# Cross-Cultural Study into the use of Text to Speech with Electronic Files to aid access to Textbooks

E.A. Draffan[a 1], Mike WALD[a], Mamoru IWABUCHI[b], Maiko TAKAHASHI[b], Kenryu NAKAMURA[b]
[a] *ECS, University of Southampton, UK*
[b] *RCAST, the University of Tokyo, Japan*

**Abstract.**

**Objective** At present, pupils, teachers and parents struggle with the lack of textbooks and supporting materials in accessible formats that can be used by pupils with visual or print impairment including specific reading difficulties such as dyslexia. Independent projects in Japan and the UK were conceived to assess whether the provision of textbooks and teaching materials as electronic files, along with technologies to convert and 'read' them could provide a new and sustainable model and enhance the skills of the users.

**Main Content** In the UK, 40 students with print impairment were presented with Microsoft Windows XP system laptops that had specialist text to speech software. The software either provided full screen reading with highlighting and magnification or a tool bar above the etext provided in MS Word document format. The latter allowed for text resizing, colour changes, reading speed options, voice preferences and text highlighting. In Japan, Apple iPads were given to 30 self-selecting students (some of whom were dyslexic) over a period of 10 weeks. There was the option to use a 'Touch and Read' application which offered text to speech and phrase highlighting with an outlined box around the characters in vertical mode. These etext books were presented in PDF format with the same look and feel as the actual text books used by the rest of the class.

**Results** Over 90% of the students involved in the projects aged between 10 and 14 years showed improvements in self-esteem, continued to be motivated and there were clear indications that the use of the technology aided both reading skills and confidence levels. Teachers supporting the students in the UK study commented on significant improvements in reading skills for those who had dyslexia and improved concentration for those with visual impairments. Time saved by the use of electronic texts was also commented upon in relation to the provision of alternative formats. In the Japanese study, students chose to use the 'Touch and Read' software preferring the look and feel of the original text books and without training soon learnt to zoom and scroll on the iPads.

**Conclusion** The projects confirmed that making teaching materials available to print and visually impaired students in an appropriate electronic form along with access technologies to read them can make a significant difference to their reading, writing, confidence, development and inclusion. The same electronic materials can also provide productivity savings for staff in schools and local authorities who support, in particular, visually impaired students.

**Keywords.** Alternative formats, etexts, text to speech, print impairment, laptops and iPads

[1] Correspondence author, ead@ecs.soton.ac.uk

## Introduction

Ease of access to teaching and learning materials is rarely considered an issue for most students. The time taken to find a chapter or read a page within a textbook when a teacher is discussing a particular topic is rarely considered an issue. However, this is a matter of some concern for the student who needs provision of paper-based text in a different format, such as Braille, audio or large print. There may be a delay before they receive the alternatives and they may even have to drop out of the class to receive extra support or attempt to catch up at another time.

Studies in the UK and Japan have shown that there is a paucity of accessible textbooks at all levels of education for those with print impairment. For the purposes of this paper print impairment includes those who are blind, visually impaired (VI) or have a specific difficulty with reading such as dyslexia. In this case dyslexia is described as a specific learning difficulty, which mainly affects the development of literacy and language related skills.[1] None of the students who took part in this study appeared to have physical or intellectual difficulties that would affect their use of the technologies.

The 'Right to Read' campaign estimated that one in eight of the UK population cannot enjoy 'standard print' and "that the education of over 20,000 blind and partially sighted children is being affected by not getting textbooks in a format they can read."[2] Pennington [3] suggested that up to 10% of the population show some signs of dyslexia. In Japan statistics for disability do not have a classification for print impairment, but around 2.5 per cent of the school population has a difficulty with reading and writing.

Both the study in the UK and Japan were pilot projects, undertaken with a small number of students, to see whether the provision of textbooks and teaching materials as electronic files, along with technologies to convert and 'read' them, could provide a new and sustainable model for the provision of alternative formats and enhance the skills of the users

## 1. Background to the Projects

In the UK, the University of Loughborough [4] undertook a survey that estimated the number of accessible textbooks available to schoolchildren aged 11 to 16 years. The report summary showed that many textbooks were not available in alternative format such as Braille, Daisy format, simple audio or large print, and that there were major differences between school subjects. 80% of the English Literature textbooks were available in accessible format compared to 21% in Mathematics and 14% for Science. The only reported figures for accessible textbook provision in Japan, relate to the provision of 11,298 Braille or large print textbooks in 2006, to 634 elementary and junior high school students who were blind or had low vision. [5]

In both countries preparation of teaching materials in alternative formats is carried out by many different individuals depending on the situation and type of materials required. Subject teachers, teaching assistants, special needs coordinators or specialist producers who may be situated in transcription centres or work as part of the team within the school district may all be involved. Some schools have a specialist resource centre as part of their disability support, but even with the close proximity of experts in the provision of alternative formats; it takes time to develop these materials.

