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The effects of multimedia learning on children with different special education needs

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Abstract

The project sought to determine if two groups of children with different learning difficulties could benefit from using the same multimedia learning system. The project focused on children under the age of 11 with either Autism or Down's Syndrome. These children are often taught in mainstream classrooms together without special learning systems. The results indicate that benefits can be drawn from the use of multimedia systems in learning for those who have learning difficulties. The specially developed system proved beneficial for the autistic children, which highlights the potential benefits that a multimedia system can have as a learning tool. However, the project as a whole shows that a system aimed specifically at a disability set may be more effective than a general system trying to incorporate the needs of different disability groups

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1. Introduction

Autism is a common disorder that affects many children and adults worldwide. However, a wide range of research has been conducted in this area to offer suitable approaches, such as treatment and education to help children and adults who suffer from Autism. Internationally many possible treatments and educational approaches have been developed to help cope with Autism, of which two developed in the United State of America have found wide application: The Picture Exchange Communication System (PECS) and the Treatment and education of Autistic and related Communication handicapped Children (TEACCH). These two programs are now extensively implemented worldwide.

Children and adults who have Autism will be affected in many areas, one being the ability to communicate. Some children will learn to communicate slowly throughout their lives on the other extreme some may never be able to talk. The Delaware Autistic Program in the USA developed a system called PECS. This system is used to help children and adults to initiate communication skills by using objects and picture symbols. The system has six main stages and is considered cost effective to use. Another program that was introduced in the USA, North Carolina in the 1960s is TEACCH, which is a structured teaching program that can help arrange the child's environment, by

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providing clear, concrete and meaningful visual information. The aim of this program is to prepare people with Autism to function independently in their home, at schools and in the community. Furthermore, the program is based on the fact that most Autistic people are visual learners rather than learning through written or spoken information. For example rather than asking the child directly what s/he wants for breakfast, adults can show pictures of the different kinds of things they could have. The child can point to the picture rather than saying what they would like for breakfast.

Our approach to investigating how best to support these learners with special educational needs was to build a multimedia learning system aimed specifically at learners with autism or Down's syndrome, and to test whether there was evidence of disparate levels of learning from each group of learners. The system was designed from educational technology principles (Mayer and Moreno, 2003), best practice and observations of actual teaching scenarios, so that it would be transparent how it sought to support particular learning needs. This paper presents some background to the development process and discusses the main findings and conclusions that can be offered.

2. Background

This project aims to design a multimedia learning system for children with Autism or Down's syndrome. Therefore it is necessary to look in to the theory behind multimedia learning. Richard Mayer defines multimedia learning as learning from words and pictures (Mayer, 2001). He states that "multimedia messages that are designed in light of how the human mind works are more likely to lead to meaningful learning than those that are not" (p.41). The Dual-channel, Limited capacity and Active processing are Mayer's assumptions of a cognitive theory of multimedia learning. Our research project is mainly concerned with the dual-channel assumption, which is based on people having two separate information processing channels: one for visual represented materials and the other for auditory represented materials. The Dual-channel assumption provides for two separate information processing channels: auditory/verbal channel and the visual/pictorial channel.

When presenting instructional materials to the learner it is better to take advantage of both channels, auditory and visual as opposed to a single channel. This principle is particularly important for learners with auditory impairment and a greater reliance on their visual processing channel. It is worth noting that Mayer's model was developed for typically developing children and does not try to account for children with special needs. As such, these ideas need to be tested for their suitability to children with special education needs such as autism and Down's syndrome where there is a greater need to reduce processing in the auditory channel.

Cognitive load is the total amount of mental activity imposed on working our memory at an instance in time (Sweller and Chandler, 1991). Sweller and Chandler's theory of cognitive load suggests that effective instructional material facilitates learning by directing cognitive resources toward activities that are relevant to learning rather than toward preliminaries to learning (Paas et al, 2003). Therefore, when ineffective designs of instructional materials are presented to the learner this can cause unnecessary cognitive load on their working memory that can prevent learning.

