

# Augmented Reality at Students with Special Educational Disabilities

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**Abstract:** The use of digital technology has improved the learning process whether we refer to general or special education. Research shows that the use of augmented reality in education receives positive feedback from both pupils and teachers. Pupils are excited with its interactivity and freedom it provides to explore a topic in a safe environment, while teachers provide positive feedback on its effectiveness in supporting learning goals. In this article, research in the field of augmented reality focused on teaching children with special learning disabilities is presented.

Key words: virtual reality, education, special-needs education, augmented reality

# **1. Introduction**

Information and Communication Technology (ICT) has helped shape our society by affecting almost every aspect of our daily lives (Gimbert & Cristol, 2004). Within educational context, the ongoing technological revolution that we are experiencing requires the transformation of traditional teaching and learning processes. The integration and effective use of emerging technologies have become fundamental challenges in the education sector (Moustakas, Paliokas, Tzovaras, & Tsakiris, 2015).

In recent years, there has been a worldwide effort in the educational community to introduce and integrate modern applications into the learning process with the primary aim of responding to current school developments (Fokidis & Foniadaki, 2017).

The on-going technological revolution in the field of computer science offers an array of possibilities for technology utilization, with typical examples being the use of personal digital assistants, tablets or the use of smartphones which in conjunction with application development offer a range of opportunities in the learning process (Murphy, 2011; Fokidis & Foniadaki, 2017).

In particular, the applications of augmented reality constituting its connection with the virtual reality can, according to international research, provide positive elements in the educational process by paving the way and contributing new ideas to the achievement of pedagogical and educational goals (Bidin & Ziden, 2013; Mang & Wardley, 2013). Learning to use smart devices in addition to offering an original way, contributes to the whole process as educators are able to keep students alert throughout the classroom (Moustakas et al., 2015).

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## 2. Augmented Reality

#### 2.1 Definition

Augmented reality can be considered a subset of mixed reality (Milgram & Kishino, 1994). Azuma (Azuma et al., 2001) defines it as a system that complements the real world with potentially (computer-generated) objects that coexist within the same space as in the real world. In their typical form, these applications relate to the overlap of three-dimensional digital information over a realistic view of the natural environment (Azuma 1997). Several studies point to the great potential of applications in learning and teaching (Billinghurst & Duenser, 2012; Johnson, Smith, Willis, Levine, & Haywood, 2012) as they offer both learner and trainer something new and innovative (Milgram & Kishino, 1994).

#### 2.2 Forms

Augmented reality applications are divided into two forms: artefact-based and geolocated. The first one is based on the digital object and uses physical markers which, after being investigated by a camera, can perform a predetermined action, such as viewing a video embedded content (FitzGerald et al., 2013). The second form is based on the geographical location and detection of an object using the Global Positioning System displaying information including physical locations and map references (Munnerley et al., 2012). Sensors, combined with internet access, are paving the way for a new category of applications that leverage geographic information and at the same time be responsible for monitoring the position and movement of the camera(Bower, Howe, McCredie, Robinson, & Grover, 2014).

#### 2.3Augmented Reality in Education

The literature indicates that applications can support and improve a variety of pedagogical approaches (Bower et al., 2014). Constructive-based learning encourages students to deepen their understanding of concepts (Bower et al., 2014). In terms of game-based learning, augmented reality supports it through game creation and digital storytelling by making students the protagonists and supplying them with material that can be used to reinforce the lesson (Bower et al., 2014). Another pedagogically supported approach is "situated learning" (Lave & Wenger, 1991), in which in-depth learning is triggered by the integration of classroom experiences from the real world. Finally, research-based learning can be implemented through the electronic collection of real-world data and models by researching a subject from a particular science (e.g., history, biology, computing) (Paraskeyaidis, 2017).

The use of Augmented Reality applications in education provides the following advantages - opportunities:

- Increase students' understanding of content;
- Improve their performance;
- Further exploration and deepening of learning material;
- Significant contribution to lessons in which tangible examples are hard to apply such as astronomy;
- Enhance co-operation between learners and educators;
- Improving students' creativity (Radu, 2014).

