TOWARDS THE ENGAGEMENT OF CHILDREN WITH ADHD USING SIFTEO CUBE TECHNOLOGY

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ABSTRACT

This paper examines the impact of Sifteo Cube Technology in engaging children with attention deficit hyperactivity disorder (ADHD). ADHD is an early childhood neurodevelopmental disorder which starts as early as five years of age. The core symptoms are inattentiveness, impulsiveness, and hyperactivity. By identifying the history of games development and ADHD, the researchers explored the viability of using the kinesthetic technology of Sifteo Cubes to engage these children. Engaging children with ADHD can lead to better management of the children, administering of learning materials, or aid other therapeutic methods. To carry out this research, an adventure game playable on the Sifteo Cubes using open-source games development kit called Wildflower was developed and evaluated with children with ADHD for qualitative analysis. Results obtained from video capture and ethnography proved favourable. Sifteo Cubes can effectively engage the children for an average of 20 minutes. The results show that Sifteo Cubes is effective is in engaging children with ADHD.

Keywords: Game-based learning; kinesthetic; wildflower; games development, behavioural disorder

INTRODUCTION

Attention-Deficit/Hyperactivity Disorder is an early childhood developmental disorder and is a prevalent mental disorder affecting children and adolescents (Bruce et al. 2017). It is most common in young children but can affect children till adolescence and adulthood if not treated. The majority of the childhood of children with ADHD is rampant with problems like poor academic performance, poor self-confidence, poor social relationship, depression and anxiety that undermine their lives (Bul et al. 2015).

Stimulants, Antidepressants, and Antihypertensive agents, can be used to the treat core symptoms of ADHD (Bokhari & Schneider 2011; Kollins et al. 2011; Mick et al. 2011; Rangel & José 2014; Schnoebelen et al. 2010). However, these medications have many side effects, especially for children (Barkley & Murphy 2006). Non-pharmaceutical methods are also used in treating ADHD. These methods include self-management skills training, environmental restructuring, cognitive behavioural treatment (CBT), psycho-education, and parenting coaching (Davidson 2008).

In this paper, the focus is on the learning aspects of children with ADHD. Precisely, to determine if a kinesthetic game approach can be used to retain the attention of children with ADHD. The motivation is in the continuous use of video games in conventional learning. Constructivist learning theory states that players can be self-engaged in the learning process by participation and play (Gampell et al. 2017). Especially for a generation that is so tech-savvy, an environment centred on harnessing the educational capabilities of video games while maintaining the sound understanding of learning and education is desirable (Turkay et al. 2014).

There is a continued debate on the eligibility of video games for educational purposed. One inevitable thing is that the vast majority of children play video games. Video games, in general, are very useful in capturing and retaining the attention and motivation of children, very often for several hours. In the past, video games have been shunned as being a distraction from activities such as homework or physical activities which are deemed worthier. However rather than completely dismissing the notion of playing video games as a positive activity, modern research takes a more open approach to ask if this new powerful medium can be harnessed as a resource for childhood learning especially in such an information and technology age (Kirriemuir & Mcfarlane 2004).

In this study, a game for Sifteo cube platform was developed and evaluated to determine whether it can be used to engage children with ADHD. The game was developed using open-source development package called Wildflower. The results from ethnography and analysis of video captured show that kinesthetic games technology such as Sifteo Cube Technology can be used to retain the attention of children with ADHD and can, therefore, serve as an alternative method of teaching them.

The remainder of this paper is organized as follow. Section 2 contains the literature review. Section 3 describes the research methodology. Section 4 explains the evaluation and usability studies. Section 5 presents the results and discussion, while section 6 presents the conclusion and future work.

LITERATURE REVIEW

The literature review is grouped into the motivation and engagement issue, ADHD vs kinesthetic learner behaviour Indicators, games as a medium for engagement, and related work.

THE MOTIVATION AND ENGAGEMENT ISSUE

ADHD belongs to a broader type of disorder called Behavioral, Emotional and Social Difficulties (BESD). Children who are affected by BESD tend to have challenging behaviours, poor social skills, and trivial spans of attention. These traits are commonly found in children with ADHD (Ogundele 2018).

Children with ADHD tend to be easily demotivated and disengaged from their surroundings and thus tend to move from one mundane activity to the next. This behaviour, if it is very severe and disruptive, can detract from learning, especially from caretakers and teachers point of view. They would end up having to focus more on the management of behaviour than administering education (Nash et al. 2016).

