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Using Digital Game-Based Learning for Students with Intellectual Disabilities – A Systematic Literature Review

Kristian STANČIN[1], Nataša HOIĆ-BOŽIĆ[1], Sanja SKOČIĆ MIHIĆ[2]
[1]*University of Rijeka, Department of informatics*
Radmile Matejčić 2, 51000 Rijeka, Croatia
[2]*Faculty of Teacher Education, University of Rijeka*
Sveučilišna avenija 6, 51000 Rijeka, Croatia
e-mail: kristian.stancin@inf.uniri.hr, natasah@inf.uniri.hr, sskocic_m@uniri.hr

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Abstract. The purpose of this systematic literature review is to explore the area of digital Game-Based Learning (GBL) for students with intellectual disabilities as a tool that enables positive impact on learning and mastering specific skills in order to make recommendations for future research. Twenty-one studies were selected from different databases. The results showed that the most common type of game was serious game, and the most common used technology was PC with additional equipment, but tablets were also often used. In addition, the studies were more focused on the development of cognitive abilities rather than of adaptive skills.

Keywords: Game-based Learning, educational games, serious games, intellectual disabilities.

1. Introduction

Using games as a medium to master certain learning outcomes enables students to explore and understand the world around them (Piaget, 1962), which is important for 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 (American Psychiatric Association, 2013).

According to the new edition of DSM-V deficits in intellectual functioning are deficits in "*reasoning, problem solving, planning, abstract thinking, judgment, academic learning, and learning from experience"* and are confirmed by clinical evaluation and individualized standard IQ testing while deficits in adaptive functioning result in *"failure to meet socio-cultural standards"* (e.g. lack of judgment) and are related to intellectual impairments (American Psychiatric Association, 2013, p. 33). Adaptive functioning skills include a set of conceptual, social and practical skills that a person has adopted

with the purpose of functioning in everyday life (American Association of Intellectual disabilities and Developmental Disabilities (AAIDD), 2019; Not, 2008). Comparing to previous edition of DSM-IV (American Psyhiatric Association, 2000) defining intellectual disabilities has been changed in 4 domains: (1) replacing old stigmatizing term mental retardation, (2) emphasizing on individual's cognitive, social and practical functioning (self-management), (3) decreasing reliance on psychometric IQ scores in favor of comprehensive assessment based on adaptive functioning and (4) deleting four levels of severity based on IQ tests – mild (IQ 50–69), moderate (IQ 36–49), severe (IQ 20–35) and profound (IQ below 20) (NLESD, 2014).

For diagnosing the intellectual functioning standardized testing was dominantly used, where the IQ score below 70± indicates intellectual disabilities. Still, that data point is insufficient for diagnosing a student with an intellectual disability (Woolfork, 2016) and nowadays diagnosing should be interpreted in the context of adaptive functioning and age-appropriate daily life skills.

This lifelong condition is related to uncompleted brain development and functions that affected all aspect of development. Because of the underdevelopment of the central nervous system that occurs during the early development of a human being, the consequences of such a condition cannot be completely removed, but it is possible to stimulate social and cognitive development (Poredoš Lavor & Radišić, 2011). Students with intellectual disabilities usually have difficulties in *"cognitive, motor, auditory, language and psychosocial functioning"* (Vuijk, Hartman, Scherder, & Visscher, 2010, 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) (Maulik, Mascarenhas, Mathers, Dua, & Saxena, 2011; Vuijk, Hartman, Scherder, & Visscher, 2010).

The scientific investigations were aimed to explore the impact of using digital games for people with intellectual disabilities as a tool that enables learning and mastering specific skills. The stimulating environment for learning is very important for students with intellectual disabilities which precisely reflects the possibility of using games for educational purposes. 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 (Sigh & Agarwal, 2013). 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 (Sigh & Agarwal, 2013).

In this article the authors conducted a systematic literature review in order to find and analyze the available literature dealing with the use of DGBL (Digital Game-Based Learning) for students with intellectual disabilities to enhance their capacitate for learning through structural activities. The aim of this study is to find which technologies and games are used in order to accomplish DGBL for students with intellectual disabilities and analyze if the DGBL systems have a positive impact on students with intellectual disabilities. Besides, the authors defined for which fields, subjects and areas are the found games developed and which testing methods are used in order to evaluate the ef-

fects of the games. Applicative purpose of this study is to determinate the direction of further research focused on DGBL which can introduce certain educational content to students with intellectual disabilities in a suitable and to them understandable way.

