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Mediation criteria for interactive serious games aimed at improving learning in children with attention deficit hyperactivity disorder (ADHD)

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Abstract

The PASS intelligence theory (Planning, Attention-Arousal, Simultaneous and Successive) was used together with Feuerstein's mediation model to develop a system of categories for mediation in educational games. This system was used to analyze and improve the design of interactive games that can enhance mediation in learning, particularly in children with attention deficit hyperactivity disorder (ADHD). To this end, interactive games designed for a tabletop device were evaluated within an educational context. 27 children (3–14 years old), who had been diagnosed with ADHD, took part. The tabletop has an intuitive system that allows children to interact directly with objects with which they are familiar, providing opportunities for play and communication. These games were evaluated by the participant observation of individual and group playing experiences, interviews, and two focus groups. The results show that mediation recommendations can be useful in the design of the games. They also confirm the need to improve the adaptability of the games to enable children with ADHD to mediate, plan, and focus their attention. With the aid of a facilitator, the mediating function of learning-games can therefore be applied in the development of the executive functions that are key to learning.

Keywords: Interactive games, Educational games, Mediation, ADHD, Attention, Planning

Introduction

Attention deficit hyperactivity disorder (ADHD) is one of the most frequently diagnosed neurodevelopment disorders in childhood, with a prevalence of around 5% in Spain (Graham et al., 2011) and 10% in the USA (Akinbami, Liu, Pastor, & Reuben, 2011). It is characterized by a high degree of inattentiveness, hyperactivity, and impulsiveness, according to Barkley (2015), *The Diagnostic and Statistical Manual of Mental Disorders* (DSM5) (APA. American Psychiatric Association, 2014) and *The International Statistical Classification of Diseases and Related Health Problems* (ICD10) (MSSSI, 2016).

This disorder can have very serious effects on children's lives (Harpin, 2005). Children with ADHD can have difficulties developing mathematical (Cragg & Gilmore, 2014; Iseman & Naglieri, 2011) and language (Kuijper, Hartman, Bogaerds-Hazenberg, & Hendriks, 2017) skills and in general with academic learning (Dietz & Montague, 2006). Social skills can also be affected (Barkley, 2015). Comorbidity is another frequent issue in that many children with ADHD also suffer from dyslexia, tic disorders, and Tourette's (Spencer, Biederman, & Mick, 2007). ADHD can also appear alongside autistic spectrum disorder and sufferers may lack empathy.

Attention deficit hyperactivity disorder from the perspective of the PASS theory of intelligence

In school, this can often lead to academic failure and even exclusion experiences, especially, if ADHD is comorbid with conduct problems. ADHD children often need more attention and care both at school and at home, where their condition can lead to stress and tension within the family (Harpin, 2005). For this reason, some children with ADHD receive support in school, such as behavioral interventions, adapted teaching methods, and home-school communication programs (DuPaul, Weyandt, & Janusis, 2011).

The problems these children face at school have been attributed to weakness in their executive functions resulting in inattention, disorganization, and impulsiveness or lack of planning, which make problem-solving difficult (Barkley, 2015). Current research confirms that cognitive dysfunctions in attention and planning processes are strong predictors of ADHD (Das & Misra, 2015). In a similar vein, studies based on the PASS theory of intelligence (Das, 2018) indicate that people with ADHD find it very hard to pay attention to relevant stimuli and to inhibit incorrect answers and have a great difficulty formulating and supervising plans and strategies (Canivez & Gaboury, 2016).

The PASS theory of intelligence explains cognition through three systems (planning, attention-arousal, codification). Codification (simultaneous and successive processing) and planning interact to coordinate and facilitate knowledge acquisition. However, these superior functions depend on us paying attention to enable learning to take place. Base knowledge and mediation modulate the way we use them (Das, Naglieri, & Kirby, 1994). Therefore, effective processing of the information we receive requires the interaction of base knowledge, planning, attention-arousal, and codification. The task we are being asked to do must also be taken account (Das, 2018; Mahapatra, 2016) (Fig. 1).

Planning is a mental process that allows us to identify, select, and solve problems in an effective way (Das, 2018). It requires awareness, motivation, and meta-cognitive skills. Effective planning therefore requires active strategic cognition and behavior. Attention helps us to maintain arousal levels and ensures that we focus exclusively on the relevant stimuli, ignoring all irrelevant or extraneous input. The planning system is responsible for controlling and organizing, for executing plans and strategies, and for monitoring our actions and taking decisions (Mahapatra, 2016)

There is also a strong link between codification and planning, as tasks can be codified in different ways; the implementation of simultaneous and/or successive processing is influenced by the executive functions and the earlier learning experiences of the person (Das, 2018; Mahapatra, 2016; Walker, 2010).

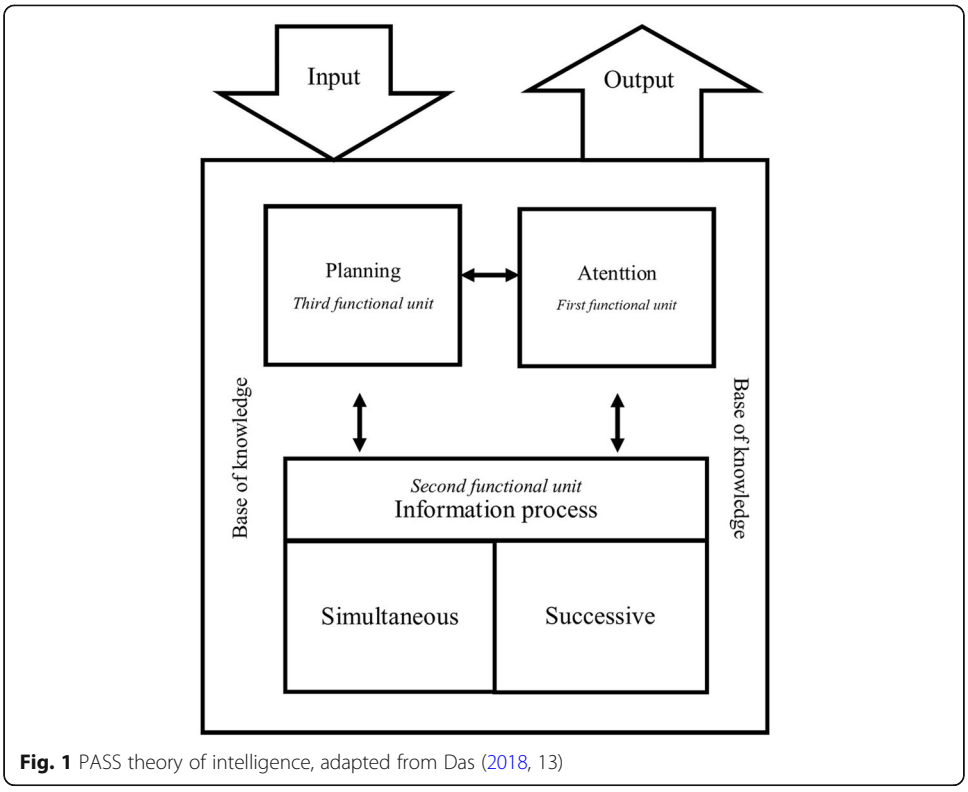

Fig. 1 PASS theory of intelligence, adapted from Das (2018, 13)

According to PASS theory, if children have attention problems are disorganized and show impulsive behavior (ADHD), the planning process must be taken into account when evaluating their needs and attending to them. Working with these children to help improve their selective attention, strategic behavior and metacognitive knowledge will help them inhibit an inappropriate level of excitement. It will also facilitate the activation of strategic action plans and allow them to self-regulate and thereby solve their attention problems. Improving self-control must therefore be a priority. Das's conceptual definition (1998, page 58) of planning as "a self-organized and reflective process of which the person is aware... and which requires motivation and metacognitive capacities" captures the importance of the "planning process" in educational intervention with ADHD children.