When planning and implementing the projects, it was felt essential to involve all those involved in supporting the student with those developing the chosen technologies to ensure the best outcomes. To speed the process of access to materials, it was also felt essential that there should be a consistency as to file format and that students should be in control of the technologies they wished to use to read their documents. Both projects set out to examine whether electronic media and access technologies could be used in a cost effective and sustainable manner to the benefit of all involved.

## 2. Method

It was coincidental that both the Universities of Southampton and Tokyo were involved in similar projects with each team working with a group of self-selecting students and teachers. Those involved in the software development provided support and adaptations to the software to suit user needs. In the UK, specialist producers were willing to trial the create and convert technologies having received Microsoft Word files to further enhance the look of graphical and scientific documents from the textbooks.

Despite the similarities between the two projects and the outcomes achieved, there were also distinct differences in the way the files were delivered to students, their format and reading methods. These aspects of the projects are described in more detail in the following sections.

### *2.1. UK Accessible Resources Pilot Project*

The UK project team included Dolphin Computer Access, who specialise in software for those with visual impairment and dyslexia, Inclusive Technology who provide training and support in these technologies plus the support of specialist tutors, producers, schools and students for the academic year 2009/2010.

19 students with VI and 21diagnosed as having dyslexia aged between 11 – 14 years, from nine schools in the north of England, took part in the project. All undertook an initial questionnaire related to their use of technology and how easy they found accessing their teaching and learning materials. They were each provided with a 15 inch screen laptop running the Microsoft Windows XP operating system with either the SuperNova screen reader or TextHelp Read and Write, ClaroRead, or Easy Tutor text to speech software. In addition EasyConverter with Easy Reader enabled students to convert their own files to a chosen alternative format. MP3 digital players were also provided. Similar conversion technologies were also made available to 10 ‘specialist producers’. Staff and pupils were trained in the use of software. Interviews were undertaken towards the end of the project and a simple progress questionnaire was given to the teachers. Textbooks were converted into structured electronic files in MS Word format using a standard specification. [6]

Depending on the school’s facilities students received the files via the school intranet or on a USB pen drive. They then made a decision as to whether they wished to convert their MS Word files further, for example into audio to listen on the MP3 player or Daisy format for navigable audio reading. Most students tended to use their screen reader or text to speech software with text highlighting or colour changes to suit their needs.

*2.2. Japan iPad Project*

The Japanese iPad project involved a team from the University of Tokyo, including the developer of the Touch and Read software, used in two schools with specialist support tutors and teachers over a period of 10 weeks.

Nineteen students chose to use the technologies to read alongside their peers who had textbooks. The students, aged between 6-13 years (Grade 1-6) did not necessarily have any reading difficulties, although during the project it was discovered that several had reading difficulties including dyslexia. The students, who were given iPads, had a choice of three e-textbook readers. 'Touch and Read' (TR) prototype software was uploaded to the iPads plus the iBooks and iBunko HD applications. The digital version of the textbooks were loaded onto the devices by the developer in Adobe Portable Document Format (pdf), so that the students had a digital replica of the book as seen by their peers. The text was highlighted as the words or phrases were read out, by the synthesised speech. Students were able to pinch and zoom pages to increase font sizes on the touch screen and swipe to turn pages.

Questionnaires were given to the teachers about each student before and after the project and marks from previous reading tests were gathered along with test scores at the end of the project. Students' comments were collated and comparisons were made between those who read the text from books and those who used the technologies.

## 3. Results

As each project team gathered its results in a different way over different periods with students who used different technologies this section has also been divided. Notwithstanding these differences, the results were surprisingly similar with time savings and skill improvements alongside the building of self -esteem and an enjoyment in the use of the technologies, despite issues outside the control of the researchers, such as the weather, absences and technology difficulties.

*3.1. UK Accessible Resources Pilot Project*

In the initial questionnaire students were asked about their use of computers both at school and at home and 85% were able to access a computer at home with 67% acknowledging a need to change the settings on their desktop (76% changed their settings by the end of the project) and just over half the students used assistive technologies (AT) (52%). By the end of the project there was 100% use of AT with personalised settings on the majority of laptops.