2. Terminological Definition of Terms Game-Based Learning, Serious Games and Educational Games

GBL (Game-based Learning) is a process of learning with the use of digital games (Prensky, 2003; Gee, 2003; Whitton, 2009; Rugelj, 2016) order to accomplish certain learning outcomes (Shaffer, Halverson, Squire, & Gee, 2005). It is similar to problem-based learning, but the problem scenarios are integrated into a game (Tsai & Fan, 2013). GBL includes the design of educational or serious games and requires educators to integrate best practices of a game in the traditional curriculum design process (Sereti, *et al.*, 2020; Alaswad & Nadolny, 2015). The term DGBL (Digital Game-based Learning) has an additional restriction – that the games have to be digital. In this sense, (D) GBL interprets what the students are doing when they use games in order to achieve the learning outcomes.

The term educational game (EG), also used terms: instructional games and games for learning, includes software application that uses game technologies – game playing and storytelling for creating educational content (Tang, Hanneghan, & El Rhalibi, 2007; Yue & Mat Zin, 2009) and most of them do not fully satisfy the users expectations because the entertainment factor is low (Tang, Hanneghan, & El Rhalibi, 2007). This means that EG are primarily used as tools for practice of factual information in education and do not use all the advantages for discovering new knowledge (Kiili, 2005).

On the other hand, serious games (SG) as resources from videogame field reapplied for the purposes beyond entertainment – education, healthcare, productivity and more (Smith, 2008; Girard, Ecalle, & Magnan, 2013). SG's have more than just story, art and software (Zyda, 2005). The authors Prayaga and Rasmussen (2008, p. 11) state that SG are those games that "*help develop a skill, learn a language or acquire concept knowledge*". In this sense, it is the credit of pedagogy that makes games serious, but it is necessary that the entertainment factor comes first (Zyda, 2005). This means that the instructional content is well incorporated within the game characteristics (Garris, Ahlers, & Driskell, 2002) which allows students to have fun and forget about the learning part of the game "*even though they are constantly presented with new concepts which they have to adapt in order to be successful in game*." (Rugelj, 2016, p. 96). Also, SG's must have well-defined learning outcomes and have positive impact on developing new skills or acquire knowledge (Zapušek, Cerar, & Rugelj, 2011).

Additionally, gamification is a term that is often linked with the before mentioned terms and means the use of a game element to engage the participants and motivate their actions in situations that are not games *per se* (Deterding, Dixon, Khaled, & Nacke, 2011; Strmečki, Bernik, & Radošević, 2015). Most often used game elements in gamification are points, achievements, badges, levels, challenges, time-restricted activities and so on (Glover, 2013).

3. Related Work

The authors Cano, García-Tejedor and Fernández-Manjón (2015a; 2015b) presented a literature review with the aim of identifying and reviewing the available literature on SG for people with intellectual disabilities and classifying the games they found according to four categories of learning outcomes in SG – cognitive skills, motor skills, affective learning and communicative learning. 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). After applying the inclusion criteria, 43 papers were selected, analyzed, and the conclusion was that most of the reviewed papers had games designed for users with a certain disability because of the heterogeneity of the skills that this type of users had, but most of the studies had a positive result – the users acquired new skills using SG.

Jiménez, Pulina and Lanfranchi (2015) conducted a literature review about the use of video games in relation to people with intellectual disabilities. The authors put the focus on children, adolescents, young and older adults with intellectual disabilities, and one of the included criteria was that the paper should have the focus on computer-game based training or video-game based training with a design that tests the effects of the before mentioned. After that, 11 papers were selected and included in the narrative review. The conclusion was that video games have been successfully used to improve several cognitive abilities of people with intellectual disabilities.

Tsikinas and Xinogalos (2018) presented a systematic literature review on the effects of SG on people with intellectual disabilities or ASD. The authors excluded studies older than 2005 and studies based on educational software which means that only game solutions were included. This led to 54 studies which were categorized based on the limitations in intellectual functioning and adaptive behavior that people with intellectual disabilities or ASD addressed. Most of the studies have a positive impact on people with intellectual disabilities or ASD with the focus on better social and communicational skills for people with ASD, and better conceptual and cognitive skills for people with intellectual disabilities.

The authors Cano, García-Tejedor and Fernández-Manjón (2015a; 2015b) classified the studies by acquisition of knowledge through the design or adaptation of games, some patterns and behaviors in games and by methodoliogy for game design or developement. Jiménez, Pulina and Lanfranchi (2015) in their research put the focus on computer-game based training or video-game based training with a design that tests the effects of the before mentioned but they didn't classify the found papers, and Tsikinas and Xinogalos (2018) classified their papers according to skills – adaptive behavior and intellectual functioning separately for intellectual disabilites and ASD.