The PASS theory also covers the emotional processes that emerge from learning. The meaning that children confer on success and failure experiences can influence their motivation (Rosenthal & Jacobson, 1968). It also stresses the importance of making the implicit explicit, as this helps children with structuring and planning, key aspects of self-control. This process of self-awareness turns interaction into a source of learning. The purpose of mediation must therefore be to enable children to make decisions, reflect on them, discover different alternatives, and share them. To this end, attention and planning processes must be strengthened by means of intervention, interaction, and dialog.

Mediation as a facilitator of learning

Mediated learning (Feuerstein et al., 2006; Feuerstein & Feuerstein, 1991; Vygotski, 1996) is a sociocultural approach to learning that seeks to understand human beings in

a broad context. For learning to become a mediated learning experience, and for this learning to have an effect on the child's cognitive system, the interaction must have a special quality. This helps produce a higher level of modifiability in children. Feuerstein et al. (2006) proposes 11 categories for the mediation described in Table 1.

Interaction and mediation are key issues in improving cognitive and motivational processes, in that they can generate learning (Amod, Heafield, & Seabi, 2018; Chan et al., 2017). In mediated learning, internalization and self-regulation are of crucial importance because students must be active, conscious, independent, and creative. Mediation is a process in which the mediator guides and provides support to other people to enable them to learn. This support is built inductively, through dialog, experimentation, and argumentation.

By interacting with the learners, the mediator (also referred to as the facilitator) creates opportunities to produce and choose the most appropriate cognitive planning strategies, in this way, encouraging a more abstract level of thought, so promoting the process of change in an experiential way. Dialog helps to define problems and to compare and discover new possibilities, which means that social interaction is crucial in supporting learning (Farrell Frey, Iwa, & Mikroyannidis, 2017; Sulisworo, Agustin, & Sudarmiyati, 2016). It can improve planning and attention processes, ensure correct understanding, and expand or enlarge meaning and motivation (Garrido, 2004). Feuerstein refers to this kind of interaction, with an impact on motivation, as "mediation."

This process induces a feeling of change known as "cognitive modifiability" (Feuerstein et al., 2006), a concept associated with the "zone of proximal development" proposed by Vygotski (1996). Interaction and mediation are key factors in the mediated learning experience model (MLE), which is structured around eleven parameters: intentionality and reciprocity, mediation of transcendence, mediation of meaning, feeling of competence, reflective practice, interdependency and sharing, individual esteem, goal seeking and achieving, challenge of novelty, change awareness, and the search for optimistic alternatives (Feuerstein & Feuerstein, 1991; Oon Tan, 2003; Tzuriel, 2013).

Table 1 Feuerstein's mediation categories

Reciprocity	M1. To find the meaning of the task and to be actively engaged in order to promote active responses
Transcendence	M2. To generate new needs (precision, accuracy, new knowledge…)
Feeling of competence	M3. To feel acknowledged, to acknowledge oneself, and to show it with positive stimuli
Meaning	M4. To encourage meaningful questioning
Regulation of behavior	M5. Discover ways of behaving according to sociocultural norms.
Sharing	M6. To help them to argue their answers and to express their own ideas.
Psychological differentiation	M7. To encourage convergent and divergent points of view and justify their answers.
Goal seeking and achieving	M8. To increase flexibility, with new information to generate new responses.
Challenge of novelty	M9. To acquire flexibility, to include new perspectives and generate new answers.
Change awareness	M10. To facilitate a higher level of abstraction.
Search for optimistic alternatives	M11. To anticipate the future using the situation in which the children have achieved their objectives.

Games are a privileged context in which educators can act as mediators, inviting children to explore and generate questions that can enhance planning and attention abilities. In this sense, interactive games can be incentives for learning (Mayer, 2015) and can mediate to improve attention, planning, and self-regulation.

Interactive games and ADHD

Games are essays for real life and offer a natural way to stimulate different cognitive processes. Games link abstract thinking with specific experiences, so allowing children to try out what they have learnt, putting their newly acquired knowledge into practice without the fear of being wrong (Paris & Winograd, 2003). In this way, games can contribute to teaching strategies and the development of teacher mediation practices (Jong, Dong, & Luk, 2017)

Children with ADHD show interest in competitive sports and games and in those that involve movement, intense activity, and frequent changes, as they normally prefer quick answers and short interventions (Colombo et al., 2017). However, they can also have social skill deficits that make peer relationships difficult (Marton, Wiener, Rogers, Moore, & Tannock, 2009), leading them to reject games that entail cooperation and linguistic abilities (Young & Gudjonsson, 2006).

To stimulate motivation and commitment to the task (Geurts, Luman, & Van Meel, 2008), it is important to understand how interactive games enhance the learning process. They strengthen experiential autonomous learning (Fokides, Chronopoulou, & Kaimara, 2019; Pina & Bordonaba-Juste, 2018) and allow learners to implement their knowledge-building skills (Piñeiro-Otero & Costa-Sánchez, 2015). Videogames encourage learning and can help improve academic performance (Harley, Poitras, Jarrell, Duffy, & Lajoie, 2016), especially in children with experience of academic failure, a frequent issue for ADHD sufferers (Karande, Mahajan, & Kulkarni, 2009). Videogames interact with the players and provide them with information through images and sounds, so boosting multisensory representation of knowledge. An attractive design is therefore a key factor in the quality of any activity aimed at children (Crescenzi-Lanna & Grané Oro, 2016) and in order for these games to achieve positive results and impacts, it is important to take into account how the contents are presented, which perceptive and cognitive abilities are put into practice and in what way the social and affective skills are enhanced (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012).

In this study, we analyze the benefits of tangible interactive games in which physical objects are handled on a table with an active surface, the *NIKVision Tabletop* (Cerezo et al., 2019). The interfaces have physical form enabling children to perceive and touch the different elements of the games (De la Guía, Lozano, & Penichet, 2015). The tabletop also has an internal projector that projects images and animated films on to the surface, which then become part of the game, in combination with auditory stimuli (Fig. 2). Games can be played either individually or in groups. The physical appearance of the tabletop is very similar to that of a standard table. The interaction is carried out by moving physical objects over the surface. Direct handling of the objects reinforces the motivational impact of the games (Read & Markopoulos, 2013).

Fig. 2 Tabletop. Interactive table

Research questions

The purpose of this study was to evaluate the function of tabletops as mediators in the learning process of children diagnosed with ADHD. The study analyzed the qualitative data to assess the function of tabletops as mediators from a perspective based on PASS theory and Feuerstein's model of mediation. Three questions guided the study:

- Do the interactive games developed for the tabletop enhance the mediation process in learning, as proposed by Feuerstein?
- How must the games be designed to provide children with ADHD with mediation functions in the learning process?
- Which kinds of mediation could be included in interactive games to promote the attention and planning processes (PASS theory) in children with ADHD?