In 2008 an experiment was carried Carr (2011) out to test the effectiveness of engaging children with BESD using commercial computer games. The hypothesis was that commercial games could be used as a tool to facilitate learning for children who suffer from BESD and are less likely to be engaged by traditional educational materials. Most participants were children with ADHD. The children had to play a variety of games for a 45-minute session; such games were of adventure, driving, simulation, sport, and other mini-game genres.

Observations showed that when the children were engrossed in playing the game, they would continue playing with full concentration and attention until the end of the session. Most of the male participants have prior gaming experience and found the experiences easy. One male participant played only the simple bus driving simulation for the whole session. Girls had a tougher time playing the games.

An interesting part of the experiment found that one girl did not possess the necessary skills to use an XBOX controller and progress past the beginning and relatively simple tasks in a 3D platform game. She then changed her game to a simple `point and click' adventure game,

which was controlled by a mouse. She was able to accomplish the tasks until the end of the session without any hindrance. The results showed that the right computer games could capture the attention and motivation of the children. It must appeal to the individual playing it because ensuring engagement just by using the game as a medium is insufficient (Carr 2011).

ADHD VS KINESTHETIC LEARNER BEHAVIOR INDICATORS

There has been extensive research done in the past to see the correlation between the learning styles and children with learning disabilities (as well as without). One worth mentioning was carried out by Geurts, Luman, & van Meel (2008), which sought to explore some of the reasons why the brains of children with ADHD are particularly responsive to motivation and how results showed improved academic performance (Geurts et al. 2008). Many kinesthetic learners (may include children with ADHD also) are taught in schools that generally conform to a certain standard of teaching style that does not suit their needs. Sometimes children who are kinesthetic learners have been misdiagnosed with ADHD (nearly 1 million according to Bridgeway Academy) simply because they are kinesthetic learners and their learning style does not match that of their peers who fit the conventional teaching style (Rief 2015).

In the conventional way of learning, the children are typically told to "comprehend" first and then "do" later. This is hard for a kinesthetic learner because they must first grasp the concepts by manipulating the objects or equipment around them. Teachers often notice that kinesthetic learners are quite impatient to get started and are often asked by teachers to explain what they must do before they start. This causes difficulties for these students because, for them, the understanding and explanation come with the doing (Landrum & McDuffie 2010).

GAMES AS A MEDIUM FOR ENGAGEMENT

Various tools could be used to engage children with challenging behaviours such as ADHD. The use of 'third party' objects such as stories, games, or toys has been utilised by teachers, caretakers, and therapists to aid the therapeutic process. The usage of commercial computer games has been experimented by child therapists to facilitate opportunities and the right context to implement therapeutic processes (Brezinka 2014).

The general idea is that once motivation and engagement are captured and retained, then the player/child will eventually learn or gain certain skills. Moreover, games that are more educational harvest the fun aspect of these entertaining games, by integrating educational contents. This effect is ensured by the retention of motivation and engagement through the enhanced provisions by making education more enjoyable and fun; this is the main rationale behind the development of using games as a medium for learning (Carr 2011).

RELATED WORK

Research on games development for children with ADHD is scarce. The games that are developed for children with ADHD tend to be of a serious games nature or belong to a game genre called Edutainment, which literature reveals is insufficient. Many Games have been developed by for Children with special needs, especially those with Attention Deficit Hyperactivity Disorder. These Games usually focus on improving attention through cognitive exercises (Wrońska et al. 2015).

In another research, Shaw et al. (2005) conducted two-part research in an attempt to study the inhibitory performance of children with ADHD on computerized Tasks and Games. In the first part, children with ADHD and the Typically Developing (TP) children were allowed to play to commercially available games Frogger and Bandicoot II. In the second part, the children performed the Continuous Performance Test II; CPT II and the Pokemon task. The

Pokemon task is like the CPT II, but the characters are presented in colours, and the character Pikachu replaced the target letter X. The results show that the inhibitory performance of children with ADHD is like that of TP children on commercial games. However, children with ADHD demonstrated an improvement in terms of reduction in impulse responding and a significant increase in on-task activities compared to the CPT II while the TP children showed no much difference on performance in the two tasks.

A study was conducted to examine the impact of games in enhancing motivation and performance of children with ADHD. Participants were randomly assigned to two different groups, the standard Working Memory (WM) training and the game version of the WM training. The result showed that children who trained on the game version of the WM task were more motivated and did better during the training than the other group (Prins et al. 2011).

