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Early Detection of Preschool Children with ADHD and the role of mobile Apps and AI

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Abstract. Attention Deficit Hyperactivity Disorder (ADHD) is a common neurodevelopmental disorder with the main symptoms of attention deficit, hyperactivity and impulsivity, to the extent that it creates or exacerbates existing behavioral problems and is a brake on a person's daily life. The process of early detection of developmental disorders is done with different diagnostic criteria, which are evaluated by the relevant interdisciplinary team in order to conclude if the child has ADHD and what therapeutic approach should be followed (3). It seems that many of the adverse long-term consequences that characterize ADHD can be avoided when an intervention is started in preschool, when the brain is likely to be more "plastic" and possibly prone to permanent modifications, and before complicating factors such as comorbid psychiatric disorders, academic failure and poor social and family relationships emerge, making successful treatment more difficult. The result of the study of the above researches confirms that the development of diagnostic tools, the interest of researchers and the awareness of parents through a child-centered pedagogical upbringing system makes the Early Detection of ADHD possible (8). The interest of teachers and parents has turned to prevention, Early Detection and Early Intervention while creating the idea of integration and social inclusion of children with problems(3).

Keywords. Early detection, ADHD, preschool children

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a common neurodevelopmental disorder with the main symptoms of attention deficit, hyperactivity and impulsivity, to the extent that it creates or exacerbates existing behavioral problems and is a brake on a person's daily life. Based on various studies, it has been observed that a significant percentage (5.3%) of children and adolescents worldwide show the symptoms of this disorder, while 2/3 of them continue to show the symptoms even in adulthood (1). According to scientists, the main cause of ADHD is the dysfunction of the part of the brain associated with attention retention, while heredity is also responsible for a large percentage, as the majority of children diagnosed with ADHD come from families where at least one parent had diagnosed with this disorder (2)

2. A brief theoretical approach of ADHD

One of the most commonly diagnosed disorders in school children is Attention Deficit Hyperactivity Disorder (ADHD). It is internationally known as Attention Deficit Hyperactivity Disorder (ADHD). According to Karabatzaki 2010 (3) "Attention Deficit Hyperactivity Disorder with or without Hyperactivity Disorder is a developmental disorder that occurs very early, usually in infancy and consists of a series of symptoms in three areas: short attention span, impulsivity and hyperactivity.

First, we need to clarify that there are three types of this disorder. In the first type the element that excels is Attention Deficit Hyperactivity, in the second type Impulsivity prevails, while in the third type we have a combination of the above types, the person is characterized by Attention Deficit Hyperactivity Disorder and Impulsivity. Therefore, in order to diagnose a person with ADHD, they must have had 6 of the 9 symptoms according to the DSM-V for the first two types and 6 of the 9 symptoms for each feature in the combination type. These symptoms should appear until the age of 7 and for others up to the age of 12, remain visible for at least 6 months in more than two environments, usually at school and at home (4)

The symptoms of ADHD are initially divided into 2 parts: a) in primary symptoms (inattention, spontaneous movements and hyperactivity) and b) in secondary symptoms (behavioral difficulties, school failure that may have to do with other learning difficulties, also lack friends or lack of social relationships and low self-esteem (5).

As has been shown by various studies, the causes of cleavage are both genetic and environmental. According to Klein et al., 2017,(6), genetic factors affect the intensity and type of disorder by 70-90%. The researchers focused more on the study of genes involved in dopamine and serotonin transport, while a meta-analysis of previous research showed a high association of ADHD with chromosome 16. In addition, ADHD has been observed to be associated with various biological such as the development of the nervous system and the connection of neurons. These genes, therefore, seem to affect the development and function of the brain. The majority of those diagnosed with ADHD appear to have a deficit in executive cognitive function or an abnormality in the cortex that leads to inability to concentrate, dysfunction of working memory, and difficulty in managing information retrieval (7).

According to Karabatzaki, 2010,(3) the process of early detection of developmental disorders is done with different diagnostic criteria, which are evaluated by the relevant interdisciplinary team in order to conclude if the child has ADHD and what therapeutic approach should be followed. A good tool for gathering information is interviewing the child, his parents and anyone else involved in his upbringing and education. The types of interviews that exist are structured, unstructured, localized or not, direct or indirect, repetitive, clinical and in-depth (3). With this method it is important to pay attention to the choice of questions, so as to focus on the object we are studying. One of the most well-known methods of a child's developmental development is observation. Many times the detection of developmental disorders in preschool children is done through Observation. We can observe a child by keeping a diary or by recording at regular intervals or even during intense behavior. According to Karabatzaki, 2010 (3) the areas of behavior that are proposed to be observed in a child are the physical function and development, the social interaction of the child with peers and adults, the emotional expression, the language, the cognitive functions, the function of the Ego and the general picture child's. The Observation Key is an important and necessary tool at this stage. The standard evaluation criteria, ie the tests, can also provide us with important information. According to Dimitriou (2011) (8) the diagnostic criteria and scales that will be used for the evaluation and diagnosis of a child with ADHD must be reliable, valid, and easy to use. The

most common are the DSM-IV and subsequent editions of the American Diagnostic Manual, as well as the ICD-10 issued by the World Health Organization. Some rating scales used are:

The Behavior Assessment System for children scale (BASC-2)

The Child Behavior Checklist (CBCL)

The Conners 'Parent and Teacher Rating Scale (CRS)

The ADHD Rating Scale IV

The ADHD scale the Swanson, Nolan, and Peiham Questionnaire (SNAP)

The Diagnostic Rating Scale

The ADHD-SC4 scale

The ADD-H: Comprehensive Teacher's Rating Scale (ACTeRS)

The most widely used of the above are the ADHD Rating Scale-IV and the Conners 'Parent and Teacher Rating Scale (8)

3.Challenges related to the Correct Diagnosis of Children with ADHD

It is understandable studies have proved that ADHD has a negative impact on the lives of children who characterize them, as well as their families (9, 10). Therefore, a proper diagnosis of this disorder is essential. However, the diagnosis of ADHD is particularly difficult in relation to other mental disorders due to high rates of diagnosis and the common symptoms with numerous other disorders such as anxiety disorders (11, 12,) such as the opposite provocative Autism Spectrum Disorder (ODD), Autism Spectrum Disorder (ASD), and Learning Disabilities (SLD) (13). It is important to note that for the diagnosis of ADHD along with another disorder, full criteria must be met for both disorders (14). There is also evidence of frequent misdiagnosis of ADHD due to subjective perception on the part of parents (15, 16,17). This is expected to happen, as symptom and impairment assessments are greatly influenced by the views of the child's parents or teachers. It has also been reported that children from higher-income families are more likely to receive an ADHD diagnosis simply because of increased access to resources (18).

4.The importance of early detection of preschool children with ADHD

Children with ADHD also often face difficulties in daily life, including their social relationships, academic performance and achievement, and low self-esteem. In addition, they may have disadvantages in working with audiovisual and verbal memory, vigilance, inhibition control and programming, problems with coordination of gross and motor functions, movement sequence, difficulties with working memory and self-regulation of emotions. language and speech, stimulation and activation and time processing of information and timing (19). Throughout the development of children, it is found that the role of diagnosis for children who "stand out" is important and multidimensional (8). A team of specialists in different specialties (special educator, psychologist, developmental pediatrician) are asked to use weighted special psychometric tools to assess whether the child deviates from the typical developmental stages, as well as whether the child exhibits behaviors consistent with her symptoms. attention and hyperactivity.

Referring first to the diagnostic criteria and techniques for early diagnosis of ADHD in children, it should be noted that in order to receive appropriate treatment, children with ADHD must first be correctly diagnosed (15). There are currently many factors that affect the correct early diagnosis technique for children with ADHD, which will be discussed in the following sections. These factors can cause, however, an excessive diagnosis (ie false positive) but also an underestimation - under-diagnosis (ie, false negative). Under-diagnosis is a problem

because the child is unlikely to receive adequate treatment for ADHD, creating a potential waste of time and money spent on ineffective treatment, while the child's academic, social and emotional functioning still suffers. (14).

On the other hand, over-diagnosis of children with ADHD causes similar problems, as the child receives inappropriate treatment and may continue to have the same symptoms if there is another disorder. In addition, the misdiagnosis of ADHD introduces the problem of prescribing drugs for children for which they may be inappropriate and even harmful (15). The correct diagnosis of ADHD, strictly means the care with diagnostic criteria, early and on a later basis. The two most accepted sources of ADHD diagnostic criteria are currently the Fifth Edition Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (13) and the ICD-10 (20). A comparative review of the DSM-5 (13) and ICD-10 (2004) reveals significant similarities in the two organizations that seek primarily in the nosology and operational definition of mental disorders. However, there are key differences, including the term used in the diagnosis, the number and variety of symptoms required, and the age of onset required. The ICD-10 is updated annually and a new version has been put into use on October 1, 2017 (21). The 2018 version will include the major name change from Hyperactivity Disorder to Attention Deficit / Hyperactivity Disorder (ADHD), as in the DSM-5. Given that the current version of the ICD-10 requires careless and hyperactive / impulsive symptoms to be present for diagnosis, the 2018 version includes the subtypes mentioned in the DSM-5, such as careless type, hyperactive type, and combined type. With the 2018 updates, the ICD-10 and DSM-5 criteria for ADHD will start to look much more similar.