By exploring existing literature, it has been shown that none of the found articles analyzed the use of DGBL only for students with intellectual disabilities, but they included students with ASD or young and older adults. The conclusion from the first review by Cano, García-Tejedor and Fernández-Manjón (2015a; 2015b) was that it

is necessery to identify, implement and test best practises in order to create a general methodology to simplify the creation process of effective games. Jiménez, Pulina and Lanfranchi (2015) concluded that it is relevant to study immediate effects of video games on cognitive abilities and the importance of defining the most important game characteristics in order to be useful for individuals with intellectual disabilities. The study from Tsikinas and Xinogalos (2018) points out the importance of devising SGs for covering adaptive behavior and intellectual skills. From the before mentioned, the authors consider that it is 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 who can also have intellectual disabilities because their educational needs and learning abilities can be more complex, compering to students with intellectual disabilities.

4. Differences between Intellectual Disabilities and other Developmental Disabilities

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 (Friedman & Bryen, 2007; Rocha, Bessa, Melo, Barroso, & Cabral, 2016), their primary disability may otherwise affect the use of games in the learning process. In addition, the impact of games on the learning process of students with intellectual disabilities is an unexplored area, and consequently there are very few game solutions for this group of students (Williams, Jamali, & Nicholas, 2006).

The study of Brereton, Tonge and Einfeld (2006) established that young people with ASD suffer significantly more from emotional and behavioral problems compared to young people with intellectual disabilities. In the before mentioned research, 381 participants with ASD, and a representative group of 581 young people with intellectual disabilities aged 4 to 18 participated. Parents or trustees provided details of emotional and behavioral problems of their children using Developmental Behavior Checklist (DBC-P) (Einfeld, *et al.*, 2002). The authors also mentioned that increased mental health problems in children with ASD may be the result of higher stress experienced by children in their interactions with their environment which also affects the use of games for educational purposes (Brereton, Tonge, & Einfeld, 2006).

Similar results were obtained in the research by Matson, Rivet, FodStad, Dempsey and Boisjoli (2009) where 337 adults were evaluated using the Vineland Adaptive Behavior Scale (Sparrow, Balla, & Cicchetti, 1984) to examine whether differences emerged between adults with ASD and intellectual disabilities and adults with intellectual disabilities alone. The results have shown that individuals with intellectual disabilities alone evinced more adaptive skills across all domains of functioning – communication, daily living and socialization (Matson, Rivet, FodStad, Dempsey, & Boisjoli, 2009).

5. Methodology

The systematic review has originally been developed from health science which has specific research methods. For that reason, this study follows a guide to conducting a systematic literature review of information system research by the authors Okoli and Schabram (2010) because it meets the needs of information system researchers who have to combine social science and computing science research methods.

a) **Purpose.**

The purpose of this systematic literature review is to explore the area of DGBL for students with intellectual disabilities in order to make recommendations for future research.

b) **Research questions.**

The purpose of this study will be achieved by answering the following research questions:

- **Q1:** Which technologies and games in particular are used in order to accomplish DGBL for students with intellectual disabilities?
- **Q2:** For which abilities, skills and teaching subjects are the games being developed?
- **Q3:** What are the characteristics of the participants in the studies and which testing methods are used to evaluate the effects of the games developed for students with intellectual disabilities?
- **Q4:** Do the DGBL systems have a positive impact on students with intellectual disabilities?

Regarding to the research, it is important to know which technology is used for students with intellectual disabilities. By technology the authors mean a medium for achieving DGBL – PC (Personal Computer), tablet, smartphone, VR glasses and microcontroller. Also, it is important to classify games by its type (SG or EG) as explained in section 2.

Through Q2, the researchers want to classify games according to abilities, skills and teaching subjects. The term "abilities" means the developmental areas that the game encompasses – intellectual or adaptive abilities. Inside these abilities there are specific skills (Tassé, Luckasson, & Schalock, 2016) that the games address which is also important to list (e.g. logical skills, academic skills, socio-emotional skills). The games also need to be linked to a specific teaching subject within the school system in order to get information which of them are dominantly covered by games.

