
Supporting Behavioural Disorders and Dyslexia on Digital Tables

Jessica Szeto

SMART Technologies
3636 Research Road NW
Calgary, AB T2L1Y1 Canada
Jessica.szeto@smarttech.com

Edward Tse

SMART Technologies
3636 Research Road NW
Calgary, AB T2L1Y1 Canada
edwardtse@smarttech.com

Min Xin

SMART Technologies
3636 Research Road NW
Calgary, AB T2L1Y1 Canada
minxin@smarttech.com

Abstract

While specialized technologies exist to support learners with special needs, the majority of disabled learners are mainstreamed into regular classrooms. For this reason, educational technologies must deliver both regular and special needs tailored instruction. We describe how our multi-touch table leverages personal space to help students with behavioural disorder learn together. For learner that cannot yet read, or those with difficulty reading speech support can provide assistance while freeing a teacher to focus on other core competencies.

Copyright is held by the author/owner(s).
CHI 2012, May 5–10, 2012, Austin, TX, USA.

Keywords

Special needs, language, universal design, digital table.

ACM Classification Keywords

H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

General Terms

Design, Human Factors

Introduction

Lawmakers in the United States have led special needs support in public schools through specific funding programs targeted at resources and teaching that is accessible to all learners. This funding has been substantial, in the 2009 American Recovery and Reinvestment Act (ARRA) funding for the Individuals with Disabilities Act (IDEA) exceeded education technology spending by a factor of one hundred (\$10B versus \$100M USD) [1].

Mainstreaming is the process of bringing disabled learners into the main stream of public education programs. Mainstreaming enthusiasts highlight how this practice supports independent living, self-direction, self-care, and ultimately economic self-sufficiency. Since mainstreaming is becoming the norm, school are increasingly expecting their investments in technology to also provide support for special needs learning.

Related Work

One approach to understanding disability and disorder is to look at the four main categories listed by the International Statistical Classification of Diseases (ICD-10). These disorders are based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) that is typically used for assessment [7]. While many technologies exist to support sensori-motor and scholastic skills, we felt that the interactive tabletop display was particularly suited for support of behavioural disorders and the specific scholastic disorder of dyslexia as young children who cannot read can also benefit from this support.

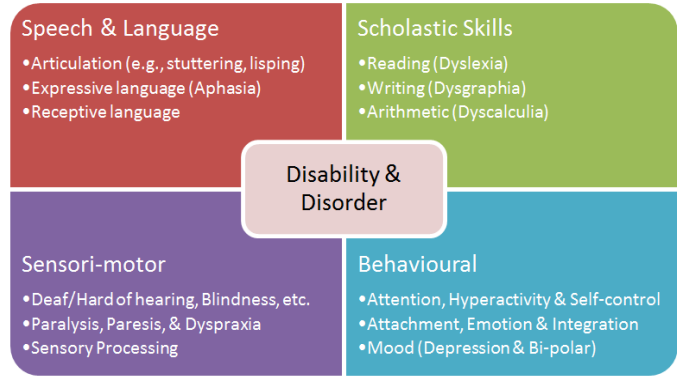


Figure 1. Classifications of Disability and Disorder

Behavioural: According to IDEA in 2009, 6% of all learning disabled students had Autism Spectral Disorder [8]. Children with autism are characterized by impaired social interaction and communication. Learners with Autism Spectral Disorder may engage in *stimming* (i.e. repetitive rocking, hand waving, or non-word vocalizations). They may also have abnormalities of social interactions such as Asperger’s Syndrome.



Figure 2. The Table Hardware

Accelerometers can be used to monitor stimming and inform caregivers of a child’s mood as shown by Kientz et al. [3]. Table top displays have shown benefits for learners with Asperger’s Syndrome in research such as Piper, et al. [2].

Dyslexia: Children typically learn to read between the ages of 4-7. For children with reading difficulty speech synthesis (provided on most operating systems) can read out words that they would otherwise struggle with. Some devices provide image to spoken word mappings such as the Go-Talk hardware by Attainment Company and the I Hear Ewe App on Apple’s iPad. These tools also support early age learning by mapping animal names to pictures so that very young children can learn word sounds and pronunciations.

Supporting Behavioural Disability

During the early development phase of our interactive tabletop, we observed that young learners would be very eager to approach and play with the digital table. This playing behaviour would often result in one learner performing global actions on behalf of the group that interrupted the flow of collaboration. For example one learner might close an application or answer all the questions before the other learners had a chance to participate. This broke down the collaboration and hindered collaboration. To mitigate this issue we designed our table hardware so that young children could easily reach into the centre of the display and would need to stretch to reach the opposite side (Figure 2). We did this so that we could place buttons in each learner’s own personal spaces so that they would need to negotiate in order to perform global actions [4] and enforce agreement [6]. We describe two examples of this enforcement: answer agreement and closing.

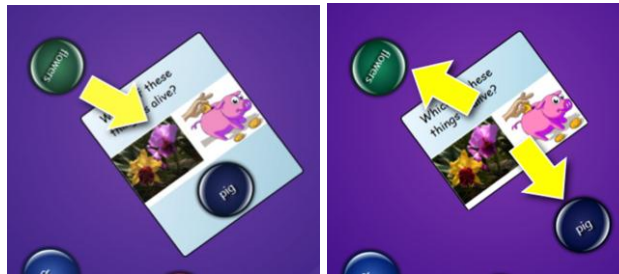


Figure 3. Answer Agreement in Multiple Choice

Answer agreement: Figure 3 shows the multiple choice question “Which of these things is alive?”. Each learner selects an answer by moving the circular bubbles into the answer region in the middle of the table. If the answers are different or incorrect they are ejected (Figure 3, right) providing an opportunity for learners to try again. This prompts discussion and enforces consensus so that learners test their understanding against their peers and can construct their own view of the world [5].