Controlling cognitive load is highly significant when dealing with children with autism or Down's syndrome since they tend to have different visual and auditory balance compared to typically developing children. When designing multimedia messages for special needs children, complicated or irrelevant information has to be reduced even further and more so than for typically developing learners.

3. Methodology

The research was conducted over a period of one week at a moderate learning difficulty (MLD) school in the UK. This particular school teaches children with different learning difficulties up to the age of 11. Since the end users in this case have communication difficulties, direct interactions with them was not appropriate. Instead, requirements for the system were taken from observations of the end users, interviews with their classroom teachers, and from the literature. These observations were recorded using a written account since taped recordings were not permitted due to regulatory constraints. Interviews were conducted with five school teachers to ascertain their opinions on teaching strategies that would be suitable for their pupils. All teachers were qualified to teach and support children with learning difficulties, and in particular, they were experienced with autism and Down's syndrome. Two groups (seven children in each) of children were formed from equal ability classes across the school. Although no formal pre-testing or profiling was conducted for this research project, the school had previously assessed these children

and designated them to be at equivalent levels of ability without prior teaching in the target domain of photosynthesis.

4. Data gathering

The main aim of observing a group of children with autism and Down's syndrome was to identify the best teaching strategies being used at the school, and, to determine whether different strategies were used for different learning difficulties. It was clear that the teaching methods most commonly used for teaching and communication for both children with Autism and Down's syndrome were the Makaton technique and pictures with Makaton symbols together with words. Both groups of children are happy with these techniques and have no problems in comprehending them. It has been further acknowledged that the teacher uses the same teaching strategies for these two groups of children. There were no distinct differences in the methods of teaching. Moreover, the observations clearly show that both groups are exposed to the same teaching strategies. After conducting an interview with the teachers and the head teacher at the school it emerged that they recommended the Makaton symbols, as these symbols are used widely for the children's worksheets. The most beneficial method of teaching was pictures and Makaton symbols with words, which is compatible with Mayer's *multimedia principle*.

5. Research Results

5.1. Experiment 1

Experiment 1 tested two conditions: the time taken to answer a set of questions following their time learning with the system; and secondly, the number of attempts it took the children to answer the questions correctly. The results are as follows. Children with Autism took fewer attempts to answer questions correctly whereas the Down's syndrome group took two or more attempts. There was only one occasion where an Autistic child had to take two attempts to answer a question correctly. Autistic children took less time to answer the question compared to those with Down's syndrome.

An independent t-test was used to test the hypotheses. There were two tests carried out: first of all, to compare the number of attempts taken to answer questions by the autistic and the Down's syndrome children; and secondly, the time it took each group to answer the questions correctly. The result from the first test (number of attempts) shows that there is a significant difference between the learning performance of the Autism and Down's syndrome groups. The hypothesis was a two-tailed test with the calculated t of 2.651, $p=0.05$ for two groups of seven children. The results from the second test (time taken) shows that there is also a significant difference in the time taken to answer the questions between the Autism and Down's syndrome groups. The hypothesis was a two-tailed test with the calculated t of 2.449, $p=0.05$.

To conclude, both results show significant difference in the learning performance of the tested groups. There is evidence to suggest that there is a difference in the children's performance level when learning from the same multimedia system. Even though the system was designed according to the literature, observations and interviews to cater for both groups of learners.

6. Revised System 2

The system was redesigned using the results from a usability evaluation and the observations to identify where the potential problems were. The system was then changed accordingly to these results.

6.1. Experiment 2

The system was redesigned and the experiment was taken again. The same conditions were recorded: time and number of attempts. The autism group only took one attempt to answer questions correctly. However the Down's syndrome group still took more than one attempt to answer questions correctly. The autism group took less time to answer the questions correctly compared to children with Down's syndrome. An independent t-test was used again to test the hypotheses. The same children were used to test the system. The results are as follows, with $p=0.05$. The

first test was on the number of attempts, which indicates that there was still a significant difference between the learning performance of the Autistic and Down's syndrome children. The second test (time taken) shows that there was also a significant difference in the time taken to answer the questions between the two groups.