Methodology

Objectives

The current paper aims, firstly, to analyze various tabletop games on the basis of the mediation learning experience model, as a way of assessing the suitability of interactive games for the development of planning and attention processes in children with ADHD. Secondly, it attempts to design a mediation guidance model within which to develop interactive games that improve attention and planning (PASS theory). Feuerstein's mediation functions are included in the design of the software and in the work of the mediator/facilitator.

Research design

A case study was carried out using qualitative methodologies (Flick, 2008; Merrian, 2009), in order to understand the meaning of the different interactive and communicative processes in real life (Kaplan & Maxwell, 2005). Specifically, formative research (Frick & Reigeluth, 1999) analyzes and evaluates ways of improving the design of games to favor mediation aimed at enhancing attention and planning processes in children with ADHD.

Learning environments

In this study, the children interacted in person with the Nikvision tabletop (Fig. 2) with 4 kinds of games (riddles, memory, mazes, and stories).

These games included a range of different activities, each with different levels. In the games with mazes for example, the children have to reach a place on the map, overcoming various challenges (riddles and letter-word order problems) (Fig. 3) along the

Fig. 3 Maze. Levels 1, 2, and 3. Ages 7–14

way. In memory games (Fig. 4), the children have to remember and describe a picture they have previously been shown, and in letter-word order problems, they have to arrange letters or words in such a way as to form meaningful words or phrases. For its part, the stories activity involves reading or listening to a story and then answering comprehension questions about it (Fig. 5). The games have different levels to cater for the different age groups and to create new challenges (Figs. 3 and 4).

Participants

The participants are children from an association of families with ADHD children. The educators at this association provide extracurricular educational support to ADHD children with learning or social difficulties. Twenty-seven children from this association, aged between 3 and 14 years old took part in the study. Of these, 1 was 3 years old, 12 were between 6 and 8 years old, 8 were between 9 and 11 years old, and 6 were between 12 and 14 years old. 19 of these children had been diagnosed with ADHD, of whom 9 had associated behavior problems. Six children had been diagnosed with ADD, one with autism (ASD) and one with ADD and mild intellectual disability. Their educator accompanied and observed the children during the play sessions.

Before the study began, the families of the children gave informed consent for their children to participate in 3-h observation sessions (from 17:00 to 20:00) over the course of 3 months, as part of the study.

Fig. 4 Memory game. Level 1 (8 levels). Ages 3–7

Fig. 5 Comprehension activity. Children have to classify and associate this picture with a previous story

Data collection

The method used to collect the data was participant observation (Kawulich, 2005; Spradley, 1980). The data was collected with three different tools or methods at various stages of the process (Table 2).

Firstly, four researchers observed the children at play, taking specific notes in the field diary in relation to technical aspects of the operation and programming of the game, and regarding the relationships, mediation processes, and dynamics established amongst the participants. All incidents or problems were documented. The researchers acted merely as observers and did not interfere with the dynamics of the children and the educators.

Secondly, two interdisciplinary discussion groups were organized. The first focus group was held in the middle of the study. The following participants took part:

Table 2 Sources, methods, and times for collecting data

Step	When implemented	Participants	Methodology and Tools	Role of researchers	Purpose
1	Throughout the 3-month period.	27 children with ADHD.	Participant observation noted in a field diary.	Four researchers observed the process and took specific notes without interfering in any way	To analyze the technical operation and programming of the game and assess the relationships, mediation processes, and communicative dynamics.
2	In the middle of the study	1 education expert (EE), 1 computer engineer (CE), 2 educators (E4, E5)	Interdisciplinary focus group I, with open questions.	Two researchers organized and led the discussion group.	To discuss to what extent the guidance offered by the game helped the children understand it, and to analyze the interactions between children, educators and the game.
3	At the end of the study	3 educators (E1, E2, E3)	Interviews with open questions	Two researchers interviewed the educators.	To inquire about the support required to enhance the children's cognitive processes, the role of mediators, and how the games work.
4	At the end of the study	1 education expert (EE), 1 computer engineer (CE), 3 educators (E4, E5, E6), 1 psychologist	Interdisciplinary focus group II, with open questions.	Two researchers organized and led the discussion group.	Participants discussed the benefits of the game in terms of improving learning, cognitive processes, and commitment.

an education expert, a computer engineer, and three educators from the ADHD association. The second focus group, held at the end of the study, was made up of four members of the first focus group (an education expert, a computer engineer, and two educators from the ADHD association) plus two new experts in this field. One was an educator from the ADHD association and the other was a psychologist. As a result, a total of 8 people took part in the two focus groups, in which they discussed the progress made by the children during the sessions, exploring above all the following issues:

To what extent the guidance offered by the game helped the children:

- To understand the game and actively take part in it.
- To understand the context of the game.
- To ask themselves if they had done it well or why they had acted in one way or another.
- To feel that they had taken the right decisions after analyzing other options with regard to possible consequences and degree of satisfaction.
- To express their ideas and support them with arguments.
- To create new strategies and adapt to new challenges.
- To work at different levels of abstraction.
- To enhance commitment to the task.

Finally, interviews were conducted with three of the educators, who were asked open questions about the support required to enhance the children's attention and help them plan their actions during the games. The educators offered their professional opinions regarding the children's participation in the games and as to whether the activities had functioned as expected (Brinkmann & Kvale, 2014). In the open interviews, the educators were asked about how the children had behaved when interacting with the game, both spontaneously and when prompted by the suggestions offered by the game and by the facilitator. They were also asked why and when it was necessary for a mediator to intervene to ensure that children learned. The interviews were carried out at the educational center at times when the educators were not with the children. The interviews lasted about half an hour each.

Procedure

The children were observed playing four tabletop games (riddles, memories, mazes, and stories) that had previously been designed for workshops or activities with children (Fig. 6). These games were included as part of the extracurricular activities carried out at the ADHD association. The children played with the activities on the tabletop for 10–15 min with the support of educators at the end of each session. Twelve of them played individually with the tabletop, while the other fifteen played in groups of three or four, respecting the dynamic of the previous session. The researchers offered support to the children and collected information about the games and the children's response to them. This support was only provided when the children were unable to solve the game for themselves. This support involved asking questions to encourage them to reflect and to search for alternative strategies to solve the game, in this way improving