Another factor that influences the correct technique of early diagnosis of children with ADHD is family history. According to Miller et al., 2021 (22) infants with an older sibling or parent diagnosed with ADHD were distinct from infants without a family history of ADHD as early as 12 months of age based on behavioral reports observed directly by examiners. Parents of infants at family risk for ADHD also reported significantly more behavioral / temperament concerns as early as 12 months of age than parents of infants at low risk for ADHD. Investigation of early motor signs during the first year of life could be of great importance for the study of early biomarkers of common neurodevelopmental disorders, such as ADHD and Autism, which may share relevant neurobiological factors. There is evidence that children with ADHD have worse motor skills and abilities than their typically developing peers (19) ADHD also involves emotional deregulation and these temperamental traits also appear earlier. Here, we report a first attempt to use emotional regulation indicators to determine ADHD-related responsibility in infancy. Affective response at 6 months of age may identify infants with familial history of ADHD, providing an early indicator of ADHD liability (22) Child behavioral problems (e.g., contradictory behaviors and behavioral problems) are also associated with infant anger reactivity and ADHD (23)

Evidence suggests that early detection and appropriate treatment can change the likelihood of a negative developmental trajectory (24). and often the symptoms are evident from the preschool years. In fact, it is suggested that the detection of symptoms can start from the age of 4. It has been shown that preschool children with ADHD may have low increased risk for numerous school-related problems, such as functional disability during primary education and persistent low academic performance ever since (25). -They also may have lower mental and neuropsychological functionality. Due to the early onset of ADHD symptoms, the investigation of the mental characteristics associated with this condition in preschool children is considered important. The presence of ADHD symptoms affects abstract thinking, language development, critical ability, visual perception and visual-motor coordination. Organizational

skills are also the most affected area in both sexes and probably more so in girls (24). In a study by Klingberg et al. tested a computer program designed to improve working memory in children with ADHD. Positive effects on visual-spatial working memory, verbal working memory, complex reasoning were observed after 5 weeks of training, which confirms that early education lays the foundations for future development (26). Recognition and prevention of developing mental retardation, followed by early intervention to enhance change-tolerant skills such as organizational skills and programming, thus revealing the need to assess pre-academic skills in pre-school children with to alleviate possible academic dysfunction (24)

5. Conclusions

It seems that many of the adverse long-term consequences that characterize ADHD can be avoided when an intervention is started in preschool, when the brain is likely to be more "plastic" and possibly prone to permanent modifications, and before Complicating factors such as comorbid psychiatric disorders, academic failure and poor social and family relationships emerge, making successful treatment more difficult. Such an intervention is proposed by (27) who argue that environmental influences and physical exercise can be used to enhance nerve growth and development, which in turn will have lasting and long-term impact on the ADHD trajectory. Central to this idea are 2 hypotheses: 1) environmental influences can facilitate the structural and functional development of the brain and 2) changes in the structure and function of the brain are directly related to the severity of ADHD during development and the degree to which the disorder persists or subsides over time.

The result of the study of the above researches confirms that the development of diagnostic tools, the interest of researchers and the awareness of parents through a child-centered pedagogical upbringing system makes the Early Detection of ADHD possible (8). The interest of teachers and parents has turned to prevention, Early Detection and Early Intervention while creating the idea of integration and social inclusion of children with problems(3).

The pedagogical value of the Early Detection of ADHD is considered extremely important for the academic progress of the child, a fact that not only strengthens his psychology as a student but also as an individual within society. By knowing what is happening to their child, parents can change their behavior from an early age and give the child the understanding he or she needs to strengthen his or her self-esteem. In most cases, research has shown that the role of parents, teachers and the whole social environment of the child creates two-way interactions in terms of the effectiveness of therapeutic interventions and medication (28). It is well established that parental care is part of a two-way and dynamic process in which both parent and child influence each other (29,30). In contrast, another study concluded that parents were reluctant to use medication in their children and wanted to try other interventions first (31). Our results converge with previous studies and show that infant anger reactivity is an early risk indicator for ADHD. (32), fewer signs of early maternal warmth, as well as less sensitive interactions between mothers and children, also predicted a later state of ADHD. (33) During the application of early detection and treatment techniques for ADHD, three large groups of people involved in this process are parents, teachers and children diagnosed with ADHD, whose prospects for interventions are all important (34). The ADHD depends on many factors as can be seen in the article of Driga, A. M. & Drigas, A. (2019) (35), but due to the evolution of technology there are many ways to deal with intervention (77, 78). Therefore many mobile applications specifically designed can be used to detect ADHD in preschool children (36,43,47). Also STEM applications can be adapted to support ADHD detection (37) Artificial Intelligence is a powerful tool for ADHD detection & training, too (38, 46, 52, 76). The whiteboards