Craven & Groom (2015) reviewed three different foci for the use of a game in treating ADHD; human performance, educational and medical focus. The result of their review showed that must of the games developed for ADHD are for assessing human performance, therapy or are based on a cognitive test. Using the Go/No-go and stop-signal task, they were able to propose new game designs and concepts for monitoring and therapy in ADHD. Using their new idea, they developed two games, Awkward Owls and Wormy Fruit.

An iPad-based game for improving the skills of children with ADHD was developed by Wrońska et al. (2015). The game has three stages with nine exercises of different difficulty levels. Participants are to read a text, understand it and then answer by dragging the button from the toolbox and dropping on the picture or label. After playing the game, each participant was given a questionnaire to fill. Results obtained showed a great improvement in comprehension skills of participants with ADHD.

Chillfish is a biofeedback game developed by Sonne & Jensen (2016) to help children with ADHD to reach a relaxation state as offered by traditional exercises. The impact of the Chillfish on the participants' heart rate variability (HRV) was measured and compared to other activities; playing Pac Man, relaxation, and casual conversation. The result shows the feasibility of combining breathing exercises and controlled video game. A significant decrease in HRV was observed when the participants were playing the Pac Man game. Furthermore, there was an increase in participants' HRV values compared to that of casual conversation. These show that participants were more relaxed playing the game than in any other activities.

METHODOLOGY

This section explains the game development method, the participants, as well as the procedure used:

GAME DEVELOPMENT

Literature review of previous studies was used to determine methods of engaging children diagnosed with ADHD. The methods identified were then incorporated into the game developed. Also, after careful consideration, the genre of "adventure" was chosen. The game was developed based on an open-source games development kit for Sifteo called Wildflower, which was developed by Frank Force in 2013, as shown in Figure 1. Changes were made to the existing world of the wildflower editor to achieve the desired game specifications. Slightly different styles were used for the ground tiles and the sky tiles. More clouds were added in the outdoor screen for more simplistic contrast of colours. More coins as a reward system were added to reassure the children playing that they are working towards a goal. Also, when the player acquires these coins, there is a sound-triggered as an attempt to reassure the retaining of attention in case they subconsciously get distracted. Certain structures and layouts of the map were changed at random using a "spirit of the moment" design. The tree tiles were changed to

a more emphatic green as the original one. Instead of ledges that had various patterns, the current design incorporates the emphatic green tiles that give the illusion of green bush/scrub ledges. The character was reinvented by using GIMP (GNU Image Manipulation Program).

FIGURE 1. The Wildflower editor

Two sound files come with the original Wildflower development kit, and both were changed and replaced with another music file called ultrasydtoy world that is supplied by Sifteo. Figure 2, 3 and 4 show some screenshots of the Cave Dweller Game developed for children with ADHD. Table 1 describes the interactions supported by the Cave Dweller game developed.
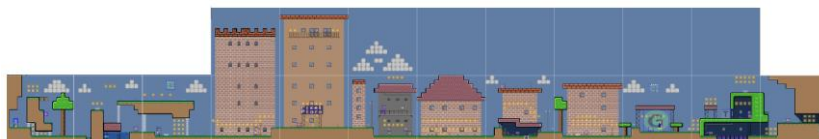

FIGURE 2. Outdoor Screen

FIGURE 3. Indoor Screen

FIGURE 4. Underground Screen

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TABLE 1. Cave Dweller Exercises

Cave Dweller Exercises	Description
Single Tap	Single tapping the screen of a Sifteo cube makes the in-game character jump. In the simulator, because we cannot physically touch the screen, the jump function is done by tilting the cubes upwards.
Double Tap	Double-tapping the screen will only yield a function once the player has the 'Ball' Power-up with can be attained by completing the first mission. Double-tapping the screen will transform the player into a ball.
Holding Single Tap	Whenever there is something that the player thinks can be climbed or traversed then he/she can click and hold the screen, and the player will climb up said 'something'.
Tilting the cube	Tilting the screen in either left, right, up, or down would make the character go in that direction.

PARTICIPANTS

A total of five participants (three males and two females) were sampled from a centre for children with disabilities called Akademi Fakih Intelek. All the children were older than 11 but under the age of 18.