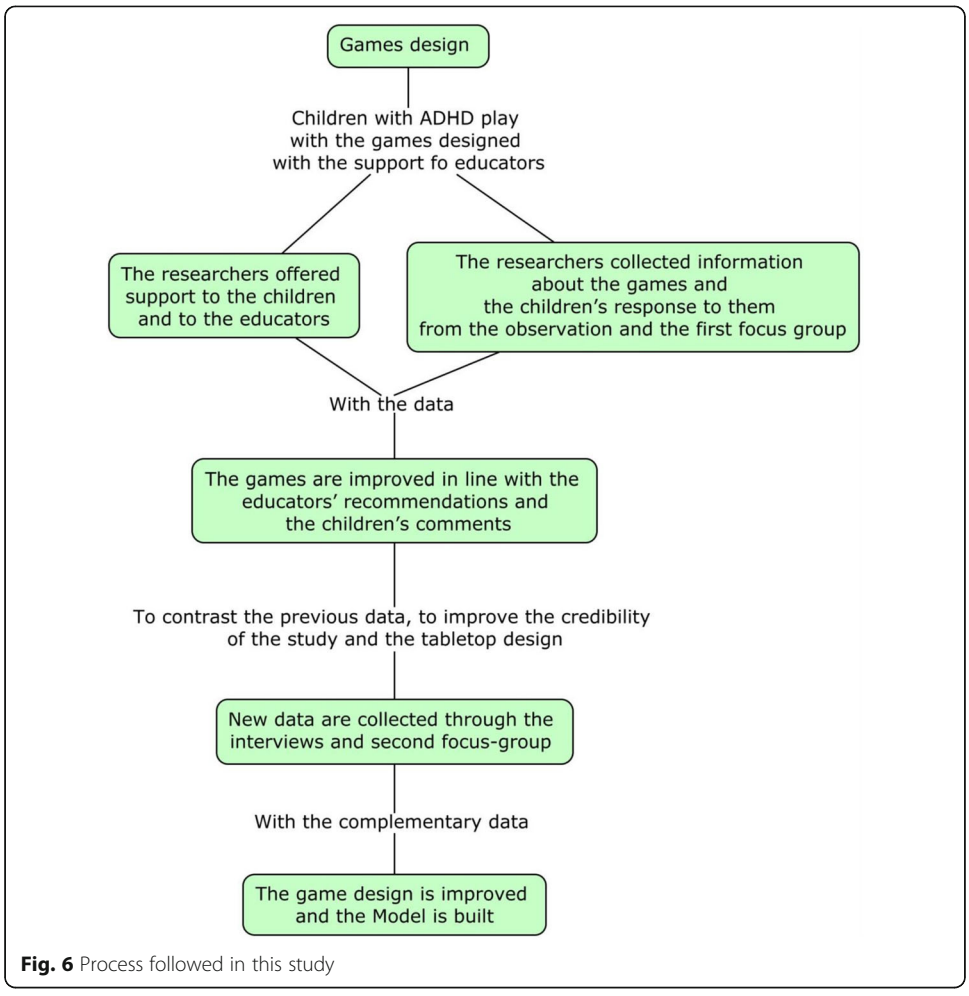

Fig. 6 Process followed in this study

their attention and planning skills. The computer engineers monitored the games to make sure that everything was working correctly.

Through participant observation, the researchers assessed the mediation processes, the relationship between the participants, and the interaction between the players and the game. As far as possible, the researchers tried to improve the games in line with the educators' recommendations and the children's comments. The interviews and the first discussion group were very useful for improving the games, in that they provided a means of assessing the mediation processes on the basis of the perceptions of both educators and children, so applying a user-centered methodology for enhancing game design (Powell, Parker, & Harpin, 2017).

The data collected in relation to the interaction and mediation processes was categorized according to the parameters of MLE, based on references from the literature (Feuerstein & Feuerstein, 1991; Oon Tan, 2003; Tzuriel, 2013). Participant observation was carried out considering the relevant criteria for children with ADHD, and from a global perspective, in order to enable our results to be applied to any interactive game. Later, in a second interdisciplinary discussion group, the researchers and educators discussed the possibilities of the game for improving mediation-for-learning processes. So as to ensure the credibility and honesty of the procedure, the researchers shared the

transcriptions of the interviews and focus groups with the participants as well as the results of the research (Guba & Lincoln, 1982). This validation by the respondents not only enhanced the credibility of the procedure, but also helped improve the design of the tabletop. The credibility of the qualitative study also benefited from the triangulation process involving the sources of information, the tools used, and an interdisciplinary team of researchers.

Results

The results stem from a systematic thematic analysis (Braun & Clarke, 2012) based on the parameters characterizing mediated learning experience (Feuerstein et al., 2006; Feuerstein & Feuerstein, 1991) and PASS theory (Das, 2018). In this analysis, we searched for structures and meanings, which were then organized into categories. This involved a deductive categorization process based on a systematic, iterative data analysis, in line with previous scientific studies. This analysis allowed us to build meanings from the data and make sense of commonalities.

After analyzing the data in relation to mediated learning, we proposed recommendations for the eleven mediation parameters that should be considered in the design of interactive games, so as to ensure that these games can mediate in the learning process (Table 3), in which the facilitator also takes part (Coma, 2015). In this way, we tried to incorporate the mediation guidelines into the structure and design of the games. Table 3 shows the types of mediation that most influence the attention or planning processes, although as the PASS model makes clear, these functional units are interconnected.

The results show how adjustments to the games can encourage mediation. *Reciprocity*, *transcendence*, and *feeling of competence* were the categories most involved in the attention process, according to the researchers' analysis of the data in relation to mediated learning.

As regards *reciprocity* (M1), we noticed that children engaged best when it was easy for them to understand what they had to do. For example, one of the educators explained in an interview that "I found it very useful to be able to go back and reread the instruction when a child did not remember what they had to do" (interview, educator 1) (Figs. 7 and 8). Similarly, children may achieve most when the game is flexible and adapts to their needs: "We noticed that when children read an instruction themselves, they generally understood it better. We therefore asked the game's designer to include an option allowing the children to choose between reading or listening to the instructions" (focus group 2, educator 4) (Fig. 8).

Table 3 Categories for mediation recommendations for interactive serious games

	PASS model	
	Greater influence on the attention processes	***Greater influence on the planning processes***
Feuerstein's mediation categories	M1. Reciprocity M2. Transcendence M4. Feeling of competence	M3. Meaning M5. Regulation of behavior M6. Sharing M7. Psychological differentiation M8. Goal seeking and achieving M9. Challenge of novelty M10. Change awareness M11. Search for optimistic alternatives

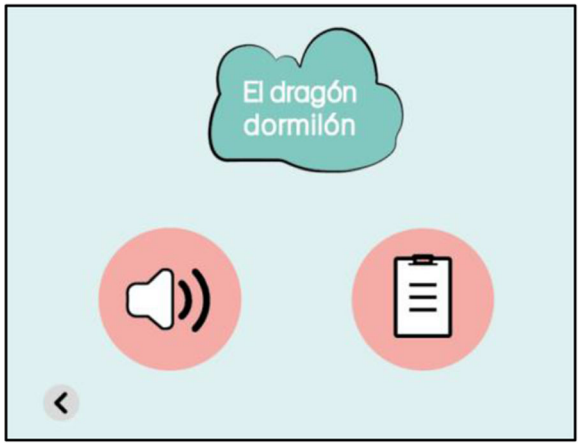

Fig. 7 Tool allowing the child to read or listen to the instructions

As regards *transcendence* (M2), the games need to facilitate attention to the important elements, with the aid of the educators. Educator 2 (interview) explained it like this: "Sometimes, children respond to riddles they know, but there are other riddles that they don't understand, and I have to help them by explaining the context behind the play on words?".

At the beginning of the study, one of the educators suggested that "The games should have different degrees or levels of activity" (Field diary). We therefore added different levels to the game to encourage a *feeling of competence*. After this, the same educator offered some interesting feedback in a focus group discussion: "The mazes were very dynamic and visual. The children worked very well (…). They were responsible for managing the pace of the game" (focus group 1, E4) (Fig. 9). In this way, when children were playing the game, they made decisions and tried out different options. Successful completion of the game allowed children to feel responsible for achieving their goals, so developing a *feeling of competence* (M4). They can also learn from their mistakes by going back to try different options to help them achieve their goals. As educator 1 explained in an interview: "When they fail, we can encourage them to try and try again."

Fig. 8 Control allowing the child to pause the game or go backwards and forwards

Fig. 9 Positive feedback

The categories most closely related to planning are *meaning, regulation of behavior, sharing, psychological differentiation, goal seeking and achieving, challenge of novelty, change awareness,* and the *search for optimistic alternatives*.

