Teaching, Learning, and Leading With Computer Simulations

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Chapter 8
Using a 3D Simulation for Teaching Functional Skills to Students with Learning, Attentional, Behavioral, and Emotional Disabilities

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ABSTRACT

The study presents results from the use of a 3D simulation for teaching functional skills to students with learning, attentional, behavioral, and emotional disabilities, attending regular schools. An A-B single-subject study design was applied. The participating students (eight eight-to-nine years old) explored the simulation (a virtual school), encountered situations in which they observed how they are expected to behave, and had to demonstrate what they have learned. Each student attended a total of four two-hour sessions. Data were collected by means of observations and semi-structured interviews. All students demonstrated improved functional skills both in terms of the number of behaviors they acquired and in terms of those that were retained and manifested in the real school environment. On the basis of the results, it can be argued that 3D simulations are a promising tool for teaching functional skills to students with disabilities.

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INTRODUCTION

The Salamanca Statement paved the way for the inclusion of children with special needs in regular schools (Unesco, 1994). The fundamental goal of inclusion is to avoid social discrimination by offering opportunities for students with disabilities to learn together with their non-disabled peers in typical classrooms. Students with special needs studying at regular primary schools represent a variety of disabilities, including -but not limited to- learning difficulties, social, emotional, and communication deficits, physical and mental disabilities (Espelage, Rose, & Polanin, 2016; O'Brennan, Waasdorp, Pas, & Bradsow, 2015). As a result, the idea of inclusion is not free of problems. For example, the disadvantaged students find it difficult to communicate with others and engage in a debate, while their interpersonal relationships constitute a stress factor. Their imagination may be limited and their participation in games is passive or dysfunctional. Their academic progress is inconsistent with that of their peers and quite often they exhibit severe weakness, for example, in mathematics or spelling (Wagner, 1995). Their emotional immaturity, their inability to be aware of or understand the emotions of others, leads to non-functional social relationships, isolation, outbursts of anger, and, in general, problems in understanding everyday situations (Nye, Gardner, Hansford Edwards, Hayes, & Ford, 2016; Vlachou, Stavrousi & Didaskalou, 2016). Finally, their deficits in focusing attention on a given task or situation and the neglect of the self, are factors that increase the likelihood of being victimized or manifesting undesirable/ unacceptable behaviors (Thompson, Whitney, & Smith, 1994).

In order to improve students' well-being, additional help is provided through structured school programs, aiming to support their academic performance and improve their everyday functional skills, both within and outside the school environment (Rose, Shevlin, Winter, & O' Raw, 2015). Such programs try to enhance their emotional (e.g., Domitrovich, Cortes, & Greenberg, 2007), behavioral (e.g., Espelage et al., 2016) and communication skills (e.g., Blandon, Calkins, Grimm, Keane, & O'Brien, 2010). Despite the fact that such programs exist and as far as students with mild disabilities (with learning difficulties, attentional, behavioral, and emotional disabilities) are concerned, it seems that the emphasis often lies in structuring the environment to accommodate their academic needs, while issues regarding their social adjustment are neglected (Office of Special Education and Rehabilitative Services, 2015). What is more, the relevant literature suggests that there is a need for intervention studies examining strategies for enhancing their social skills (Garrote, Dessemontet, & Opitz, 2017).

Needless to say, educational technology plays an important role in the above interventions. One such technology is 3D simulations, which is an umbrella term for a family of technologies such as virtual reality and extended reality. 3D simulations are realistic representations of a situation through the computer and users interact with the virtual objects in a lifelike way (Freina & Ott, 2015). Moreover, users can get emotionally involved as they feel the senses of presence and immersion (Portman, Natapov, & Fisher-Gewirtzman, 2015). In general, 3D simulations are considered effective teaching tools (Merchant, Goetz, Cifuentes, Keeney-Kennycutt, & Davis, 2014), because they offer safe and controllable environments as well as the context in which knowledge is applied (Marshall, 2014). In addition, users can practice their social skills (Didehbani, Allen, Kandalaft, Krawczyk, & Chapman, 2016), skills of self-care and self-protection (Kalyvioti & Mikropoulos, 2014), and also express their emotions (Lorenzo, Lledo, Pomares, & Roig, 2016). Due to the above, simulations can be used to teach students with special educational needs new skills, reduce unacceptable behaviors, and prepare them to manifest the appropriate behaviors in real life.

Taking into account that: (a) more studies are needed in order to establish effective strategies for enhancing the social skills of students with learning, attentional, behavioral, and emotional disabilities and (b) 3D simulations can be an effective teaching tool, a short research project was designed and implemented in order to study exactly this. The skills/behaviors were related to how students are expected to function in the school environment. The rationale, methodology, and the results of the project are presented and analyzed in the coming sections.

BACKGROUND

Several studies have used simulations for teaching functional living skills to students with special educational needs such as learning and mental disabilities, developmental disorders, psychological or emotional disorders, and motor or sensory impairments (Lanyi, Geiszt, Karolyi, Tilinger, & Magyar, 2006). For example, Wuang, Chiang, Su, and Wang (2011) tried to improve the motor skills of children with Down Syndrome. Language skills were the objective in another study (Lan, Hsiao, & Shih, 2018). On the other hand, it seems that most of the research targets students with autism spectrum disorders (ASD). The core problem in students with ASD is the impairment of social communication and social relations (Ames, McMorris, Alli, & Bebko, 2016). Given that, Stichter, Laffey, Galyen, and Herzog (2014) tried to improve the social performance of students with ASD through a virtual environment. Wang, Laffey, Xing, Galyen, and Stichter (2017) used a 3D multi-user simulation with the same objective. In another study, researchers implemented an intervention using Opensimulator with the objective to advance the problem-solving skills of students with ASD (Volioti, Tsiatsos, Mavropoulou, & Karagiannidis, 2014). Researchers also tried to teach social and emotional skills to children with ASD, through problematic situations presented in a virtual world (Craig, Brown, Upright, & DeRosier, 2016).

Students with ASD are also confronted with severe difficulties in everyday school life (Vasquez, Marino, Donehower, & Koch, 2017). As a result, simulations of school environments have been (effectively) used for enhancing skills like social perception, interaction, and communication (e.g., Cheng & Ye, 2010; Ke & Im, 2013; Ke & Moon, 2018; Stichter et al., 2014). Cheng, Huang, and Yang (2015) tried to teach students with ASD social understanding through an immersive virtual environment that included two conditions: in a bus and in the classroom. Didehbani et al. (2016) used Second Life for presenting different settings like a classroom, a school dining room, and a schoolyard, in order to teach students with ASD how to make friends, confront someone who harasses them, deal with social dilemmas, and advise a friend. Teaching interaction and communication skills to students with ASD was the goal in another study; it was implemented during school time and regualr students participated as well (Parsons, 2015).