All research questions are created to explore the use of DGBL for students with intellectual disabilities. In that sense, it is important to know: are the games mostly for PCs or tablets/smartphones and are they dominantly serious or educational (Q1), which fields and areas of development the games address, and for which teaching subjects are they made (Q2), what are the characteristics of the participants in the already conducted studies, and which testing methods are used to evaluate the effects of games (Q3), and have the games a positive impact on stu-

dents (Q4). All collected information will be used for future work of the authors as explained in section 8.

c) **Protocol.**

Before conducting the literature review, a prior protocol was made. In the protocol the authors defined that this research should include scientific journals as well as conference proceedings. Papers from conferences are being published faster which provides more current data. Likewise, it was defined that only studies involving students whose primary disability are intellectual disabilities will be included in the analysis rather than students whose intellectual disabilities are the result of other primary difficulties. Also, the protocol encompassed databases to be searched for literature – IEEE Xplore, Scopus and Science Direct, keywords for the database query and other inclusion and exclusion criteria for the papers which will be discussed in the following subchapters.

d) **Searching for literature.**

In order to collect papers that talk about DGBL and students with intellectual disabilities the following query was used:

("DGBL" OR "digital game-based learning" OR "GBL" OR "game-based learning" OR "serious games" OR "educational games" OR "gamification" OR "VR" OR "virtual reality" OR "AR" OR "augmented reality" OR "instructional games" OR "games for learning" OR "edutainment") AND ("intellectual disability" OR "intellectual disabilities" OR "mental retardation" OR "mental impairment" OR "learning disability" OR "learning disabilities" "mentally challenged")

The query was used in the digital research databases with the keywords defined in the prior created protocol. Databases used for this paper were IEEE Xplore, Scopus and Science Direct because of the fields of engineering and social sciences. The listed databases are the best one for the interdisciplinary field that connects developing digital games with GBL pedagogical approach, and with the field of developmental disabilities. The query listed 453 papers in total within all observed databases.

e) **Practical Screen.**

Since the query found a large number of papers that meet the search criteria, it was necessary to reduce the given set of papers by applying some *include* and *exclude* criteria. After applying *exclude* and *include* criteria no. 1 to 3 listed in Table 1 and deleting duplicate studies, there were 309 papers left.

f) **Quality Appraisal.**

After limiting the year, language and the type of studies, it was necessary to examine the articles more closely to assess their quality. By doing that, the criteria no. 4 to 7 listed in Table 1 were applied. After applying all criteria, 21 articles were left for analyzing (Fig. 1). The articles were analyzed by the authors as a part of the methodology by Okoli and Schabram (2010) that this literature review follows. Concepts were singled out from the research questions and the text was coded exactly as they appear in the papers and later adjusted. The text was coded by researchers because of a small number of studies that have to be analyzed and because of easier recognition of errors (e.g. misspelling).

Table 1

Include and exclude criteria (Source: authors)

No.	Exclude Criteria	Include Criteria
1	Studies older than 2010	Studies from 2010 to 2019
2	Literature reviews and book sections	Journal and conference articles
3	Studies that are not written in English	Studies written in English
4	Studies that cover a different primary disability – Autism spectrum disorder, Cerebral palsy, Down syndrome, Traumatic brain injury, elderly with cognitive impairments, Alzheimer, Dementia, Learning disabilities	Studies that cover intellectual disabilities as primary disability
5	Studies which don't cover the design, development or evaluation of game solutions or which haven't game elements	Studies that cover the area of digital game-based learning
6	Studies that examine usability of the game solutions	Studies that examine the influence of the game solutions on students
7	Solutions designed for adults	Solutions designed for students

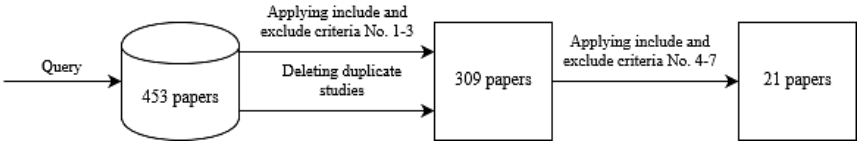

Fig. 1. Flow of the process. (Source: authors)

g) **Data Extraction.**

All citations were exported in the BibTeX format and analyzed in the JabRef tool. After that, the collected data about the papers were inserted and analyzed in the Microsoft Office Excel tool. The decision about which data were necessary to collect was based on the research questions established during the initial phase.

h) **Synthesis of studies.**

The database query listed 453 papers in total, and after the application of the criteria, 21 papers were left for the analysis in this research. As described in the fourth include/exclude criteria in Table 1, this research is focused only on students whose intellectual disabilities are primary difficulties and for that reason a minor number of articles were collected in relation to related work. Of the above mentioned 21 papers, 9 papers are conference proceedings, while 12 are from scientific journals. Fig. 2 shows the number of papers per year. Most studies were conducted in the year 2005 (5 studies).