### 3. Special Needs Education

Improving teaching methods via the use of dynamic media remains a key concern for teachers. Modern

technologies must be interconnected with course concepts aimed at assisting participants in the learning process (Thornton, Ernst, & Clark, 2012). Recent technological developments have led to products, such as smart phones and tabletop devices, being used in educational programmes for children with learning disabilities (Achmadi, Kagohara et al., 2012). Navigating overlay images has been shown to be useful for understanding a learning goal (Sugimoto, Yasuda et al., 2010) while teaching and learning opportunities provided by augmented reality have been recognized as appropriate by research teachers (Wu, Lee, Chang, & Liang, 2013).

#### **3.1 Learning Disabilities**

Learning difficulties refer to a neurobiological disorder that affects a person's brain and interferes with his or her ability to think and remember and manifests in hearing, thinking, reading, writing, spelling or arithmetic disorders. Children with some form of learning disability need special treatment in order to be able to "deal" with children who do not have this problem (Vinumol, Chowdhury, Kambam, & Muralidharan, 2013). These children are able to see, hear and do not have severe mental deficits but have behavioral and psychological developmental disabilities to the extent that they are unable to adapt at home or learn through the usual methods at school. These disorders are intrinsic to the individual and are thought to be due to dysfunction of the central nervous system.

Learning disabilities can be classified as mild, moderate, and severe. Degree definitions are usually expressed in terms of intelligence, behavioral ability and whether or not there is a need for specific treatment. Children displaying moderate learning disabilities typically have verbal scores and performance in the 50–70 range (intelligence index test). They often have significant limitations on adaptive behavior in conceptual, social and practical adaptive skills (K $\omega$ v $\sigma$ t $\alpha$ v $\tau$ ív $\omega$ v $\kappa$ . $\alpha$ ., 2006). Specifically, cognitive deficits exist in areas such as memory, attention, or language. One of the most common learning characteristics of children with moderate learning disabilities is that they find it difficult to comprehend academic content (Vinumol et al., 2013).

Removing these children from the school environment often has negative consequences. The integration of children with learning disabilities into mainstream schools is an important social and educational issue. The fundamental principle of inclusive school is that all children should learn together, wherever possible, whatever difficulties or differences they may have. Integration is based on a social model that treats disability as a socially created problem and problem management requires social action in the form of environmental modifications required for the full participation of people with disabilities (Vinumol et al., 2013). Children with intellectual disabilities have similar cognitive processes to those considered "normal" when it comes to reading and writing. However, their pace is different because they take longer to acquire reading and writing. They can feature many characteristics that interfere with knowledge construction. Some of them are: perception, reasoning, attention, motivation and memory.

#### 3.2 Autism

According to the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013), people with autism spectrum disorders feature quality impairments in social communication and social interaction in multiple settings. Other common features include difficulty in verbal reasoning, short-term memory, and daily living skills, which may continue in adulthood (Carpentieri & Morgan, 1996).

These difficulties present both plausible as well as pedagogical challenges in teaching students through traditional methods. Conversely, teaching tools that incorporate visual support (e.g., pictures, video games) are recognized as proven practices that exploit students' strengths (Ayres & Langone, 2005). However, the above methods are not devoid of problems. One common problem is that students find it difficult to focus on a video

(McPartland, Webb, Keehn, & Dawson, 2011). One way to address this issue is to apply the Social Learning Theory (Bandura & Walters, 1977) which refers to learning by observing a pattern that demonstrates a skill that the student maintains and imitates, when properly motivated. With regards to children with learning disabilities, the procedure adopts an intuitive method and children can use it for repeated application of the instructions, which may help to solve the problem (Lin, Chai et al., 2016).

#### 3.3 Advantages of Augmented Reality in Special Education

Using a mobile device can support real-time feedback (Τσιότσια, 2017). In addition, it can enhance concentration and stimulate learning motivation. Through the system, 'curiosity' concerning digital applications can enhance interaction among students by enabling them to develop more opportunities to interact with 'regular' students, which could greatly benefit traditional learning methods. Finally, they can improve operating frequency and allow the learning process to use game models by increasing learning motivation (C. Y. Lin et al., 2016).