Far fewer studies targeted students with other (milder) disorders, such as attention-deficit/hyperactivity disorder (ADHD) and tried to improve skills like socializing, problem-solving and self-protection (e.g., Didehbani et al., 2016). The use of a virtual environment also significantly improved the social problems and psychosomatic behavior of children with ADHD (Shema-Shiratzky et al., 2018). With respect to difficulties in working memory, executive function, and attention in children with ADHD, the findings of other studies indicated that simulations can be very helpful to assess and improve these conditions (e.g., Rose, Brooks, & Rizzo, 2005; Schwebel, Gaines, & Severson, 2008). As simulations facilitate action-based answers, they can be used for reducing the behavioral symptoms and problems of children with ADHD (e.g., Dehn, 2011; Wang & Reid, 2011). Other studies indicated that 3D virtual environments can improve memory functionality, sensory processing, and attention, in individuals with ADHD (e.g., Schwebel et al., 2008). Then again, none of the above studies was conducted in the school environment nor did the applications they used simulate a school environment. Thus, it can be concluded that even though there are studies that used simulations, targeted students with mild disorders, and tried to teach or train them in life functional skills (e.g., social, communicational, and emotional skills), few illustrated specific and plain behaviors that are anticipated in school conditions, for example, during lessons, breaks, or a school event.

DEVELOPMENT AND EVALUATION OF THE 3D SIMULATION

On the basis of what was presented in the preceding section, it was considered worth examining if a 3D simulation can help students with mild disorders (i.e., learning, attentional, behavioral, and emotional disabilities) to understand how they are expected to function in the school environment. The study employed a single-subject design with a baseline and a treatment phase (A-B design). In this type of research, participants serve as their own controls. Data are collected multiple times during the baseline phase (A phase) until stability is reached. The treatment is introduced during the intervention phase (B phase) and data are, once again, collected for multiple times. The researcher then seeks for changes in level or trend in the dependent variable (i.e., behaviors/performances before the intervention are contrasted with those that occurred during or after the intervention) (Engel & Schutt, 2012; Wong, 2010).

This type of research design is commonly employed in the field of special education as an alternative to group designs and constitutes the most feasible type of experimental design for individuals with disabilities (Engel & Schutt, 2012; Parker, Grimmett, & Summers, 2008). In special education, a significant problem is that large sample sizes are, most of the times, not achievable. An advantage of the single-subject design is that research can be conducted with just one, or, typically, with three to eight participants (Horner, Swaminathan, Sugai, & Smolkowski, 2012). It has to be noted that a withdrawal design (A-B-A) was also considered but could not be implemented, as the study involved skills and behaviors which are impossible to un-learn (Ledford & Gast, 2009).

As the study sought to examine the impact of simulations on students' behavior in the school environment, one has to consider what constitutes a school environment. In essence, a student has to function properly in the classroom (i.e., during lessons), in the schoolyard (i.e., during breaks and when playing), and when all students are gathered for an event (i.e., during a school play, a speech, and a ceremony). The above conditions, which require certain skills/behaviors, provided the basis for the design of the simulation and also for the formulation and testing of the study's research hypothesis, namely: 3D simulations can help primary school students with learning, attentional, behavioral, and emotional disabilities, attending regular schools, to understand how to function/behave in the school environment, during lessons, breaks, or a school event.

Participants and Sample Size

As the study's target group was primary school students with learning, attentional, behavioral, and emotional disabilities, a major problem was the proper selection of participants, because the terms "learning, attentional, behavioral, and emotional disabilities" are used for describing a wide range of conditions and there is always the chance that the sample may not be homogeneous. Thus, a set of selection criteria was applied, in order to avoid selecting extreme cases or cases that differed significantly. Following three months of observations of students with learning, attentional, behavioral, and emotional disabilities attending typical classes in a number of public schools in Athens, Greece, eight students were recruited (five boys and three girls, aged between eight and nine). All (i) were Greeks, (ii) had a similar social and family background, (iii) did not have sensory-motor disabilities, (iv) their mental abilities were normal as assessed by the Greek version of Wechsler Intelligence Scale for Children, (v) their disorders were formally diagnosed by a public assessing institution and fall into the "learning, attentional, behavioral, and emotional disabilities" category, (vi) they attended regional public regular schools, and (vii) were supported, on a daily basis, by a special education teacher, each according to their diagnosis needs. More importantly, all had problems (to a varying extent) in their functional skills regarding the school environment. Detailed data for the extent of these deficits are presented in the "Results" section. The participants' profiles were as follows:

- XS (boy, 8y 2m). Diagnosed with ADHD and learning disabilities. He is often distracted to the point of not remembering the correct order of simple instructions. Because of this lack of functional attentional focus, he does not manifest appropriate or expected social behaviors.
- NF (boy, 9y 2m). Diagnosed with social-emotional and learning disabilities (SELD). He hardly focuses on lessons. The lack of concentration leads to an apparent indifference to social conventions or sometimes ignorance of the expected acceptable behaviors.
- LR (boy, 8y 6m). Diagnosed with ADHD and behavioral problems. He has trouble following rules; often gets involved in fights with his classmates; he is indifferent to social conventions; refuses to respect and follow commonly accepted rules; and often breaks out in bouts of anger.
- DA (boy, 8y 6m). Diagnosed with SELD. He faces severe concentration difficulties and often has outbursts of anger and denial. He also refuses to comply with rules or engages in socially unacceptable activities. He is usually the leader of a team or a group; however, his aim is to negatively influence the decisions and actions of the team.

- KB (boy, 8y 11m). Diagnosed with SELD and ADHD. He is intensely hyperactive and impulsive. His actions are careless and he often engages in inappropriate behaviors. Because he does not process or make sense of the social stimuli, he is unable to choose the correct behavior. The non-functional focus of his attention prevents him from manifesting the desired behaviors.
- DB (girl, 8y 10m). Diagnosed with ADHD and learning disabilities. She has a limited repertoire of attitudes and skills, she is highly introvert, and has a generalized weakness in social interactions. Her poor mnemonic skills allow the manifestation of inappropriate behaviors.
- MG (girl, 8y 10m). Diagnosed with ADHD and learning disabilities. She appears not to be able to revoke and use the desired behaviors in the appropriate contexts. She is also easily distracted and disorganized.
- AL (girl, 8y 11m). Diagnosed with SELD. She is highly introvert, has low self-esteem, intense insecurities, and introspective behavior. She is often isolated. Depending on the circumstances, she hesitates or avoids to manifest the required behaviors.