applications can support procedures for ADHD detection (39, 69) and with the usage of video games we can predict and detect ADHD (40, 49, 55, 65, 73) An indicative reference is many online applications that support the assessment & improvement of problem-solving skills that are affected by ADHD. (44, 45, 50, 66, 67, 68, 70, 71, 75). Without treatment, ADHD can be detrimental to a child's social and academic life and emotional well-being. The future results for children with undiagnosed ADHD are extremely negative (41, 42). In addition, the integration of ICTs (48, 51, 53, 54, 56, 57, 58, 59, 80-87) in a learning environment, which promotes interactivity and self-directed learning, contributes to the assessment and development of cognitive and metacognitive skills such as attention, concentration, memory, self-regulation, creativity, flexibility, critical logic, communication, skills necessary for the development and strengthening of Cognition. (60, 61, 62, 63, 64, 72, 74).

References

- [1] Hvolby, A., Jørgensen, J., & Bilenberg, N. (2008). Actigraphic and parental reports of sleep difficulties in children with attention-deficit/hyperactivity disorder. *Archives of pediatrics & adolescent medicine*, 162(4), 323-329.
- [2] Singh, A., Yeh, C. J., Verma, N., & Das, A. K. (2015). Overview of attention deficit hyperactivity disorder in young children. *Health psychology research*, 3(2).
- [3] Karabatzaki -Dimitriou Zoi (2010) SUBJECTS OF SPECIAL EDUCATION AND EDUCATION, Paralos Publications p. 59-p.60, p.93-p.94, p. 137-p.153
- [4] Christiansen, L., Beck, M. M., Bilenberg, N., Wienecke, J., Astrup, A., & Lundbye-Jensen, J. (2019). Effects of exercise on cognitive performance in children and adolescents with ADHD: potential mechanisms and evidence-based recommendations. *Journal of clinical medicine*, 8(6), 841.
- [5] Bramham, J., Murphy, D. G. M., Xenitidis, K., Asherson, P., Hopkin, G., & Young, S. (2012). Adults with attention deficit hyperactivity disorder: an investigation of age-related differences in behavioural symptoms, neuropsychological function and comorbidity. *Psychological medicine*, 42(10), 2225-2234
- [6] Klein, M., Onnink, M., van Donkelaar, M., Wolfers, T., Harich, B., Shi, Y., ... & Franke, B. (2017). Brain imaging genetics in ADHD and beyond—mapping pathways from gene to disorder at different levels of complexity. *Neuroscience & Biobehavioral Reviews*, 80, 115-155.
- [7] Wilens, T. E., & Spencer, T. J. (2010). Understanding attention-deficit/hyperactivity disorder from childhood to adulthood. *Postgraduate medicine*, 122(5), 97-109
- [8] Dimitriou Malamo (2011) "EARLY DETECTION TEST OF ATTENTION-DEFICIT/HYPERACTIVITY DIRORDER CHILDREN 4-6 YEARS (TEPY 4-6)" PhD IOANNINA UNIVERSITY FACULTY OF EDUCATION DEPARTMENT Preschool
- [9] Danckaerts, M., Sonuga-Barke, E. J., Banaschewski, T., Buitelaar, J., Döpfner, M., Hollis, C. & Coghill, D. (2010). The quality of life of children with attention deficit/hyperactivity disorder: a systematic review. *European child & adolescent psychiatry*, 19(2), 83-105
- [10] Kandemir, H., KILIÇ, B. G., Ekinci, S., & Yüce, M. (2014). An evaluation of the quality of life of children with ADHD and their families. *Anatolian Journal of Psychiatry/Anadolu Psikiyatri Dergisi*, 15(3).
- [11] Barkley, R. A. (2006). *Attention-Deficit/Hyperactivity Disorder*. Guilford Publications.