PROCEDURE

Structured observation method was used to record the activities of the participants while playing the game. The observation was conduction for two days. Each day have two sessions of 20 minutes each. An observation table was prepared, and it was used to record the activities of the participants while playing the game. Table 2 is the observation table used in recording the state of the children while playing the game. A video of the session was also recorded. The participants sat on a chair and put the cubes on the table to support them while lifting them often to play them. Their postures were leaning inward towards the cubes. They maintained this posture all through the session for day 1. The researchers tried a series of small tests as a distraction test. Randomly during the 20 minutes session, the following was done:

1. Walk around the room (which creates visual and well as an auditory distraction)
2. Make random sounds such as coughing or taking
3. Switch off the audio on the base unit of the cubes

TABLE 2. Usability testing

Type of Observation	Positive / Negative	Specific Actions Observed
Facial Expressions	Positive	Concentrating/ attentive Concerned Surprised/shocked
	Negative	Bored Distracted
Body Language	Positive	Focusing on screen Leaning towards screen Settled
	Negative	Fidgeting Looking around the room
Comments	Positive	Discussion of game elements Laughs Assertion of joy
	Negative	Assertion of boredom Discussion of issues outside of game Requests to stop the activity
In-Game Behavior	Positive	Staying on task

	Negative	Following instructions Spending long time on a question Answering questions randomly Skipping tasks Ignoring tasks

EVALUATION AND USABILITY STUDY

USABILITY TESTING

Usability testing is a method used in evaluating how easy it is to use a system. Therefore, to evaluate the game developed, usability testing was used. Three people participated in usability testing. Table 3 presents a summary of their feedback.

TABLE 3. Usability testing

Tester	Time (minutes)	Comments
1	6	Game is interesting. Technology is very interesting. Controls are understandable, but combining tilting and pressing got to be a little confusing. The navigation was hard especially when navigating indoors and from indoors to outdoors
2	1	The game is easy to play. The tilting of cubes and need to constantly join the cubes utilise a lot of my upper body muscles, makes me feel involved in the game. Achieving goal one was quite easy, got me used to the handling of the game. The rest of the game was quite tricky. I like the use of sounds that are triggered when I interact with the environment, for example, jumping or collecting coins. I did not find much use for the third cube, which was used to show messages which I did not read but only found useful for navigation and for keeping track of my scores.
3	3	Controls required more time to be fully understood. The game was not easy, nor was it hard. The game looked like there are many things to do; however, I did not fully explore it as the gameplay was abruptly halted. Sometimes the game lags.

FUNCTIONAL TESTING

Functional testing was used to evaluate if the game fulfils the functional and non-functional requirements. Functional testing was carried out by the researches. The results are shown in Table 4:

TABLE 4. Functional testing

Test No.	Functional Requirements	Results
1	At least 2 or more functions of the Sifteo cube will be incorporated in the game.	Full-colour LCD screen; button/screen pressing; sounds; adjacent cubes placement; tilting of cubes.
2	The flipping, tilting, shaking, placing of adjacent cubes, and pressing of cubes to invoke corresponding responses from the game	Tilting the cubes up makes the player jump; tilting the cubes right, left, up, or down makes the character traverse in that direction; touching the screen (without holding for long periods) is to crouch or become a ball, pressing the cubes makes the player jump however pressing and holding invokes the pausing of the game.
	The use of audio	Background audio is present; there is corresponding sounds for each action in the game, for example, a unique sound is played when a player jumps,

continued..

		collects coins, achieves a goal, enters a building, dies, or re-spawns.
4	The game must have 1 or more "goals" that requires the child playing to attempt to achieve.	There are 3 goals and 1 continuous goal of collecting all the coins.
5	One of the cubes that contain the minimap should also keep score or a counter of the points or coins the children collect. This can be used to motivate the children to do better, beat their score in the next round, or add a competitive edge when another child picks up the game.	Out of the 3 cubes used, 1 is used and fulfils all requirements of this test.
6	The game must allow the child to pause the game.	This is achieved by touching screen during the game and holding the touch.
7	The pause menu must present the child with: 1. Their progress information 2. The current goal to be achieved. 3. Nonsolid tiles must allow for the player to walk/climb/jump through while solid tiles must restrict the player's movement.	1. This is done by calculating the number of coins that the child/player has collected versus the total amount of coins in the game/world. 2. This is satisfactory by the flashing red arrow indicating where to go next (shown on the Minimap cube) 3. This is satisfactory.
8	Connecting the unused cube to the current active cube should must another potion of the map (the unused cube is now part of the active group of cubes).	This is satisfactory as it is crucial to playing the game.
9	There must be subsequent relevant changes to Minimap.	This is satisfactory.

