe	No	N/A
14.	iBooks	Yes	Maybe	No	N/A
15.	Dictation Feature	Yes	Maybe	No	N/A
16.	Speak Selection Feature	Yes	Maybe	No	N/A

17. What do you like <u>most</u> about your school iPad?

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18. What do you like <u>least</u> about your school iPad?

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WECDSB

Chromebook A/T Training: Student Evaluation

(To be completed at the end of Student Training)

To Be Completed by A/T Trainer: Final Training Date: ____________________

Training: ☐ Initial ☐ Supplementary Student Grade: ________

School Board: ☐ GECDSB ☐ WECDSB

To Be Completed by Student:

1.	I enjoyed Chromebook training.	Yes	Maybe	No
2.	I think Chromebook training was helpful.	Yes	Maybe	No
3.	I feel that Chromebook training was a good use of my time.	Yes	Maybe	No
4.	I am interested in learning more about my Chromebook and apps.	Yes	Maybe	No

I think the following apps (or features) will help make my school work better:

5.	Gmail	Yes	Maybe	No	N/A
6.	Calendar	Yes	Maybe	No	N/A
7.	Google Drive	Yes	Maybe	No	N/A
8.	Documents	Yes	Maybe	No	N/A
9.	Presentations	Yes	Maybe	No	N/A
10.	Read&Write	Yes	Maybe	No	N/A
11.	Mindomo	Yes	Maybe	No	N/A
12.	VoiceNote II	Yes	Maybe	No	N/A

13. What do you like most about your school Chromebook?

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14. What do you like least about your school Chromebook?

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____

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