THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN UPBRINGING AND EDUCATION OF STUDENTS WITH INTELLECTUAL DISABILITIES

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Abstract

One of the main reasons for introducing information and communication technology (ICT) in the upbringing and education of students with disabilities is to enable them to acquire more easily functional and adaptive skills and knowledge that eases their integration into society. The paper focuses on students with intellectual disabilities which are usually insufficiently involved in society in general, and especially in the information society. Each student has the right to acquire experience in accordance with his/her developmental abilities by accessing various content in a customized way. In this context ICT can be used to assist students with intellectual disabilities in acquiring functional knowledge and fundamental skills to become more independent in everyday life.

This paper defines the term “intellectual disability” as a complex concept, discusses specifics and obstacles that may occur in the ICT supported education of students with intellectual disabilities, and lists categories of ICT for students with intellectual disabilities. According to that, ICT can be applied as assistive technology or a tool, used as a virtual tutor or for assessment and management purposes.

Besides assistive technology and intelligent tutoring systems, the focus is on digital games as well as virtual and augmented reality for educational purposes. Using games and game elements as a medium to master certain learning outcomes enables students with intellectual disabilities to explore and understand the world around them. The concepts of Digital Game-Based Learning (DGBL) and gamification motivates students to stay engaged for a longer period of time and experience everyday situations by playing roles or by performing simple practical exercises. The paper presents a work-in-progress in the research area on the use of DGBL in upbringing and education of students with intellectual disabilities. As the first step of the research, an overview of existing games and other ICT tools designed for students with intellectual disabilities as well as for educational rehabilitators who work with such students is presented.

Keywords: students with intellectual disabilities, special education, ICT, inclusion, tutoring systems, digital game-based learning, gamification.

1 INTRODUCTION

Intellectual disabilities affect 2-3% of younger population [1]. It is estimated that in the EU live in total 3,5 million individuals with intellectual disabilities [2], while the world sees that number rise up to 2-3% of the population, as an isolated state or a as a part of a wider disorder [3].

One of the main reasons for introducing information and communication technology (ICT) into education of students with intellectual disabilities is to enable them to acquire functional and adaptive skills and knowledge as easily as possible, which enables them easier integration into society. Authors Black and Wood [4] quote that the use of ICT can help students with disabilities increase their self-confidence and motivation through creative activities and web search. It can also encourage learning independence, quick feedback, patience and individual study rhythm. But Lloyd et al. [5] and Saad et al. [6] quote that the real benefit from ICT use diminishes because of low quality of programming solutions which includes content that is insufficiently adjusted to the age group, educational content that doesn't meet the criteria and inability of independent study.

2 STUDENTS WITH INTELLECTUAL DISABILITY

The phrase *students with disabilities* encompasses [7]: *‘’(1) students with developmental disabilities, (2) students with learning disabilities, behavioral and emotional issues and (3) students with disabilities caused by upbringing, social, economic, cultural and linguistic factors’’.* This article deals with a certain group of students with developmental disabilities, intellectual disabilities (earlier term in use being mental

retardation) which implies that the psychosocial development (especially cognitive development) is lagging behind the average psychosocial development of a student of the same age [8]. Etiology of intellectual disabilities is not unambiguous, but it implies complex interactions of genetic, chromosomal, prenatal, perinatal and postnatal factors [9]. Even though the term mental retardation is archaic and pejorative, it is still used as a diagnostic category in DSM-V, The Diagnostic and Statistical Manual of Mental Disorders [10]. Since one-dimensional understanding of the term mental retardation based on intelligence quotient (IQ) is falling out of use [11], the term *intellectual disability* is being adopted because it represents a complex concept, which includes biological, psychological and social factors [11]. In other words, the concept it represents is determined as a result of three key elements: the individual's ability, their environment and real functioning inside a social space. Intellectual functioning is to this day measured through intelligence tests that use IQ as a measure unit, and a borderline result of intelligence quotient of 75 is one of the indicators of a disability. Still, that data point is insufficient for diagnosing a student with an intellectual disability [12]. Given how IQ is not a perfect indicator of individual functioning ability, Taylor et al. [13] recommend a classification which is based upon the amount of support an individual needs to be able to function at their peak. That support can be temporary (only in certain situations), limited (consistent but limited by time), expanded (everyday care) or complete (constant support in all aspects of an individual's life) which indirectly reflects on the degree of independent use of ICT. Intellectual disability 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 [14]. That is why a stimulating learning environment is of crucial importance for students with intellectual disabilities, where the possibility of using ICT is being reflected.

