

A mobile app as a gamified early intervention for ADHD students

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World Journal of Biology Pharmacy and Health Sciences, 2024, 18(01), 048–053

Publication history: Received on 16 February 2024; revised on 01 April 2024; accepted on 03 April 2024

Article DOI: <https://doi.org/10.30574/wjbphs.2024.18.1.0146>

Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is a prevalent behavioral disorder that typically starts during infancy but can also emerge during adolescence or adulthood. This research study concentrated on developing an engaging supplementary resource to aid children with ADHD who face challenges with executive functions. The gamified system was specifically designed as an Android mobile application, aiming to provide a helpful tool for parents as well as an educational tool for teachers to proceed in early intervention and track the progress of students with ADHD or other special educational requirements.

Keywords: Attention Deficit Hyperactivity Disorder (ADHD); Mobile application; ICTs; Executive functions; Learning disabilities.

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a highly prevalent neurological disorder affecting children and adolescents. However, despite its frequency, a comprehensive understanding of its underlying mechanisms remains elusive. The primary symptoms of ADHD include difficulties with attention and impulsivity, arising from dysfunctions in specific brain regions responsible for executive functions. Executive functions encompass vital cognitive abilities such as short-term memory, flexible thinking, and self-regulation, which play a crucial role in an individual's socio-emotional well-being (Drigas & Driga, 2019).

Cognitive ability has been widely recognized as a significant predictor of academic achievement. When a child's performance in school is negatively impacted by personal limitations, it can often lead to lower self-esteem (Karabatzaki et al., 2018). The early cultivation and mastery of these cognitive skills form the basis for crucial abilities such as attention, organizational skills, task focus, emotional regulation, and self-evaluation (Drigas & Driga, 2019).

Executive functions and especially self-regulation is a crucial area in which children with ADHD often struggle, and it is closely connected to emotional intelligence. Emotional intelligence serves as the guiding force for perceiving, thinking, learning, problem-solving, and decision-making processes. It plays a pivotal role in effectively navigating and managing one's emotions, which is particularly relevant for individuals with ADHD (Drigas & Driga, 2019). Additionally, self-control is a significant aspect of self-regulation, encompassing an individual's ability to delay instant gratification, withstand irritations, and regulate impulses. It reflects the strength of one's ego and the capacity to manage and govern their behavioral responses (Doulou, Drigas & Skianis, 2022).

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2. ADHD: bad genes or bad parenting?

The causes of ADHD are complex and multifactorial, involving a combination of genetic and environmental factors. It is not accurate to attribute ADHD solely to "bad genes" or "bad parenting." Research suggests that genetic factors play a significant role in ADHD, with certain genes believed to contribute to its development. However, it is important to note that having a genetic predisposition does not mean that an individual will definitely develop ADHD (Mate, 2011).

Environmental factors, such as prenatal exposure to substances, premature birth, low birth weight, exposure to environmental toxins, even adoption may also contribute to the development of ADHD. Parenting style and family dynamics can influence a child's behavior and emotional well-being but are not considered the sole cause of ADHD (Mate, 2011). It is crucial to approach ADHD from a comprehensive perspective that recognizes the interaction between genetic, environmental, and neurological factors. ADHD is a complex neurodevelopmental disorder, and understanding its causes requires considering both genes and environment (Drigas & Driga, 2019). Human brain is not programmed by biological heredity alone, that its circuits are shaped by what happens after the infant enters the world and even while it is in the uterus (Mate, 2011).

3. ADHD and executive functions

Attention-deficit/hyperactivity disorder (ADHD) is a prevalent developmental disorder, affecting approximately 5.3% of children and adolescents worldwide (Polanczyk et al, 2007). Common symptoms of ADHD include inattention, impulsivity, impaired inhibition, and hyperactivity (Association AP, 2016). Children and adolescents with ADHD often experience difficulties in high-level cognitive functions known as executive functions. These executive dysfunctions may contribute to the behavioral problems commonly observed in individuals with ADHD. Various treatment options are available for ADHD, including medication, psychotherapy, psychoeducation, neurofeedback, and behavior management. Mobile apps for educational purposes have emerged as effective strategies for managing ADHD (Fenghua Sun et al, 2022).

It must be noted that executive functions (EFs) are incredibly important in various aspects of daily life, contributing to good health, quality of life, learning abilities, and overall achievement. Regarding Wannapaschaiyong (2022) EFs are also essential for proper emotional, behavioral, and social functioning in children. Impairments in EFs can have negative consequences in multiple ways. Physically, they can contribute to health issues such as obesity, hypertension, diabetes mellitus, and dyslipidemia. Mentally, they can be associated with substance dependence, attention deficit hyperactivity disorder (ADHD), depression, and obsessive-compulsive disorder. Impaired EFs can also lead to difficulties in work and learning, including learning disabilities, decreased productivity, and challenges in maintaining employment.