- [12] Gupta, R., & Kar, B. R. (2010). Specific cognitive deficits in ADHD: A diagnostic concern in differential diagnosis. *Journal of Child and Family Studies*, 19(6), 778-786.
- [13] American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub
- [14] Delavarian, M., Towhidkhah, F., Dibajnia, P., & Gharibzadeh, S. (2012). Designing a decision support system for distinguishing ADHD from similar children behavioral disorders. *Journal of Medical Systems*, 36(3), 1335-1343
- [15] Bruchmüller, K., Margraf, J., & Schneider, S. (2012). Is ADHD diagnosed in accord with diagnostic criteria? Overdiagnosis and influence of client gender on diagnosis. *Journal of Consulting and Clinical Psychology*, 80(1), 128-138.
- [16] Chilcoat, H. D., & Breslau, N. (1997). Does psychiatric history bias mothers' reports? An application of a new analytic approach. *Journal of the American Academy of Child and Adolescent Psychiatry*, 36(7), 971-979
- [17] Merten, E. C., Cwik, J. C., Margraf, J., & Schneider, S. (2017). Overdiagnosis of mental disorders in children and adolescents (in developed countries). *Child and Adolescent Psychiatry and Mental Health*, 11, 5
- [18] Evans, S. W., Schultz, B. K., DeMars, C. E., & Davis, H. (2011). Effectiveness of the Challenging Horizons after-school program for young adolescents with ADHD. *Behavior therapy*, 42(3), 462-474. .
- [19] Athanasiadou et al., (2020). Early motor signs of attention-deficit hyperactivity disorder: a systematic review. *European Child & Adolescent Psychiatry* (2020) 29:903-916
- [20] World Health Organization [WHO]. (2004). *International Classification of Diseases, Tenth Revision (2nd ed.)*. Geneva, Switzerland: WHO.
- [21] Centers for Disease Control and Prevention. (2017b). International Classification of Diseases, Tenth Revision, Clinical Modification. Retrieved August 7, 2017, from <https://www.cdc.gov/nchs/icd/icd10cm.htm>
- [22] Sullivan, E. L., Holton, K. F., Nousen, E. K., Barling, A. N., Sullivan, C. A., Propper, C. B., & Nigg, J. T. (2015). Early identification of ADHD risk via infant temperament and emotion regulation: A pilot study. *Journal of Child Psychology and Psychiatry*, 56(9), 949-957.
- [23] Lahey, B. B., Pelham, W. E., Loney, J., Lee, S. S., & Willcutt, E. (2005). Instability of the DSM-IV subtypes of ADHD from preschool through elementary school. *Archives of general psychiatry*, 62(8), 896-902
- [24] Magyary, D., & Brandt, P. (2002). A decision tree and clinical paths for the assessment and management of children with ADHD. *Issues in mental health nursing*, 23(6), 553-566.
- [25] Thomaidis, L., Choleva, A., Janikian, M., Bertou, G., Tsitsika, A., Giannakopoulos, G., & Anagnostopoulos, D. C. (2017). Attention deficit/hyperactivity disorder (ADHD) symptoms and cognitive skills of preschool children. *Psychiatrike= Psychiatriki*, 28(1), 28-36.
- [26] Kokkalia, G. K., & Drigas, A. S. (2015). Working Memory and ADHD in Preschool Education. The Role of ICT'S as a Diagnostic and Intervention Tool: An Overview. *International Journal of Emerging Technologies in Learning*, 10(5)
- [27] Halperin, J. M., Bédard, A. C. V., & Curchack-Lichtin, J. T. (2012). Preventive interventions for ADHD: a neurodevelopmental perspective. *Neurotherapeutics*, 9(3), 531-541
- [28] Mavridou, S., & Lazoga, Ch. (2020). ADHD: The learning profile of children, the psychological state of parents & the counseling approach.
- [29] Pettit, G. S., & Arsiwalla, D. D. (2008). Commentary on special section on "bidirectional parent-child relationships": The continuing evolution of dynamic, transactional