Initially, the system did not generate questions about the decisions the children had taken (Why did you choose A rather than B?). This job was left to the facilitator, so minimizing the trial-and-error thought process. As educator 6 said in focus group 2: "They put the toy down randomly on the different options on the table without trying to figure out which was the best one." If the game system generates the right questions, it can encourage children to be more aware of their actions and their thoughts—*mediation of meaning* (M3). If not, the facilitator stops the game to ask the children why they took a certain decision. As educator 5 explained in focus group 1: "We have to stop the game and ask the child why he/she has taken that decision, to make them think." With these pauses, educators mediate in reflective practice, activating strategies for reflection in decision-making (*Psychological differentiation*, M7).

In the first game sessions, the facilitator was unable to control the pace of the game to give the children time to plan. "We wanted to stop the game to allow the children to think, but it was impossible" (interview, E3). The game was then modified after which educator 5 remarked (focus group 1): "After you added the option to stop, we were able to enhance thinking and planning" (Fig. 8). The option to stop the game enabled the children to successfully complete the various tasks after explaining the reasons for their decisions (*Regulation of behavior*, M5). Playing in groups forced the children to take their peers' opinions into account (*Interdependency* and *Sharing* -M6-, and *Individual esteem*). As one of the computer engineers explained, "when children played in pairs, they had to reach a prior consensus before deciding which answer to choose" (discussion group, CE 1).

Children think more and perform tasks better when they receive references that allow them to plan. Educator 6 (focus group 2) explained this as follows: "Children do not always attribute the same meaning to words as we do. Speech balloons with instructions would help them know exactly what to do." The guidance provided by the educators is necessary for active *goal seeking and achieving* (M8), as the education expert commented: "(…) in general, the children activate planning, but adult support is needed" (focus group 1, EE).

Motivation increased after the game incorporated c*hallenges of novelty (M9)* because these involved new planning strategies and reinforced commitment to the task. Educator 3 found that "adding more levels encouraged most of the children to keep moving forward. One girl even verbalized the fact that she did not like the first level because it was too simple" (Interview, E3).

In the comprehension activities, the children read or listen to a story. They are then shown various images and must find the relationship between the images and the story (Fig. 8). This requires a higher level of abstraction. In this way, games can facilitate *structural change* (M10), although they need the support of the educators. As educator 4 said: "He needs the support of the mediator to associate concepts" (focus group 2, E4).

Technological feedback was added to let the child know if they had selected the correct option and to encourage them to continue with the task (Fig. 9). In the interview, educator 1 told us that "The children like to receive verbal or gestural confirmation. We need to include "smiley faces" or an icon to let them know whether they are right or wrong". In this way, games can help them search for *optimistic alternatives* (interview, E1) (M11).

In Tables 4 and 5, the recommendations are classified according to whether they have more influence on the attention process or the planning process. They also specify which recommendations require the involvement of a mediator, as technologically speaking it is not always easy to adjust the game to the characteristics of the participants and their learning process.

As can be seen in the table, in those recommendations in which the mediator has an important role, it is because his or her goal is to ensure that the child clearly understands how to solve the task and has the chance to look for new alternatives that adapt well to the new situation, in this way developing flexibility and cognitive modifiability.

Table 4 Attention: mediation recommendations for interactive serious games

Attention: mediation recommendations	The game requires a mediator
M1/Instructions should be clear.	
M1/It is important to verify that children have understood the instructions and can tell you what they have to do.	x
M1/Ask questions to help children focus their attention.	
M2/Ask questions to help children understand the context.	
M2/Ask questions about the new principles that children have connected with their past experience.	x
M3/Adapt tasks in line with the children's age and experience.	
M3/Cheer up.	
M3/Ask how they made their decisions and how they validated their hypothesis.	x
M3/Ask children how they make inferences and come to conclusions.	x
M3/Ask about their degree of satisfaction with the result	x
M3/Value a proper answer positively	
M3/If the answer is not correct, ask children what they would do if they had to repeat the task	
M3/After the children have thought about an alternative, give them the option to test it.	

Table 5 Planning: mediation recommendations for interactive serious games

Planning: mediation recommendations	The game requires a mediator
M4/Ask children why.	
M4/Ask children what they think about precision and what it means.	x
M5/Ask about the causes and their relation with consequences.	x
M6/Encourage children to think aloud.	x
M6/Ask what they would do differently and about other ways to solve the problem.	
M7/Ask children to justify their answers.	
M7/Ask children to explain the difference between their responses and those of other children.	x
M8/Ask them about the object of the game.	
M8/Ask them about the strategies used to achieve the object of the game.	
M9/Ask children to tell you what new things they have done and what they have created.	
M9/Ask children to compare with others in order to discover what is new in their answers, and to accept changes.	x
M9/Ask children what new principles could apply to new situations.	x
M10/Ask children about the classification and what this classification implies.	
M10/Ask children about other possible classifications or criteria.	x
M11/Ask children about the results that they expect.	
M11/Congratulate children when they answer correctly.	
M11/Encourage children when they answer incorrectly.	

Discussion and evaluation

Learning process

Previous research has shown that adults, young people, and children are motivated by serious games (Girard, Ecalle, & Magnan, 2013; Mayer, 2016), which can be effective tools for developing our cognitive skills (De la Guía et al., 2015; Jackson, Brummel, Pollet, & Greer, 2013; Nguyen, Gardner, & Sheridan, 2018). To achieve learning goals, games have to be planned to balance learning and fun (Lameras et al., 2017).

Within the framework of PASS theory, planning involves executive functions and is necessary for controlling and organizing behavior and making decisions (Georgiou & Das, 2014). It is therefore essential to take mediation criteria into account in the design of activities from an interdisciplinary perspective that ensures a preventive, stimulating intervention (Mahapatra, 2016; Paris & Paris, 2001).

According to Connolly et al. (2012), Harley et al. (2016), and Starcic, Cotic, and Zajc (2013), interactive games can improve attention processes and planning, especially in children with ADHD (Muñoz, Lopez, Lopez, & Lopez, 2015). In a systematic review, Powell et al. (2017) showed how serious games may also improve social skills and educational outcomes in ADHD children. If mediation criteria are taken into account in the design of these games, they could play an important role as a complement to learning and in the development of cognitive abilities (Amod et al., 2018; Girard et al., 2013).