It has to be noted that since minors were the study's target group, approval from the University's ethical committee was granted prior to the beginning of the project. Moreover, since it was necessary to have access to students' school performance, psychological evaluations, and diagnoses, their parents were contacted and their written consent was obtained. The schools' headmasters and teachers were also informed of the study's objectives and procedures.

Materials

The simulation was developed by the researcher using OpenSimulator (http://opensimulator.org/) and represented a school complex with classrooms, an assembly hall, and a schoolyard (Figure 1). Around fifty hours were required for its development. It was then installed in laptops, as a stand-alone, single-user application, as there was no need for multiple users to be simultaneously present at the same simulation. Programming scripts implemented basic interactions (e.g., controls for opening or closing doors) and all areas could be visited without any restrictions. While the virtual environment was pretty minimalistic in its design, it was populated with non-playable characters (NPCs) who acted (i) as students and (ii) as guides/teachers. The latter were placed at the entrance of the classrooms, the schoolyard, and the assembly hall. When students entered these areas, they were

Figure 1. Screenshots from the simulation

greeted by the teacher-NPCs who made a brief presentation of what behaviors are expected in the given area. Following that, both teacher- and student-NPCs, using a combination of pre-defined paths and animations, demonstrated how students were expected to behave. In addition, media screens in each area provided further details regarding the desired behaviors (using videos, texts, and images). All NPCs' actions could be re-run for as many times as the students/participants liked. In addition, by controlling their avatars, they could intervene and either follow the NPCs or block their actions (e.g., block their paths and push them around). If the latter was the case, as the NPCs were not programmed to avoid obstacles or correct their paths, students could cause havoc to the simulation; in essence, they could see the consequences of "inappropriate" behavior.

Procedure

The single-variable rule in A-B designs recommends that, following the baseline phase, only one variable/treatment can be introduced and studied during the intervention phase. After this cycle is complete, another variable can be introduced (McMillan, 2004). Consequently, the project was organized as follows: (i) for establishing the baseline, the participating students were observed for a period of two weeks (two observation sessions per week, each observation lasting for the whole duration of the school day), (ii) students used the simulation and one of the three conditions was introduced to them (i.e., how to behave during lessons, during breaks, and during a school event), and (iii) intervention observations were conducted, again, for a period of two weeks. The above procedure was repeated three times as there were three conditions. It has to be noted that there was an introductory session, prior to the beginning of the project, in which the participating students familiarized themselves with the simulation and how to control their avatars.

Each condition was introduced during a two-hour session on an individualized basis (one session per student). Video-modelling is an instructional technique commonly used in special education, in which the modeled behaviors/skills are presented in a video clip and then the child practices them (Miltenberger & Charlop, 2015). The principles of video-modeling, as well as other teaching guidelines frequently applied in special education, provided the basis for the study's instructional method (Ashman & Conway, 2017; Norwich & Lewis, 2001): (i) the objectives were explicitly stated, (ii) the learning material was broken into small and understandable segments and presented gradually, (iii) the teacher oversaw the whole process and draw student's attention on what was relevant, and (iv) the teacher encouraged the display of the desired skills/behaviors. In detail, the teaching method was as follows:

- At the beginning of the session, the researcher welcomed the student, and through discussion tried to establish what he/she already knew for the given condition and the behaviors/skills he/she was supposed to exhibit.
- Using a laptop, the student entered the simulation's area in which the given condition was presented. He/she could follow the teacher-NPC, watch the NPCs interact, and read, at will, the media screens. As already mentioned, the student could also intervene in such a way so that the NPCs stop functioning properly. When this was the case, the simulation was reset and rerun.
- After the simulation was explored for at least fifteen minutes, the researcher and the student engaged in a discussion, in order for the former to develop an outline of what the latter understood. Also, the NPCs behavior when they were "derailed" and the consequences provided a good starting point for a discussion. The researcher then summarized key-points and drew the student's attention to them. These key-points are presented in the "Instruments" section.
- Following that, the simulation was explored for a second time. During this part, either the researcher or the student could stop exploring the simulation and discuss the key-points established in the previous step.
- A final round of discussions followed. This time, a "What will you do if…" game was played. The researcher presented hypothetical situations (related to the condition that was the session's theme). For example, the

researcher presented a situation in which another student sitting right behind the participating student was constantly annoying/harassing him/her. The participating student was then asked to "act" how he/she would behave or what would his/her responses might be. The student was also encouraged to visit the area of the simulation in which a similar situation was presented and elaborated even further on the reasoning behind his/her course of actions.
- The last two steps were repeated if the teacher deemed it necessary.

Instruments

Data were collected using an observation protocol and semi-structured interviews. As already mentioned, there was a three-month period during which students with learning, attentional, behavioral, and emotional disabilities attending various public schools were observed. During this period, twelve behaviors/functional skills were detected, four for each condition, in which students faced significant problems:

- Functional skills/behaviors during lessons. I enter the classroom and sit down calmly; I take my books out and I wait for the lesson to begin; I raise my hand if I want to participate or if I want to answer a question; and I wait for my turn before I speak.
- Functional skills/behaviors during breaks. I walk calmly in the schoolyard; I play with my schoolmates following the rules of our game; if I have a disagreement with my classmates, I talk to them about it; and if I can't find a solution to the disagreement I ask for the teacher's help.
- Functional skills/behaviors during a school event (e.g., during a school play, a speech, and a ceremony). I enter the assembly hall before the event starts and I sit down; during the event I watch/listen carefully, during the event I try to be quiet; and at the end of the event I clap or cheer; and I leave the assembly hall calmly.

The above conditions and target behaviors/skills formed the observation protocol. Observational data (the number of times the desired behavior was evident) were collected simultaneously by two teachers in both the study's baseline and intervention phases. Both were trained prior to the beginning of the project (by observing the behavior of normal students) and during the baseline phase. An interrater reliability analysis using Cohen's kappa coefficient was performed to determine the consistency among raters. The interrater reliability was found to be $\kappa = .90$ ($p < .001$), 95% CI.88, and .92), which was considered very good (Landis & Koch, 1977).

In addition, semi-structured interviews were used on three occasions: at the beginning of each session, at the end of each session, and at the end of the project. Their objective was to examine what students knew, learned, and retained of the desired behaviors and skills.