3 SPECIFICS AND OBSTACLES IN UPBRINGING AND EDUCATION OF STUDENTS WITH INTELLECTUAL DISABILITY

Teaching students with intellectual disabilities can represent a great challenge since the advancement of a student is relatively slow (it all depends on the severity of intellectual and adjacent disabilities) which demands frequent repeating of instructions and actions. Looking over at the professional world, while teaching students with dasabilities, teaching methods and forms that stimulate all student's senses are being used most frequently (picture, sound and video) [15] in order to increase student's motivation for understanding and learning class content. The use of information and communication technology does not only lead to an increase in motivation, but also to an increase in user performance and better efficiency [16], it also has the responsibility to offer new ways of knowledge transfer, communication ability and tools that increase motivation and advance learning [17]. That is why students with intellectual disabilities can and should learn new competences [10], especially from the domain of ICT.

During the process of education and upbringing of an intellectually disabled student, what is important is the awareness of individual differences between students, and so it is necessary to choose interesting activities and adequate didactic methods [18] all the while taking into consideration obstacles that appear as a consequence of difficulties and that could lead to digital exclusion [19]. Those difficulties can be slower learning, low level of reading comprehension, limited fine motorics, lowered spatial perception, poor eyesight, as well as hand or eye coordination, poor finger dexterity and lowered treshold of information overload [20], [18].

4 CLASSICAL WAYS OF USING ICT IN UPBRINGING AND EDUCATION OF STUDENTS WITH INTELLECTUAL DISABILITY

Florian [21] and Means [22] differentiate several categories of ICT in education of students with developmental disablities according to the way it is used in teaching: (A) ICT as assistive technology, (B) ICT as a tool or an aid, (C) ICT as a tutor and (D) ICT as a system of evaluation and organization.

4.1 ICT as assistive technology

Assistive technologies can have a big role in bridging the barriers with which individuals with developmental disabilities are facing, but that also includes individuals with intellectual disabilities. This type of technology includes assistive, adaptable and rehabilitative devices that enable individuals independent execution of routine tasks [23]. In general, ICT as technical support represents the lowest level of technology use for enabling the learning process in students with intellectual disabilities, and still, Wehmeyer et al. [24] quote how using assistive technologies for individuals with intellectual

disabilities increases independence, the ability to integrate and decisivness. Additionally, Parette [25] quotes how assistive technology positively affects intrapersonal and interpersonal relationships, sensory and cognitive abilities, communication skills, motor skills and self-care.

4.2 ICT as a tool

Students with intellectual disabilities can use ICT as a tool or an aid in the form of various educational software in order to experience everyday life situations (for example: going shopping or to the bank, personal hygiene, spatial orientation, making decisions) and in order to bring closer the educational content tied to mathematics, reading, vocabulary, improving problem solving skills and preparation for personal security, integration and eventual vocational education [26]. With the goal of advancing quality of life of individuals with intellectual disabilities, Ferreras et al. [27] created idICT project, a training program with the goal of improving the skills of individuals with intellectual disabilities through an online platform that includes the initial selection of applications that have been proven useful with the goal of increasing quality of life.

4.3 ICT as a virtual tutor

Means [22] and Kirinić et al. [23] quote how tutoring programs represent *"long-lasting form of technology-assisted class"* which helps teachers to "*individualize learning through work that is paced by students themselves*." This type of work was initially known under the name of CAI (Computer Assisted Instruction) which is a method of tutoring that uses the computer as a means in helping to identify and fulfill individual needs of the student [28]. With the development of multimedia, Adaptive Hypermedia Systems (AHS) appeared which use an intelligent component and are capable of dynamically changing the content of class materials [29]. In this way, students learn independently since the system is individually adapting the class materials according to their abilities and current knowledge. Authors Alja'am et al. [30] created a system that uses multimedia elements in order to enhance comprehension of life concepts and to improve self-confidence in students with mild degree of intellectual disabilities.

Newer way of using ICT as a tutor can be seen in ITS (Intelligent Tutoring System), especially on mobile platforms which offer better possibilities of integrating a student with intellectual disability into the society [31].

4.4 ICT for assessment and management purposes

Upbringing and education of a student with intellectual disability is by itself a big challenge because educational rehabilitators have to determine a student's individual functional abilities based on their intelligence quotient, but also through other elements, while they also have to plan their educational activities based on individual needs and abilities. For this reason, systems (tools) emerged that evaluate student's condition in order to easily make a special program with individual demands. Such an evaluation tool was created by Johny et al. [32] under the name "Punarjjani" – a web tool that implements various rating scales and checklists for the evaluation of a student's condition. Mandula et al. [33] suggested a framework for evaluation and planning of student's education based on individual needs and abilities. Authors Yohny and Harish [34] created a system "Prayatna" that offers a complete environment for vocational education, including evaluation of professional readiness and evaluation of individual's abilities. The system is already integrated in the aforementioned "Punarjjani" system, which means students with intellectual disabilities can have a digitized education in India since they are five years of age.

