Hypersmart Kids: a Case Study on the Response of Students with Dyslexia and ADHD to Educational Software Games in English Language Learning

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Abstract
There is an estimated thirty per cent of children with dyslexia who also have attention difficulties. Supporting dyslexic students who have literacy difficulties and attention deficit hyperactivity disorder (ADHD) can be very challenging for teachers. Research suggests that the integration of computer technologies in special education classrooms can help provide the support these children require in language learning. Four elementary school-aged students diagnosed with dyslexia and ADHD were selected to find their response to the use of computer games in learning English. Conducted in multilingual Singapore, a case study approach was chosen and the study spanned across two school terms. The students’ reading and spelling abilities were compared using criterion-referenced tests before and after the use of two established phonics computerized programs; Nessy Learning Programme and Wordshark. The aim of the study was to determine if information and communication technologies (ICT) play a role in motivating dyslexic students with ADHD to stay on task, thereby improving their reading and spelling accuracies. The findings were mixed. There were minimal improvements in spelling accuracy, and a slight decline in reading accuracy. However, significant differences were observed in the students' behaviours in the areas of learning and attention. The teachers observed that the ADHD students did much better when presented with activities that are novel such as game-based learning. The students were enthusiastic for class and motivated to do more. Recommendations based on the students' responses are included to make it easier for teachers to consider the adoption of ICT and games-based learning in their teaching.

Keywords: ADHD, dyslexia, phonics, games-based learning, ICT

1. Introduction
Students with dyslexia, a type of specific learning differences (SpLD) struggle with learning languages. The International Dyslexia Association estimates there are thirty per cent of dyslexic children diagnosed with attention difficulties [1]. Attention deficit hyperactivity disorder (ADHD) is one of the most common childhood developmental disorders and affects an estimated five per cent of the school-age population [2]. With the rise in popularity of social media and mobile devices, children today are more immersed in gaming and connectivity than before. The increasing use of tablets and smartphones has conditioned the younger generation to crave instant gratification. Awareness of ADHD has heightened over the years. Several studies on ADHD recommend the use of ICT such as video games as one of the ways to increase students' engagement and work output [3], [4]. Other studies have experimented using immediate feedback in computer programs with ADHD children and found that their performance was comparable to the control group [5], [6]. Educators have the responsibility to take a more proactive stance in exploring alternative ways to engage students with SpLD. 21st century learning should be student-centred and not one that waits for these children to fit themselves into the curriculum.

2. Purpose
As the world progresses into one filled with fast-paced technology, children who grow up immersed in technology tend to have shorter attention spans, especially in traditional learning settings [7]. This case study was conducted to find the response of ADHD students towards educational software games in learning the English language in a small class setting. There is limited research evidence to support the use of ICT with ADHD students [8]. Research on dyslexia, ADHD and ICT in language learning is rarer still.
3. Setting

3.1 English Language in Singapore
Singapore is a multilingual society where bilingual education was made mandatory by the government for all primary schools in 1966 and secondary schools in 1969 [9]. Students are required to study English as their first language and a Mother Tongue as their second. There also exists a colloquial form of English in Singapore, known as Singlish that is heavily influenced by Mandarin, Mandarin dialects, Malay and Tamil. This unique language situation and language profile of Singapore society [10] has made teaching English language a challenge as the Education Ministry struggles to balance between synthetic and whole-language approaches.

3.2 Dyslexia Association of Singapore
The Dyslexia Association of Singapore (DAS) is a not-for-profit organization partly funded by the Ministry of Education to provide education therapy services for children with dyslexia and/or related specific learning differences. The organization has nine centres islandwide that caters to school-going children from kindergarten to secondary. Students are referred for English remediation classes after formal assessments by psychologists [11].

4. Method

4.1 Teachers
Two teachers were involved in this study. They both have postgraduate qualifications in specific learning differences and are senior educational therapists with the DAS. They have been providing English remediation to students with dyslexia for three years.

4.2 Participants
The students were selected from the two DAS centers which the teachers were based in. All of them have been formally diagnosed by psychologists with dyslexia as well as ADHD. All participant names in this research study were protected with pseudonyms.