To conclude, both results highlight significant differences in the learning ability of the two groups, therefore the null hypotheses have been rejected to show that there is a difference in the children's performance level when learning from the same multimedia system.

6.2. Paired t-test System 1 and 2

Two t-tests were conducted to see the performance of the Down's syndrome group using the first system compared to the second system. The number of attempts and the time taken were used in this test. It shows that there is no significant change in performance of the Down's syndrome group's learning for the first system and the second system on the number of attempts made to answer the question. The hypothesis was a two-tailed test and the calculated t of 2.435 is less than the critical value of 3.182.

6.2.1. Time

The calculated t-test of 3.000 is less than the critical value of 3.182, which suggests that there is no significant change in performance of the Down's syndrome group's learning from the first system and the second system on the time taken to answer the questions.

To conclude, both results indicate there is no significant learning. There is insufficient evidence to suggest that the second system benefited the Down's syndrome group's performance in learning.

7. Research Analysis

The results statistically suggest that the same system should not be used by the two different groups. There is strong evidence to suggest that there is a difference in learning performance when groups with different learning needs share the same multimedia system. Despite the modifications made to the second system in order to make it more suitable for the Down's syndrome group, significant changes in their learning performance were not evident. However, benefits were identified, as the results from experiment 1 and 2 show that the Autistic children did benefit from the multimedia learning system.

The literature implied that children with Down's syndrome have severe hearing impairment, which may have been another reason as to why they did not perform as well as the Autistic children. Moreover, the observations support this statement, as the first experiment show that the children relied heavily on the teacher's help to repeat the questions to them. This was seen happening on numerous occasions. In the second experiment it was also noticed that the children made full use of the repeat button whilst going through the questions. This may be an indication that they experienced difficulties with hearing the question narrated to them. However, the system did support the children by not overloading their auditory channel and providing them with very little narration. Unfortunately, more auditory support is needed for the children to overcome their difficulties.

Portsmouth University emphasised that children with Down's syndrome have impaired short-term memory. This is another factor that may have caused these children to perform badly in the test. The system did attempt to support the children in this area by having minimal text and more pictures on the screen. The first experiment shows that the children had a lot of problems with some aspects of the system with too much content. As a result when the system was modified some content was removed to lower the level of cognitive load on the children's working memory. Furthermore, at the bottom of every frame there was always a symbol to constantly remind the children of the activity that they were carrying out. This is so they would not have to remember what they were doing.

Despite the attempts to support the children and avoid this problem it had no affect on their performance. This result suggests that the Down's syndrome children require better management of cognitive load. Conversely, the system did benefit children with Autism.

The literature and the background research suggested using visual methods to support their learning. Thus, the system did use a variety of pictures, symbols and animated images to support the children. And moreover, the principles of cognitive load theory to take in to account that the working memory is extremely limited, were adopted to help autistic learners successfully cope with the demands of the lesson.

8. Conclusion

To conclude, the results evidently show that the system cannot be used by two different groups of special needs learners. Both groups of children found the system enjoyable and interesting due to the visual-oriented design and added support for cognitive loading. However, the Down's syndrome group did not successfully translate this enjoyment to learning and their experience was limited to having fun. Although the school had assessed these two groups to be at equivalent levels of ability, our results would suggest that each group requires different teaching strategies that are designed to focus on their particular weaknesses. The literature states that there is a difference in their learning needs but also implies that both sets of learners can benefit from similar teaching methods. Indeed, the traditional practice has been to provide a common intervention for both autism and Down's syndrome. Our research would suggest that this approach is not beneficial and, in particular, when considering developing computer based to ols, sharing the same multimedia learning system will not be appropriate. Children with Autism have problems with abstract reasoning, so they need to be supported with concrete materials. Down's syndrome children have further problems with auditory impairment and impaired short-term memory, which means more support is required in these two areas. Results indicate that Autistic children and Down's syndrome children cannot learn from the same multimedia system, and better differentiation of learning methods is necessary. The research confirmed that multimedia systems benefit disabled users provided the systems are highly specific and focused programs since different disorders, albeit with apparently similar learning needs, require specialised and individual teaching support.

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