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MULTICULTURAL EDUCATION AND GAMES USING AUGMENTED REALITY IN ADHD

EDUCAÇÃO MULTICULTURAL E JOGOS USANDO REALIDADE AUMENTADA NO TDAH

EDUCACIÓN MULTICULTURAL Y JUEGOS USANDO REALIDAD AUMENTADA EN TDAH

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ABSTRACT
According to recent data, many communities worldwide are multicultural nowadays. Culture is believed to significantly impact the creation of therapy materials, practice models, assessment instruments, and client collaboration. Also, recent works address the interaction between a therapist and a client and the need to understand a child's social needs. Even with significant advancements in the development and delivery of efficient treatments for children with ADHD, ethnic minority youths and teens continue to lag behind their non-minority peers in terms of diagnosis and treatment rates. Various learning and behavioral obstacles are linked to this disorder because of cognitive and metacognitive functioning difficulties. Individuals can only fully integrate into society if these functions have been acquired. Children can acquire alternate strategies to manage their cognitive deficits and adapt to different circumstances by using internal attention to build self-awareness, self-regulation, and self-control. The quick progress of research has led to the development of several medicinal and psychological strategies for treating ADHD, which significantly help with symptom management. The goal of the current study is to gain an understanding of the various therapeutic approaches used to help children from racial and ethnic minorities who are suffering from ADHD. These approaches include games using augmented reality (AR) environments.

KEYWORDS: Attention Deficit Hyperactivity Disorder (ADHD). Social and Emotional Development. ICTs, Augmented Reality (AR) Games. Learning. Metacognition. Ethnic Minority Children. Multicultural Education.

RESUMO
De acordo com dados recentes, muitas comunidades em todo o mundo são hoje em dia multiculturais. Acredita-se que a cultura tenha um impacto significativo na criação de materiais terapêuticos, modelos de prática, instrumentos de avaliação e colaboração do cliente. Além disso, trabalhos recentes abordam a interação entre um terapeuta e um cliente e a necessidade de compreender as necessidades sociais de uma criança. Mesmo com avanços significativos no desenvolvimento e fornecimento de tratamentos eficientes para crianças com TDAH, os jovens e adolescentes de minorias étnicas continuam a ficar atrás dos seus pares não pertencentes a minorias em termos de diagnóstico e taxas de tratamento. Vários obstáculos de aprendizagem e comportamentais estão ligados a este transtorno devido à dificuldades de funcionamento cognitivo e metacognitivo. Os indivíduos só podem integrar-se plenamente na sociedade se estas funções tiverem sido adquiridas. As crianças podem adquirir estratégias alternativas para gerir os seus défices cognitivos e adaptar-se a diferentes circunstâncias, utilizando a atenção interna para desenvolver a autoconsciência, a autorregulação e o autocontrolo. O rápido progresso da pesquisa levou ao desenvolvimento de diversas estratégias medicinais e psicológicas para o tratamento do TDAH, que auxiliam significativamente no manejo dos sintomas. O objetivo do presente estudo é compreender as diversas abordagens terapêuticas utilizadas para ajudar

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crianças de minorias raciais e étnicas que sofrem de TDAH. Essas abordagens incluem jogos que usam ambientes de realidade aumentada (AR).

PALAVRAS-CHAVE: Transtorno de Déficit de Atenção e Hiperatividade (TDAH). Desenvolvimento Social e Emocional. TICs. Jogos de Realidade Aumentada (AR). Aprendizagem. Metacognição. Crianças de Minorias Étnicas. Educação Multicultural.

RESUMEN
Según datos recientes, muchas comunidades en todo el mundo son hoy en día multiculturales. Se cree que la cultura tiene un impacto significativo en la creación de materiales terapéuticos, modelos de práctica, instrumentos de evaluación y colaboración con el cliente. Además, trabajos recientes abordan la interacción entre un terapeuta y un cliente y la necesidad de comprender las necesidades sociales de un niño. Incluso con avances significativos en el desarrollo y administración de tratamientos eficientes para niños con TDAH, los jóvenes y adolescentes de minorías étnicas continúan rezagados respecto de sus pares que no pertenecen a minorías en términos de tasas de diagnóstico y tratamiento. Varios obstáculos de aprendizaje y de comportamiento están relacionados con este trastorno debido a dificultades de funcionamiento cognitivo y metacognitivo. Los individuos sólo pueden integrarse plenamente en la sociedad si han adquirido estas funciones. Los niños pueden adquirir estrategias alternativas para gestionar sus déficits cognitivos y adaptarse a diferentes circunstancias utilizando la atención interna para desarrollar la autoconciencia, la autorregulación y el autocontrol. El rápido progreso de la investigación ha llevado al desarrollo de varias estrategias medicinales y psicológicas para tratar el TDAH, que ayudan significativamente a controlar los síntomas. El objetivo del estudio actual es comprender los diversos enfoques terapéuticos utilizados para ayudar a los niños de minorías raciales y étnicas que padecen TDAH. Estos enfoques incluyen juegos que utilizan entornos de realidad aumentada (AR).