Results

To test the study's research hypothesis, two instruments were used: semi-structured interviews and observations. The semi-structured interviews recorded students' knowledge regarding the desired skills and behaviors prior to the intervention, after the intervention, and at the end of the project. The interviews were transcribed verbatim on paper, viewed and re-viewed by the two raters, and the correct responses were summed. Table 1 and Figure 2 present the results of this procedure and clearly illustrate that, in terms of knowledge acquisition, there was a significant change in all participants. More importantly, all were able to retain a considerable portion of this knowledge at least until the end of the project.

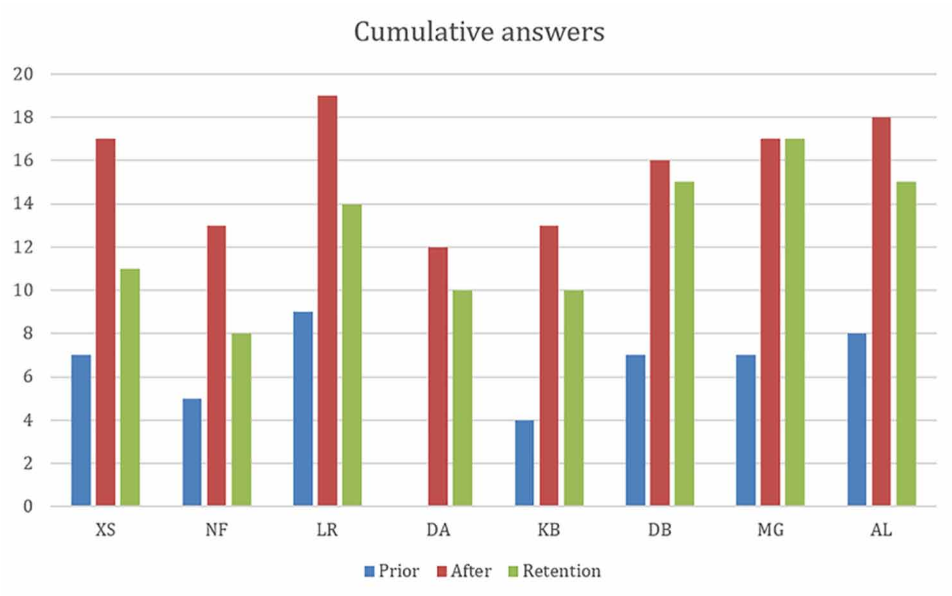
A prerequisite of A-B designs is to achieve stability of the results during the baseline phase, before proceeding to the intervention phase. The observations' results, as presented in Table 2 and Figure 3, indicate that this requirement was met. Thus, any changes in the intervention phase can be attributed to the intervention per se. Indeed, as data indicate, there was a considerable positive change in all students' behavior and in all three conditions. In detail and taking into account the results of all students: (i) on average, there were 39.67 correct behaviors during the baseline phase for the "during breaks" condition and after the intervention there were 74.75

Table 1. Participants' knowledge of the desired behaviors and skills

Condition		**During break**			**During lesson**			**During an event**		
		Prior	After	Retention	Prior	After	Retention	Prior	After	Retention
Participant	XS	2	5	4	4	7	4	1	5	3
	NF	1	4	3	3	6	3	1	3	2
	LR	4	7	5	5	8	6	0	4	3
	DA	0	4	3	0	4	4	0	4	3
	KB	1	4	3	2	6	5	1	3	2
	DB	3	7	6	2	6	6	2	3	3
	MG	2	6	7	3	7	7	2	4	3
	AL	3	7	6	3	7	7	2	4	2

Note: Although the desired skills and behaviors which were examined were 4 for each condition (12 in total), in a number of occasions, students were able to name more.

Figure 2. Number of correct answers for all conditions per participant



correct ones (88.45% change), (ii) for the "during lessons" condition the averages were 38.67 and 80.17 respectively (107.33% change), and (iii) for the "during a school event" condition the averages were 45.00 and 88.67 respectively (97.04% change).

Given that the data indicate a significant change both in knowledge acquisition and behaviors, the study's hypothesis can be accepted. It seems that 3D simulations do help primary school students with learning, attentional, behavioral, and emotional disabilities, attending regular schools, to understand how to function/behave in the school environment.

SOLUTIONS AND RECOMMENDATIONS

The purpose of the study was to examine whether simulations can help students with mild special educational needs (i.e., with learning, attentional, behavioral, and emotional disabilities) to learn and manifest functional living skills common in the school environment. Twelve such behaviors/skills were selected, falling into three conditions, namely, during lessons, during breaks, and during a school event. Four

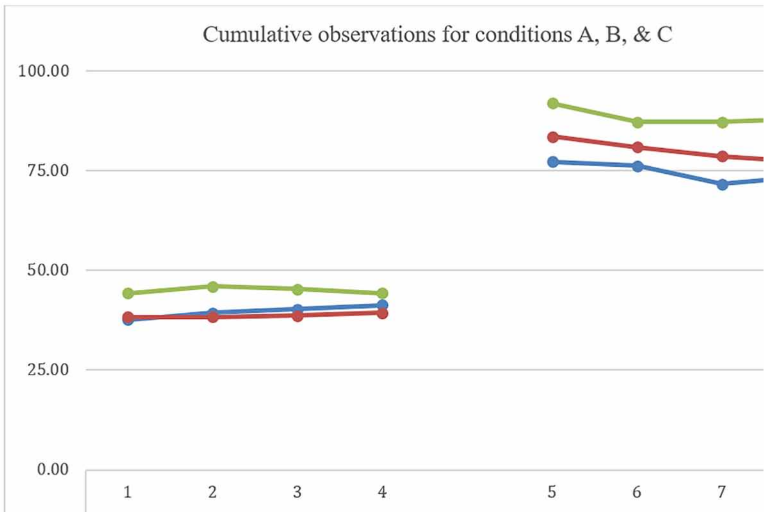
Table 2. Number of correct behaviors per observation session and per participant