Anecdotal evidence from discussions with students highlighted the improved ease of access to textbooks and the questionnaire scores, on the scale of 1 to 6 (low to high), showed improvement from 38% to 63% with the use of SuperNova, and their conversion software for those with VI and text to speech for those with dyslexia. The latter tended to comment on the type of voice and its impact on friends and relations along with positive use of text highlighting and spell checking features.

On a scale of 1 to 6, 90% of all pupils interviewed rated the value of using a computer for their schoolwork as a 4-6, 48% rated it as 6. 40% of pupils commented that they felt they had improved in their schoolwork. Those teachers supporting the students completed a form marking progress in students' reading, writing, achievement

levels, confidence, attendance and homework completion during the time of the project. No one selected the 'significant deterioration' or 'deterioration' leaving results for 'No change', 'improvement' and 'significant improvement' divided between those with Dyslexia (Dys) and Visual Impairment (VI) as seen in Table 1.

| | Dys(1)VI(2) | Mean | Std. Deviation | N |
|---|---|---|---|---|
| **Reading** | Dyslexic | .86 | .655 | 21 |
| | VI | .37 | .496 | 19 |
| | Overall | .62 | .628 | 40 |
| **Writing** | Dyslexic | .86 | .655 | 21 |
| | VI | .74 | .562 | 19 |
| | Total | .80 | .608 | 40 |
| **Achievement** | Dyslexic | .86 | .655 | 21 |
| | VI | .89 | .737 | 19 |
| | Overall | .87 | .686 | 40 |
| **Concentration** | Dyslexic | .71 | .784 | 21 |
| | VI | 1.21 | .713 | 19 |
| | Overall | .95 | .783 | 40 |
| **Attendance** | Dyslexic | .19 | .602 | 21 |
| | VI | .00 | .000 | 19 |
| | Overall | .10 | .441 | 40 |
| **Homework completion** | Dyslexic | .48 | .750 | 21 |
| | VI | .63 | .597 | 19 |
| | Overall | .55 | .677 | 40 |

**Table 1**. Number of students showing changes in abilities in certain areas

Further analysis of the results showed differences between the mean improvement scores depending on whether the student was dyslexic (Dys) or had a visual impairment (VI), where 'significant improvement' was scored '2', and 'improvement' was scored '1'.

| | **Reading** | | **Writing** | | **Achieve-ment** | | **Concen-tration** | | **Attendance** | | **Homework completion** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Progress for n of students** | **Dys** | **VI** | **Dys** | **VI** | **Dys** | **VI** | **Dys** | **VI** | **Dys** | **VI** | **Dys** | **VI** |
| no change | 6 | 12 | 6 | 6 | 6 | 6 | 10 | 3 | 19 | 19 | 14 | 8 |
| improvement | 12 | 7 | 12 | 12 | 12 | 9 | 7 | 9 | 0 | 0 | 4 | 10 |
| significant improvement | 3 | 0 | 3 | 1 | 3 | 4 | 4 | 7 | 2 | 0 | 3 | 1 |

**Table 2.** Descriptive statistics for the two groups.

The multivariate analysis of variance (MANOVA) shows that, overall the 6 areas of progress taken together, there is a significant amount of improvement in both groups, Pillai's Trace (Intercept) = 0.728, $F = 14.7$ (6,33), $p < 0.01$ and there is a significant difference in the amount of improvement between the Dyslexic group and the 'VI' group, Pillai's Trace (Dyslexic vs VI) = 0.654, $F = 10.4$ (6,33), $p < 0.01$.

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Intercept | Pillai's Trace | .728 | 14.743[a] | 6.000 | 33.000 | .000 |
| Dys1VI2 | Pillai's Trace | .654 | 10.393[a] | 6.000 | 33.000 | .000 |

**Table 3.** Multivariate Tests ([a] exact statistic)

Apart from 'Attendance', both groups improved significantly on the remaining 5 areas of progress, the F values for Reading, Writing, Achievement, Concentration, and Homework completion all show $p < .01$. However, the two groups of Dyslexic and 'VI' showed significant differences in their improvement scores on only 2 of the 6 areas of progress, 'Reading' ($F = 6.97$ (1,38), $p < .05$) and 'Concentration' ($F = 2.46$ (1,38), $p < .05$). On the remaining 4 areas or progress, there is no significant difference in mean improvement score between Dyslexic and 'VI'.