PALABRAS CLAVE: Trastorno por déficit de atención e hiperactividad (TDAH). Desarrollo social y emocional. TIC. Juegos de realidad aumentada (AR). Aprendizaje. Metacognición. Niños de minorías étnicas. Educación multicultural.

INTRODUCTION

A person who is different from the majority population in terms of race, religion, language, or cultural heritage is considered a member of an "ethnic minority" (Bhopal, 2004). This word encompasses a wide range of people and social groups, such as historically marginalized national groups, immigrants, migratory workers, refugees, and asylum seekers, who find themselves in a variety of social and political circumstances. Studies examining cross-cultural differences in the US reveal that compared to their non-minority peers, children from ethnic minorities are evaluated and treated for attention deficit hyperactivity disorder (ADHD) symptoms considerably less frequently (Morgan *et al.,* 2013; Ray *et al.,* 2006). European studies (Arat *et al.,* 2018; Knopf *et al.,* 2012; Schlack *et al.,* 2007; Wittkampf *et al.,* 2010) similarly found that compared to non-immigrant children, immigrant children had lower rates of ADHD diagnosis and therapy. Studies show that minority children are overdiagnosed with neurological disorders and disabilities and are disproportionately placed in special education despite growing concerns about the misdiagnosis and harmful health effects of ADHD within some minority communities (Coker *et al.,* 2016).

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A frequent neurological disorder affecting children and teenagers is attention deficit hyperactivity disorder. We only need a limited understanding of its functioning because it still has a complicated personality (Froehlich *et al.,* 2007; Sullivan Ball, 2013). The main traits of ADHD are impulsivity and lack of concentration, which are brought on by a disruption in the executive functions of the brain regions responsible for regulating particular skills (American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, DSM-5). A sound socio-emotional state depends on executive functioning, which includes short-term memory, mental flexibility, and self-control (Drigas A; Driga M, 2019; Drigas; Sideraki, 2021; Lytra; Drigas, 2021). Furthermore, low self-esteem results from a child's poor academic achievement that stems from personal deficiencies, even if cognitive capacity is a well-established predictor of academic advancement (Karambatzaki *et al.,* 2018). The basis for attention, organizational abilities, the capacity to concentrate on a single activity, mood regulation, and self-evaluation is laid by these talents' early development and management (Drigas A; Driga M, 2019). Another facet of emotional intelligence that has been linked to ADHD in kids is the capacity for self-regulation. The master switch for observation, reasoning, cognition, problem-solving, and judgment is emotional intelligence. It also highlights qualities of self-regulation, such as the ability to put off gratification, tolerate irritants, and restrain impulsive behavior (ego power).

Based on their research, Drigas and Papoutsi (2018) developed a tiered and hierarchical approach to the development of emotional intelligence that shows how an individual changes over time. This approach can be used as a therapeutic technique to address issues with social connections, special education, and other areas of life. These levels are mainly connected to social skills, self-actualization, self-awareness, self-management, empathy, and the ability to comprehend and recognize emotional cues. Maslow's hierarchy of needs states that self-actualization is the most significant state of self-realization, self-fulfillment, and achievement (Maslow, 1943; Maslow, 1987). In a different study by Drigas and Mitsea (2020; 2021), a multilevel metacognition model states that attention is the "center" of metacognitive abilities. Choosing, filtering, suspending, processing, storing, retrieving, forecasting, monitoring, adjusting, adapting, identifying, discriminating, remembering, and knowledge transformation are among the activities in which attention takes part. In this paradigm, every level denotes a more sophisticated control system, illustrating the subject's development of metacognition. A more complex control system develops when a person moves from lower to higher levels of metacognition, causing a shift in self-awareness and self-observation. People can only integrate the socio-emotional and cognitive skills required for social integration if they have mastered these metacognition pillars. A crucial tool for self-awareness, self-betterment, and self-care is metacognition. Thus, it should serve as the centerpiece of a particular intervention program that encourages all-encompassing learning. Since medication encourages metacognitive skills, it is accepted as the first line of treatment for easing symptoms of ADHD. However, because of its adverse effects and potential for addiction, it has several drawbacks.