		Observation session								
		Baseline phase					Intervention phase			
Subject	**Condition**	**1**	**2**	**3**	**4**		**5**	**6**	**7**	**8**
XS	A	4.33	6.33	6.00	6.00		8.67	8.33	6.67	8.33
	B	4.33	3.33	4.00	4.33		8.33	8.67	8.33	7.33
	C	5.33	5.33	5.33	5.33		10.33	10.00	10.33	9.33
NF	A	4.00	3.67	3.67	3.33		10.00	9.67	8.67	9.00
	B	2.67	2.67	2.67	2.67		9.67	9.00	9.33	9.33
	C	3.00	3.00	3.00	3.00		10.00	9.67	9.67	9.33
LR	A	4.33	4.33	4.33	4.33		7.67	7.67	7.67	7.67
	B	6.67	6.33	5.67	5.33		10.67	10.00	8.00	7.33
	C	8.67	8.00	7.00	5.67		11.33	11.00	11.33	10.33
DA	A	7.33	7.33	7.33	7.33		9.67	9.00	8.00	8.00
	B	5.00	5.00	4.33	4.33		8.67	7.67	8.00	7.67
	C	4.33	4.33	4.33	4.33		12.33	11.67	12.00	12.00
KB	A	3.33	3.33	3.33	3.33		7.67	8.00	8.33	8.00
	B	2.67	2.67	2.67	2.67		10.67	10.33	8.33	9.33
	C	4.33	4.33	4.33	4.33		10.67	10.33	10.00	10.33
DB	A	5.33	5.00	5.33	5.67		10.00	9.67	9.67	8.00
	B	5.00	6.00	5.67	6.00		11.00	11.67	11.33	11.33
	C	7.33	6.67	7.33	8.00		12.67	12.00	11.33	12.00
MG	A	5.00	5.00	6.00	6.67		12.67	13.33	13.00	13.00
	B	5.33	5.33	6.00	6.00		13.00	12.33	12.67	12.67
	C	5.00	6.00	6.33	6.67		12.00	11.67	11.33	13.00
AL	A	4.00	4.33	4.33	4.67		11.00	10.67	9.67	11.67
	B	6.67	7.00	7.67	8.00		11.67	11.33	12.67	12.33
	C	6.33	8.33	7.67	7.00		12.67	11.00	11.33	11.67

Notes: The numbers in cells are the average of the two raters' number of observations; Condition A = during breaks; Condition B = during lessons; Condition C = during a school event

two-hour sessions were conducted with eight participating students. The teaching method was formulated in accordance with the pedagogical guidelines frequently applied to special education: (i) the objectives to be explicitly stated, (ii) the learning

Figure 3. Cumulative number of correct behaviors per observation session



material to be gradually presented in small and understandable steps, (iii) the teacher to oversee the whole process, ensuring that students focus their attention on what is relevant, and (iv) the teacher to encourage the display of the desired skills/behaviors (Ashman & Conway, 2017; Norwich & Lewis, 2001).

Each of the participating students had a different starting level, though all had severe or, at least, noteworthy problems in knowing, understanding, and exhibiting behaviors that would allow them to function properly in the school environment. The results, as presented in the preceding section, demonstrated that, at the end of the project, all students had a significant positive change both in terms of the knowledge they acquired and of the behaviors/skills they were able to display in real school conditions (see Tables 1 & 2). In this respect, the study's results are in line with previous research. Indeed, according to the existing literature, in the context of special education, 3D simulations are considered ideal for life functional skills' training (Wilson, Foreman, & Stanton, 1997). Moreover, relevant research suggested that simulations do contribute to the improvement of behaviors/skills related to the school environment (e.g., Cheng & Ye, 2010; Didehbani et al., 2016; Ke & Im, 2013; Ke & Moon, 2018; Lan et al., 2018; Stichter et al., 2014; Wang et al., 2017), although most of these studies involved children with ASD.

A number of reasons related to the use of a simulation and the teaching method might have contributed to the study's positive outcomes. First, simulations provide students with special needs a controlled, realistic, secure, and rich environment, in which they have no fear of failing (Raskind, Smedley, & Higgins, 2005) and, at the same time, it is easier to transfer the behaviors they have learned in the virtual environment to real life situations (Blume, Hudak, Dresler, Ehlis, Kühnhausen, Renner, & Gawrilow, 2017; Freina & Ott, 2015; Vasquez et al., 2017). Second, it is suggested that the skills/behaviors to be taught through simulations have to be linked with skills/behaviors that are part of situations individuals experience in their daily life and with ones that they can be practiced relatively promptly and regularly (Gregg & Tarrier, 2007; Rizzo et al., 2011). This also applies to interventions in special education; the tool has to be related to real conditions and to allow students to learn how to manifest and adapt their behaviors. Furthermore, students have to be given the chance to test this new knowledge in the (real) situations it applies, to further practice it, and, ideally, to generalize it in similar circumstances (Blume et al., 2017; Freina & Ott, 2015; Vasque, et al., 2017). The above guidelines were followed in the present study. While exploring the simulation, the participants faced plausible/realistic conditions in which they recognized elements from their daily school life. They were able to see how they are expected to function and they were encouraged to focus their attention on NPCs' actions and the relevant material presented to them. They were then asked to apply and demonstrate the target behaviors/skills, and, also, to further elaborate on the matter with their teacher.

The literature also suggested that 3D simulations are effective because they motivate students with special educational needs to be actively involved in the learning process, resulting in better understanding and knowledge gains (Blume et al., 2017; Didehbani et al., 2016; Freina & Ott, 2015; Ramachandiran, Jomhari, Thiyagaraja, & Mahmud, 2015; Vasque et al., 2017). This, in turn, gives them a sense of fulfillment and satisfaction (Rix, Hall, Nind, Sheehy, & Wearmouth, 2009). In addition, by seeing that they can master skills important to their social, emotional, and behavioral status in school life, their self-esteem and self-image are improved and they also gain more confidence (Craig et al., 2016; Sakiz, Sart, Börkan, Korkmaz, & Babür, 2015). As they become more confident, they feel that they can be more independent, which encourages them to manifest even more behaviors that are acceptable by others (Lan et al., 2018).

The above chain of knowledge-behavior transformations can be confirmed through the study's results. From Table 1 and Figure 2, it can be inferred that almost all participants had limited initial knowledge regarding all conditions. Right after each intervention, there was a peak in the results, indicating significant knowledge gains. Although at the end of the project there was a decline in the results, the retention of knowledge was still significant. Moreover, from Table 2 and Figure 3, it can be inferred that during the baseline phase the limited knowledge of correct behaviors was not the most crucial problem; students manifested a limited number of acceptable behaviors as well (again in all conditions). As the results in the intervention phase indicate that the number of correct behaviors was almost doubled, it can be concluded that knowledge was "transformed" into actual skills/behaviors. More importantly, as data were recorded not in a single point in time but multiple times during a span of two weeks, this indicates that students mastered these skills/behaviors and that they became more confident.