ADHD is a prevalent mental disorder that significantly affects children, characterized by symptoms such as difficulty paying attention, hyperactivity, and impulsive behavior (Fuhs et al, 2016). Its impact extends to various aspects of life, including academic and professional achievements, interpersonal relationships, self-esteem, and social functioning. In the past, impaired executive functions (EFs) were believed to be the primary cause of ADHD symptoms and their negative consequences. However, current evidence challenges this notion. Therefore, the objective of this review is to explore the connections between EFs and ADHD symptoms, highlighting the importance of assessing and addressing executive dysfunction alongside ADHD symptoms (Wannapaschaiyong, Kiewkong & Bunman 2022).

4. The development of Strigi's 9998: 9 in 1 puzzle

We understand the importance of providing both education and entertainment for our young children. However, with busy schedules, it can be challenging to dedicate enough time and effort to these activities on a daily basis. Fortunately, there are many excellent online games available for preschoolers that are both educational and free. One notable example is Strigi's 9998: 9 in 1 puzzle, a mobile game/application created by StrigiformGames, which focuses on teaching numbers, colors, patterns, letter recognition, and provides fantastic options for kids aged 4 to 8. The app is designed to make learning enjoyable by incorporating fun elements. This study demonstrates the features that make this app an excellent choice for young learners especially those who are at risk of ADHD.

Strigi's 9998: 9 in 1 puzzle offers access to a diverse collection of nine different games, each specifically designed to engage and challenge the brain in unique ways. These stimulating games cover a wide range of categories, including computational puzzles, intellectual teasers, memory games, and analytical brainteasers. The app brings together this variety of games into a single application, providing users with a comprehensive and enriching experience. One notable advantage of Strigi is that it does not require an active internet connection to play. This means you can enjoy the games

offline at any time, making it an ideal companion for long commutes or flights where a reliable internet connection may not be available.

Strigi's 9998: 9 in 1 puzzle offers a range of key features that make it a valuable app for users who are diagnosed or at risk of ADHD:

Brain training: The app includes games that are designed to train and challenge the brain, helping to improve cognitive abilities and mental processing skills.

- Reaction training: Some games focus on improving reaction time and enhancing quick thinking abilities.
- Logical games: The app includes logical puzzles and games that encourage problem-solving and critical thinking.
- Brain teasers: Users can enjoy a variety of brain teasers that stimulate the mind and provide a fun challenge.
- Games for mental processing: The app offers games that exercise mental processing skills, such as memory, attention, and concentration.
- Mathematical games: Users can engage in mathematical games that promote numerical skills and logical reasoning.
- 9 games in 1: Strigi combines nine different games into a single app, offering a diverse range of mental challenges and entertainment options.
- Completely free games: All the games within the app are available for free, ensuring accessibility to users without any additional costs.
- Ideal for leisure time: Strigi is designed to be played during leisure time, allowing users to engage in stimulating and enjoyable activities whenever they have a moment to spare.
- Puzzle books to exercise the mind: The app provides puzzle books that offer further opportunities to exercise and strengthen the mind.
- Different levels of difficulty: Games within Strigi offer varying levels of difficulty, catering to users of different skill levels and allowing them to progress and improve over time.
- Solve word and number games: Users can enjoy games that involve solving word-based and number-based challenges, promoting language and numerical skills.

Suitable for students or even adults with ADHD: Strigi is designed to be enjoyed by users with ADHD, ensuring that both children and adults can benefit from its educational and entertaining features.

5. Discussion

Finally, it's critical to emphasize the useful and vital function that all digital technologies play in the field of education. These technologies, including mobile devices (11-12), a range of ICT applications (13-16), AI & STEM ROBOTICS (17-20), and games (21), facilitate and improve educational processes including evaluation, intervention, and learning. Additionally, the use of ICTs in conjunction with theories and models of metacognition, mindfulness, meditation, and the development of emotional intelligence [22-33], accelerates and improves educational practices and outcomes, particularly for students with ADHD.

More Specifically, the integration of digital technologies in the field of education has proven to be highly productive and successful (Kakoura & Driga, 2023). It enhances and improves educational processes through various means such as mobile devices (Vlachou & Drigas, 2017), applications utilizing information and communication technologies (ICTs) (Drigas & Koukianakis, 2006), artificial intelligence (AI) and STEM (science, technology, engineering, and mathematics) and educational games (Papanastasiou, Drigas & Skianis, 2017). Furthermore, when combined with theories and models related to metacognition, mindfulness, meditation, and emotional intelligence cultivation (Drigas & Mitsea, 2020), as well as considering environmental factors and nutrition (Driga & Drigas, 2019), the use of ICTs in education becomes even more effective and yields better educational practices and outcomes (Kakoura & Drigas, 2023). This integration creates a synergistic effect, amplifying the benefits and improvements in the educational field.