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Intercept | Reading | 14.983 | 1 | 14.983 | 43.820 | .000 |
| | Writing | 25.344 | 1 | 25.344 | 67.558 | .000 |
| | Achievement | 30.614 | 1 | 30.614 | 63.359 | .000 |
| | Concentration | 36.956 | 1 | 36.956 | 65.490 | .000 |
| | Attendance | .362 | 1 | .362 | 1.900 | .176 |
| | Homework completion | 12.241 | 1 | 12.241 | 26.341 | .000 |
| Dys1VI2 | Reading | 2.383 | 1 | 2.383 | 6.968 | .012 |
| | Writing | .144 | 1 | .144 | .385 | .539 |
| | Achievement | .014 | 1 | .014 | .029 | .865 |
| | Concentration | 2.456 | 1 | 2.456 | 4.353 | .044 |
| | Attendance | .362 | 1 | .362 | 1.900 | .176 |
| | Homework completion | .241 | 1 | .241 | .518 | .476 |

**Table 4.** Tests of Between-Subjects Effects

### *3.2. Japan iPad Project*

The students taking part in the Japanese project answered questions that related to their enjoyment in the use of the iPad, how easy they found its use for reading, whether they found paper based reading easier and if they wanted to keep the device. (see Table 6)

| | | (1) enjoy | (2) easy to use | (3) printed text is easier | (4) keep using iPad |
|---|---|---|---|---|---|
| Grade 1 | Students used TR on iPad in Japanese class (n = 8) | 4.56 ( SD = 1.33) | 4.33 ( SD = 1.41) | 1.88 ( SD = 1.45) | 5.00 ( SD = 0) |
| | Students used iPad in free time (n = 16) | 4.56 ( SD =1.07) | 4.50 ( SD =1.32) | 3.66 ( SD =3.17) | 4.72 ( SD = .99) |
| Grade 4 | Students used TR on iPad in Japanese class (n = 7) | 4.43 ( SD =1.13) | 3.71 ( SD =1.25) | 2.43 ( SD =1.27) | 3.71 ( SD =1.38) |
| | Students used iPad in free time (n = 28) | 4.23 ( SD = .91) | 3.85 ( SD = 1.22) | 2.96 ( SD = 1.22) | 3.77 ( SD = 1.34) |
| Grade 6 | Students used TR on iPad in Japanese class (n = 8) | 4.86 ( SD = .38) | 4.57 ( SD = 1.13) | 1.71 ( SD = 1.25) | 4.57 (SD = .79) |
| | Students used iPad in free time (n = 23) | 4.73 ( SD = .63) | 4.23 ( SD = 1.02) | 2.81 ( SD = 1.10) | 3.86 ( SD = 1.13) |

**Table 6**. Response to the questionnaire

On a scale of 1(Absolutely disagree) to 5 (Absolutely agree) For each item, 2 × 2 ANOVA was conducted examining the effects by grade (Grade 1, 4 & 6) and by group (Students used TR in Japanese class, or other students who used the iPad, but not TR).

(1) I enjoyed using iPad in class - Despite the fact that there was no significant difference between the scores many students commented on their enjoyment of the use of the iPad in class (Fs < 1.5, n.s.).

(2) iPad easy to use - There was no significant difference seen in the scores but students commented highly on the ease of use of the iPad (Fs < 2.1, n.s.).
(3) iPad (TR) is easier to use than printed textbook - Students in the group who chose to use the iPad with TR found the technology significantly easier to use compared to textbooks (F (1, 83) = 8.15, p < .01). Those students who used textbooks but watched their peers using the technology had no definite opinions on the subject. (Fs < 1, n.s).
(4) I want to keep using iPad to learn - There were significant differences of opinions between the grades (F (2, 83) = 5.75, p < .01). The 1st graders scored this item higher than the 4th and 6th graders. 1st graders appeared to be more highly motivated to use the iPad for learning during school hours compared to older users. (Fs < 1.4, n.s).

The Japanese study also included an analysis of test results before and after the use of text to speech technologies when reading.

| | | Before | After | After - Before |
|---|---|---|---|---|
| Grade 1 | Students used TR (n = 8) | 95 ( SD = 9.26) | 92.5 ( SD = 14.88) | -2.5 |
| | Other students (n = 16) | 92.94 ( SD =10.00) | 94.12 ( SD = 8.94) | 1.18 |
| Grade 4 | Students used TR (n = 7) | 82.86 ( SD =18.90) | 94.71( SD =7.45) | 11.85 ** |
| | Other students (n = 28) | 94.29( SD =8.36) | 95.36 ( SD =9.62) | 1.07 |
| Grade 6 | Students used TR (n = 8) | 74.38 ( SD =17.48) | 98.25 ( SD =2.92) | 23.87 ** |
| | Other students (n = 23) | 84 ( SD =9.97) | 97.39 ( SD = 4.80) | 13.39 ** |

**Table 7.** Test results - + $p < .10$, * $p < .05$, ** $p < .01$ (Grade 1, 4 and 6 corresponds to age ranges of 6-7, 10-11 and 12-13, respectively)