Mediation guidelines

Guidelines have proved useful for defining and describing the kind of mediation that could take place in games and offer a new range of possibilities to be applied in game design that will be verified in future investigations. The findings show different effects on the attention and planning processes. In accordance with the findings of previous studies, game design must consider diversity, age group characteristics, and different mental approaches to learning and their cultural referents (M.1) (Asiry, Shen, & Calder, 2015; Mayer, 2016). Games must have graphics and elements with a clear meaning. People need to understand these elements to be able to play the game (Starks, 2014). The games have to mediate in reciprocity and allow the necessary adjustments to maintain a feeling of competence (M.3.) (Fokides et al., 2019; Lameras et al., 2017; Russell, Amod, & Rosenthal, 2008), and autonomy and meaning (M.4.) (Kulpa, 2017). Emotional feedback in real time encourages learning (Chan et al., 2017) especially if the feedback is customized and instantaneous (M.11.) (Argasiński & Węgrzyn, 2018). Recent evidence indicates that immediate response and communication dynamics can foster learning motivation and develop the attention process. Recent research also highlights how the acquisition of correct knowledge can motivate learning and develop the attention process (Blasco-Serrano, Arraiz Pérez, & Garrido Laparte, 2019). The design of the interface for children must be simple, engaging, and based on their previous experiences, interests, and understanding of the game context (M.2.) (Fessakis, Gouli, & Mavroudi, 2013). Because children have different abilities and needs, games should be flexible and adapted to help them face new challenges (M.9) (Nguyen et al., 2018). Some mediation categories have been detected through the difficulties in the game process. The players need to be aware of the rules of the game (M.4.). Regulation of behavior (M.5) should be taken into account by designers to improve cognitive and affective skills (Argasiński & Węgrzyn, 2018), especially for children with ADHD (Bul et al., 2015; Prins et al., 2013). To enable them to focus their attention, players with ADHD need to apply strategies and to separate relevant tasks from non-relevant tasks while playing (M.8.) (Van Sande, Segers, & Verhoeven, 2015). Mediation and oral interaction strategies (M.6) can facilitate the selection and building of strategies to improve learning and increase the levels of learning engagement. Furthermore, interaction and explicit metacognition can strengthen hypothesis generation and shared decision-making between players (Falloon & Khoo, 2014) and the ability to consider another person's viewpoint develops self-awareness (M.7) (Frith & Metzinger, 2016). As Frith (2012) argues, discussion with others enables us to go beyond our own beliefs and thoughts, to considerer new perspectives at a higher level of abstraction (M.10).

This opens great challenges regarding the possibilities of mediation in games and emphasizes its importance. As Niemi and Multisilta (2016) point out, mediation skills are important for those acting in a digital environment.

Conclusions

It is important to promote attention and metacognition processes in children with ADHD. Mediation, interaction, and dialog encourage these processes and decision-making. Our results indicate that games can be adjusted and improved to encourage the mediation process, using the mediation guidelines. Serious games can mediate to enhance attention, planning, and self-regulation, especially in ADHD children.

The facilitators also play a very important role by mediating between the children and the games. This is a great responsibility in that they are offering support and recommendations for learning. Designers should bear in mind the features required to make games attractive and to facilitate planning, explicit metacognition, and the feeling of competence. Children's interests and prior knowledge must also be considered. Proposals are required in which both the technology and the facilitators encourage those taking part in the game to verbalize their thought processes so that the learning may be significant (Jong et al., 2017; Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013) and so that they can become aware of the importance of the decisions they are taking.

As regards the limitations of this study, it may be necessary to carry out the research over a longer period and with a larger sample group in order to find out whether following these recommendations in serious games enhances attention and planning processes.

It is necessary to continue with this line of research and develop new serious interactive games with these characteristics. This will enable us to evaluate the application of mediation criteria and their influence on learning and the development of cognitive and motivational skills (especially attention and planning) over a long period of time, combining qualitative research with pre- and post-test quasi-experimental assessment.

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Teresa Coma-Roselló, María Ángeles Garrido Laparte, and Ana Cristina Blasco-Serrano have researched, collected the information, and designed the mediation criteria. Antonio Aguelo Arguis has contributed to the writing and supervision of the paper. The authors read and approved the final manuscript.

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Consent for publication
All authors consent to the publication of this paper.

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The authors declare that they have no competing interests.

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References

Akinbami, L. J., Liu, X., Pastor, P. N., & Reuben, C. A. (2011). *Attention deficit hyperactivity disorder among children aged 5-17 years in the US, 1998–2009. NCHS Data Brief, 70*. National Center for Health Statistics Available at: https://files.eric.ed.gov/fulltext/ED524624.pdf Accessed July 17, 2018.

Amod, Z., Heafield, D., & Seabi, J. (2018). Assessing a remedial intervention programme in developing the planning skills of grade 4 and 5 learners. *International Journal of Disability, Development and Education*, *65*(4), 428–441.

APA. American Psychiatric Association (2014). *DSM-5*. Washington: APA.