<table>
<thead>
<tr>
<th>Students</th>
<th>Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amos</td>
<td>Age 11, has been attending DAS since he was eight years old. His reading and spelling ages are approximately 8 years, well below his chronological age.</td>
</tr>
<tr>
<td>Bryan</td>
<td>Age 10, tends to talk excessively but is reading and spelling at 11 years and 10 years respectively.</td>
</tr>
<tr>
<td>Chris</td>
<td>Age 9 was a fairly new student in DAS and takes medication for his ADHD. His reading and spelling ages are on par with his chronological age.</td>
</tr>
<tr>
<td>Diane</td>
<td>Age 9 and the only girl in this study started attending DAS when she was in Kindergarten. She takes medication for her ADHD in school daily and is reading and spelling at age 8, slightly below her chronological age.</td>
</tr>
</tbody>
</table>

4.3 Software
Nessy Learning Program is an interactive learning system developed with specialist teachers at the Bristol Dyslexia Centre that teaches and reinforces reading and spelling through animated fun activities. Wordshark combines the excitement of computer games with the serious task of learning to read and spell [12]. Its strength lies in its option to create personal word lists for practising single-word reading and spelling. Wordshark also provides syllabification games, which is the cutting of words into smaller syllables to aid reading.

4.4 Assessments
Criterion-referenced testing was chosen to aid the teachers in identifying and planning remedial instruction in specific areas [13]. The words in the criterion-referenced tests were based on the scope and sequence of the Essential Literacy Approach [14] used at the DAS. A total of 50 words, (30 for reading and 20 for spelling) testing common vowel teams and spelling rules in the English language were administered before and after ICT usage.
4.5 Procedures
The students attend lessons at DAS twice a week for an hour each time. In each lesson, English phonograms were introduced and reviewed using the selected educational software, Nessy or Wordshark. In total, they received 14 hours of audio-visual training over a period of 20 weeks. Using laptops and headphones, the students practiced single-word reading and spelling individually within game format for about 20 minutes each time. These two programs were chosen for their close relevance to the DAS’ Essential Literacy Approach. At the end of two terms, an informal focus group interview was conducted with the students. This was then triangulated with the teachers’ structured observations. All data collection was conducted in accordance with the ethical guidelines set by the British Educational Research Association [15].

5. Results

5.1 Criterion-Referenced Tests
The participants were tested for word reading and spelling individually over two sessions, the first session being conducted in June before ICT was introduced and the second one in November after forty sessions of phonics training on the computer. Both the reading and spelling components were conducted on the same day of the tests and the results are shown in Table 1.

<table>
<thead>
<tr>
<th>Students</th>
<th>Single-Word Reading</th>
<th>Single-Word Spelling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>Amos</td>
<td>20/30</td>
<td>20/30</td>
</tr>
<tr>
<td>Bryan</td>
<td>27/30</td>
<td>28/30</td>
</tr>
<tr>
<td>Carey</td>
<td>23/30</td>
<td>21/30</td>
</tr>
<tr>
<td>Diane</td>
<td>23/30</td>
<td>19/30</td>
</tr>
</tbody>
</table>

Table 1: Pre- and Post- Reading and Spelling Scores

5.2 Students’ Comments
Throughout the course, the students would often ask the teachers “Are we using computer today? Can we do Nessy today?” At the end of the ICT training, the teachers asked the students collectively how they felt about using the computer to learn English. During the short interview, all students answered “yes” when asked if they enjoyed using the programs. Specifically, they expressed a preference for Nessy’s animated rules and Wordshark’s reward games.

5.3 Teachers’ Observations
All four students had full attendance during the two terms of ICT training. A structured observation checklist based on the DSM-IV [16] was created to look for manifestations of attention deficit and hyperactivity such as excessive talking, fidgeting and leaving their seats. The teachers observed more positive behaviours including the desire to attempt more reading and spelling tasks when the students were working on the computer as compared with normal classroom activities.
- Amos who talks excessively and gets easily distracted during class was generally very quiet while playing the reading and spelling games on the computer. The game-based approach to learning English suited his competitive nature well as he wanted to do more reading and spelling in order to win his classmates.
- Bryan is always eager to start class and would rush to switch on the computer when he enters the classroom. When he was at his terminal, he was observed to fidget less with his hands and feet. However, there were two occasions that he asked to do paper-and-pen activities and said he was bored with playing the same games.
- Chris tends to drift off during class but having a personalized screen and headphones have helped to reduce his distractibility to the surroundings.
- Diane is often “on-the-go” but remained seated throughout the gameplay on the computer. Her excessive talking nature was better regulated.

