

RESEARCH ARTICLE

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Educational games and their role in alleviating the symptoms of attention deficit hyperactivity disorder (ADHD)

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Abstract:

This research paper aims to clarify the role of educational games in alleviating the symptoms of attention deficit hyperactivity disorder (ADHD) in children, given that educational games are able to stimulate learners' internal motivation and enhance their attention and concentration.

By addressing the study variables, defining them theoretically, and attempting to link them together, we present some of the results of previous studies that addressed the role of educational games in reducing the symptoms of attention deficit hyperactivity disorder (ADHD), from different perspectives, as support and confirmation of the effective role of these two.

Keywords: Educational games, attention deficit hyperactivity disorder.

1- Introduction:

Attention Deficit Hyperactivity Disorder (ADHD) is a worldwide public health issue, which has an estimated prevalence of 3–8% in children and adolescents globally and is classified as a disorder of childhood, with symptoms defined by inattention, hyperactivity and impulsivity. The symptoms of ADHD will completely interfere with social activities and will severely disrupt learning, which can lead to educational disruption, academic failure and impact quality of life. Youth diagnosed with attention-deficit hyperactivity disorder often experience academic tasks which require prolonged and lengthy attention and focus as very difficult to accomplish tasks. (Wrońska et al., 2015)

often persists into adulthood; through no fault of their own, untreated young people with ADHD can become socially or professionally challenged which can become a feature of their lives.

Children with attention-deficit hyperactivity disorder (ADHD) can be challenged by academic tasks that require sustained focus and extended attention, such tasks are often considered monotonous and not engaging by these students.

Research into educational games, specifically digital or gamified learning tools, have shown promise in the last decade as an adjunct treatment to the presenting symptoms of ADHD among children and adolescents .

Educational games are designed to engage users in cognitive tasks that may improve attention span, executive function and behavioral regulation .

This paper will describe the pathways in which educational games can assist students with Attention Deficit Hyperactivity Disorder (ADHD) particularly cognitive, emotional and behavioral pathways.

2- Definition and Symptoms Attention Deficit Hyperactivity Disorder (ADHD) :

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that encompasses difficulties initiating and sustaining attention, hyperactivity, and impulsivity. Defined by The World Health Organization (WHO) defines the disorder as a mental disorder characterized by the two patterns of inattention and/or hyperactivity-impulsivity, which affects normal functioning or development - through a clinical interview and/or standard symptom rating scale(s), such as the Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Worldwide, ADHD is reported to affect approximately 5% of the population, and this mental disorder is associated with several academic difficulties. **(Luo et al., 2024).**

3- Definition of Educational Games :

Educational Games Defined Educational games are defined as a subgroup of play with clearly defined goals, rules, and feedback mechanisms designed to accomplish something. They are typically intended primarily for entertainment purposes, primarily for education purposes, and even for serious purposes. **(Dieter Stiller & Schworm, 2019).**

A classification approach to looking at games can provide different gaming dimensions, for example, how many players will you have - restricted or massive - and whether it will be played on portable, immobile or innovative media type violations with regard to games format. The dimensions can be used to further classify by digital or non-digital format, purpose, kind, subject discipline, and platform. For example, the typical game genres are action, adventure, fighting, puzzle, role-playing, simulation, tricks, and strategy. Educational games combine the characteristics of games, fun experiences, and motivations with the focus of learning and education.

4- Study objectives:

1. To articulate the impact of educational games in promoting attention and concentration.
2. To present real life examples of quality games.
3. To present field studies that have proven the effectiveness of educational games as a promising tool for treating and supporting people with attention deficit hyperactivity disorder (ADHD).

4. To make recommendations for implementing games in the educational milieu.

5- Significance of Educational Games for ADHD :

Educational games have proven to be a promising tool for treating and supporting individuals with Attention Deficit Hyperactivity Disorder (ADHD). They can complement traditional treatments (such as medication and behavioral therapy) by providing interactive, stimulating, and structured environments that contribute to the development of essential cognitive and behavioral skills. Here's an overview of their importance:

5-1 -Improved Attention and Focus :

Individuals diagnosed with ADHD have difficulties maintaining sustained attention. Educational games are developed to be stimulating and interactive so they often improve children and adults' attention span, and maintain focus longer than more traditional methods of learning. Over time, the brain can be trained to focus.

- Important Features.
- Timed activities that offer quick thinking, indicate a need to stay focused and engaged for optimum performance.
- Levels/base systems that provide progressive incentives measure/indicate goal behavior.