Argasiński, J. K., & Węgrzyn, P. (2018). Affective patterns in serious games. *Future Generation Computer Systems*, *92*, 526–538. https://doi.org/10.1016/j.future.2018.06.013.
Asiry, O., Shen, H., & Calder, P. (2015). Extending attention span of ADHD children through an eye tracker directed adaptive user interface. In *Proceedings of the ASWEC 2015 24th Australasian Software Engineering Conference*, 149–152, https://doi.org/10.1145/2811681.2824997.
Barkley, R. A. (2015). *Attention-deficit hyperactivity disorder: a handbook for diagnosis and treatment*. New York: Guilford.
Blasco-Serrano, A. C., Arraiz Pérez, A., & Garrido Laparte, M. Á. (2019). Mediation in the development of reading comprehension. A Qualitative Study in Primary Education. *REOP*, *30*(2), 9–27. https://doi.org/10.5944/reop.vol.30.num.2.2019.25335.
Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, Vol. 2. Research designs: quantitative, qualitative, neuropsychological, and biological*, (pp. 57–71). Washington: APA. https://doi.org/10.1037/13620-004.
Brinkmann, S., & Kvale, S. (2014). *InterViews: learning the craft of qualitative research interviewing*. London: Sage.
Bul, K. C., Franken, I. H., Van der Oord, S., Kato, P. M., Danckaerts, M., Vreeke, L. J., … Maras, A. (2015). Development and user satisfaction of "Plan-It Commander," a serious game for children with ADHD. *Games for Health Journal*, *4*(6), 502–512. https://doi.org/10.1089/g4h.2015.0021.
Canivez, G. L., & Gaboury, A. R. (2016). Construct validity and diagnostic utility of the cognitive assessment system for ADHD. *Journal of Attention Disorders*, *20*(6), 519–529. https://doi.org/10.1177/1087054713489021.
Cerezo, E., Coma, T., Blasco-Serrano, A. C., Bonillo, C., Garrido, M. Á., & Baldassarri, S. (2019). Guidelines to design tangible tabletop activities for children with attention deficit hyperactivity disorder. *International Journal of Human-Computer Studies*, *126*, 26–43. https://doi.org/10.1016/j.ijhcs.2019.01.002.
Chan, K. Y. G., Tan, S. L., Hew, K. F. T., Koh, B. G., Lim, L. S., & Yong, J. C. (2017). Knowledge for games, games for knowledge: designing a digital roll-and-move board game for a law of torts class. *RPTEL. Research and Practice in Technology Enhanced Learning*, *12*, 7. https://doi.org/10.1186/s41039-016-0045-1.
Colombo, V., Baldassini, D., Mottura, S., Sacco, M., Crepaldi, M., & Antonietti, A. (2017). Antonyms: a serious game for enhancing inhibition mechanisms in children with attention deficit/hyperactivity disorder. In *Virtual Rehabilitation (ICVR), 2017 International Conference IEEE*. https://doi.org/10.1109/ICVR.2017.8007457.
Coma, T. (2015). *Mapa de distinciones para orientar el proceso de empatía "cuerpo de la mente": diferencias en la forma de crear sobre la experiencia*. Universidad de Zaragoza: Ph. D. Dissertation.
Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, *59*(2), 661–686. https://doi.org/10.1016/j.compedu.2012.03.004.
Cragg, L., & Gilmore, C. (2014). Skills underlying mathematics: the role of executive function in the development of mathematics proficiency. *Trends in Neuroscience and Education*, *3*(2), 63–68. https://doi.org/10.1016/j.tine.2013.12.001.
Crescenzi-Lanna, L., & Grané Oro, M. (2016). An analysis of the interaction design of the best educational apps for children aged zero to eight. *Comunicar*, *24*(46), 77–85. https://doi.org/10.3916/C46-2016-08.
Das, J.P. (2018). *Brain-based approaches to the study of intelligence*. Oxford Research Encyclopedia.
Das, J. P., & Misra, S. B. (2015). *Cognitive planning and executive functions*. London: Sage.
Das, J. P., Naglieri, J. A., & Kirby, J. R. (1994). *Assessment of cognitive processes: the PASS theory of intelligence*. Toronto: Allyn & Bacon.
De la Guía, E., Lozano, M. D., & Penichet, V. M. R. (2015). Educational games based on distributed and tangible user interfaces to stimulate cognitive abilities in children with ADHD. *British Journal of Educational Technology*, *46*(3), 664–678. https://doi.org/10.1111/bjet.12165.
Dietz, S., & Montague, M. (2006). Attention deficit hyperactivity disorder comorbid with emotional and behavioral disorders and learning disabilities in adolescents. *Exceptionality*, *14*(1), 19–33. https://doi.org/10.1207/s15327035ex1401_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. https://doi.org/10.1080/00405841.2011.534935.
Falloon, G., & Khoo, E. (2014). Exploring Young Students' Talk in iPad-supported Collaborative Learning Environments. *Computers & Education*, *77*, 13–28. https://doi.org/10.1016/j.compedu.2014.04.008.
Farrell Frey, T., Iwa, K., & Mikroyannidis, A. (2017). Scaffolding reflection: Prompting social constructive metacognitive activity in non-formal learning. *International Journal of Technology Enhanced Learning*, *9*(4), 277–306. https://doi.org/10.1504/IJTEL.2017.087800.
Fessakis, G., Gouli, E., & Mavroudi, E. (2013). Problem solving by 5–6 years old kindergarten children in a computer programming environment: a case study. *Computers & Education*, *63*, 87–97. https://doi.org/10.1016/j.compedu.2012.11.016.
Feuerstein, R., & Feuerstein, S. (1991). Mediated learning experience: A theoretical review. In R. Feuerstein, P. S. Klein, & A. J. Tannenbaum (Eds.), *Mediated Learning Experience: Theoretical, Psychosocial and Learning Implications*. London: Freund.
Feuerstein, R., et al. (2006). *Creating and enhancing cognitive modifiability: The feuerstein instrumental enrichment program*. Jerusalem: ICELP.
Flick, U. (2008). *Designing Qualitative Research*. London: Sage.
Fokides, E., Chronopoulou, M. I., & Kaimara, P. (2019). Comparing videos and a 3D virtual environment for teaching school-related functional skills and behaviors to students with ADHD or developmental dyslexia, displaying challenging behaviors: a case study. *RPTEL. Research and Practice in Technology Enhanced Learning*, *14*(1), 22. https://doi.org/10.1186/s41039-019-0117-0.
Frick, T. W., & Reigeluth, C. M. (1999). *Formative research: A methodology for creating and improving design theories. Instructional-design theories*, (pp. 633–652). Hillsdale: Lawrence Erlbaum Associates.
Frith, C. D. (2012). The role of metacognition in human social interactions. *Philosophical Transactions of the Royal Society B*, *367*(1599), 2213–2223. https://doi.org/10.1098/rstb.2012.0123.
Frith, C. D., & Metzinger, T. (2016). What's the use of consciousness? In A. K. Engel, K. Friston, & D. Kragic (Eds.), *Where's the Action? The Pragmatic Turn in Cognitive Science*. Cambridge: MIT Press.
Garrido, M. A. (2004). La lectura y el modelo PASS: Perfiles lectores e intervención educativa. In M. Deaño (ed.) *Inclusión social y educativa: Modelos para la inclusión social, educación escolar inclusiva y aprendizaje escolar colaborativo*, 237–262. XXXI Reunión Científica Anual, AEDES. Ourense: Asociación Española para la Educación Especial.