However, technology-based intervention techniques, including augmented reality gaming, have also shown to be successful.

1. THE IDEA OF 'MULTICULTURAL/INTERCULTURAL EDUCATION'

The ability to identify and feel empathy for others, the capacity for comparison, and the adoption of "different" cultural elements are all prerequisites for human communication when people from different cultural capitals come together. However, developing and using specific competencies through an education geared towards intercultural principles is critically relevant because multiculturalism is only sometimes easy to grasp. Intercultural education is described in this framework as a novel view of education that calls for diversified practice in educational institutions. This is predicated on the understanding that a restricted, nationally focused education needs to be updated and reflect 21st-century reality (Dietrich, 1997). The primary goals of intercultural education are further examined in the following section, as outlined in the international bibliography.

According to Helmut Essinger (1991), the guiding principles of intercultural education are as follows: (A) Empathy education. This is about developing empathy for others, putting ourselves in their situation, and seeing things from their perspective regarding their ideas and issues. For this to be feasible, young people should be encouraged in their schooling to express an interest in the "difference" or the issues of the "others," whether these "others" be immigrants who live next to us as neighbors or other people who reside outside of our boundaries. (b) Education for solidarity: This focuses on helping students build a collective consciousness that transcends the boundaries of groups, nations, and races and is based on the premise that everyone has the same worth and the ability to experience the same issues. It is acceptable to anticipate one another's assistance in these situations. (c) Intercultural respect education. We may gain This respect by "opening up" to other cultures and simultaneously asking them to engage with our own. (d) Educating against nationalistic thinking, which attempts to promote tolerance, communication, and the eradication of prejudice and stereotypes specific to one's own country.

Various topics are covered by Georg Auernheimer (1995), who highlights the need for intercultural education. By the first premise, intercultural education is viewed as social learning, through which a person learns social skills, including empathy, tolerance, solidarity, and the capacity to resolve conflicts. The second part of intercultural education refers to the ability to engage in cross-cultural communication. Acceptance of cultural differences and the capacity to deal with them are prerequisites for the latter. A broad education that offers Mult perspectivity is the third factor. This would imply that, in the case of Greece, the information taught in schools refers not just to the world of the Greek people but also to the immigrant pupils represented in Greek classrooms (Hodolidou, 2018). This applies to every topic in the curriculum. This makes it feasible to recognize the shared cultural traits that bring people together. If we want to build and uphold the spirit of peaceful collaboration, multilayered understanding,

and engagement, this is desirable and the desideratum. Auernheimer (1995) also makes the case for intercultural education as antiracist and citizenship education. It is simple to determine how intercultural education and citizenship education are related. This would entail educating people against nationalistic ideas as well as educating them to respect other cultures. For instance, this may involve discussing in-class issues like xenophobia and attacks on immigrants in class. These are unquestionably crucial components of civic education. Antiracist and intercultural education are related, as the latter tries to eradicate stereotypes, prejudice, and possibly racist attitudes and behaviors. Antiracist education differs from traditional education in that it emphasizes changing social organizations and structures rather than just changing individual views, such as those of teachers and students.

Additionally, it is crucial to try to alter the social and educational systems, both of which can contain racist features. Finally, bilingual education has a direct connection to multicultural education. The latter is crucial for the identity of students from linguistic minorities to develop normally. Thus, it is emphasized that every student's mother tongue or first language should be represented in the educational system, both as the medium of instruction and for language instruction. The goal is to successfully learn both the mother tongue and the second language (Cummins, 2001). The goal of intercultural education places a strong focus on bilingual education, which affects linguistic minorities in addition to immigrant children.