5-2- Executive Function Enhancement Through Play :

Executive functions, encompassing abilities such as working memory, planning, task switching, and even impulse control, are frequently observed to be less effective in individuals diagnosed with ADHD. Educational games often inherently demand that players retain instructions, arrange tasks in a specific order, and adapt their strategies as needed – all activities that engage, and potentially train, executive function skills. **(Holmes, et al ,2009).**

It's worth remembering that play encompasses a child's interactions, experiences, and freely chosen activities (Wrońska et al., 2015). Because games are, of course, a significant aspect of play, a child's interaction with their learning environment is usually maximised. Evidence suggests that some games can indeed improve WM performance following intervention, notably processing and attention training programs. Consequently, various electronic games that encourage working and short-term memory may help in improving mental concentration, in addition to enhancing other cognitive skills in individuals with ADHD.

5-3- Motivation Through Gamification:

Motivation can be a significant barrier for those with ADHD, especially in educational contexts.

Games use a reward system (points, badges, leveling up) to give immediate positive feedback, which can enhance intrinsic motivation through a sense of competency. Advantages of game training:

- Promotes persistence and resiliency.
- Minimizes frustration with static learning methods.

5-4 - Behavioral training and self-regulation:

Some educational games are specifically designed to reinforce behavioral strategies to managing ADHD, such as learning to recognize emotions, follow rules, or manage impulsivity.

- Examples of strategies include:
- Scenario-based learning that allows learners to practice decision making.
- Real-time feedback that helps learners recognize and correct impulsive behaviors.

5-5- Customizability and adaptability:

Many digital games offer customizable difficulty and overview about personalization. This ensures the game remain challenging (but not insurmountable), which is often the case for learners with ADHD, who may quickly become demotivated because of failure or become bored with repetitiveness.

5-6- Encourage Self-Regulation and Inhibition Control:

Instruct structured tasks to help reduce impulsive behavior and strengthen one's ability to regulate responses from demands or cues. Examples of games that support turn-taking, obeying rules, and delaying gratification will aid with behavioral inhibition and emotional self-regulation. (Prins, P. J. M., et al. (2013))

5-7. A Safe, Controlled Learning Environment:

Unlike some real-world experiences that might be too much for the individual, educational games provide organized and predictable settings where real-world consequences are absent. The individual with ADHD can explore, make mistakes, and learn.

5-8. A Complement to Multimodal ADHD Treatment:

While educational games are not a substitute for medical or psychological treatment, they act as an excellent substitute. Educational games can be used at home or school using parents and teachers to engage the learning experience that extends or strengthens the learning at home or school, providing regular opportunities to reinforce therapy strategies carried out within each education game.

6- The Role of Educational Games:

- provide an increasing category of product expressions that combine entertainment with a particular teaching purpose.
- Educational games enable learning through play that uses digital technology all in game play to learn, ultimately with the goal of developing general knowledge, subject-specific knowledge and skills.
- Formats include several themes and formats which include stacked boxes, puzzles, multi-block or various random block games adapted a type of game mechanics to learning opportunities.
- As society emphasizing the integration of educational games into educational systems and within classrooms, the evolution of educational games creates an opportunity for flexible play while enhancing self-regulation, motivation and sustained engagement.

-Educational games can be viewed as an expanding group of products that promote learning while also serving entertainment purposes.

They take advantage of digital technologies to support the process of learning by providing interactive play and engaging the learner in the acquisition of general knowledge and domain-specific skills. They can take many forms, ranging from stacked boxes and puzzles to multiple block and random block designs, each utilizing game play and mechanics in different learning situations.

With increased societal attention paid to educational games and their potential role as alternative and interactive ways of teaching, they show promise for adding interest and value to traditional forms of instruction.

Educational games utilize digital media as a recognized tool to teach and reinforce learning in the subject areas of English, math, and physics. (Wrońska et al., 2015).

It is suggested computer-based learning creates an emphasis on visual and auditory elements that increases focus and motivation while providing immediate feedback via scores and collectibles. This can make educational games, or digital play, highly appropriate for children with attention concerns and educational games may hold an important means of improving educational outcomes for youth with Attention Deficit Hyperactivity Disorder (ADHD).

7- Examples of Educational Activities for ADHD:

-EndeavorRx : an FDA-approved digital therapeutic to be prescribed for children with ADHD.

-Cogmed : a working memory training program.

-Lumosity, Elevate, Peak - not specific to ADHD, but can assist training cognitive skills if used properly.

8- Some the results of field studies that highlight the positive contribution of educational games in alleviating the impact of attention deficit hyperactivity disorder symptoms:

Below is a brief summary of the studies and evidence relating to educational games in the contexts of alleviating attention deficit disorder and improving duration of attention especially in persons (especially children) diagnosed with attention deficit hyperactivity disorder (ADHD), some of which include:

8-1- Study (Joanneke Weerdmeester et al , 2016)

Title: A Feasibility Study on a Full Body Videogame Intervention to Reduce Attention Deficit Hyperactivity Disorder Symptoms (Games for Health Journal, 2016)

Objective: Examine whether a full body videogame (Adventurous Dreaming Highflying Dragon) is capable of reducing ADHD.

