

The importance of using digital games for educational purposes for students with intellectual disabilities

Kristian Stancin^a, Natasa Hoic-Bozic^a

^a University of Rijeka, Department of informatics, Ulica Radmile Matejic 2, 51000, Rijeka

Abstract

Acquiring academic and practical skills for students with intellectual disabilities is a great challenge. The use of digital games and game-based simulations in order to accomplish certain learning outcomes can be a good mediator in adopting these skills. The aim of the paper is to present the field of digital games for students with intellectual disabilities by giving an overview of recent research in the field. The research is focused on finding how to define most important game concepts, how important are digital games in the education process of students with intellectual disabilities, and what is the purpose of existing games. Throughout the work, the following contributions have been made: the terms game-based learning, educational games, serious games were defined and connected them with the term intellectual disabilities, and new findings in using digital games in the upbringing and education of students with intellectual disabilities were pointed out. This paper also describes the research in the context of the project “Digital games in the context of learning, teaching and promoting inclusive education;” related to the possibilities of using games for students with intellectual disabilities.

Keywords 1

Digital games, Game-based learning, Serious games, Intellectual disabilities, Inclusion

1. Introduction

Games are an important part of learning and teaching of all age groups, especially of students with developmental disabilities. Teaching that perceives digital games as a concept which includes a special set of behaviors, takes into consideration the individual approach. In this way, certain educational content can be introduced to the students in a suitable and understandable way [1]. This fact especially makes digital game-based learning an interesting field for research because learning based on digital games can help students with intellectual disabilities to form a way of thinking, learn new data, acquire life skills, learn and develop social and other skills. A game acts on a student through a social, cultural, emotional (affective), cognitive, physical and biological aspect This has a direct influence on behavior, on the way of thinking and on the perception of the world in which an individual lives and acts [2].

The motivation for writing this paper is to obtain information about using digital games for educational purposes for students with intellectual disabilities in order to get a better overview of digital game concepts, and to present the Digital games project [3]. The aim of the paper is to present the field of digital games for students with intellectual disabilities and give an overview of recent research in the field. The research questions of this paper are focused on finding how to define most important game concepts, and terms intellectual disabilities and inclusion, how important are digital games in the education process of students with intellectual disabilities, and what is the purpose of existing games.

The main contributions of this paper are to: 1 - terminologically define terms game-based learning, educational games, serious games and connect them with the term intellectual disabilities; 2 - point out new findings in using digital games in the upbringing and education of students with intellectual disabilities. This research will continue within the scientific project “Digital games in the context of

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EMAIL: email1@mail.com (A. 1); email2@mail.com (A. 2); email3@mail.com (A. 3)

ORCID: XXXX-XXXX-XXXX-XXXX (A. 1); XXXX-XXXX-XXXX-XXXX (A. 2); XXXX-XXXX-XXXX-XXXX (A. 3)



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learning, teaching and promoting inclusive education;” so the possibilities of using games for students with intellectual disabilities will be further investigated.

This paper is organized as follows: section 2 terminologically defines most important game concepts, section 3 describes the term intellectual disability, section 4 gives an overview of digital games for educational purposes for students with intellectual disabilities, and section 5 describes the Digital games project. Finally, section 6 concludes this paper and gives an overview of future research.

2. Game concepts

The most common terms used when describing digital games for educational purposes are educational games, serious games, gamification, and game-based learning. Although the terms sound similar, there are big differences between them, so they need to be clarified and terminologically defined.

Educational games (also used terms: instructional games, games for learning), include software that uses game technologies – game playing and storytelling for creating educational content [4]. This means that educational games are primarily used as tools for practice of factual information in education [5].

Serious games as resources from videogame field reapplied for the purposes beyond entertainment – education, healthcare, productivity and more [6]. In the field of education, serious games must have well-defined learning outcomes and have positive impact on developing new skills or acquire knowledge [7]. It is the credit of pedagogy that makes games serious [8], but the instructional content must be well incorporated within the game characteristics [9] which enables students to have fun and forget about the learning part of the game.

Additionally, gamification means the use of a game elements to engage the participants and motivate their actions in situations that are not games *per se* [10]. Most often used game elements in gamification are points, achievements, badges, levels, challenges, and time-restricted activities [11].

On the other hand, game-based learning (GBL) is a process of learning with the use of digital games [12] in order to accomplish certain learning outcomes [13]. In other words, it interprets what the students are doing when they use games in order to achieve the learning outcomes. Game-based learning tells how to properly design educational or serious games, or incorporate game elements in a non-game environment which requires to integrate best practices of a game in the traditional curriculum design process [14].

