ICTs in Special Education: A Review

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Abstract. The use of information communication technologies (ICTs) in a special educational needs (SEN) environment has gathered accumulative evidence around it during the last decade (2001-2010). In many settings ICT has become an important element of the learning and teaching process. ICT assessment tools can better recognize and integrate learning difficulties across students, while computer-based intervention tools can play a significant role in a child's life. In this report we provide a brief overview of the most representative articles for applications used for assessment and intervention purpose after classifying them according to the areas of needs they serve.

Keywords: ICT, special education, sensory and physical impairments, learning difficulties, assessment, intervention.

1 Introduction

Over the last decades the tremendous development of ICTs are changing the world and the way education is conducted. It is probably fair to say that the use of ICTs affects every aspect of our daily life. The impact of ICT in education has its roots back in the 1970s, where the governments in several countries started to realize the need of using technology in order to improve the relevance and quality of education [1]. ICT is considered a mean to bridge the gap between different groups of people such as the group of people with special educational needs. Recently, there has been a growing number of researches that supports the fact that, ICTs and assistive technologies more generally, enable people with special educational needs to lead more fulfilled lives [1], [2].

The term 'special educational needs' covers a range of problems which can cause difficulties in learning. Even though there have been many definitions over the years, comparative studies show that the term 'special educational needs' can mean different things to different countries [3]. One of the most dominant categorizations that recommends a graduated approach to educating learners in need of special provision is the one introduced below. 'The areas of needs' as defined in the 2001 SEN Code of

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Practice are: Communication and Interaction, Sensory and/or Physical, Cognition and Learning, Behaviour, Emotional and Social Development [4]. Defining the area of 'Special Needs' has been a widely discussed issue. Titles as Learning Disabilities or Learning Disorders are also used to describe a group of the population that have problems in their school performance and maybe later in their lifetimes.

Even though the use of ICTs has been acknowledged for at least three decades, the first important program studies to support students with SEN start to appear amongst the latest years [1]. During the last decade there is a significant number of studies that address how ICTs are being used in practice and what impact they have on the life of children and adults with special educational needs. Dominant issues in the ICT literature report the benefits of alternative communication, assistive or enabling technology, internet applications, virtual environments, teacher education and technology integration [2]. In this report we will focus on the use the most popular applications that are used for assessment and intervention purposes of specific difficulties. They provide school staff, specialists and parents with the possibility to employ different ICT strategies which might lead to an easier understanding of children's learning differences. Moreover, several benefits are limited cost, greater precision, savings in time and labour [5]. For the past decade there has been conducted great progress in the design and the development of ICT software programs to provide students with special educational needs equal access to education [6]. In order for these applications to be presented we created a framework which consists of two main categories. The first one includes diagnostic and intervention tools regarding people with sensory and physical impairments, while the next one includes the major domains of learning difficulties.

2 Sensory and Physical Impairments

Students with sensory and physical impairments have different capabilities and needs. For this group of learners it is often necessary the use of assistive devices such as touch screens, trackerballs, joysticks, keyboards and mouse alternatives [2]. In order for an ICT intervention tool to be effective it is always best to discuss before implementing any adaptations to practice.

Fujiyoshi et al. (2010) introduced a testing system with a digital audio player and document structure diagrams for newly blind users who have difficulties in Braille or print. The system gives them the chance to take the National Center Test for university admission. This study showed that the audio tests results were almost similar to normal-print-format and braille-format tests in score [7].

Choi and Walker (2010) developed the Digitizer Auditory Graph, a sonification software tool which allows visually impaired users to take an image of a line graph with an optical input device (e.g. webcam) and then hear an auditory graph of the digitized graph image. This tool helps both teachers and students, since teachers have difficulties in explaining graphs and visually impaired students' access to graphs is limited. Experimental results suggest that the users are able to understand the auditory output while using the optical input helps them create graphs easier and faster [8].

Drigas et al., in 2005 presented a Learning System designed for deaf and hard of hearing people. This prototype system offers Greek Sign Language videos in correspondence to all texts in the learning environment. The students for the first time have the opportunity to learn in their own language, the Greek sign language. The system includes also the involvement of the teacher and the administrator. Through appropriate training the users evaluate the knowledge they gained and they continue in further study [9].