RESULTS AND DISCUSSION

All the participants played the game for the entire sessions. They were also not distracted by distraction tests. When the volumes were turned down, they noticed immediately and turned it back up. The random walking around and the making of sounds did nothing to break their engagement as well. The participants were amused by tilting and pressing the cubes. Throughout the session, small questions like do you like the game? Do you like collecting the coins? Are you happy? were asked. They would answer positively without breaking engagement, they answered without looking at the researchers, all the while concentrating on the game. For 20 minutes, they did not exhibit any signs of hyperactivity, impulsiveness, or inattention. On the second day, the participants were allowed to play the game in a room for 20 minutes after which they were taken outside to play the game for another 20 minutes. The outdoor environment was boisterous, but they still displayed the same amount of engagement as exhibited indoors. This is very favourable and indicates that the technology is very successful in capturing and retaining the attention and motivation of children with ADHD.

The average time that the participants were engaged is 20 minutes. However, the researchers feel an engagement of a longer duration is possible. As observed and captured on video, the technology is very engaging. Participant 1 specifically was much immersed in the whole experience of using the cubes, and video footage show him tilting the cubes and at times of an "overload of immersion", he would twist/tilt his body trying to better play with the technology and the game. Based on video evidence and observations, the participants seemed more immersed and less likely to be disinterested and bored by the Sifteo Game. Their posture, lack of movement, and overall observed engagement level suggest likewise.

CONCLUSION AND FUTURE WORK

This paper was an effort to determine whether kinesthetic games technology of Sifteo Cube Technology can be used as a medium to engage children with Attention Deficit Hyperactivity Disorder. An adventure game was developed, and experiments were carried out to determine the potential of engaging these children. The first experiment shed some light on the game as well as the technology. The technology coupled with the game seemed to engage the children fully however the difficulty level of the game restricted further observations and analyses. The second experiment saw the game difficulty scaled down a tad and again the children were fully engaged, and this time the children didn't exhibit the troubles navigating the complicated aspects of the game. The results obtained show children diagnosed with ADHD can be engaged with Sifteo Games. Therefore, this technology can be used in the learning process.

In future studies, further thorough experiments could be done on children with ADHD and wider sample size to get more empirical data. Experiments could also be carried out in a more professional and controlled setting. Since results show that Sifteo Technology can engage children with ADHD, further research could be done to determine if it can be used as a tool for administering traditional forms of learning such as language or mathematics is favourable. Sifteo Technology promotes the thinking skill of "Cooperation & Collaboration", and this would be good for further experiments to see whether children with ADHD could be collaboratively engaged using Sifteo cubes, effectively enhancing their group cooperation skills.

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REFERENCES

Barkley, R. A. & Murphy, K. R. 2006. Attention-deficit hyperactivity disorder: A clinical workbook (3rd ed.). New York, NY: Guilford Press.

Bokhari, F. A. S. & Schneider, H. 2011. School accountability laws and the consumption of psychostimulants. *Journal of Health Economics* 30(2): 355–372. doi:10.1016/J.JHEALECO.2011.01.007

Brezinka, V. 2014. Computer games supporting cognitive behaviour therapy in children. *Clinical Child Psychology and Psychiatry* 19(1): 100–110. doi:10.1177/1359104512468288

Bruce, C. R., Unsworth, C. A., Dillon, M. P., Tay, R., Falkmer, T., Bird, P. & Carey, L. M. 2017. Hazard perception skills of young drivers with Attention Deficit Hyperactivity Disorder (ADHD) can be improved with computer based driver training: An exploratory randomised controlled trial. *Accident Analysis & Prevention* 109: 70–77. doi:10.1016/J.AAP.2017.10.002

Bul, K. C. M., Franken, I. H. A., Van der Oord, S., Kato, P. M., Danckaerts, M., Vreeke, L. J., Willems, A., et al. 2015. Development and User Satisfaction of "Plan-It Commander," a Serious Game for Children with ADHD. *Games for Health Journal* 4(6): 502–512. doi:10.1089/g4h.2015.0021

Carr, J. 2011. *Educational games to engage the un-engagable* (Doctoral Dissertation). The University of Nottingham. Retrieved from http://eprints.nottingham.ac.uk/13329/ [10 April 2019]