3. Students with intellectual disabilities

Intellectual disability is a neurodevelopmental disorder that is characterized with deficit in individual's intellectual and adaptive functioning that are present during childhood [15]. It is not an illness or a psychiatric disorder, but a state of insufficient development of the central nervous system during the early development of an individual, and that is why it cannot be cured, but a possible development can be stimulated [16].

Students with intellectual disabilities usually have difficulties in “*cognitive, motor, auditory, language and psychosocial functioning*” [17, p. 956], and their school performing depends on their cognitive functioning and adaptive skills. Deficits in adaptive skills are in conceptual (language, money, time concepts), social (inter and intrapersonal skills, judgment, social problem solving), and practical adaptive skills (self-care, activities of daily living, occupation) [18].

While developing digital games for students with disabilities, some authors equate intellectual disabilities with other disabilities like Autism Spectrum Disorder (ASD) or Cerebral palsy. For example, the authors Cano, García-Tejedor and Fernández-Manjón [19] presented a literature review with the aim of identifying and reviewing the available literature on serious games for people with intellectual disabilities. While conducting the research, the authors put the focus on Autism Spectrum Disorder (ASD) and Down Syndrome (DS) claiming that DS is the “*most common intellectual disability associated with mental impairment*” (p. 96), and ASD is the disorder with the “*largest number of scientific investigations among the intellectual disabilities*” (p. 96). Even though students with e.g. ASD or Cerebral palsy may have the same difficulties as students with intellectual disabilities, for example slower learning, low level of reading comprehension, limited fine motoric, lowered spatial perception,

poor eyesight, as well as hand or eye coordination, poor finger dexterity and lowered threshold of information overload [20], their primary disability may otherwise affect the use of games in the learning process. The study of Brereton, Tonge and Einfeld [21] established that young people with ASD suffer significantly more from emotional and behavioral problems compared to young people with intellectual disabilities. Similar results were obtained in the research by Matson, Rivet, Fodstad, Dempsey and Boisjoli [22].

4. Using digital games for educational purposes for students with intellectual disabilities

Even though numerous research studies question the influence of games on general (typical) student population, only a small number of research studies was dealing with the effect of games on students with intellectual disabilities. In general, people with intellectual disabilities experience high level of digital exclusion [23]. There are multiple reasons for that, but one of the main reasons is accessibility [24]. Through time devices became more complex and the Universal Design paradigm (a paradigm for teaching students with disabilities) mostly focuses on accessibility for sensory or physical disabilities rather than those with intellectual disabilities [25]. Also, the great challenge for students with intellectual disabilities using digital games for educational purposes is the design, content and mechanics of the game [26]. Emerging theories of game mechanics and user-centered design put the focus on the interaction between an individual and a game which aims to understand the actual game-based learning process itself. In that sense, there is a need to adopt a more explicit pedagogical approach that highlights both – the specification of learning outcomes targeted by a game and how these will be realized via game mechanics [24]. If the above is taken into account, digital games, especially serious games offer many opportunities to promote inclusion and empower students and people with intellectual disabilities. One of rare studies was done by Singh and Agarwal [27] with the goal of examining the influence of computer games on teaching mathematical concepts on a sample of 18 children. The results have shown that the experimental group achieved overall better results in all three testing areas – calculating skills, money and money management skills, and time skills.

A review of the literature [28] showed that there are 21 games that are exclusively intended for students with intellectual disabilities in the period from 2010 to 2019 (according to available references). Most of the games were classified as serious games (9 games plus 3 games that the creators classified as augmented or virtual reality) and 7 games were educational games. In addition to this, some authors described their games as edutainment which represents the use of various media (video games, films, music, websites) to promote learning in a fun way [4].

The authors Shabalina et al. [29] developed two mobile games that enable people with severe intellectual disabilities learning everyday life skills. The games are for independent use, so they are designed to minimize any uncertainty in playing. The first game helps recognizing and distinguishing objects in the players surrounding. The second game enables the development of communication skills by using picture exchange communication system. The results showed that the mobile games can help people with intellectual disabilities acquire everyday life skills in an enjoyable way.

The benefits of using digital games are also visible in the study by the authors Brown et al. [30] who wanted to find out if participating in game-based learning can improve mathematical skills in students with intellectual disabilities. In the research, students played the game Cheese Factory, and the results showed that students in the experiment group significantly improved their understanding of fractions, while the control group showed no significant improvement which means that digital games can have a positive impact on the functional skills of people with intellectual disabilities, which can promote their inclusion into society.