With the increasing popularity of smartphones and advancements in technology, mobile software applications (apps) are now being utilized in the healthcare sector. While similar software capabilities are available on other devices such as personal laptops, the advantage of smartphones (and smaller tablets) lies in their mobility and immediate accessibility for the user. This allows individuals to stay connected with people, whether they are friends, family, or healthcare professionals, and access information or support through the internet at any time and almost anywhere. The objective of this study was to conduct a literature review on the use of mobile applications for identifying and treating symptoms associated with attention-deficit/hyperactivity disorder (ADHD). Mobile applications, powered by new

technologies, have the potential to play a significant role in therapeutic interventions, particularly in addressing ADHD symptoms (Doulou, Drigas & Skianis, 2022).

Children with ADHD commonly display a specific set of symptoms, including inattention, hyperactivity, and impulsivity. Angelopoulou and Drigas (2021) suggest a connection between memory and attention during task performance, highlighting the significance of these cognitive functions in treating individuals with ADHD. Higher levels of working memory are associated with longer attention spans, making them crucial for cognitive function improvement.

6. Advantages

Mobile devices offer several advantages for students with ADHD, providing tools and resources that can help them manage their condition and succeed academically. One significant advantage is the plethora of organizational apps available. Apps like Todoist, Trello, or Google Calendar can assist in creating schedules, setting reminders for assignments and deadlines, and breaking down tasks into manageable steps. Research has shown that digital organization tools can improve time management and task completion for students with ADHD (Harris & Aglinskas, 2012).

Note-taking apps are another valuable asset for these students. Applications such as Evernote, OneNote, or Notability allow for easy organization, tagging, and searching of notes. They often support audio recording as well, which can be beneficial for capturing important information during lectures (Rabiner, 2014). In addition, access to educational apps is a significant advantage of mobile devices. Apps like Khan Academy, Quizlet, or Duolingo offer interactive and engaging ways to learn, catering to different learning styles and needs. For students with ADHD, these apps can help improve focus and retention (Pediatrics, 2018).

Mobile devices also provide visual and auditory aids to support learning. Apps with timers or countdowns can help students manage time effectively. Additionally, there are apps designed to block distracting websites or notifications during study sessions, aiding in concentration (Mikami et al., 2010). Moreover, digital textbooks and resources are increasingly available, providing more engaging materials for students with ADHD. These texts often include interactive elements, multimedia content, and search functions, making it easier for students to find and focus on the information they need (Pediatrics, 2018).

Communication with teachers is made more accessible through mobile devices. Students with ADHD can use email or messaging apps to ask questions, request clarification, or seek help when needed. This fosters improved understanding of coursework and better relationships with teachers (Rabiner, 2014). Lastly, mindfulness and relaxation apps can be beneficial for students with ADHD. Apps like Headspace or Calm offer guided meditation, breathing exercises, and relaxation techniques that help reduce stress and improve focus (Harris & Aglinskas, 2012). In conclusion, mobile devices can be powerful tools for students with ADHD, providing support for organization, note-taking, learning, time management, communication, and mental well-being.

Recommendations

The development of this current mobile game/application created by StrigiformGames, Strigi's 9998: 9 in 1 puzzle can provide insights into how digital devices are used by parents or teachers to children with ADHD. This information can assist educators in adapting their approaches to the learning environment by digital tools, exploring new possibilities for utilizing digital devices as learning tools, and meeting the needs of children. It is recommended to conduct future research on a large sample or single subject research.

7. Conclusion

Children with ADHD commonly display a specific set of symptoms, including inattention, hyperactivity, and impulsivity. A connection between memory and attention during task performance, highlighting the significance of these cognitive functions in treating individuals with ADHD. Higher levels of working memory are associated with longer attention spans, making them crucial for cognitive function improvement. Furthermore, children with ADHD often experience deficits in working memory. Given their tendency to become bored quickly, it is important to continuously engage and hold their attention. Mobile applications offer a means to achieve this as they require ongoing focus from the child. Engaging children with ADHD and keeping them occupied throughout an intervention is essential. Mobile applications have the advantage of capturing their attention, keeping them busy, and stimulating all their senses. This adds to the overall interest and effectiveness of the intervention.

The discussion surrounding ADHD and its rehabilitation methods reflects the evolving nature of our understanding in these fields. Further research is required to develop alternative therapies utilizing mobile applications, aiming to enhance cognitive and metacognitive skills in children with ADHD and facilitate their integration into the social environment. Continued exploration and investigation in this area can lead to innovative approaches that have a positive impact on the lives of these children.

Compliance with ethical standards

Acknowledgments

The Authors would like to thank Demokritos Team for their support.

Disclosure of conflict of interest

The Authors proclaim no conflict of interest.

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