Those above should clarify that intercultural education encompasses the majority, or the students from the dominant culture, and the minority students and their education, who are seen as an educational challenge (Dietrich, 1998). Intercultural education is another significant topic, which refers to both "state" and "interstate" levels. In contrast to the latter, which deals with cross-state cultural exchange and interaction, the former refers to immigrants, repatriates, refugees, and other minorities residing inside the borders of a particular state. Additionally, multicultural education eventually affects all schools, including those with no students of color within their student body.

Following the concepts above are some intercultural education best practices: (a) The primary practice is the coeducation of children from diverse linguistic and cultural backgrounds, which entails that minority children and those from the mainstream culture are taught in the same classrooms. By doing this, it is possible to prevent the marginalization of minority kids, which can occur if those pupils attend different schools. (b) Including minority cultures more prominently in educational curricula (Marburger, 1991). If the curriculum does not incorporate the "view of the other," the abovementioned coeducation is meaningless and may even result in cultural absorption. All of the curriculum's disciplines can incorporate the multicultural perspective. Today, this only sometimes occurs. (c) The elimination of bias, stereotypes, and depictions of adversaries from textbooks and curriculum. This entails highlighting both inter- and intra-ethnic commonalities as well as cultural variances. This method is backed by worldwide textbook research, the findings of which are particularly illuminating about the Balkans (Xochellis; Toloudi, 2001). It also applies exceptionally well to the situation of the Balkan nations. (d)

Setting up joint projects for students from various cultural backgrounds utilizing history, literature, music, etc., promotes cross-cultural interaction and helps students recognize their shared cultural traits. This exercise is especially crucial since it affects both the cognitive and emotive spheres of the student's personality. This is important if we consider that understanding and accepting something on a cognitive level differs significantly from converting it into attitudes and behaviors. (e) Incorporating intercultural education ideas into pre-service and in-service teacher education. This is crucial, given that instructors have a specific role in this process. Including intercultural education in teacher preparation programs should first focus on equipping teachers with specific competencies (acceptance of the multicultural society, openness, acceptance of difference, elimination of prejudice and racist views) and then on providing appropriate educational and didactic know-how. Because knowing how to do something effectively differs from simply being willing to do it. In this context, it is now believed that teachers' preparation for the accomplishment/realization of their professional duty must include instruction in the principles and methods of intercultural education.

2. THE CONCEPT OF 'OTHERNESS'

In social science disciplines, "otherness" refers to characteristics that differentiate groups of people (Banks, 2012). Ethnicity, cultural background, spoken language, skin color, religion, gender, social class, sexual orientation, and disabilities or special educational needs are typical features of otherness (Ajodhia-Andrews, 2016; Banks, 2012). These and various other factors categorize the individual into a group of people that differs from the dominant group that is considered "normal" and acceptable. Dimensions of otherness can be either overt, subtle, or invisible (Thompson, 2015).

The forms of otherness (e.g., race, ethnicity, language, religion, and disability) are dynamic concepts. At the same time, their meaning is fluid and determined each time depending on the historical, political, and sociocultural context (Ajodhia-Andrews, 2016). These are social constructions (Barnes, 2012; Lopez, 1994) created to categorize people based on physical or mental differences (Ajodhia-Andrews, 2016). Otherness is a constitutive element for the definition of human identity (Bolle De Bal, 1997; Kalantzis, 2011) since the construction of personal identity refers to the individual being similar to a group of people but simultaneously different from other groups. Other aspects can lead to discrimination, oppression, and exclusion from providing equal educational opportunities (Banks, 2012). Furthermore, they can contribute to the manifestation of bullying behavior, especially when there are prejudices and stereotypes about anything that looks different from what is accepted as usual, i.e., from the so-called "normality" (Elame, 2013).

The general school is the primary environment for acquaintance and interaction between students, teachers, parents, education professionals (social workers, psychologists), and social institutions (associations, social groups). It exerts a significant influence on the acceptance of otherness and the elimination of negative perceptions towards people who are "different" (e.g., people with

disabilities) (Deropoulou-Derou, 2004). Thus, studying the various aspects of diversity in schools can help understand how children are different, improve teachers' skills, support these children, and deconstruct what is stereotypically seen as 'normal' and "normal' (Petrou *et al.,* 2009).