Georgiou, G. K., & Das, J. P. (2014). Reading comprehension in university students: Relevance of PASS theory of intelligence. *Journal of Research in Reading*, *37*(S1), S101–S115. https://doi.org/10.1111/j.1467-9817.2012.01542.x.
Geurts, H. M., Luman, M., & Van Meel, C. S. (2008). What's in a game: The effect of social motivation on interference control in boys with ADHD and autism spectrum disorders. *Journal of Child Psychology and Psychiatry*, *49*(8), 848–857. https://doi.org/10.1111/j.1469-7610.2008.01916.x.
Girard, C., Ecalle, J., & Magnan, A. (2013). Serious games as new educational tools: how effective are they? A meta-analysis of recent studies. *Journal of Computer Assisted Learning*, *29*(3), 207–219. https://doi.org/10.1111/j.1365-2729.2012.00489.x.
Graham, J., Banaschewski, T., Buitelaar, J., Coghill, D., Danckaerts, M., Dittmann, R. W., … Hulpke-Wette, M. (2011). European guidelines on managing adverse effects of medication for ADHD. *European Child & Adolescent Psychiatry*, *20*(1), 17–37. https://doi.org/10.1007/s00787-010-0140-6.
Guba, E. G., & Lincoln, Y. S. (1982). Epistemological and methodological bases of naturalistic inquiry. *Educational Technology Research and Development*, *30*(4), 233–252. https://doi.org/10.1007/BF02765185.
Harley, J. M., Poitras, E. G., Jarrell, A., Duffy, M. C., & Lajoie, S. P. (2016). Comparing virtual and location-based augmented reality mobile learning: emotions and learning outcomes. *Educational Technology Research and Development*, *64*(3), 359–388. https://doi.org/10.1007/s11423-015-9420-7.
Harpin, V. A. (2005). The effect of ADHD on the life of an individual, their family, and community from preschool to adult life. *Archives of Disease in Childhood*, *90*(1), i2–i7. https://doi.org/10.1136/adc.2004.059006.
Iseman, J. S., & Naglieri, J. A. (2011). A cognitive strategy instruction to improve math calculation for children with ADHD and LD: A randomized controlled study. *Journal of Learning Disabilities*, *44*(2), 184–195. https://doi.org/10.1177/0022219410391190.
Jackson, A. T., Brummel, B. J., Pollet, C. L., & Greer, D. D. (2013). An evaluation of interactive tabletops in elementary mathematics education. *Educational Technology Research and Development*, *61*(2), 311–332. https://doi.org/10.1007/s11423-013-9287-4.
Jong, M. S. Y., Dong, A., & Luk, E. (2017). Design-based research on teacher facilitation practices for serious gaming in formal schooling. *RPTEL. Research and Practice in Technology Enhanced Learning*, *12*, 19. https://doi.org/10.1186/s41039-017-0056-6.
Kaplan, B., & Maxwell, J. A. (2005). Qualitative research methods for evaluating computer information systems. In *Evaluating the organizational impact of healthcare information systems*, (pp. 30–55). New York: Springer.
Karande, S., Mahajan, V., & Kulkarni, M. (2009). Recollections of learning-disabled adolescents of their schooling experiences: A qualitative study. *Indian Journal of Medical Sciences*, *63*(9), 382–391. https://doi.org/10.4103/0019-5359.56109.
Kawulich, B. (2005). Participant observation as a data collection method. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, *6*(2), 43 http://nbn-resolving.de/urn:nbn:de:0114-fqs0502430.
Kuijper, S. J. M., Hartman, C. A., Bogaerds-Hazenberg, S. T. M., & Hendriks, P. (2017). Narrative production in children with autism spectrum disorder (ASD) and children with attention-deficit/hyperactivity disorder (ADHD): Similarities and differences. *Journal of Abnormal Psychology*, *126*(1), 63–75. https://doi.org/10.1037/abn0000231.
Kulpa, A. (2017). Applied gamification: Reframing evaluation in post-secondary classrooms. *College Teaching*, *65*(2), 58–68. https://doi.org/10.1080/87567555.2016.1232693.
Lameras, P., Arnab, S., Dunwell, I., Stewart, C., Clarke, S., & Petridis, P. (2017). Essential features of serious games design in higher education: Linking learning attributes to game mechanics. *British Journal of Educational Technology*, *48*(4), 972–994. https://doi.org/10.1111/bjet.12467.
Mahapatra, S. (2016). Development of planning behaviour and decision-making ability of children. *Journal of Education and Practice*, *7*(6), 74–77 https://files.eric.ed.gov/fulltext/EJ1092502.pdf.
Marton, I., Wiener, J., Rogers, M., Moore, C., & Tannock, R. (2009). Empathy and social perspective taking in children with attention-deficit/hyperactivity disorder. *Journal of Abnormal Child Psychology*, *37*(1), 107–118. https://doi.org/10.1007/s10802-008-9262-4.
Mayer, R. E. (2015). On the need for research evidence to guide the design of computer games for learning. *Educational Psychologist*, *50*(4), 349–353. https://doi.org/10.1080/00461520.2015.1133307.
Mayer, R. E. (2016). What should be the role of computer games in education? *Policy Insights From the Behavioral and Brain Sciences*, *3*(1), 20–26 77/2372732215621311.
Merrian, S. B. (2009). *Qualitative research. A guide to design and implementation*. San Francisco: Jossey-Bass.
MSSSI (2016). *CIE10*. Madrid: Unidad Técnica Codificación.
Muñoz, J. E., Lopez, D. S., Lopez, J. F., & Lopez, A. (2015). Design and creation of a BCI videogame to train sustained attention in children with ADHD. In *Computing Colombian Conference*, (pp. 194–199). *IEEE*. https://doi.org/10.1109/ColumbianCC.2015.7333431.
Nguyen, A., Gardner, L. A., & Sheridan, D. (2018). A framework for applying learning analytics in serious games for people with intellectual disabilities. *British Journal of Educational Technology*, *49*(4), 673–689. https://doi.org/10.1111/bjet.12625.
Niemi, H., & Multisilta, J. (2016). Digital storytelling promoting twenty-first century skills and student engagement. *Technology, Pedagogy and Education*, *25*(4), 451–468. https://doi.org/10.1080/1475939X.2015.1074610.
Oon Tan, S. (2003). Mediated learning and pedagogy: Applications of Feuerstein's theory in twenty-first century education. *REACT*, *22*(1), 53–63 Available at: https://repository.nie.edu.sg/bitstream/10497/3866/1/REACT-2003-1-53.pdf, Accessed 17 Aug 2018.
Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist*, *36*(2), 89–101. https://doi.org/10.1207/S15326985EP3602_4.
Paris, S. G., & Winograd, P. (2003). *The role of self-regulated learning in contextual teaching: Principals and practices for teacher preparation*. Washington: Office of Educational Research and Improvement.
Pina, J. M., & Bordonaba-Juste, V. (2018). Students' experience with online simulation games: From computer anxiety to satisfaction. *Interacting with Computers*, *30*(2), 162–171. https://doi.org/10.1093/iwc/iwy003.
Piñeiro-Otero, T., & Costa-Sánchez, C. (2015). ARG. Contributions, limitations, and potentialities to the service of the teaching at the university level. *Comunicar*, *22*(44), 141–148. https://doi.org/10.3916/C44-2015-15.
Powell, L., Parker, J., & Harpin, V. (2017). ADHD: Is there an App for that? A suitability assessment of apps for the parents of children and young people with ADHD. *JMIR mHealth and uHealth*, *5*(10), e149.

Prins, P. J., Brink, E. T., Dovis, S., Ponsioen, A., Geurts, H. M., De Vries, M., & Van Der Oord, S. (2013). "Braingame Brian": Toward an executive function training program with game elements for children with ADHD and cognitive control problems. *Games for Health: Research, Development, and Clinical Applications*, *2*(1), 44–49. https://doi.org/10.1089/g4h.2013.0004.

Read, J. C., & Markopoulos, P. (2013). Child–computer interaction. *International Journal of Child-Computer Interaction*, *1*(1), 2–6. https://doi.org/10.1016/j.ijcci.2012.09.001.

Rosenthal, R., & Jacobson, L. (1968). *Pygmalion in the classroom*. New York: Holt.

Russell, C., Amod, Z., & Rosenthal, L. (2008). The effects of parent-child mediated learning experience (MLE) interaction on young children's cognitive development. *Perspectives in Education*, *26*(4), 28–41 https://hdl.handle.net/10520/EJC87499.

Spencer, T. J., Biederman, J., & Mick, E. (2007). Attention-deficit/hyperactivity disorder: diagnosis, lifespan, comorbidities, and neurobiology. *Journal of Pediatric Psychology*, *32*(6), 631–642. https://doi.org/10.1093/jpepsy/jsm005.

Spradley, J. P. (1980). *Participant observation*. New York: Holt, Rinehart and Winston.

Starcic, A. I., Cotic, M., & Zajc, M. (2013). Design-based research on the use of a tangible user interface for geometry teaching in an inclusive classroom. *British Journal of Educational Technology*, *44*(5), 729–744. https://doi.org/10.1111/j.1467-8535.2012.01341.x.

Starks, K. (2014). Cognitive behavioral game design: A unified model for designing serious games. *Frontiers in Psychology*, *5*, 28. https://doi.org/10.3389/fpsyg.2014.00028.

Sulisworo, D., Agustin, S. P., & Sudarmiyati, E. (2016). Cooperative-blended learning using Moodle as an open source learning platform. *International Journal of Technology Enhanced Learning*, *8*(2), 187–198. https://doi.org/10.1504/IJTEL.2016.078089.

Tzuriel, D. (2013). Mediated learning experience and cognitive modifiability. *Journal of Cognitive Education and Psychology*, *12*(1), 59–80. https://doi.org/10.1891/1945-8959.12.1.59.

Van Sande, E., Segers, E., & Verhoeven, L. (2015). The role of executive control in young children's serious gaming behavior. *Computers & Education*, *82*, 432–441. https://doi.org/10.1016/j.compedu.2014.12.004.

Vygotski, L. S. (1996). *Thought and language*. Massachusetts: Massachusetts Institute of Technology.

Walker, J. M. (2010). A Validation Study of the Planning, Attention, Simultaneous, and Successive (PASS) Theory and its Relationship to Reading Achievement in Adults. University Northern Colorado: Ph.D. Dissertation. Available at: https://digscholarship.unco.edu/cgi/viewcontent.cgi?article=1269&context=dissertations. Accessed 17 Oct 2019.

Wouters, P., van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, *105*(2), 249–265. https://doi.org/10.1037/a0031311.

Young, S., & Gudjonsson, G. H. (2006). ADHD symptomatology and its relationship with emotional, social and delinquency problems. *International Journal on Psychology, Crime & Law*, *12*(5), 463–471. https://doi.org/10.1080/10683160500151183.

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