Craven, M. P. & Groom, M. J. 2015. Computer Games for User Engagement in Attention Deficit Hyperactivity Disorder (ADHD) Monitoring and Therapy. *2015 International Conference on Interactive Technologies and Games*, pp. 34–40. IEEE. doi:10.1109/iTAG.2015.9

Davidson, M. A. 2008. Literature Review: ADHD in Adults. *Journal of Attention Disorders* 11(6): 628–641. doi:10.1177/1087054707310878

Gampell, A. V., Gaillard, J. C., Parsons, M. & Fisher, K. 2017. Beyond Stop Disasters 2.0: an agenda for exploring the contribution of video games to learning about disasters. *Environmental*

Hazards 16(2): 180–191. doi:10.1080/17477891.2016.1275502

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. doi:10.1111/j.1469-7610.2008.01916.x

Kirriemuir, J. & Mcfarlane, A. 2004. *Literature Review in Games and Learning* (hal-00190453). *HAL Archives Ouvertes*, Lyon, France.

Kollins, S. H., Jain, R., Brams, M. & Segal, S. 2011. Clonidine extended-release tablets as add-on therapy to psychostimulants in children and adolescents with ADHD. *Pediatrics* 127(6): e1406-e1413. doi: 10.1542/peds.2010-1260.

Landrum, T. J. & McDuffie, K. A. 2010. Learning Styles in the Age of Differentiated Instruction. *Exceptionality* 18(1): 6–17. doi:10.1080/09362830903462441

Mick, E., McGough, J. J., Middleton, F. A., Neale, B. & Faraone, S. V. 2011. Genome-wide association study of blood pressure response to methylphenidate treatment of attention-deficit/hyperactivity disorder. *Progress in Neuro-Psychopharmacology and Biological Psychiatry* 35(2): 466–472. doi:10.1016/J.PNPBP.2010.11.037

Nash, P., Schlösser, A. & Scarr, T. 2016. Teachers' perceptions of disruptive behaviour in schools: a psychological perspective. *Emotional and Behavioural Difficulties* 21(2): 167–180. doi:10.1080/13632752.2015.1054670

Ogundele, M. O. 2018. Behavioural and emotional disorders in childhood: A brief overview for paediatricians. *World journal of clinical pediatrics* 7(1): 9–26. doi:10.5409/wjcp.v7.i1.9

Prins, P. J. M., Dovis, S., Ponsioen, A., ten Brink, E. & van der Oord, S. 2011. Does Computerized Working Memory Training with Game Elements Enhance Motivation and Training Efficacy in Children with ADHD? *Cyberpsychology, Behavior, and Social Networking* 14(3): 115–122. doi:10.1089/cyber.2009.0206

Rangel, A. & José, F. 2014. Attention deficit disorder with and without hyperactivity (ADHD) and violence: Literature review. *Salud Mental* 37(1): 75. doi:10.17711/SM.0185-3325.2014.009

Rief, S. F. 2015. The ADHD book of lists : A practical guide for helping children and teens with attention deficit disorders (2nd ed.). San Francisco: John Wiley & Son.

Schnoebelen, S., Semrud-Clikeman, M. & Pliszka, S. R. 2010. Corpus Callosum Anatomy in Chronically Treated and Stimulant Naïve ADHD. *Journal of Attention Disorders* 14(3): 256–266. doi:10.1177/1087054709356406

Shaw, R., Grayson, A. & Lewis, V. 2005. Inhibition, ADHD, and Computer Games: The Inhibitory Performance of Children with ADHD on Computerized Tasks and Games. *Journal of Attention Disorders* 8(4): 160–168. doi:10.1177/1087054705278771

Sonne, T. & Jensen, M. M. 2016. ChillFish. *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction - TEI '16*, hlm. 271–278. New York, New York, USA: ACM Press. doi:10.1145/2839462.2839480

Turkay, S., Hoffman, D., Kinzer, C. K., Chantes, P. & Vicari, C. 2014. Toward Understanding the Potential of Games for Learning: Learning Theory, Game Design Characteristics, and Situating Video Games in Classrooms. *Computers in the Schools* 31(1–2): 2–22. doi:10.1080/07380569.2014.890879

Wrońska, N., Garcia-Zapirain, B., Mendez-Zorrilla, A., Wrońska, N., Garcia-Zapirain, B. & Mendez-Zorrilla, A. 2015. An iPad-Based Tool for Improving the Skills of Children with Attention Deficit Disorder. *International Journal of Environmental Research and Public Health* 12(6): 6261–6280. doi:10.3390/ijerph120606261

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