When looking at countries where the researches have been conducted, most of them were from Spain (4 studies), followed by Brazil with 3 studies. Four papers did not indicate in which country the research was conducted. Other countries that did some research in the field of DGBL for students with intellectual disabilities are shown in Fig. 3.

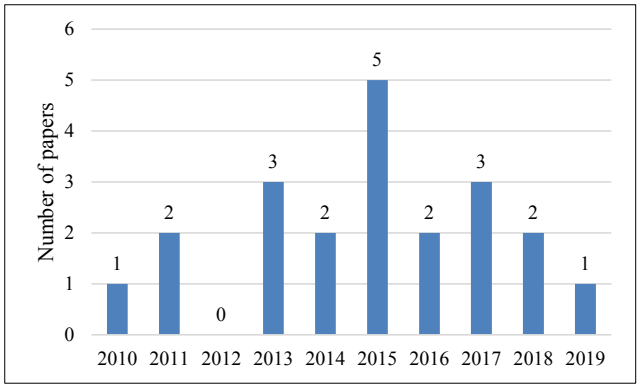

Fig. 2. Number of papers by year. (Source: authors)

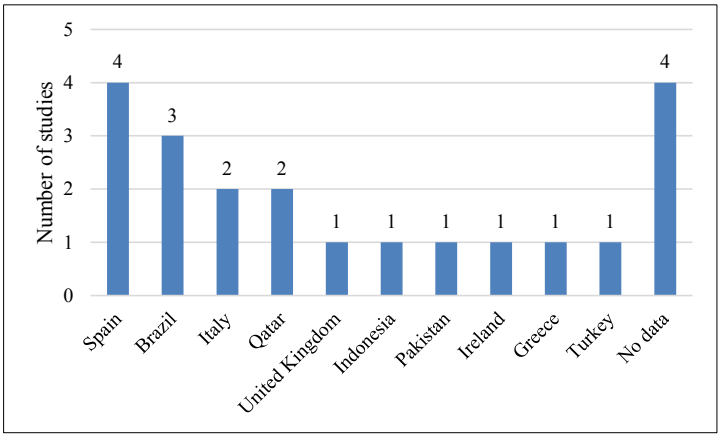

Fig. 3. Number of studies by country. (Source: authors)

6. Discussion

This chapter covers the discussion of the findings with respect to the defined research questions.

Q1: *Which technologies and games in particular are used in order to accomplish DGBL for students with intellectual disabilities?*

As part of the analysis, the authors wanted to find out which type of game and technology was used in order to achieve DGBL. Most authors classified their game as a SG (9 studies) and as an EG (7 studies). In addition to this, some authors used the term edutainment (2 studies) which represents the use of various media (video games, films, music, websites) to promote learning in a fun way (Tang, Hanneghan, & El Rhalibi, 2007), and some specified their studies as AR (Augmented Reality) or VR (Virtual Reality) – 3 studies in total.

Regarding to the technology, in 9 studies PCs were used, and in 5 cases (of the before mentioned 9) additional equipment was required such as a webcam like in the studies by authors Colpani and Homem (2015), Guarnieri *et al.* (2019) and Karal *et al.* (2010) or a microcontroller mat as in the studies by authors Dandashi *et al.* (2015) and Saleh *et al.* (2013). Furthermore, in 6 studies tablets were used, considering that the system by the authors Bonet-Codina *et al.* (2015) can be used on PCs and tablets, but it was tested on PCs because PCs were only available at the school where the research was conducted, so it was counted in the category of PCs. In a surprisingly small amount, mobile phones were used, only in one study, VR glasses in 2 studies, and in 3 studies Kinect was used. Kinect, as a newer type of console, has several advantages – low costs which enables the rehabilitation program for more people, the training itself becomes more personal and easier to be spread due to the use of VR which simulates home environment, the motivation increases and it promotes the ability to learn through multimedia (Fu, Wu, Wu, Chai, & Xu, 2015). The authors Kushwardhana, Hasegawa and Juhanaini (2017) quote that students with intellectual disabilities may not be able to hold a console to play a game, so they used Kinect sensor for motion detection in their ITG (Instructional Thematic Game) framework. For students with intellectual disabilities the development of intelligence and body motion is of great importance, as confirmed by a study of Bartoli, Corradi and Garzotto (2013) which demonstrated that motion-based touchless games can improve attention skills in students with cognitive disabilities. From the analysis of the game type and used technology it can be concluded that SG and EG are most used game categories (16 out of 21 studies), and PCs and tablets are most used as technology for playing (15 out of 21 studies).