6. Discussion
The study was designed to investigate the response of four students with ADHD and dyslexia towards English language learning using computer games. It was evident that the students enjoyed learning through the computer as they were observed to remain seated for a sustained period of time as opposed to their usual fidgety and hyperactive nature. Evidence from these classroom observations
support similar findings from existing literatures where ADHD students displayed an increased level of engagement when teaching is paired with the usage of ICT. As Kleiman et al. [6] explained, computers like televisions, have the ability to shut out external stimuli, captivating children and adult alike. Hence, this case study will analyse features that make computer games work well with ADHD children in learning English.

6.1 Students’ Response

Immediate Feedback
Unlike a traditional classroom setting, computer programs are able to ‘praise’ a child immediately when a correct answer is given and inform the child when it is not. This immediacy helps to manage and regulate the students’ impulsivity or ‘the-right-here, right-now’ personality. In developing reading skills, practice is most efficacious when timely corrective feedback is provided [12].

Extrinsic Rewards
One of the most distinct motivators was the practice of immediate rewards. Both software programs, Nessy and Wordshark give tokens at the end of each completed task. These made the students more driven to complete additional tasks in order to earn those tokens. This in turn translates into more practice with the eventual goal of automaticity in applying the learned phonograms. ADHD-diagnosed children often need more tangible rewards than other children because they are less motivated by internal feelings of satisfaction from a job well done than they are by the prospect of earning stars to exchange for a toy, a form of delayed rewards [17]. The software programs’ extrinsic rewards of ‘coins’ and ‘nuggets’ has transformed into an internal motivation where the students derived pleasure and satisfaction from the successful completion of tasks. This supports findings which maintain that ADHD children can concentrate for a longer period of time when there is instant gratification [18], [5].

Learner-centred Features
The attractive graphics of Nessy and simple navigation layout of Wordshark kept the students intrigued which led to an increase in attention span. These observations concurred with Kleiman et al’s study [6]. The students enjoyed using the programs and attempted more questions on the computer as opposed to regular classwork. There were also marginal improvements in some of their reading and spelling scores [see Table 1]. Self-paced learning was also another learner-centred aspect that resulted in a positive response in these ADHD students towards literacy building.

7. Literacy Achievements
Though the outcome did not show significant increases in reading and spelling accuracies, the students showed greater engagement in lessons. This resulted in a more settled class which gave the teachers the opportunity to pay more attention to the errors made by the students. When the students were working at their respective terminals, the teachers were able to observe how they spelled and could analyze the recurring errors that could be due to other factors such as visual-spatial or auditory processing difficulties. While students stayed engaged, ICT could not cure their impulsivity. Bryan could have obtained higher scores for the post-spelling test if he had checked his work (e.g. envous for envious, kindess for kindness). Inconsistent behavior is a symptom of ADHD students [1], hence testing may not be the most accurate reflection of their spelling ability and their knowledge in the English language [19].

Despite the advantages of ICT, teachers must understand that ICT can also stand for ‘It Can’t Teach’ [20]. Teachers need to be cautious that they do not get swept into a hype of replacing traditional teaching methods with computer games. In each lesson component where ICT is used, teachers must still be present to facilitate students’ learning. Children with ADHD are often impulsive and competitive which means they may want to complete the activities as fast as they can to earn points. Therefore, teachers need to supervise and ensure that the students meet learning objectives when using ICT.

8. Conclusions
Uncontrolled factors such as novelty effects and amount of previous exposure to computers which includes keyboarding skills were not taken into account [12]. Mistakes such as letter reversals and transposition of letters are skills sets that were not successfully corrected in the course of study and may require further investigation on whether ICT can remediate these skills. Another limitation is the brevity of this study, which was conducted over two school terms or approximately 40 hours. A more longitudinal study is needed to explore the possibility of computer games playing a more substantial role in compensating for the impulsivity of ADHD students.
role in their literacy achievements now that the current study shows positive behavior modification towards learning. This study focused on elementary school-aged students with dyslexia and ADHD using phonics software to improve their reading and spelling of single English words. More studies are needed in other areas that include the use of ICT for other SpLD such as dyspraxia or with older groups of students. With a highly sophisticated ICT infrastructure, schools in Singapore are more poised than before to cater to the learning needs of children with ADHD. This case study has provided a glimpse into the possible ways that ADHD children can be engaged in language learning. It is time for educators to reconsider ways to provide a more inclusive curriculum for these children by integrating more ICT into teaching.

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References