For each grade, 2 × 2 ANOVA was conducted to examine the effects on the group (using and not using Touch & Read (TR) and the time taken to read (pre or post-test). The results for those in the 4th grade gave a marginal significant difference ($F$ (1, 33) = 3.45, $p < .08$) and the effect of the time was significant ($F$ (1, 33) = 5.22, $p < .05$). Analyses of the simple main effects revealed a significant effect on time for the group of students using TR ($F$ (1, 33) = 8.79, $p < .01$) This group's scores also significantly improved through the use of TR. Time differences were significant for the 6th graders, ($F$ (1, 29) = 62.28, $p < .01$). The scores were also significantly improved in both groups (Using TR $F$ (1, 29) = 51.12, $p < .01$; Others $F$ (1, 29) = 16.08, $p < .01$). The degree of the improvement was significantly higher in the group using TR compared to those not using the software application (others) ($t$ (29) = 2.22, $p < .05$).

## 4. Summary of Results and Discussion

In both projects there were clear indications that the technologies supporting the students had helped to improve reading skills and confidence levels. Similarities could be seen in the preferences for text highlighting alongside text to speech and the ability to reread content that provided over learning for some students.

Both projects found that training needs to incorporate support for staff and students as there were times when students were more confident about their use of the technology compared to staff. In the UK project the provision of the project's electronic files to specialist producers reduced the time taken to prepare alternative format textbooks by in excess of 90% and in most cases to less than 1 hour. The Japanese project, where the books were uploaded before the students had their reading classes, showed how instant access can make significant differences, and preparation time was nonexistent in class. Nevertheless, this system did not allow for the flexibility that was available with the UK method of file download, in that students could make

choices about the content chosen and the way they read documents at home and when working independently at school.

It was found that UK students, staff and specialist producers working across many schools could adapt the MS Word templates and resulting documents were later shared by many other students once released by the RNIB. The same could occur with the pdfs supplied to the Japanese students but further adaptations would need to occur for Braille and Daisy formats.

Teaching staff are often prompted to provide accessible electronic texts by specialists who work with visually impaired students. However, this is not the case for those students with dyslexia. A recent study carried out in the UK [8], found that two thirds of dyslexic students interviewed thought it would be a good idea to have textbooks in digital format. They had never had this as a suggestion before and yet from the results of both projects it is clear that electronic texts can be enormously helpful when used with specialist software such as screen reading, text-to-speech and highlighting of words and phrases

Advances in information technology have the potential to improve the learning experience of students with a wide range of abilities. Easy access to electronic files, whether they are whole books, chapters or worksheets have the power to enable print impaired students to achieve improved academic results. Individualized and targeted support for the production of alternative formats can be cost effective, allowing students to fully participate in the enjoyment of teaching and learning materials alongside their peers with the use of access technologies.

## Acknowledgements

The authors would like to thank the students, staff and organizations that have supported these projects including Dolphin Access Computers, Inclusive Technologies, Jim Russell, Project Manager (UK) and Lester Gilbert from the University of Southampton for his help with the statistical evidence provided for the UK projects.

## References

[1] BDA. Dyslexia Research Information. *About Dyslexia.* [Online] British Dyslexia Association, 2009. [Cited: 14 May 2011.] http://www.bdadyslexia.org.uk/about-dyslexia/further-information/dyslexia-research-information-.html .

[2] RNIB. Right to Read Campaign. *Right to Read.* [Online] RNIB, 5 May 2011. [Cited: 14 May 2011.] http://www.rnib.org.uk/getinvolved/campaign/accesstoinformation/righttoread/Pages/righttoread.aspx.

[3] Pennington, B. F. *Diagnosing Learning Disorders.* New York : Guilford, 1991.

[4] Lockyer, S and Creaser, C. *Blind and partially sighted children's right to read school text books.* Loughborough : University of Loughborough, 2006.

[5] MEXT, Large print textbook promotion meeting report, [Online] Ministry of Education, Culture, Sports, Science and Technology [Cited: 14 May 2011.] http://www.mext.go.jp/a_menu/shotou/kyoukasho/1282359.htm 2008.

[6] Keil, S.,Parris, D., Cobb, R., Edwards, A., and McAllister, R., *Too Little, Too Late: Provision of school text books for blind and partially sighted pupils.* London : RNIB, 2006.

[7] Russell, J. and Draffan, E.A. *Final Report for the Accessible Resources Pilot Project*, Dolphin Consortium 2010

Hover, F. *Dyslexia Review* Spring 2009, volume 20 number two