Q2: *For which abilities, skills and teaching subjects are the games being developed?*

All collected studies are grouped in two main categories (Table 2): the development of intellectual functions (11 studies) and the development of adaptive skills (9 studies). Only the game by authors Bonet-Codina, von Barnekow and Tost Pardell (2015) could not fit in just one of the before mentioned categories because it is a game for professional training and social empowerment which addresses the development of intellectual functions and adaptive skills. The game reproduces the InOut hostel near Barcelona and presents several tasks to train cleaning procedures, vocabulary and social behavior.

After categorizing the studies into categories, each of the studies were marked with a teaching subject that they cover. The most common teaching subject is mathematics, which is in some studies combined with physical education and reading. Mathematics is followed by the field of science and reading. Accordingly, studies are associated with skills that they address. Most common skills are logical skills (8 studies) followed by the holistic approach of competence development, which includes motor skills, perception, cognition and visual processing, and food (4 studies). Only one or two studies dealt with the areas of professional skills, socio-emotional skills and academic skills (Fig. 4).

Table 2
Classifications of games (Source: authors)

Abilities	Teaching subject	Skills	Name of the game or project	Reference
Intellectual	Mathematics	Logical skills	Cheese factory	(Brown, Ley, Evett, & Standen, 2011)
	Mathematics	Logical skills	CLES project	(Hussaan, Sehaba, & Mille, 2011)
	Mathematics	Holistic approach	MeMapad	(Saleh, Aljaam, Karime, & Saddik, 2013)
	Mathematics	Logical skills	N/A	(Lopez-Basterretxea, Mendez-Zorrilla, Garcia-Zapirain, Madariaga-Ortuzar, & Lazcano-Quintana, 2014)
	Reading	Logical skills	N/A	(Colpani & Homem, 2015)
	Mathematics	Logical skills	Games: Twin Mach, The memory game, Math game	(Dandashi, *et al.*, 2015)
	Science	Logical skills	Smart Angel	(Freina, Bottino, Ott, & Costa, 2015)
	Mathematics	Logical skills	N/A	(Piki, Markou, & Vasiliou, 2016)
	Reading	Academic skills	Headsproud	(Yakkundi, Dillenburger, & Goodman, 2017)
	Mathematics	Logical skills	Parity	(Yasir, 2018)
	Reading and mathematics	Academic skills	MoviLetrando	(Guarnieri, *et al.*, 2019)
Adaptive	Mathematics and physical education	Holistic approach	N/A	(Karal, Kokoç, & Ayyıldız, 2010)
	Science	Food	N/A	(Isasi, Basterretxea, Zorrilla, & Zapirain, 2013)
	Mathematics	Food	VirtualMat	(Oliveira Malaquias, Malaquias, Lamounier Jr., & Cardoso, 2013)
	Science	Food	Shopping with us	(Lopez-Basterretxea, Mendez-Zorrilla, Garcia-Zapirain, Madariaga-Ortuzar, & Lazcano-Quintana, 2014)
	Mathematics and physical education	Holistic approach	Game System for Rehabilitation based on Kinect	(Fu, Wu, Wu, Chai, & Xu, 2015)
	Reading	Socio-emotional skills	Wildcard	(Gelsomini, Garzotto, Montesano, & Occhiuto, 2016)
	Science	Holistic approach	N/A	(Bravo, Ojeda-Castelo, & Piedra-Fernandez, 2017)
	Mathematics and physical education	Holistic approach	N/A	(Kuswardhana, Hasegawa, & Juhanaini, 2017)
	Reading and mathematics	Food	N/A	(Panerai, Catania, Rundo, & Ferri, 2018)
Intellectual and adaptive	Vocational subject	Professional skills	IntegraGame	(Bonet-Codina, von Barnekow, & Tost Pardell, 2015)

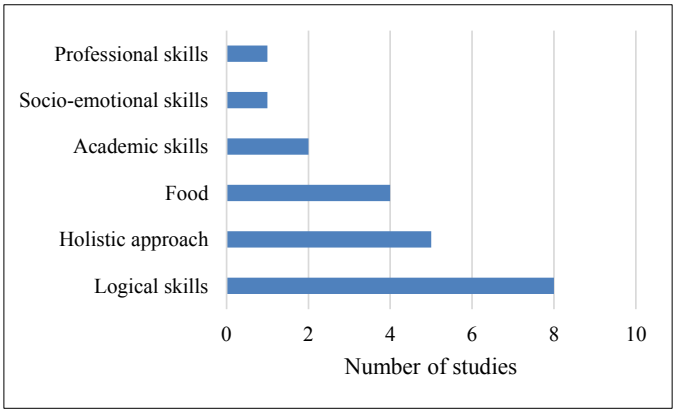

Fig. 4. Number of studies per area of development. (Source: authors)