The authors in [31] created a virtual reality game called “Learning with Activities” which aims to encourage the development of cognitive skills that are important for academic learning. The game received a positive feedback in supporting the literacy process of students with intellectual disabilities. The serious game was developed using 3ds Max and Unity 3D tools based on requirements identified with professionals in the field of special education. The game enables the player to identify objects and situations that are part of the student’s daily life, categorize them and provide the written form of objects. The results of the study have shown that serious games are a great tool for development literacy

skills of students with intellectual disabilities. In this sense, serious games and virtual reality have potential to contribute to the inclusion of students with intellectual disabilities in the educational context.

Further, the authors Kang and Chang [32] designed an augmented reality technology to gamify ATM (Automated Teller Machine) skill training. The game was implemented on iOS operating system and simulated the steps of using ATM systems. The results of the study showed that the proposed game can be used for effective training of children with intellectual disabilities using an ATM independently.

5. Digital Games project

The purpose of the University of Rijeka's scientific project Digital games – “Digital games in the context of learning, teaching and promoting inclusive education” (Figure 1.) is to explore the possibilities of games and digital tools, as well as modern teaching models for building the GBL-based frameworks, for learning and teaching subjects in schools.

One of the studies in the project focuses on exploring how the GBL can be used to promote the inclusion of students with intellectual disabilities through the assistance in acquiring new data, developing new skills and gaining everyday life skills. Main goal will be the development and promotion of contemporary pedagogical-technological framework for the evaluation of educational games and digital tools designed for students with intellectual disabilities.



Figure 1: Digital Games project web site (<https://degames.uniri.hr/>)

The research in the context of the project started with the scientific investigations aimed to explore the impact of using digital games for people with intellectual disabilities as a tool that enables learning and mastering specific skills [36]. The authors conducted a systematic literature review in order to find which technologies and games are appropriate and have a positive impact for students with intellectual disabilities. As mentioned before, it was important to find researches and solutions created exclusively for students with intellectual disabilities, and not solutions that are adjusted for students with ASD or Cerebral palsy. The analysis showed that the area of socio-emotional skills for students with intellectual disabilities is not sufficiently covered, so there are no available games that develop this area such as the

ability to recognize and understand other feelings and emotional states, empathy, how to express strong feelings and establish relationships with other people.

The next step of the project is focused on creating an ontology for the domains of digital games for education and the characteristics of students with intellectual disabilities. Ontologies play an important role in knowledge management and representation. It is a formal description of domain concepts, their mutual relations, and limitations over them. In this context “formal” means in a language with well-defined syntax and semantics [33]. As a knowledge representation method, ontologies are used with great success in education because they allow to formulate the representation of a learning domain by specifying all concepts involved, relations between concepts and all properties and conditions that exist [34]. Ontologies are often used in educational systems, in the period from the year 2015 to 2019, there were 95 papers dealing with ontologies for educational purposes in the IEEE Xplore digital research database [33]. The authors in [35] point out that ontologies are used to capture domain knowledge in a generic way. Domain ontologies define semantic data models and combine them with associated domain knowledge by defining links between different types of semantic knowledge [36]. Taking this into account, a domain ontology will be created as part of the project because domain ontologies enable that the individual needs of students with intellectual disabilities can be better and more formally described. In order to develop a good domain ontology, various experts in the field must be involved, so special education teachers are already being interviewed as part of the project.

6. Conclusion and future work

The goal of this paper was to obtain information about using digital games for educational purposes for students with intellectual disabilities by giving an overview of recent research in the field.

Acquiring academic and practical skills for students with intellectual disabilities is a great challenge. Game-based learning as a process of learning with the use of digital games and game-based simulations in order to accomplish certain learning outcomes can be a good mediator in adopting these skills. Taking this into consideration, it would be useful to create an expert system which would facilitate the upbringing and education process of students with intellectual disabilities including digital games. The system would provide special education teachers with recommendations which will help them in designing the teaching process based on digital games intended to meet the individual educational needs of students with intellectual disabilities. In order to achieve this, it is important to precisely define the domains of digital games and intellectual disabilities so the first step is to create an ontology for the domains of digital games for education and the characteristics of students with intellectual disabilities. The new ontology will be designed in cooperation with special education teachers for better determining adequate games for students with intellectual disabilities. By using the expert system, special education teachers can implement in the teaching process digital games for education that will address the student’s individual needs with the goal of developing intellectual and adaptive skills they need most to be able to function at their peak.

So far, the contributions of the research in the context of the project have been evident in: defining terms game-based learning, educational games, serious games and connecting them with the term intellectual disabilities, and pointing out new findings in using digital games in the upbringing and education of students with intellectual disabilities. These findings helped to better understand the field of digital games for students with intellectual disabilities and will have a significant role in the following steps of the project which include the development of a domain ontology as a starting point for the development of the future expert system.

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