The use of augmented reality is a very promising option for teaching students with learning difficulties and its implementation is a challenge. Teachers can collaborate on creating augmented reality teaching materials as well as materials that can be shared through cloud applications. Augmented Reality Technology is an auxiliary bridge system in special education as it supports intuitive and interesting learning processes for children with learning needs by combining the real and the potential world (DePriest, 2012).

However, no teaching method or approach is profoundly effective. The advantages of using this technology are best used for students who have difficulties in monitoring or retaining attention and need more support (Hall, Meyer, & Rose, 2012). Teachers can organize a whole lesson of activities using an augmented reality system. Through these teaching materials, students can repeat assignments independently, thereby reducing teacher dependency, so teachers can design multilevel teaching strategies to help children adapt to independent learning (C. Y. Lin et al., 2016). In addition, teachers can work with researchers in specific areas to design appropriate individual education programs. In contrast, the design of teaching material that uses technologies requires the acquisition of specific IT skills that must be taught to those teachers.

#### 3.4 Examples of Studies

All studies that have used augmented reality report positive results in both content learning (Liu, 2009) and motivation. Following are those that have been implemented in real time and have detailed results from their implementation. These studies are interlinked as they all relate to students with severe learning disabilities which cause these students to be disadvantaged in real-life situations.

For example, McMahon et al. (McMahon, Cihak, Wright, & Bell, 2016) examined the effects of teaching using augmented reality technology to teach scientific terminology to four students with intellectual disabilities. Students received a printed booklet containing the words and a tablet with one application installed. Students were instructed to scan the words to activate the digital content that included a word definition video and a visual example of how it was used. The result was that the students understood the words and were able to respond correctly to the mapping task involved in the application.

Another study conducted by McMahon et al. (McMahon, Cihak, Gibbons, Fussell, & Mathison, 2013) evaluated the effects of using an app to detect potential food allergens for seven students with autism and mental disability. Participants received instructions on how to scan the bar codes of food products and determine whether or not the item contains specific allergens. The results showed an immediate improvement in students' ability to identify foods with potential allergens when using the application.

Their work (Parton & Hancock, 2012) presents a magical book-type educational application that runs on mobile devices and allows young children to manipulate two-dimensional and three-dimensional images of plants in a simple and intuitive way. The application includes activities aimed at making decisions by students with as little teacher guidance as possible while fulfilling the goal of autonomy (Richard, Billaudeau, Richard, & Gaudin, 2007).

A number of researchers have recognized that learning through play can help children overcome their initial fears and even begin to enjoy learning. For example, a puzzle could be used as an auxiliary tool to develop children's skills such as imagination, shape analysis, creativity and reasoning (C. P. Lin, Shao, Wong, Li, & Niramitranon, 2011). In particular, with regards to children with learning difficulties, puzzle-based activities can reduce the learning burden and their frustration. The experiment involved 21 students with various learning disabilities who were asked to do activities based on solving a puzzle. After seeing the model through the Aurasma platform, the students were trying to solve it using the pieces in front of them. The results of the study were positive as the primary objective of stimulating students' self-confidence had been achieved.

#### 4. Conclusion

The use of augmented reality in education can have both positive effects on both special and general education. The use of multiple media is able to make the learning process more attractive and at the same time effective. Educating students with learning disabilities is a challenge. This technology can stimulate their interest, attention, confidence and have positive learning outcomes. The technology used makes learning more interesting and interactive for students. The results of researches show that students can acquire knowledge by using these applications by reducing learning barriers. Experience so far shows that when computer tools are used to assist in the learning process, students are encouraged to learn, participate and interact with each other and with their teachers. In these learning environments, student involvement and motivation are crucial. Augmented reality supports ICT learning by encouraging students to discover knowledge on their own, applying a learning technique in which they take control of their own learning process, obtain information and use it to complete sets that may not be feasible in reality due to time as well as space constraints and learning opportunities.

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