- models of parenting and youth behavior problems. *Journal of Abnormal Child Psychology*, 36(5), 711-718.
- [30] Gordon, C. T., & Hinshaw, S. P. (2017). Parenting stress as a mediator between childhood ADHD and early adult female outcomes. *Journal of Clinical Child & Adolescent Psychology*, 46(4), 588-599.
- [31] Clarke, J. N., & Lang, L. (2012). Mothers whose children have ADD/ADHD discuss their children's medication use: an investigation of blogs. *Social work in health care*, 51(5), 402-416.
- [32] Rabinovitz, B. B., O'Neill, S., Rajendran, K., & Halperin, J. M. (2016). Temperament, executive control, and attention-deficit/hyperactivity disorder across early development. *Journal of Abnormal Psychology*, 125(2), 196.
- [33] Keown, L. J. (2012). Predictors of boys' ADHD symptoms from early to middle childhood: The role of father-child and mother-child interactions. *Journal of abnormal child psychology*, 40(4), 569-581
- [34] Ewe, L. P. (2019). ADHD symptoms and the teacher-student relationship: a systematic literature review. *Emotional and Behavioural Difficulties*, 24(2), 136-155.
- [35] Drigas, A. M., & Drigas, A. (2019). ADHD in the Early Years: Pre-Natal and Early Causes and Alternative Ways of Dealing. *International Journal of Online & Biomedical Engineering*, 15(13).
- [36] Kokkalia, G. K., & Drigas, A. S. (2016). Mobile learning for special preschool education. *International journal of interactive mobile technologies*, 10(1)
- [37] Kefalis, C., & Drigas, A. (2019). Web Based and Online Applications in STEM Education. *International Journal of Engineering Pedagogy*, 9(4).
- [38] Drigas, A. S., & Ioannidou, R. E. (2011, September). A review on artificial intelligence in special education. In *World Summit on Knowledge Society* (pp. 385-391). Springer, Berlin, Heidelberg.
- [39] Drigas, A. S., & Papanastasiou, G. (2014). Interactive White Boards in Preschool and Primary Education. *International Journal of Online Engineering*, 10(4).
- [40] Kefalis, C., Kontostavrou, E. Z., & Drigas, A. (2020). The Effects of Video Games in Memory and Attention. *Int. J. Eng. Pedagog.*, 10(1), 51-61.
- [41] Barbaresi, W. J., Colligan, R. C., Weaver, A. L., Voigt, R. G., Killian, J. M., & Katusic, S. K. (2013). Mortality, ADHD, and psychosocial adversity in adults with childhood ADHD: a prospective study. *Pediatrics*, 131(4), 637-644.
- [42] Shaw, M., Hodgkins, P., Caci, H., Young, S., Kahle, J., Woods, A. G., & Arnold, L. E. (2012). A systematic review and analysis of long-term outcomes in attention deficit hyperactivity disorder: effects of treatment and non-treatment. *BMC medicine*, 10(1), 1-15.
- [43] Drigas, A. S., & Angelidakis, P. (2017). Mobile Applications within Education: An Overview of Application Paradigms in Specific Categories. *International Journal of Interactive Mobile Technologies*, 11(4).
- [44] Karyotaki, M., & Drigas, A. (2016). Online and Other ICT-based Training Tools for Problem-solving Skills. *International Journal of Emerging Technologies in Learning*, 11(6).
- [45] Karyotaki, M., & Drigas, A. (2016). Online and Other ICT-based Assessment Tools for Problem-solving Skills. *International Journal of Emerging Technologies in Learning*, 11(4).
- [46] A Drigas, J Vrettaros (2004). An intelligent tool for building e-learning contend-material using natural language in digital libraries. *Transactions on Information Science and Applications*, 5(1)