Q3: *What are the characteristics of the participants in the studies and which testing methods are used to evaluate the effects of the games developed for students with intellectual disabilities?*

Out of total of 21 studies, 11 were evaluated using a case study, 4 were made using experiments, and 6 studies did not have an available evaluation (Fig. 5). The largest number of participants had studies which used an experiment as a method of evaluation. Authors Brown *et al.* (2011) had 16 participants, Dandashi *et al.* (2015) 77 participants, Guarnieri *et al.* (2019) 88 participants, and Fu Wu, Wu, Chai and Xu (2015) had 112 participants. Case study evaluations averaged about 8 participants (minimum 2, and maximum 16 participants).

Regarding the age of the participants, researchers took a wider range, so students from 3 to 22 years of age participated in studies. Six studies with available evaluation have not defined for what degree of difficulty the DGBL systems were created. Three out of 15 studies with evaluation included mild, moderate and severe degree of intellectual

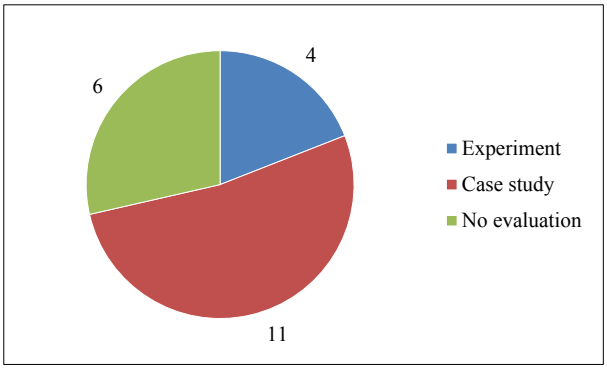

Fig. 5. Evaluation method of the studies. (Source: authors)

disabilities, only one study had the focus only on mild intellectual disabilities, 4 studies put their focus on mild to moderate disabilities, one study dealt only with moderate degree, and no studies were made for students with only severe or profound degree of intellectual disabilities. It is important to note that no research has indicated whether they took into consideration psychological and social factors, besides IQ for defining the degree of intellectual functioning.

The environment in which the research was conducted is also important for the evaluation. Out of 15 studies with available evaluations, 4 of them did not indicate whether the study was conducted in a regular system or in a special institution. Furthermore, 6 studies were conducted exclusively in a special institution, 2 studies in the regular system and in special institutions, and only the study by authors Oliveira Malaquias, Malaquias, Lamounier Jr. and Cardoso (2013) was conducted only in a regular system. Also, the study by Lopez-Basterretxea *et al.* (2014) was conducted in a local association, and the study by Gelsomini, Garzotto, Montesano and Occhiuto (2016) at a local therapeutic center.

Q4: *Do the DGBL systems have a positive impact on students with intellectual disabilities?*

In order to answer this research question, only the 15 studies with an evaluation are taken into account. All of those studies have had a positive impact on students with intellectual disabilities, and the most interesting findings are described below.

The authors Brown, Ley, Evett and Standen (2011) wanted to find out if participating in GBL can improve mathematical skills in students with intellectual disabilities. For this purpose, students played the game Cheese Factory for twenty minutes over five weeks. The results of the experiment showed that students in the experiment group significantly improved their understanding of fractions, while the control group showed no significant improvement. Also, the experiment showed that some students struggled with the keyboard so it was necessary to use computer "switches" or larger keyboards, but the authors did not mention on which level of intellectual functioning the students were. Nevertheless, the study has shown that GBL can have a positive impact on the functional skills of people with intellectual disabilities, which can promote their inclusion into society.

With a tablet game, the authors Isasi, Basterretxea, Zorrilla and Zapirain (2013) wanted to instill healthy eating habits to children and adolescents with intellectual disabilities. The purpose of the SG is to learn the appropriate products to make a salad and a breakfast. The preliminary results of the case study have shown that some of the users participating in the tests already knew how to use a tablet as well as mobile phones, and all the users had fun playing the game and would play it again.

The edutainment system consisted of multimedia technology based games with tangible user interface from the authors Dandashi *et al.* (2015) was created to address the needs for integrating physical activity into their daily lives. It was tested on students with different levels of intellectual disability. The results have shown that the edutainment system had a positive effect on students in terms of cognition and motivational levels. Besides, the students were more physically active in the classroom. Students with

mild intellectual disabilities achieved the best results of scores and coordination, but the Math game was left out of the statistical evaluations because most of the students were not able to perform well on this game (with the exception of some students with mild cognitive disability).