5 NEW WAYS OF USING ICT IN UPBRINGING AND EDUCATION OF STUDENTS WITH INTELLECTUAL DISABILITY

The classification according to Means [22] originally dates from 1994, and it was still relevant in 2004 [21] and 2010 [23], and since newer classifications never got made, it is necessary to highlight current, but still not well studied ways of ICT supported education for students with intellectual disabilities.

5.1 Game-Based Learning and gamification

Using games as a medium for acquaring certain learning outcomes enables students to research and understand the world around them, and while mimicking game elements, they increase their creativity and imagination [35]. Game-Based Learning (GBL) and gamification are used in education with

increasing frequency. GBL encompasses the use of didactic games with the goal of acomplishing certain learning outcomes [36]. As this type of learning by its own definition does not imply that the didactic game has to be in digital form, a new term is introduced: Digital Game-Based learning (DGBL), which includes computer games. On the other hand, gamification means use of game element in situations that are not games *per se* [37]. Kapp [38] defines gamification as using the mechanics, aesthetics and way of thinking that are characteristic for games in order to engage the participants, motivate their actions, promote learning and solve problems. Most often used game elements in gamification are points, achievements, badges, levels, challenges, time-restricted activities and so on [39]. The main argument for why games are used for educational purposes is motivation [40]. Game elements motivate students to stay engaged during a longer period of time and to accomplish a goal. Students with intellectual disabilities can experience everyday situations in this way with the help of roleplaying or with simple practical exercises [26].

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. One of rare studies was done by Singh and Agarwal [41] with the goal of examining the influence of computer games on teaching mathematical concepts on a sample of 18 children. Calculating skills were tested alongside skills tied to time and skills tied to money and money management. The results have shown that the experimental group achieved overall better results in all three testing areas.

5.2 Virtual Reality

Virtual reality (VR) represents a replica of the real world based on computer graphics and 3D world, where users create content and are in interaction with the digital environment [42]. According to authors Liou and Chang [43] there exist two basic types of virtual reality systems – (1) game-oriented systems that have strict rules, limited activities and specific roles and (2) socially-oriented systems which enable free character creation and freedom of movement in virtual environment. De Oliveria Malaquias et al. [44] created educational virtual environment (VirtualMat) for learning mathematical and logical concepts for students with intellectual disabilities. The system has been tested on a group of 15 students and qualitative and quantitative results have shown that virtual reality significantly contributes to the process of learning for students with intellectual disabilities [44].

5.3 Augmented Reality

Augmented Reality (AR) is an umbrella term for technologies that connect the real and virtual worlds [45]. This type of technology is interactive and uses three main components – computer vision, image processing and digital computer techniques in order to integrate virtual content into the real world in real-time [46]. Number of research studies that are testing augmented reality in education is rising, but not the ones that are dealing with students with intellectual disabilities, because researches usually focus on students with movement disability [1]. For this reason, Colpani and Homem [1] offered a framework for learning with help from augmented reality and gamification, which offer additional support in the learning process for students with intellectual disabilities. The demands of the system were created based on data gathered through interviews with educational rehabilitators and psychologists, and they were realized with the tool Unity and C# programming language. For the system to be adequate for various students, two levels of difficulty were created, taking into consideration the differences in mental maturity of a student.

6 OVERVIEW OF EXISTING SYSTEMS

Table 1 shows an overview of existing systems used by ICT in upbringing and education of students with intellectual disabilities. The fourth column is referring to an already carried out system evaluation which assumes usage of the system in real environment in order to determine whether the system has positive or negative effects on students. There was no evaluation conducted on five systems shown within this article, while on the rest of the systems, it was conducted mostly through using experiments as a method of evaluation.