3. THE CONCEPT OF 'DISCRIMINATION'

The concept of "discrimination" has undergone various interpretations over time. Although discrimination can sometimes be considered justified or positive (e.g., due to potential differences in skills or experiences) in intergroup relations, today, it has negative connotations (Dovidio; Gaertner, 2010; Lewis *et al.,* 2011). Historically, it has been seen as a problem primarily associated with race and gender (Lewis *et al.,* 2011). However, the concept no longer focuses on race and does not refer exclusively to immigration but concerns the human species (Elame, 2013). Discrimination does not simply refer to categorizing social subjects (Dovidio; Gaertner, 2010). The term is used to describe an unequal behavior or action that directly or indirectly leads someone to separate, exclude, limit, or favor a person based on certain factors that indicate otherness, such as gender, sexual orientation, age, religion, belief, ethnic origin, disability or even special educational needs, as well as other personal characteristics (Elame, 2013; Fiske, 1998; Harris *et al.,* 2004).

Although discrimination, stereotypes, and prejudices emerge through social categorization, their meaning varies. Specifically, discrimination refers to some actual behavioral reaction towards an individual or a group of individuals, depriving members of a group of opportunities and privileges that other groups have (Dovidio; Gaertner, 2010; Giddens, 2006). On the contrary, stereotypes (the set of shared perceptions or beliefs that members of one group have towards another group) and prejudices (the socially constructed attitudes, evaluations, and judgments) are intrapsychic phenomena and do not involve some behavior (Dovidio; Gaertner, 2010; Wright; Taylor, 2007). The existence of prejudices and stereotypes often accompanies discrimination. In essence, discrimination refers to our negative actions toward the group that is the object of our prejudice (Harila, 2000). For example, students belonging to minority groups may experience ongoing forms of discrimination within the school due to implicit prejudices and stereotypes in a failed attempt by these children to conform to dominant norms (Messiou, 2006; Petrou *et al.,* 2009). However, these two concepts are only sometimes combined since individuals may have prejudices but not proceed with acts of discrimination (Giddens, 2006).

4. GAMES USING AUGUMENTED REALITY (AR) AND ADHD

By combining game design and instructional design methodologies, as well as taking into account different factors like learning theories, a theory of play, mobile platform and technologies (for mobile games), game design, and instructional design, game-based learning (GBL) can be successfully developed and implemented in the learning environment (Zaibon; Shiratuddin, 2010).

Students utilize games to investigate, learn about, and pose questions. The notions of "learning by doing" and "active learning" are crucial foundational ideas for game-based learning (Mcclarty *et al.,* 2012). Compared to traditional teaching strategies, GBL more successfully engages students in meaningful learning and accurately reflects how they learn today (Yang, 2012). According to Van Eck (2006), elements that explain the broad interest in GBL include the popularity of games, continuous research on the effectiveness of digital game-based learning, and rising student disengagement from traditional education.

Technology-enhanced learning has shifted its attention in recent years to emerging technologies like learning analytics, augmented reality, ubiquitous learning, mobile learning, serious games, and ubiquitous learning to enhance user satisfaction and experiences in enhanced multimodal learning environments (Elmqqadem, 2019). Various mobile and location-based technologies offer opportunities to integrate learning into real-world contexts, enhancing engagement and learning outside conventional formal educational settings.

A virtual world of digital content can be overlaid and blended into the learner's perceptions of the natural world, creating an enhanced and augmented reality. Augmented reality is currently regarded as one of the key emerging technologies in education, offering new opportunities for teaching and learning. AR has become increasingly attractive and practicable in many fields, including education, due to recent technological advancements and the spread of inexpensive hardware and software (Johnson *et al.,* 2014). Combining digital learning resources with media directly related to the physical environment, such as tools or objects, creates "situated learning" and offers a novel learning environment. Making learning more enjoyable and rewarding alters how we teach and learn (Pedaste *et al.,* 2020).

With constructivist educational ideas, where students manage their learning via active interactions and inquiries with the actual and virtual surroundings, augmented reality is ideally suited. Most typically, augmented reality is effectively utilized in inquiry-based learning frameworks to fulfill cognitive learning objectives and, less frequently, motivational and emotional learning goals (Wang, 2012).

The development of virtual worlds where the player may learn via experimentation and practice (manipulating objects, for example)—possibly in cooperation with others—are game design implications. The principles of social constructivism in teaching and learning also align with well-designed contextual augmented reality experiences (Cheng; Tsai, 2013). These qualities are succinctly summed up by Lee (2012), who claims that augmented reality can inspire students to find information from various angles.