- [47] Papoutsis, C., Drigas, A. & Skianis C. (2018). Mobile Applications to Improve Emotional Intelligence in Autism – A Review. *International Journal of Interactive Mobile Technologies*, 12 (6), 47-61. <https://doi.org/10.3991/ijim.v12i6.9073>
- [48] Drigas, A., & Karyotaki, M. (2014). Learning tools and applications for cognitive improvement. *International Journal of Engineering Pedagogy (iJEP)*, 4(3), 71-77. <http://dx.doi.org/10.3991/ijep.v4i3.3665>
- [49] G. Kokkalia, A. Drigas, A. Economou, P. Roussos y S. Choli, «The Use of Serious Games in Preschool Education,» *International Journal of Emerging Technologies in Learning(iJET)*, vol. 12, n° 11, pp. 15-27, 2017. <https://doi.org/10.3991/ijet.v12i11.6991>
- [50] Drigas, A. S., & Ioannidou, R. E. (2013). ICTs in special education: A review. In *World Summit on Knowledge Society* (pp. 357-364). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-35879-1_43
- [51] Drigas, A., & Karyotaki, M. (2019). Executive Functioning and Problem Solving: A Bidirectional Relation. *International Journal of Engineering Pedagogy (iJEP)*, 9(3), 76-98.
- [52] Vrettaros, J., Vouros, G., & Drigas, A. (2007). Development of an intelligent assessment system for solo taxonomies using fuzzy logic. In *Symbolic and Quantitative Approaches to Reasoning with Uncertainty* (pp. 901-911). Springer Berlin Heidelberg.
- [53] Drigas, A., Vrettaros, J. and Kouremenos, D. (2004a) ‘Teleeducation and e-learning services for teaching English as a second language to deaf people, whose first language is the sign language’, *WSEAS Transactions on Information Science and Applications*, September, Vol. 1, No. 3.
- [54] Drigas, A. S., & Pappas, M. A. (2017). The consciousness-intelligence-knowledge pyramid: an 8x8 layer model. *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*, 5(3), 14-25. <https://doi.org/10.3991/ijes.v5i3.7680>
- [55] A. S. Drigas, and M. A. Pappas, “On Line and Other Game-Based Learning for Mathematics”. *International Journal of Online Engineering (iJOE)*. July 2015.
- [56] M. Karyotaki, A. Drigas, and C. Skianis, “Attentional Control and other Executive Functions,” *Int. J. Emerg. Technol. Learn.*, vol. 12, no. 3, pp. 219–233, 2017. <https://doi.org/10.3991/ijet.v12i03.6587>
- [57] Mitsea, E and Drigas, A. (2019), “A journey into metacognitive learning strategies” *International Journal of Online and Biomedical Engineering (iJOE)*.15(14).4-22. DOI: 10.3991/ijoe.v15i14.11379.
- [58] Papanastasiou, G., Drigas, A., Skianis, C., & Lytras, M. D. (2017). Serious games in K-12 education: Benefits and impacts on students with attention, memory and developmental disabilities. *Program*, 51(4), 424-440. <https://doi.org/10.1108/prog-02-2016-0020>
- [59] Xanthopoulou, M., Kokalia, G. & Drigas, A. (2019). Applications for Children with Autism in Preschool and Primary Education. *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*, vol. 7(2), pp. 4–16
- [60] Agathi Stathopoulou, Dionisis Loukeris, Zoe Karabatzaki, Evangelia Politi, Yolanda Salapata, Athanasios Drigas. (2020). Evaluation of Mobile Apps Effectiveness in Children with Autism Social Training via Digital Social Stories. *International Journal of Interactive Mobile Technologies*. 14(3): 4-18. <https://doi.org/10.3991/ijim.v14i03.10281>
- [61] A.S.Drigas, E-course support and delivery for e-psychology, *WSEAS Transactions on Advances in Engineering Education*, Issue1, Volume 2, January 2005
- [62] Drigas A, Argyri K, Vrettaros J (2009) Decade review (1999-2009): progress of application of artificial intelligence tools in student diagnosis. *Int J Social Humanistic Comput* 1:175–191. <https://doi.org/10.1504/IJSHC.2009.031006>

- [63] Alexopoulou, A., Batsou, A. & Drigas, A. S. (2019). Effectiveness of Assessment, Diagnostic and Intervention ICT Tools for Children and Adolescents with ADHD. *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*, 7(3), 51-63. <https://doi.org/10.3991/ijes.v7i3.11178>
- [64] Mitsea, E. & Lytra, N. & Akrivopoulou, A. & Drigas, A. (2020). Metacognition, Mindfulness and Robots for Autism Inclusion. *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*. 8. 4-19. DOI:10.3991/ijes.v8i2.14213.
- [65] Drigas, A. & Papanastasiou, G. P. (2014). Interactive White Boards in Preschool and Primary Education. *International Journal of Online Engineering*, 10(4), 46-51. <https://doi.org/10.3991/ijoe.v10i4.3754>
- [66] A. Drigas, L. Koukianakis, and Y. Papagerasimou, 2006 “A web based e-learning and e-psychology modular environment,” *Proceedings of International Conference on Next Generation Web Services Practices*, pp. 168-174, <http://dx.doi.org/10.1109/NWESP.2006.5>
- [67] Drigas, A., & Vasiliki, T. (2015). Lifelong learning and ICTs: A review. *International Journal of Recent Contributions from Engineering Science & IT*, 3(2), 15–20. <https://doi.org/10.3991/ijes.v3i2.4353>
- [68] Pappas, M. A., Polychroni, F., & Drigas, A. S. (2019). Assessment of mathematics difficulties for second and third graders: Cognitive and psychological parameters. *Behavioral Sciences*, 9(7), 76. <https://doi.org/10.3390/bs9070076>.
- [69] Drigas, A. S., & Papanastasiou, G. (2014). Interactive white boards' added value in special education. *International Journal of Interactive Mobile Technologies*, 10(6), 58-62. doi:10.3991/ijoe.v10i6.4004.
- [70] Drigas, A. S., & Gkeka, E. G. (2016). Montessori Method and ICTs. *IJES*, 4(1), 25–30. <https://doi.org/http://dx.doi.org/10.3991/ijes.v4i1.5481>
- [71] J. Vrettaros, G. Vouros, A. Drigas, 2004 “Development of a Diagnostic System of Taxonomies Using Fuzzy Logic – Case SOLO (useful for e-learning system”, *WSEAS Transactions on Information Science and Applications*, Issue 6, Volume 1
- [72] A. Drigas and J. A. Vlachou, “Information and communication technologies (ICTs) and autistic spectrum disorders (ASD),” *Int. J. Recent Contrib. Eng. Sci. IT (iJES)*, vol. 4, no. 1, p. 4, 2016. <https://doi.org/10.3991/ijes.v4i1.5352>
- [73] Vrettaros, J., Pavlopoulos, J., Vouros, G.A. and Drigas, A. (2008) ‘The development of a selfassessment system for the learners answers with the use of GPNN’, *WSKS*, No. 1, pp.332–340.
- [74] Athanasios S. Drigas and Kostas S. Ioannis, “Online and other ICTs Applications for Teaching Math in Special Education”, *International Journal of Recent Contributions from Engineering, Science & IT*, Vol 2, No. 4, 2014.
- [75] M. Karyotaki and A. Drigas, 2016 “Latest trends in problem solving assessment,” *International Journal of Recent contributions from Engineering, Science & IT (iJES)*, vol. 4, no. 2. <https://doi.org/10.3991/ijes.v4i2.5800>
- [76] Pappas, M., & Drigas, A. (2016). Incorporation of artificial intelligence tutoring techniques in mathematics. *International Journal of Engineering Pedagogy*, 6(4), 12–16. <https://doi.org/10.3991/ijep.v6i4.6063>
- [77] Drigas, A. S., Karyotaki, M., & Skianis, C. (2018). An Integrated Approach to Neurodevelopment, Neuroplasticity and Cognitive Improvement. *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*, 6(3), 4-18. <https://doi.org/10.3991/ijes.v6i3.9034>