Finally, an issue that has to be addressed is whether it is feasible to integrate 3D simulations in special education, given that the availability of such applications is limited and they are not that easy to develop. As already mentioned, although the simulation was rather simplistic, it took the researcher around fifty hours to develop. Moreover, the researcher was, by no means, an expert programmer. The reason for this approach was to test whether a special education teacher can undertake such a task. One might argue that because the application was "amateurish", it was ineffective, and, quite possibly, its weaknesses had a negative impact on the results. Then again, it is questionable whether a large number of such applications can be professionally developed. That is because students with special educational needs present a great number of diverse problems and disabilities; thus, an application suitable for a set of problems, quite possibly, is not suitable for another set. In addition, Stichter et al. (2014) argued that applications developed by the special education teachers are better aligned with the needs of their students, as they are developed for their specific needs. It seems that the issue cannot be easily resolved as both sides present equally valid arguments. A plausible solution is to develop software tools that make the whole process of developing simulations much more efficient and appealing to non-experts (Scacchi, 2012).

FUTURE DIRECTIONS

While the results were interesting, there are limitations to the study that should be acknowledged but that also provide several avenues for future research. The sample size, although acceptable for a single case study with a baseline and intervention phase, raises concerns regarding the generalizability of the results. This is a weakness of all studies dealing with individuals with special educational needs. Also, due to restrictions imposed by the schools' timetables, there was a limited number of interventions and the number of observations was also limited (although within the suggested number of observations for a baseline and an intervention phase). Thus, one might question whether they were enough either for the establishment of behavioral changes or their accurate recording. The long-term retention of knowledge and skills is also unknown. In future research, the target group can encompass students from different age groups and with other special needs and compare the results. More observations and interviews will allow an in-depth understanding of the impact of simulations. Professionally developed applications can also be used to examine whether there is a significant variation in the results. Finally, an interesting research path is to use multiuser simulations, the target group to be both regular and special needs students and examine if and how inclusion works in virtual environments.

CONCLUSION

In sum, despite the aforementioned limitations, the study provided an idea about how 3D simulations might prove useful to students with mild disabilities. What is more, it contributes to the relevant literature by providing evidence that, through 3D simulations, students with learning, attentional, behavioral, and emotional disabilities can: (i) learn and retain knowledge related to how they are expected to function in the school environment and (ii) apply this knowledge and significantly change their behavior in real-life conditions. In conclusion, the study's findings might prove useful to researchers and teachers in understanding and effectively utilizing 3D simulations in special education.

REFERENCES

Ames, M. E., McMorris, C. A., Alli, L. N., & Bebko, J. M. (2016). Overview and evaluation of a mentorship program for university students with ASD. *Focus on Autism and Other Developmental Disabilities*, *31*(1), 27–36. doi:10.1177/1088357615583465

Ashman, A. F., & Conway, R. N. (2017). *Using cognitive methods in the classroom*. London, UK: Routledge; doi:10.4324/9781315271019

Blandon, A. Y., Calkins, S. D., Grimm, K. J., Keane, S. P., & O'Brien, M. (2010). Testing a developmental cascade model of emotional and social competence and early peer acceptance. *Development and Psychopathology*, *22*(4), 737–748. doi:10.1017/S0954579410000428

Blume, F., Hudak, J., Dresler, T., Ehlis, A. C., Kühnhausen, J., Renner, T. J., & Gawrilow, C. (2017). NIRS-based neurofeedback training in a virtual reality classroom for children with attention-deficit/hyperactivity disorder: Study protocol for a randomized controlled trial. *Trials*, *18*(1), 41. doi:10.118613063-016-1769-3

Cheng, Y., Huang, C. L., & Yang, C. S. (2015). Using a 3D immersive virtual environment system to enhance social understanding and social skills for children with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities*, *30*(4), 222–236. doi:10.1177/1088357615583473

Cheng, Y., & Ye, J. (2010). Exploring the social competence of students with autism spectrum conditions in a collaborative virtual learning environment-The pilot study. *Computers & Education*, *54*(4), 1068–1077. doi:10.1016/j.compedu.2009.10.011

Craig, A. B., Brown, E. R., Upright, J., & DeRosier, M. E. (2016). Enhancing children's social emotional functioning through virtual game-based delivery of social skills training. *Journal of Child and Family Studies*, *25*(3), 959–968. doi:10.100710826-015-0274-8

Dehn, M. J. (2011). *Working memory and academic learning: Assessment and intervention*. Hoboken, NJ: John Wiley & Sons.

Didehbani, N., Allen, T., Kandalaft, M., Krawczyk, D., & Chapman, S. (2016). Virtual reality social cognition training for children with high functioning autism. *Computers in Human Behavior*, *62*, 703–711. doi:10.1016/j.chb.2016.04.033

Domitrovich, C. E., Cortes, R. C., & Greenberg, M. T. (2007). Improving young children's social and emotional competence: A randomized trial of the preschool "PATHS" curriculum. *The Journal of Primary Prevention*, *28*(2), 67–91. doi:10.100710935-007-0081-0

Engel, R. J., & Schutt, R. K. (2012). *The practice of research in social work*. Thousand Oaks, CA: Sage.

Espelage, D. L., Rose, C. A., & Polanin, J. R. (2016). Social-emotional learning program to promote prosocial and academic skills among middle school students with disabilities. *Remedial and Special Education*, *37*(6), 323–332. doi:10.1177/0741932515627475

Freina, L., & Ott, M. (2015). A literature review on Immersive Virtual Reality in education: State of the art and perspectives. *eLearning & Software for Education*, 1.

Garrote, A., Dessemontet, R. S., & Opitz, E. M. (2017). Facilitating the social participation of pupils with special educational needs in mainstream schools: A review of school-based interventions. *Educational Research Review*, *20*, 12–23. doi:10.1016/j.edurev.2016.11.001

Gregg, L., & Tarrier, N. (2007). Virtual reality in mental health. *Social Psychiatry and Psychiatric Epidemiology*, *42*(5), 343–354. doi:10.100700127-007-0173-4

Horner, R. H., Swaminathan, H., Sugai, G., & Smolkowski, K. (2012). Considerations for the systematic analysis and use of single-case research. *Education & Treatment of Children*, *35*(2), 269–290. doi:10.1353/etc.2012.0011

Kalyvioti, K., & Mikropoulos, T. A. (2014). Virtual environments and dyslexia: A literature review. *Procedia Computer Science*, *27*, 138–147. doi:10.1016/j.procs.2014.02.017

Ke, F., & Im, T. (2013). Virtual-reality-based social interaction training for children with high-functioning autism. *The Journal of Educational Research*, *106*(6), 441–461. doi:10.1080/00220671.2013.832999

Ke, F., & Moon, J. (2018). Virtual collaborative gaming as social skills training for high-functioning autistic children. *British Journal of Educational Technology*, *49*(4), 728–741. doi:10.1111/bjet.12626

Lan, Y. J., Hsiao, I. Y., & Shih, M. F. (2018). Effective learning design of game-based 3D virtual language learning environments for special education students. *Journal of Educational Technology & Society*, *21*(3), 213–227.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*(1), 159–174. doi:10.2307/2529310

Lányi, C. S., Geiszt, Z., Károlyi, P., Tilinger, Á., & Magyar, V. (2006). Virtual reality in special needs early education. *The International Journal of Virtual Reality*, *5*(4), 55–68.