Due to several pedagogical qualities, augmented reality is a perfect teaching tool for various topic areas. Because technology enables students to perceive intricate spatial relationships and abstract ideas, augmented reality has attracted much public interest (Lin *et al.,* 2015). A better understanding of

how new knowledge is used in actual circumstances may be achieved when information is given through augmented reality in a contextually appropriate environment (Barrow *et al.,* 2019; Dede, 2012). Students benefit from contextual learning because it makes new material more relevant and enables them to see how it could change their surroundings (Sahin; Yilmaz, 2020; Dikkers *et al.,* 2014).

The BRAVO (Beyond the Treatment of Attention Loss Hyperactivity Disorder) software was developed by Barba *et al*., (2019). For youngsters with ADHD, this virtual and augmented reality setting uses rehabilitation exercises in the form of severe games and aids therapists in overseeing the treatment plan. The system's primary user is the child. The system's identification process is activated once the kid is in front of the treatment room and the youngster interacts with his or her unique virtual avatar. The avatar will always treat the child's psychological profile with kindness, making them feel at home and welcomed. The avatar not only follows the kid during the duration of therapy in the form of a digital hologram (displayed through Microsoft Hololens) but is also shown on a screen at the entry and exit of the treatment room (Barba *et al.,* 2019).

The BRAVO platform gathers information using sensors (EEG helmet and wristband to measure pressure levels and performance throughout the game), analyzes user emotion, and transmits information with other system parts to enable real-time game modifications. Along with ideas for the game and suggested difficulty levels, it also includes a therapist's toolbox that may be used to track progress throughout therapy (Barba *et al.,* 2019).

Three serious games make up the BRAVO environment, which aims to promote rule compliance, attention, action prediction, and social skills.

1. Topological: The game is created to be played with an HTC Vive and a controller, allowing the player to maneuver in a virtual world like a physical one. Users will explore three settings in the game (a classroom, a bedroom, and a garden) and will be required to do specific objectives in each.

2. The eight-level game Infinite Runner aims to instill respect for the law, active listening, and knowledge of one's limitations. The Kinect gaming system will be used to play the game, allowing users to decode their actions without using additional gear by simply moving their bodies. The user enters the game and is requested to run down a course in a virtual setting representing a city or country street. The player must move in the proper direction as the game advances to avoid various hazards or to obtain any needed items.

3. Space Travel Trainer is an instructional video game with seven levels that teaches players how to manage their social interactions and plan their activities. The Kinect gadget detects the player's hand motions and is used to operate the game. The player assumes the role of an astronaut in the game who attempts to guide the spacecraft to the planet of his pals. He or she will encounter many obstacles along the way, including the need to develop problem-solving skills, decision-making abilities, and, most importantly, interpersonal skills to work with teammates to defeat the enemy (Barba *et al.,* 2019).

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The 27-week BRAVO final stage will be used to assess the advantages. The participation of 60 new patients will represent the following age ranges: three age groups: 3-6 years, 6–9 years, and 9–12 years. Each age group will be split into two more groups of similar size at random. The first group will act as a control group receiving standard care, while the second group will be the test group getting the novel care while playing an augmented and virtual reality game. Both groups will be evaluated three times throughout the treatments: before, during, and after the intervention. Usability and effectiveness testing will be used to determine the BRAVO system's true impact (Barba *et al.,* 2019).

A cognitive model that may be utilized as an alternate intervention to conventional CBT (Cognitive Behavioral Therapy) was designed and simulated by Alqithami et al. in 2019. This paradigm uses recent advancements in augmented reality to involve patients in actual and virtual game-based situations. Through an interactive environment, augmented reality fuses natural and three-dimensional virtual material (Azuma, 1997). Augmented reality (AR) enhances interactions with 3D items in a natural environment as opposed to virtual reality (VR), which depicts the actual world in 3D visuals on a computer screen (Burdea; Coiffet, 2003; Billinghurst *et al.,* 2015).