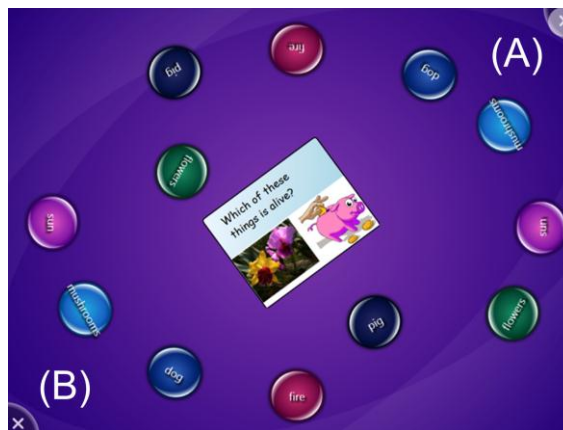


Figure 4. Collaborative Agreement for Closing an Application

Personal territories are also used to mitigate the negative effects of closing an application prematurely. When a learner presses the close button in the top right corner of the display the button moves out from the corner closest to the personal space of one learner (Figure 4A) and into the opposite side of the screen (Figure 4B) often into the personal space of another learner. We have observed learners protecting their personal space by covering their hands over the corner of the table to prevent others from closing an application before they are finished.

Supporting Dyslexic Learners

Text heavy activities are challenging for students who cannot yet read and those with dyslexia. Support for computer supported reading was a common request among teachers. All instructions, questions, and objects on our table can be associated with voice. Voice instructions are activated when the application first starts (e.g. “Count with your fingers”). Question based applications such as multiple choice (Figure 4) allow a different spoken command on each page (e.g. “Which one of these things is alive”) and can be activated using a quick tap (press with one finger and then release).

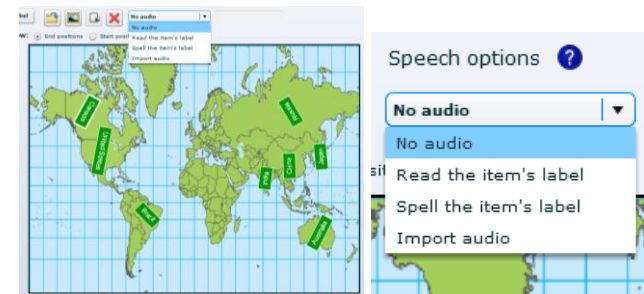


Figure 5. Audio for Answer Labels (left) Audio Options (right)

Answer labels and objects (e.g. dog, fire, sun in Figure 4) can also have audio associated with them. One can set the audio to play the printed text as a word or spelt out as letters via a speech synthesizer and they can also record and play an audio file to teach phonetics or to play real world sounds. This allows a teacher to create a picture book for multiple learners by setting the answers to pictures and adding custom audio. This allows each learner to select the words that they are unfamiliar. While multiple sounds can be played concurrently, a erratic playing of many sounds repeatedly is often a signal for the teacher.

Survey

Through site visits and written surveys we evaluated our Table Software with 7 special needs teachers who taught learners of ages 3-12 with autism spectrum disorder, behavioural disorders, ADHD, and dyslexia.

Results: We installed the table hardware in a classroom for children with Asperger's syndrome. These sessions were initially guided by a special education teacher, but the teacher found that learners would eventually keep each other accountable for the rules of the activity. After 2 weeks of in-class use the teacher reported that children normally unable to work together were sharing and collaborating using our hardware and collaborative agreement software. The table cannot solve all behavioural issues in a classroom. One of the Autistic children threw his chair against the table, and while the table received surface scratches it continued to function properly.

In site visits, teachers personalized speech feedback in activities so that students could spell words suited for their reading level. This enabled teachers to support

students who have difficulty reading. Since a long tap or move on an object does not trigger audio, students were not immediately able to discover our quick tap trigger. Instead the instructor had to show them how to use audio playback. In the future, our system would benefit greatly from clear instructions on how to use the tap gesture when they first use the digital table. While our system worked with the built in Microsoft Anna voice, some teachers commented that it would have been beneficial to have a text to speech engine that works with their particular dialect (e.g. UK English, or other languages).

References

- [1] ARRA, <http://1.usa.gov/yf5IjC>, 2009.
- [2] Piper, A., O'Brien, E., Morris, M., Winograd, T., SIDES: a cooperative tabletop computer game for social skills development. Proc. ACM CSCW 2006, pp. 1-10.
- [3] Kientz, J., Hayes, G., Westeyn, T., Starner, T., Abowd, G., Pervasive Computing and Autism: Assisting Caregivers of Children with Special Needs. Proc. IEEE Pervasive 2007, pp. 28-35.
- [4] Scott, S. Carpendale, S., Inkpen, K. Territoriality in collaborative tabletop workspaces. Proc. ACM CSCW 2004, pp. 294-303.
- [5] Vygotsky, L. Mind and society: The development of higher psychological processes. 1978, Cambridge, MA, Harvard University Press.
- [6] Zurita, G., Nussbaum M. A Constructivist Mobile Learning Environment Supported by a Wireless Handheld Network. In Journal of Computer Assisted Learning 2004, pp. 235-243.
- [7] International Statistical Classification of Diseases, <http://bit.ly/1agB7O>, 2010.
- [8] IDEA, <http://1.usa.gov/bCQv74>, 2009.