Ledford, J. R., & Gast, D. L. (2009). *Single Subject research methodology in behavioral sciences: Applications in special education and behavioral sciences*. London, UK: Routledge; doi:10.4324/9780203877937

Lorenzo, G., Lledó, A., Pomares, J., Roig, R., & Arnaiz, P. (2016). Bibliometric indicators in the study of Asperger syndrome between 1990 and 2014. *Scientometrics*, *109*(1), 377–388. doi:10.100711192-016-1975-5

Marshall, A. (2014). Sensemaking in Second Life. *Procedia Technology*, *13*, 107–111. doi:10.1016/j.protcy.2014.02.014

McMillan, J. H. (2004). *Educational research: Fundamentals for the consumer* (4th ed.). Boston, MA: Allyn and Bacon.

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, *70*, 29–40. doi:10.1016/j.compedu.2013.07.033

Miltenberger, C. A., & Charlop, M. H. (2015). The comparative effectiveness of portable video modeling vs. traditional video modeling interventions with children with autism spectrum disorders. *Journal of Developmental and Physical Disabilities*, *27*(3), 341–358. doi:10.100710882-014-9416-y

Norwich, B., & Lewis, A. (2001). Mapping a pedagogy for special educational needs. *British Educational Research Journal*, *27*(3), 313–329. doi:10.1080/01411920120048322

Nye, E., Gardner, F., Hansford, L., Edwards, V., Hayes, R., & Ford, T. (2016). Classroom behaviour management strategies in response to problematic behaviours of primary school children with special educational needs: Views of special educational needs coordinators. *Emotional & Behavioural Difficulties*, *21*(1), 43–60. doi:10.1080/13632752.2015.1120048

O'Brennan, L. M., Waasdorp, T. E., Pas, E. T., & Bradshaw, C. P. (2015). Peer victimization and social-emotional functioning: A longitudinal comparison of students in general and special education. *Remedial and Special Education*, *36*(5), 275–285. doi:10.1177/0741932515575615

Office of Special Education and Rehabilitative Services (ED). (2015). *37th annual report to Congress on the implementation of the" Individuals with Disabilities Education Act*. ERIC Clearinghouse.

Parker, A. T., Grimmett, E. S., & Summers, S. (2008). Evidence-based communication practices for children with visual impairments and additional disabilities: An examination of single-subject design studies. *Journal of Visual Impairment & Blindness*, *102*(9), 540–552. doi:10.1177/0145482X0810200904

Parsons, S. (2015). Learning to work together: Designing a multi-user virtual reality game for social collaboration and perspective-taking for children with autism. *International Journal of Child-Computer Interaction*, *6*, 28–38. doi:10.1016/j.ijcci.2015.12.002

Portman, M. E., Natapov, A., & Fisher-Gewirtzman, D. (2015). To go where no man has gone before: Virtual reality in architecture, landscape architecture and environmental planning. *Computers, Environment and Urban Systems*, *54*, 376–384. doi:10.1016/j.compenvurbsys.2015.05.001

Ramachandiran, C. R., Jomhari, N., Thiyagaraja, S., & Mahmud, M. M. (2015). Virtual reality based behavioural learning for autistic children. *The Electronic Journal of e-Learning, 13*(5), 357-365.

Raskind, M., Smedley, T. M., & Higgins, K. (2005). Virtual technology: Bringing the world into the special education classroom. *Intervention in School and Clinic*, *41*(2), 114–119. doi:10.1177/10534512050410020201

Rix, J., Hall, K., Nind, M., Sheehy, K., & Wearmouth, J. (2009). What pedagogical approaches can effectively include children with special educational needs in mainstream classrooms? A systematic literature review. *Support for Learning*, *24*(2), 86–94. doi:10.1111/j.1467-9604.2009.01404.x

Rizzo, A., Parsons, T. D., Lange, B., Kenny, P., Buckwalter, J. G., Rothbaum, B., ... Reger, G. (2011). Virtual reality goes to war: A brief review of the future of military behavioral healthcare. *Journal of Clinical Psychology in Medical Settings*, *18*(2), 176–187. doi:10.100710880-011-9247-2

Rose, F. D., Brooks, B. M., & Rizzo, A. A. (2005). Virtual reality in brain damage rehabilitation. *Cyberpsychology & Behavior*, *8*(3), 241–262. doi:10.1089/cpb.2005.8.241

Rose, R., Shevlin, M., Winter, E., & O'Raw, P. (2015). *Project IRIS, inclusive research in Irish schools. A longitudinal study of the experiences of and outcomes for pupils with special educational needs (SEN) in Irish schools. Trim (Meath).* National Council for Special Education.

Sakiz, H., Sart, Z. H., Börkan, B., Korkmaz, B., & Babür, N. (2015). Quality of life of children with learning disabilities: A comparison of self-reports and proxy reports. *Learning Disabilities Research & Practice*, *30*(3), 114–126. doi:10.1111/ldrp.12060

Scacchi, W. (2012). *The future of research in computer games and virtual world environments*. Irvine, CA: Institute for Software Research, University of California.