-related symptoms (in attention, hyperactivity, impulsivity, motor deficits) in unmedicated school aged children.

Participants: Dutch school-aged children (N = 73) with elevated ADHD symptoms.

Study Design and Intervention:

- A randomized controlled trial.
- Intervention group: Played 'Highflying Dragon' that was developed with ADHD training components selected related to the ADHD symptoms.
- Control group: Played a similar full-body driven game without ADHD specific elements (i.e., 'Angry Birds Trilogy')
- Length of intervention: Six 15-minute sessions (total 1.5 hours.), done over 3-4 weeks during school time.

Outcome Measures:

- Teacher ratings of ADHD symptoms (via the AVL questionnaire) 'Neuropsychological tests', including:
- Fine and gross motor skills.
- Go/no go task to evaluate attention sustained.

Outcome Measures:

- Teacher ratings of ADHD symptoms (by teacher report via the AVL questionnaire) "Neuropsychological tests" which included:
- Fine and gross motor skills.
- Go/no go task for sustained attention and impulsivity.

Key Findings

1. Teacher-rated ADHD Symptoms: a. The experimental group had somewhat better improvement as compared to the control group, overall ADHD ratings
2. Fine Motor Skills: a. No differences between groups in improvement of fine motor coordination
3. Gross Motor Skills: a. Neither group showed any improvements in gross motor behaviors
4. Sustained Attention (Go/No Go Task):
 - Both groups showed a decrease in the number of hits (i.e., correct responses), indicating decreased sustained attention in both groups post-intervention .
5. Impulsivity (False Alarms): - The intervention group had a larger increase in false alarms compared to the control group, indicating an increase in impulsivity
6. Engagement & Feasibility: - The game was promising: significant changes with short bouts of play, and good overall participant satisfaction .

Final Thoughts: The feasibility study raises the possibility that full-body videogame interventions like -Highflying Dragon- can engage children with ADHD and potentially reduce observable symptoms in a short time frame.

8-2- Study (Verónica Estrada-Plana et al 2019):

Title: A Pilot Study of the Efficacy of a Cognitive Training Based on Board Games in Children with Attention-Deficit/Hyperactivity Disorder: A Randomized Controlled Trial.

Objective: To determine if a board-game-based cognitive training can enhance executive functions (EFs) and clinical symptomatology in children with a clinical diagnosis of ADHD.

Design A "nonblinded randomized controlled trial (RCT)" with two groups:

Experimental (training) group: 13 children (mean age \sim 9.46 years, SD = 1.20; \sim 53.8% boys.

- «Wait»list control group»: 14 children (mean age \sim 9.50 years, SD = 1.09; \sim 71.4% boys.

Randomization was stratified to balance age and sex between the groups.

Measurements: Evaluated at the points of "pretest", "posttest", and "follow-up", measured the following: - Executive functions (e.g. linguistic short-term memory)

-Clinical symptoms (e.g. conduct problems)

Major Findings :

- Post Intervention Improvements The board games training group made additional statistically significant gains compared to the control group:

-Linguistic short term memory: $F(1,28) = 7.45$, $p = 0.02$

- Conduct problems: $F(1,28) = 12.51$, $p < 0.001$

- Effect Sizes at Follow-Up While the follow-up differences were not statistically significant, there were «large effect sizes» suggesting, that there was sustained improvement in important areas.

These promising findings suggest that board-game-based EF training may be a viable "therapeutic or preventative intervention" for children with ADHD.

8-3- Study (Radwan Baazi & Nadir Guendouzen, 2020):

Title: The Function of Educational Games to Decrease Hyperactivity and Attention Deficit Disorder Symptoms in Children.

Objective: To determine how effective educational games are in decreasing hyperactivity and attention deficit disorder symptoms in children.

Study Design:

-Participants: 10 second grade children from "Shahid Si Sheikh School."

-Groups: Participants randomly allotted into two equally sized groups:

.Control group No intervention.

Experimental group Participated in educational games.

Assessment Instrument: Conners' Mini Scale was used to diagnose attention deficit with hyperactivity.

Analysis: Statistical analysis performed using SPSS.

Key Findings :

- The study was able to demonstrate significant effectiveness of educational games to decrease hyperactivity and distractibility in children when compared to the experimental group.