In 2008 Drigas et al., presented 'Dedalos' project which deals with the teaching of the English language as a second language to deaf people. In developing this system, the researchers created a platform which includes methods such as distant linguistic training and an educational e-content designed specifically for the needs of this group of people. The project promotes a complete support system for the education of the deaf and hearing impaired individuals while at the same time opens the way for the inclusion of the deal and hearing impaired Greek students in Greece [10].

In 2008 Chin et al., introduced an integrated electromyogram and eye-gaze tracking cursor control system for individuals with motor disabilities. This system was designed for users who are unable to use their hands due to spinal dysfunction or other afflictions. The basic components of the system are the electromyogram (EMG) signals from muscles in the face and point-of-gaze coordinates produced by an eye-gaze tracking system (EGT). Additionally EMG-EGT system enables users to modify cursor position pixel by pixel and it provides a reliable left-click operation. However, the results of the EMG-EGT system was evaluated inside a laboratory environment, further experiments need to be conducted with learners with motor difficulties [11].

3 Learning Difficulties

3.1 Learners with Autistic Spectrum Disorders

One category within the group of 'Developmental Disorders' is known as Autistic Spectrum Disorders (ASD). ASD is a set of developmental problems that affect the social and communication skills. The latest years, important attempts have been made in the field of ICT assessment. Moreover, intervention is considered to increase the quality of life and functional independence of a child with ASD.

Ozonoff et al., (2004) developed the Cambridge Neuropsychological Test Automated Battery (CANTAB), a computer-administered set of neuropsychological tests designed to examine specific components of cognition. These tests examine the integrity of frontal functions since several studies support involvement of frontal cortex in autism. This method was tested to 79 participants with autism and 70 typical controls and the results indicated that the autism group had difficulties in planning efficiency and extradimensional shifting relative to controls comparing to the control group. Based on the results of this study, they argued that there is frontal lobe involvement in autism [12].

Vera et al., (2007) presented the use of 'Real Time' graphic applications as intervention tools in the educational process for people with learning difficulties.

Their main features are the use of 3D graphics, the user only needs a computer (with screen, keyboard, mouse and joystic) and he/she can interact with the tool easily. They can be used from people who have specific problems in attention, perception, memory, people with down syndrome and autism. These 'Real Time' applications give the users the chance to understand and control abstract concepts, very difficult to represent in real world [13].

3.2 Learners with Reading-Writing Difficulties and Difficulties in Mathematics

Proficient reading and writing is one of the major tasks a young learner will achieve in his or her lifetime. It is a process that depends upon a wide range of component skills and needs several years to master fully. Difficulties in mathematics affect also children with or without special needs. An early identification of these difficulties is of major importance in order to use later the appropriate intervention methods that will help the child overcome his or her difficulties.

One of the most widely used software tools is the Cognitive Profiling System (CoPS), a computerized psychometric assessment system which identifies the cognitive strengths and difficulties for ages 4-8. CoPS consists of eight tests in the form of games and a total assessment time of no longer than twenty minutes. The students are tested in sequential and associative memory, auditory and color discrimination and phonological awareness. CoPS is used across the UK, Scotland and British schools around the world [5], [14].

Lange et al., (2009) presented the effects of using an assistive software homophone tool on students with reading difficulties who were at least one year behind in reading. The homophone tool is used to point errors in learners' own writing. The pupils who participate in the research used Microsoft Word on a Windows-based laptop PC as the platform for accessing proofreading passages. Three groups were used to evaluate the effect of homophone tool by reading the passages under three conditions; with the homophone tool, with homophones highlighted only, or with no help. The different results amongst the three groups indicated that highlighting improve students' performance (14.6% improvement from no help) and offering homophonic choices could lead to additional benefits [15].

Starcic et al., in 2010 present the findings of the use of SEVERI, an e-learning environment for students who have difficulties with reading, writing and perceiving. It includes tools such as guidance messages, a learning diary, calendar, library, tasks, materials and group-specific discussions. The SEVERI project was adapted to the education context of five countries. This research supports the fact that SEVERI provides students guidance in their learning when at the same time helps teachers to improve the planning and organization of their teaching. In addition it supports networking and co-operation between specialists and parents [16].