The Microsoft-HoloLens emulator and the Unity application were used by Alqithami *et al.* (2019) to create the augmented reality game, which was then tested in a case study. This game simulates two 3D balls, the target ball and the other not. To be considered a successful hit, the player must adhere to the rules and strike the target ball within the allotted time. If unsuccessful, his effort will be counted as an omission or error and added to the total of unsuccessful hits. Throughout a single treatment session, the kid may participate in many games. They may play more or fewer rounds depending on how well they perform in the game and how skilled they are. There are ten trials of one minute each in each game. The youngster will see "target" and "non-target" balls on each trial. During the trial, the youngster will be instructed to catch the target ball to drop it within the interval. The response time is the time that passed between the start of the trial and striking the target. If the child's response time shortens, their performance has improved. The inability of the youngster to catch any of the balls may be a sign of inattention. This mistake demonstrates impulsivity if the toddler catches the non-target ball (Alqithami *et al.,* 2019).

There were two sections to this investigation. While the second section evaluated the impact of the child's engagement, the first looked at the impact of successful and unsuccessful efforts on the performance index. The outcomes demonstrated an improvement in the child's ability to focus on choosing the desired object, which benefited his performance index. According to Alqithami *et al.,* (2019), augmented reality games can help all kids cultivate flexibility, intelligence, responsiveness, and precision. Additionally, they believe that employing AR surroundings is more suitable than VR ones since it enables kids to see where they are in space when a game is being taught.

Avila *et al.*, (2018) used augmented reality serious games (ARSG) to help youngsters with ADHD pay more attention. They attempted to underline the therapeutic advantages of using an AR

environment with a prototype game named ATHYNOS. ATHYNOS aims to improve cognitive abilities such as visual-motor coordination, feedback, interaction, problem-solving, and focused and selective attention. The game was created using Unity 3D, the Software Development Kit (SDK), and the Vuforia Engine. Adobe Illustrator created the game's visuals, including the characters, scenarios, scripts, and environments. Adobe After Effects was utilized for animation, while Adobe Premiere Pro was used for expert video editing. Finally, a music sequence was made using listening programs like Ableton Live and Adobe Audition.

The therapist describes the process at the start of the game. Then, each youngster must log in using one of the six avatars to begin the game. Following that is a significant menu of scenes with two different sorts of treatments—Missing Character and Shape and Match—with three varying degrees of difficulty displays. For instance, the game Shape and Match includes fundamental mathematical reasoning, geometric forms, sequences, and calculations. The child's goal is to pair up the items on a scene's left and right sides and transfer them all to the middle of the screen. The outcomes are finally shown (Avila *et al.,* 2018).

Eleven children with ADHD, ages 7 to 10, including nine males and two girls, participated in the study. Every participant took part in 8 sessions. The amount of time it took to complete the tasks was noted for each session. The descriptive statistical study that followed proved that the players of ATHYNOS throughout the eight sessions were able to greatly enhance their social and time management abilities in daily life. The results also showed that the players' attention meliorated, which improved their capacity to manage frustration and significantly decreased the time required to complete the game.

Additionally, it was noted that the kids' timeframes and achievements were uniform in both situations, demonstrating that they all have comparable skills. According to Avila *et al.* (2018), this game encourages voluntary engagement and necessitates a persistent interest in problem-solving, improving learning in this way. Additionally, according to the therapist's input, practically every child showed high enthusiasm and curiosity, which left him feeling really happy.

5. METHOD

The research methodology consists of a meta-analysis and a review of the literature. In particular, search engines, including Science Direct, PsychInfo, ERIC, Pubmed, Academic Search Premier, and GateResearch, were utilized to locate research. With publishing years ranging from 1994 to 2023, the search was done using the phrases "ADHD," "Ethnic Minorities," "Augmented Reality Games," "Multicultural Education," "Emotional Intelligence," and "Metacognition skills." A total of 95 articles were examined during the bibliography evaluation process. The treatment of ADHD in children from ethnic minorities and the use of augmented reality games to improve metacognitive skills are the common threads that run through most of these articles.

6. CONSIDERATIONS

The significance of digital technologies in education and ADHD training is finally emphasized (Stathopoulou *et al.,* 2022; Stathopoulou *et al.,* 2023; Loukeri *et al.,* 2023; Vouglanis; Driga, 2023; Karyotaki *et al.,* 2022; Mitsea *et al.,* 2022). These technologies are incredibly productive and effective because they streamline and improve the processes of evaluation, intervention, and instruction. Mobile devices can be used to access them, making it possible to conduct educational activities from any location (Drigas *et al.,* 2020; Politi-Georgousi; Drigas, 2020; Stathopoulou *et al.,* 2018; Stathopoulou *et al.,* 2019; Xanthopoulou *et al.,* 2019).