The authors Fu, Wu, Wu, Chai and Xu (2015) with the game system for rehabilitation based on Kinect also proved positive results. The system consists of the rehabilitation program, the basic perceptual and cognitive program, the upper and lower limb rehabilitation program and the leisure-healthcare program. In other words, the students were involved in the learning of shape perception, reasoning, digital text, memory, classification, gross and fine motor skills of the hands, balance and recreation activities. Before the experiment, the students' abilities were evaluated with an instrument for infants and young children called Pediatric Evaluation of Disability Inventory (PEDI) (Wassenberg-Severijn, Custers, Hox, Vermeer, & Helders, 2003) in the fields of self-care, mobility and social function. After the experiment, the instrument was repeated and the PEDI scores were significantly higher than the scores before the experiment. Participants have shown the greatest progress in social function.

Oliveira Malaquias, Malaquias, Lamounier Jr. and Cardoso (2013) 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.

The other studies that have an evaluation had also a positive impact, the students had fun playing games and increased their ability to learn new things. Nothing can be said about the impact of games on students with intellectual disabilities in the studies without evaluation because most studies are in the initial phase of designing the game or have an ongoing evaluation.

7. Limitations

First limitation of this study is related to the limited access to specific digital databases and therefore it can be presumed that the access to a larger number of digital databases would give different results.

Second limitation is the query used to find papers in the given digital databases. Using more or different keywords in the query may have resulted in a larger number of articles because different authors interpret the same terms in a different way. This means that there may be studies that deal with GBL and students with intellectual disabilities, but they are differently defined and the query has not included these studies in the results.

The last limitation of this study is the include and exclude criteria. By excluding studies that cover a different primary disability, for example, ASD or Cerebral palsy, the number of studies has decreased considerably, but in the end, there is a list of games and game-based systems with specific purposes – especially for students with intellectual disabilities.

8. Recommendations For Future Research

In this paper, the authors made a systematic literature review in the field of DGBL for students with intellectual disabilities. While selecting the studies for analysis, the focus was on all solutions that include DGBL and are designed for students whose primary disability are intellectual disabilities.

Twenty-one studies were included in the final analysis. The results of the systematic literature review showed that the most common type of game was SG, and the most common used technology was PC with additional equipment, but tablets were also often used. The analyzed studies were more focused on the development of adaptive functions rather than in the development of intellectual functions. One study covered both categories.

Regarding to the evaluation of the studies, the authors did not found available evaluations for 6 studies, partly because some of the game solutions are in the development phase, and some are in the evaluation phase. Four studies had an experiment as an evaluation method, and 11 had case studies. Also, in all studies with evaluation, a positive effect was observed, the students had fun playing the games and they have adopted new knowledge and skills easier than in a traditional approach.

One of the possible further directions of research in this area is to create a framework for the evaluation of educational game solutions designed for students with intellectual disabilities using Design-based Research (DBR). DBR can be specified as a systematic but flexible research methodology which strives to improve the educational practice through iterative analysis, design, development and implementation (Wang & Hannafin, 2005). It is based on collaboration between researchers and professionals which leads to contextually sensitive principles of design and theories. DBR is an iterative process which allows the correction and improvement of solutions as many times as needed in order to satisfy all needs of the student.

According to the analysis described in this paper it can be determined that the area of socio-emotional skills is not covered at all, so there are no available games that develop this area. One of the possibilities is to further research the area of DGBL for the development of socio-emotional skills for students with intellectual disabilities. The addressed skills could be the ability to recognize and understand other feelings and emotional states, empathy, how to express strong feelings and establish relationships with other people. These skills would be of great use in everyday life and facilitate the inclusion of students with intellectual disabilities into society.

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K. Stančin is a PhD student at University of Rijeka, Department of informatics. His field of research include the use of information and communication technology in learning, especially for students with disabilities.

N. Hoić-Božić (PhD) is a full professor and vice head of the Department of informatics at University of Rijeka. Her field of research are: technology enhanced learning (e-learning) including adaptive hypermedia, recommender systems, multimedia systems, blended learning approaches and Web 2.0. tools for teaching and learning.

S. Skočić-Mihić (PhD) is an associate professor at the Faculty of teacher education, University of Rijeka. In scientific and pedagogical work, she deals with inclusive education, competences of educators and teachers for teaching students with special needs and using bibliotherapy in inclusive communities.