Schwebel, D. C., Gaines, J., & Severson, J. (2008). Validation of virtual reality as a tool to understand and prevent child pedestrian injury. *Accident; Analysis and Prevention*, *40*(4), 1394–1400. doi:10.1016/j.aap.2008.03.005

Shema-Shiratzky, S., Brozgol, M., Cornejo-Thumm, P., Geva-Dayan, K., Rotstein, M., Leitner, Y., ... Mirelman, A. (2018). Virtual reality training to enhance behavior and cognitive function among children with attention-deficit/hyperactivity disorder: Brief report. *Developmental Neurorehabilitation*, 1–6. doi:10.1080/17518423.2018.1476602

Stichter, J. P., Laffey, J., Galyen, K., & Herzog, M. (2014). iSocial: Delivering the social competence intervention for adolescents (SCI-A) in a 3D virtual learning environment for youth with high functioning autism. *Journal of Autism and Developmental Disorders*, *44*(2), 417–430. doi:10.100710803-013-1881-0

Thompson, D., Whitney, I., & Smith, P. K. (1994). Bullying of children with special needs in mainstream schools. *Support for Learning*, *9*(3), 103–106. doi:10.1111/j.1467-9604.1994.tb00168.x

United Nations Educational, Scientific and Cultural Organization (UNESCO). (1994). *The Salamanca statement and framework for action on special needs education*. Retrieved from http://unesdoc.unesco.org/images/0009/000984/098427eo.pdf

Vasquez, E. III, Marino, M. T., Donehower, C., & Koch, A. (2017). Functional analysis in virtual environments. *Rural Special Education Quarterly*, *36*(1), 17–24. doi:10.1177/8756870517703405

Vlachou, A., Stavroussi, P., & Didaskalou, E. (2016). Special teachers' educational responses in supporting students with special educational needs (SEN) in the domain of social skills development. *International Journal of Disability Development and Education*, *63*(1), 79–97. doi:10.1080/1034912X.2015.1111305

Volioti, C., Tsiatsos, T., Mavropoulou, S., & Karagiannidis, C. (2014, July). VLSS-Virtual Learning and Social Stories for Children with Autism. In *Proceedings of the 2014 IEEE 14th International Conference on Advanced Learning Technologies* (pp. 606-610). Athens, Greece: IEEE. 10.1109/ICALT.2014.177

Wagner, M. M. (1995). Outcomes for youths with serious emotional disturbance in secondary school and early adulthood. *The Future of Children*, *5*(2), 90–112. doi:10.2307/1602359

Wang, M., & Reid, D. (2011). Virtual reality in pediatric neurorehabilitation: Attention deficit hyperactivity disorder, autism and cerebral palsy. *Neuroepidemiology*, *36*(1), 2–18. doi:10.1159/000320847

Wang, X., Laffey, J., Xing, W., Galyen, K., & Stichter, J. (2017). Fostering verbal and non-verbal social interactions in a 3D collaborative virtual learning environment: A case study of youth with Autism Spectrum Disorders learning social competence in iSocial. *Educational Technology Research and Development*, *65*(4), 1015–1039. doi:10.100711423-017-9512-7

Wilson, P. N., Foreman, N., & Stanton, D. (1997). Virtual reality, disability and rehabilitation. *Disability and Rehabilitation*, *19*(6), 213–220. doi:10.3109/09638289709166530

Wong, S. E. (2010). Single-case evaluation designs for practitioners. *Journal of Social Service Research*, *36*(3), 248–259. doi:10.1080/01488371003707654

Wuang, Y. P., Chiang, C. S., Su, C. Y., & Wang, C. C. (2011). Effectiveness of virtual reality using Wii gaming technology in children with Down syndrome. *Research in Developmental Disabilities*, *32*(1), 312–321. doi:10.1016/j.ridd.2010.10.002

ADDITIONAL READING

Baker, B. L., Brightman, A. J., Blacher, J. B., Heifetz, L. J., Hinshaw, S. R., & Murphy, D. M. (2004). *Steps to independence: Teaching everyday skills to children with special needs*. Baltimore, MD: Brookes.

Danckaerts, M., Sonuga-Barke, E. J., Banaschewski, T., Buitelaar, J., Döpfner, M., Hollis, C., ... Taylor, E. (2010). The quality of life of children with attention deficit/hyperactivity disorder: A systematic review. *European Child & Adolescent Psychiatry*, *19*(2), 83–105. doi:10.100700787-009-0046-3

DuPaul, G. J., Weyandt, L. L., & Janusis, G. M. (2011). ADHD in the classroom: Effective intervention strategies. *Theory into Practice*, *50*(1), 35–42. doi:10.1080/00405841.2011.534935

Einfeld, S. L., Beaumont, R., Clark, T., Clarke, K. S., Costley, D., Gray, K. M., ... Taffe, J. R. (2018). School-based social skills training for young people with autism spectrum disorders. *Journal of Intellectual & Developmental Disability*, *43*(1), 29–39. doi:10.3109/13668250.2017.1326587

Florian, L., & Linklater, H. (2010). Preparing teachers for inclusive education: Using inclusive pedagogy to enhance teaching and learning for all. *Cambridge Journal of Education*, *40*(4), 369–386. doi:10.1080/0305764X.2010.526588

Hodkinson, A. (2015). Key issues in special educational needs and inclusion. *Sage (Atlanta, Ga.)*.

Ip, H. H., Wong, S. W., Chan, D. F., Byrne, J., Li, C., Yuan, V. S., ... Wong, J. Y. (2018). Enhance emotional and social adaptation skills for children with autism spectrum disorder: A virtual reality enabled approach. *Computers & Education*, *117*, 1–15. doi:10.1016/j.compedu.2017.09.010

Lee, F. L. M., Yeung, A. S., Tracey, D., & Barker, K. (2015). Inclusion of children with special needs in early childhood education: What teacher characteristics matter. *Topics in Early Childhood Special Education*, *35*(2), 79–88. doi:10.1177/0271121414566014

Liu, G. Z., Wu, N. W., & Chen, Y. W. (2013). Identifying emerging trends for implementing learning technology in special education: A state-of-the-art review of selected articles published in 2008–2012. *Research in Developmental Disabilities*, *34*(10), 3618–3628. doi:10.1016/j.ridd.2013.07.007

Standen, P. J., & Brown, D. J. (2005). Virtual reality in the rehabilitation of people with intellectual disabilities. *Cyberpsychology & Behavior*, *8*(3), 272–282. doi:10.1089/cpb.2005.8.272

KEY TERMS AND DEFINITIONS

3D Simulation: A three-dimensional computer-generated imitation of a real-world process or environment.

Attention-Deficit/Hyperactivity Disorder (ADHD): A brain disorder marked by an ongoing pattern of inattention and/or hyperactivity that interferes with normal functioning or development.

Autism Spectrum Disorder (ASD): A developmental disorder affecting communication and behavior. Symptoms generally appear in the first two years of life.

Learning Disabilities: Neurologically-based processing problems interfering with learning basic skills (e.g., reading, writing, and math) and/or higher-level skills (e.g., abstract reasoning, long-/short--term memory, and attention).

Non-Playable Character (NPC): Any character in a game not controlled by a player.

OpenSimulator: An open-source server platform for hosting virtual worlds.

Single-Subject Design (A-B design): A two part or phase research design composed of a baseline (A phase) with no changes, and a treatment or intervention (B phase). If changes are found, then the treatment had an effect.