Furthermore, a variety of ICT applications are essential for assisting with schooling (Xanthopoulou *et al.,* 2019; Drigas; Theodorou, 2016; Vouglanis; Driga, 2023; Bamicha; Drigas, 2022). (Drigas; Petrova, 2014). Moreover, research indicates that educational games can enhance learning processes and achieve unprecedented levels of effectiveness greatly (Bravou; Drigas, 2019; Bland Diego *et al.,* 2016; Chaidi; Drigas, 2022; Kefalis *et al.,* 2020). Furthermore, it has been demonstrated that integrating and using ICTs with theories and models of metacognition, mindfulness, meditation, and the cultivation of emotional intelligence (Drigas *et al.,* 2021; Drigas *et al.,* 2022; Drigas; Bakola, 2021; Drigas; Papoutsi, 2021) improves educational practices and outcomes, particularly for children of color who have ADHD. This method covers several areas, such as intervention and assessment.

More precisely, data from recent years indicates that a sizeable section of the populace is now multicultural. Culture significantly impacts the creation of therapeutic materials, practice models, assessment methods, and client collaboration. Recent articles have also addressed the need to understand a child's needs within the framework of their culture and the relationship between a therapist and their client. Despite tremendous progress in the creation and application of successful programs for children with attention deficit hyperactivity disorder, ethnic minority kids and teens continue to fall behind their non-minority peers in terms of evaluation and therapy rates.

Video games and other cutting-edge technologies are used more often to diagnose and treat ADHD in children (Drigas *et al.,* 2018; Stathopoulou *et al.*, 2018; Kokkalia *et al.,* 2016). Using executive, organizational, and metacognitive abilities is crucial when playing video games (Chaidi; Drigas, 2022; Papoutsi *et al.,* 2021; Drigas *et al.,* 2021; Drakatos *et al.,* 2023). In games, memory and focus are the two most frequently used skills. When completing a task, memory and attention are combined (Drigas; Karyotaki, 2019; Galitskaya; Drigas, 2021; Kefalis *et al.,* 2020; Kulman *et al.,* 2010). Longer attention spans are crucial for the cognitive functioning of people with ADHD because they are associated with higher levels of working memory (Angelopoulou *et al.,* 2021; Doulou; Drigas, 2022).

Thanks to VR settings made possible by new technology, serious games are set to play a big part in treatments, particularly in the monitoring and treatment of ADHD symptoms (Doulou; Drigas, 2022). According to Drigas and Mitsea (2021), virtual reality environments can lessen hyperactivity, distraction, and inattention symptoms. Their research concentrated on how virtual reality hypnosis

affects youngsters with disabilities. Additionally, VR environments foster a range of executive processes, boost participant reactions, and improve emotional control (Drigas *et al.,* 2022; Bravou *et al.,* 2022; Mitsea *et al.,* 2022; Drakatos *et al.,* 2023).

Children with ADHD have a short attention span. Therefore, it is essential to keep their focus at all times. Video games allow children to be vigilant and aware of their surroundings while keeping them focused and interested for the game's duration (Kulman *et al.,* 2010). The conclusions of the present bibliographic study indicate that virtual reality settings utilized in serious games benefit youngsters with ADHD regarding social skills (Hakimirad *et al.,* 2019). According to Prins *et al.,* (2013), children's executive functioning and ADHD symptoms significantly improve, and they exhibit fewer negative behaviors. Furthermore, serious games may help children with ADHD perform better in several areas, such as information processing, critical thinking, hyperactivity/impulsivity, attention, and abstract reasoning, according to research by YangKun *et al.*, (2020).

Alqithami *et al.* (2019) contend that any youngster can acquire precision, smarts, responsiveness, and flexibility skills by playing games in augmented reality environments. Additionally, they contend that AR environments are better suited for kids than VR ones since they let them know where they are at all times while a game is being taught. The program's players saw notable improvements in their attention spans, capacity for handling irritation, and real-life time management and social skills. They also saw a notable decrease in the time needed to finish gaming tasks.

The controversy around the cause of ADHD and the kinds of treatments that children from ethnolinguistic minorities can get draws attention to how quickly these areas of research are developing. More research is needed to create alternative therapies that use severe games in virtual reality settings to improve these kids' cognitive and metacognitive capacities and help them integrate into society.

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