Table 1. Overview of existing systems

[Ref.] Name *(year)*	Target group	Area	Evaluation method	Purpose and system features
Category: ICT as a tool				
[6] Multimedia-based learning system *(2015)*	Educational rehabilitators	General education competencies	Experiment	Educational system for generating and creating multimedia tutorials according to the curriculum.
[27] idICT *(2017)*	Students	Life competencies	Evaluation planed, not available	Online platform with applications that are shown to be useful for increasing the quality of life.
Category: ICT as a tutor				
[47] 3DVIA VIRTOOLS *(2010)*	Students	Spatial orientation	Experiment	Tool for creating virtual surroundings which has a goal to teach the students different routes and shortcuts.
[48] MCDPA *(2010)*	Students	Group work	Case study	This tool counts as assistive technology but students can learn to work in a collaborative environment to achieve a goal.
[30] Assistive Computerized System *(2011)*	Students	Reading, understanding, memory	-	A tutor system that provides simple sentences, video clips, images and sounds in Arabic, it is linked with games that enhance memory, and it enables extraction of keywords from a text and connecting them to pictures and sound in order for students to understand the concept of living and to develop self-confidence
[49] EACCID *(2016)*	Students	Reading and understanding	Experiment	Set of tools and checklists for better reading, writing, understanding and social skills.
Category: ICT as an assessment and management system				
[32] Punarjjani *(2012)*	Educational rehabilitators	Assessment	-	Digitizing the assessment of students
[33] ICT based Special Education Assessment framework *(2016)*	Educational rehabilitators and parents	Assessment and education planning	-	Assessment and planning of student's education process based on individual needs and abilities.
[34] Prayatna *(2016)*	Students over 18 years	Vocational education	-	Vocational education environment that assesses professional readiness and the ability to work.
Category: DGBL				
[26] EPINOISI *(2008)*	Students	Life competencies and general education	-	Education materials based on existing games for better education.
[50] Route Mate *(2011)*	People with intellectual disability	Life competencies	Evaluation planed, not available	A game that helps students travel on their own.
[51] CLES *(2011)*	Students	Life and general education competencies	Simulation	Package of games that enhances perception, attention, memory, logical thinking and language usage.

[52] Telemonitoring tool based on computer games *(2014)*	Students	Life competencies	Experiment	Little games that involve the areas of paying with money and money recognition.
Category: Virtual reality				
[44] VirtualMat *(2013)*	Students	Life competencies	Case study	Virtual educational environment (a city with houses, cars and shops) for learning mathematical and logical concepts.
Category: Augmented reality				
[1] Augmented reality framework with gamification *(2015)*	Students	Reading, writing, understanding	Evaluation planed, not available	A framework that uses two levels of difficulty considering differences in student's mental maturity. The aim is to teach students group objects in categories.

One of the possible means of evaluation is through use of Design Based Research (DBR) which can be specified as a systematic but flexible research methodology which strives to improve the educational practice through iterative analysis, design, development and implementation. It is based on collaboration between researchers and professionals which leads to contextually sensitive principles of design and theories [53]. In DBR, a learning model is conceived iteratively, which is tested afterwards in real environment and then it is corrected as many times as necessary. [54]. Main advantage of DBR in relation to an experiment is that DBR is conducted in real-time environment, and the design process is unfolding and being studied during the entire research study, because there is an interaction with the educational practice. Therefore, it is not as in an experiment with laboratory conditions but it includes real-world variables that are usually isolated during an experiment [53]. In this way, the design can be more easily revised and compared with other solutions which as a consequence, may have generation of new theories or advancement of current ones [55].

7 CONCLUSIONS AND FUTURE PLANS

As it is presented in this article, one of the main reasons for introducing ICT in upbringing and education of students with developmental disabilities is to enable them a much easier acquisition of functional and adaptive skills and knowledge, which, as a consequence, has an easier integration and full participation in a society of which they are part of.

Strategies for active learning and teaching incorporate game-based learning and teaching. Games are a vital part of learning and teaching of all age groups, especially of students with developmental disabilities. Teaching that sees 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 to them understandable way. This fact especially makes DGBL an interesting field for further research. Learning based on digital games can help students with intellectual disabilities to learn new data, learn and develop new skills, acquire life skills, develop social skills and form a way of thinking. A game acts on a student through a biological, social, cultural, emotional (affective), cognitive and physical aspect and as such has a direct influence on behavior, way of thinking and perception of the world in which an individual lives and acts. With that, focus can be put on mobile learning which is a completely uncharted territory for students with intellectual disabilities. For students with intellectual disabilities of great use would also be beformentioned adaptive hypermedia systems which can take into account individual needs and abilities of every student through an intelligent component. They can also adjust the content of class materials and the time needed to grasp certain learning outcomes. As a possible solution, development of a system that would recommend a specified learning content based on initial student evaluation is recommended. Thereat, the game element can be used upin various segments of the system – for initial evaluation and for easier grasp of learning content.

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