8-4- study (Medjralou, Ahlem & Zaoui, Ali , 2023):

title: The Role of School Physical Activities and Sports in Reducing Symptoms of Attention Deficit Hyperactivity Disorder: A Study of Primary School Students (7-12 Years Old). –Location: Algeria

Objective: determine whether a school based program of small games can reduce "ADHD" symptoms (primarily inattention, hyperactivity, and impulsivity) in primary school children aged 7 to 12 years of age .

Methodology: Participants: 12 primary school students from 7 to 12 years of age.

Intervention: A structured program of small games delivered as weekly physical activity sessions.

Assessment: A statistical estimate of -ADHD- symptom levels -before and after- use of the program, using statistical methods of estimating the significance of the differences between two sets of scores (calculated T-value - Tcal- vs tabulated T-value -Tth-)

Results : the direct and immediate program yielded -statistically significant improvements in:

- Attention: students were observed to be more attentive.
- Impulsiveness: reckless behaviors were reduced.
- Restlessness: hyperactivity was reduced.
- These behaviors were confirmed with acquired significant differences between "Tcal" and "Tth"

8-5-Study (Valerio De Luca et al , 2024) :

Title: Serious Games for the Treatment of Children with ADHD: The BRAVO Project -
Project Name: BRAVO (Beyond the treatment of the Attention Deficit Hyperactivity disorder)

Affiliations: Conducted by researchers from the University of Salento, Villa Delle Ginestre, Grifo Multimedia, and Polytechnic University of Turin.

- Objectives and Methodology :

Objective: To develop serious games through Extended Reality (XR) technologies, such as Virtual Reality (VR), Augmented Reality (AR), or Mixed Reality (MR) to help support cognitive and behavioral improvements in children with ADHD.

- Target: Improve self-control, attention, rule-following, and planning within educational and everyday contexts .

Type and Categories of Games :The study conducted three types of serious gaming:

1. Topological Categories - Virtual spaces like classroom, bedroom, garden spaces - Children can interact using devices like HTC Vive and controllers to improve spatial understanding through task-based navigation.

2. Infinite Runner: An 8-level game in which children interact with Kinect body movements to travel and collect objects as they follow the rules - intended to practice rule-following and impulse control.

3. Space, Travel Trainer (also known as planning) .

- Children role-play as astronauts using Kinect controls to complete problems, make decisions, and interact socially - focused on planning skills and social behavior.

Integration of biofeedback: The system adapts and personalizes the task when inferences are collected from psycho physiological measurements, such as EEG or pressure via a wearable sensor, which allows therapists to manage the level of difficulty, and assess emotional and cognitive states.

- Experimental Study Details Experimental Study Details .

Timeframe: A six-month experimental campaign.

Number of Participants: 60 Children with ADHD were randomly assigned to an experimental group (BRAVO games) or a control group (traditional therapy).

Assessments: Cognitive and behavioral function and emotional responses to games were assessed through standardized assessments.

Results and Outcomes:

- The BRAVO intervention produced "general improvements" in cognitive and behavioral functions among children in the sample. The children had improved self-control, attention, and respect for rules.

- The emotional effect of the games was generally positive, which is an indication that the games engaged children more than traditional therapy did.

9-Best Practices in the Implementation of Game-Based Treatment for ADHD:

- Select games based on scientific research or developed in consultative association with clinical authorities.

- Implement games as a part of a planned activity routine and not a reward or activity filler.

- Integrate with traditional interventions (drugs, behavioral therapy, coaching).

- Utilize monitoring tools for tracking student responses and difficulty adjustments accordingly.

- Utilize co-play in family members or age peers for social interaction.

Educational and serious games are novel, inexpensive, and in the majority of cases, fun interventions which can either enhance existing ADHD solutions either medication or behavioral. They:

- Enhance mental abilities such as concentration and memory.

- Sustain engagement through motivational mechanics.

- Permanently retain learning and potentially apply skills to daily life.

- Offer no pharmacological remedies, which are suitable for patients who cannot tolerate or access medicines. Although short-term effectiveness is plentifully substantiated, additional research is needed in the way of solidifying long-term effectiveness and generalizability to daily functioning.

*Educational games can act as a helpful resource in reduced deficits in concentration and attention when they are:

- Designed intentionally along cognitive lines

- In a formalized program of intervention.
- Accompanied and directed by professionals and/or care givers.

10-Conclusion

Educational games effectively lower rates of attention deficit disorder and enhance concentration When implemented in moderation as part of a broader user-focused contextual learning experience or therapeutic program. Activating students in a fun and dynamic manner work towards the higher motivation and participation while facilitating the assimilation of cognitive skills, while allowing for a structured setting ripe for concentration and focused learning. Finally, the benefits of greatly enhancing concentration and inducing cognitive learning potential would hinge upon the selection of the appropriate game, the implementation of educational games in moderation, and congruency for the individualized profile and requirements of the student.

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