In 2006 Wilson et al., developed an adaptive computer game for intervention of dyscalculia, 'The Number Race'. This software aims at training children on an entertaining numeral comparison task by introducing problems adapted to the performance level of every individual. According to the authors' study this method was

tested by using mathematical simulation and by a group of students with difficulties in mathematics. The results indicated that this software application could be effective in the remediation of dyscalculia, at least for children aged 7–8 and under [17].

3.3 Dyslexic Learners

One of the most common and most studied types of Developmental Disorders is the difficulty in reading as well as in spelling and writing, known as dyslexia. The Code of Practice highlights the importance of an evidence-based diagnosis and provides also the framework for all the professionals to examine and identify students' needs through the use of assessment tools [4]. Recently, the use of technology provides school staff the opportunity to engage in identification and intervention tools.

Lucid Adult Development Screening (Lads) was introduced by Singleton et al., in 2002. Lads is developed to screen for dyslexia from age sixteen and older in different settings (e.g. schools, colleges). Areas such as speeded lexical access, memory, phonological coding are examined in an approximately twenty minutes short test. It is a self-administered test and it is currently used in over one thousand establishments [18], [19].

Gregor et al., (2003) developed 'Seeword', a word processing environment which assist dyslexic computer users when producing and reading text. The initial prototype was designed in Microsoft Wordtm version 7 in 'word basic', the built in macro language. The program has been tested on dyslexic school students aged 14-16 years and the experimental results have indicated that they were able to read standard texts from a screen more accurately by using 'Seeword' [20].

3.4 Learners with Difficulties in Memory

Memory skills of children with special needs have been a domain of great research for professionals over the latest years. There is evidence that shows that poor memory skills characterize children failing to progress normally in different areas of needs [21], [22].

Alloway in 2007 presented the 'Automated Working Memory Assessment' (AWMA), a standarised computerized tool. This tool enables teachers and psychologists to assess working memory skills with a user-friendly interface. AWMA includes three levels of assessment. AWMA Screener is designed for students with suspected working memory difficulties, AWMA: Short Form (AWMA-S) is used for screening learners who are suspected to have memory deficits, but the specific area of their difficulties is not known and AWMA: Long Form (AWMA-L) is suitable for confirmation of working memory problems for learners identified as having working memory problems in the classroom. The results of AWMA's use suggest that working memory skills in individuals with memory deficits are relatively stable over the course of the school year. There was also a high degree of concurrence in performance between the AWMA and the WISC-IV Working Memory Index [23].

Van der Molen et al., (2010) created the 'Odd Yellow' training, a computer-based working memory tool to train adolescents with mild to borderline intellectual disabilities. In the 'Odd Yellow' method a sequence of three similar looking images is shown on the computer screen. One of the three figures is slightly different called the 'odd-one-out' while the other two are identical. They are all drawn in black apart from one of the two identical shapes, which is yellow. The user has to recreate the location of the odd-one-out and the location of the yellow figure shape. Experimental results showed improvement of students' working memory on several outcome measures [24].

4 Conclusions

This scoping study drew upon some of the most representative studies over the last decade which exploiting ICT, could facilitate the life of learners - students with special educational needs and the people around them as teachers, educators parents etc. ICT is increasingly seen as a tool in terms of creating independent learning environments, ensuring access to the curriculum and enhancing the social inclusion of all individuals. Given the multitude of manifestations of special educational needs, we attempted to examine various articles-studies for software applications regarding both assessment and intervention processes. Computer-based assessment appears to help teachers, the professionals involved as well as parents to understand deeper and to point the needs of every child. In addition, computerized intervention tools could be of great benefit since they can be used in school and home settings in a way that they promote the quality of offered education as well as self-advocacy. However, further research needs to be conducted in order to make sure that every learner has access to technology. Adaptations have to be made in relation to equity, ethnicity, culture and language for an effective delivery of technology services. Understanding the rights and needs of every child and providing a good quality of teaching, assessment and intervention via ICTs, are the most important factors to help individuals ensure access to appropriate learning and life skills programs.

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