- [78] Pappas M, Drigas A. 2019 Computerized Training for Neuroplasticity and Cognitive Improvement. *International Journal of Engineering Pedagogy*. (4):50-62.
- [79] A. DRIGAS, & PAPOUTSI, C. (2015). ICTs for assessment and intervention on cultivation of empathy. *International Journal of Emerging Technologies in Learning*, 10(5), 10–15. doi:10.3991/ijet.v10i5.4731
- [80] L. BAKOLA, NIKOLAOS D. RIZOS, A. DRIGAS. “ICTs for Emotional and Social Skills Development for Children with ADHD and ASD Co-existence ”*International Journal of Emerging Technologies in Learning (iJET)*, <https://doi.org/10.3991/ijet.v14i05.9430>
- [81] L. BAKOLA, & A. DRIGAS, (2020). Technological development process of emotional Intelligence as a therapeutic recovery implement in children with ADHD and ASD comorbidity. *International Journal of Online & Biomedical Engineering*, 16(3), 75-85.
- [82] E. MITSEA, A. DRIGAS,, & MANTAS, P. (2021). Soft Skills & Metacognition as Inclusion Amplifiers in the 21st Century. *International Journal of Online and Biomedical Engineering*, 17(4), 121–132. <https://doi.org/10.3991/ijoe.v17i04.20567>
- [83] P. THEODOROU, & A. DRIGAS, (2017b). ICTs and Music in Sensory and Motor Disabilities. *International Journal of Recent Contributions from Engineering, Science & IT (iJES)*, 5(2), 4-13. <https://doi.org/10.3991/ijes.v5i2.6386>
- [84] E.GKEKA, GOUGOUDI, A., MERTSIOTI, L., & A. DRIGAS,. (2018). Intervention for ADHD Child using the Montessori Method and ICTs. *International Journal of Recent Contributions from Engineering, Science & IT (IJES)*, 6(2), 1–13. <https://doi.org/10.3991/ijes.v6i2.8729>
- [85] A. DRIGAS, & TOURIMPAMPA, A. (2014). Processes and ICT Tools for ADHD Assessment, Intervention and Attention Training. *International Journal of Emerging Technologies in Learning (iJET)*, 9(6), 20-25. <https://doi.org/10.3991/ijet.v9i6.4001>
- [86] A. DRIGAS, KOUREMENOS, D., & VRETTAROS, J. (2010). Learning Applications for Disabled People. In P. Ordóñez de Pablos, J. Zhao & R. D. Tennyson (Eds.), *Technology Enhanced Learning for People with Disabilities: Approaches and Applications (S. 44 - 57)*: IGI Global.
- [87] G. KOKKALIA, A. DRIGAS, ECONOMOU, A. & ROUSSOS, P. 2017. Screening Tools for Kindergarten Children. *International Journal of Recent Contributions from Engineering, Science & IT* 5 (4), 76–87. Viitattu 12.1.2021. Saatavilla <https://online-journals.org/index.php/i-jes/article/view/8013/4743>