A new decade for social changes
Ict's and Dysgraphia

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Abstract. The aim of this review is the recognition of characteristics of “Dysgraphia” or “Dysorthography”, as specific learning disorder in written. Concretely, the diagnostic technological tools enable to recognize the particular characteristics of this disorder. As well as, the offer of the intervention technological tools is been evident with the effectiveness of the different applications. Indeed, the activities and the exercises of these tools on educational and game environment using augmented reality assist the children’s and the adults’ handwriting with Dysgraphia and enhance the writing skills.

Keywords. diagnostic, dysorthography, handwriting, intervention

1 Introduction

According to this article[1] “Dysgraphia” is a disorder of writing ability that comes from the Greek "dys" meaning "impaired" and "graphia" meaning "making letter forms by hand". Dysgraphia has also different names such as: dysorthography, linguistic dysgraphia or graphomotor loop. According to DSM-5 dysgraphia does not exist as a separate category but falls under the category of specific learning disorder. Autism spectrum disorder, attention deficit-hyperactivity disorder, developmental coordination disorder, and cerebral palsy are some of them. But what are the causes and etiologies that lead to this difficulty? Research models and neurobiological-genetic studies demonstrate that injury to the cerebellum of the brain could lead to dysgraphia or specific genes including chromosome 6 linked to phonemic awareness or chromosome 15 linked to poor reading and spelling. On the other hand diagnosis can be made by professionals with an educational evaluation. Some of criteria for a diagnosis of dysgraphia, are illegible handwriting, decreased writing speed, discrepancy between verbal IQ and spelling achievement and processing deficits in orthographic awareness, graphomotor planning, and/or rapid automatic naming, evaluations of posture, pencil grip, tremor, and observed writing habits.

Chung et al., define dysgraphia as a disorder with specific characteristics. Some of them are: letter formation or legibility, letter spacing, spelling, fine motor coordination, rate of writing, grammar, and composition and in general difficulty in written communication skills. Dysgraphia has been categorized as “motor”, “peripheral” or “spatial Dysgraphia”. DSM-5 includes dysgraphia under a specific learning disorder category. Writing is a task that requires the coordination of more than one cognitive processes such us working memory, motor planning, spelling, attention, visual and auditory process. The study suggests an intervention
model that consists of 3 levels. The first level is a preventing screening for difficulties. The second consists of targeted intervention and the third consist of intensive treatment. In general, the study suggest motor activities for increasing hand coordination and strength include tracing, drawing in mazes, playing with clay as well as exercises like finger tapping and rubbing/shaking the hands, teaching grip control and good writing posture. Although there are several ICTs for intervention such as Zaner-Bloser Apps writing games, Handwriting without Tears, Big Strokes for Little Folks, Sensible Pencil, Loops and Other Groups a kinesthetic approach to teach writing[2].

Brown focuses on characteristics of dysgraphia. More specifically, dysgraphia has an alternative diagnostic pattern from other disabilities. It is a disorder concerning handwriting, concretely, a 'disorder of written expressions'. More specifically, this disorder involves difficulties such us motor coordination, problems with letter order, flow and formation patterns. Symptoms can include also poor spatial planning, inconsistency in letter and word spacing, unusual body position while writing, awkward pencil grip, difficulty articulating thoughts onto paper and a significant difference between spoken and written comprehension. In addition, there are seven stages of writing, the research finds out that children with dysgraphia could get stranded in any of these stages, because their brain does not process writing like a typical student's brain would. There are three types of dysgraphia: Dyslexia Dysgraphia, Motor Dysgraphia, Spatial Dysgraphia. Moreover, dysgraphia cause unfavorable outcomes in the self-esteem and increase feelings of failure [3].

Vlachos & Avramidis define and confirm the neurobiological distinction between “Dyslexia” and “Dysgraphia”. Between these two difficulties there are similarities in the brain specifically in neural network involved in handwriting and reading. A part of this graphomotor network is brought into play during the identification of letters through visual reading. Although, there are differences as individuals with Dysgraphia have dysfunctions in extensive supraspinal networks, involving cortical areas of the brain dysfunction may be also restricted to either the cerebellum or specific cortical sites [4].

This article [5] investigates how much Dysgraphia increased over the last few years. Statistics and research present elements show a high level of Dysgraphia in children in the last few years. Some of the reasons are a deficient level of development of brain mechanisms that naturally affect cognitive processes, individual peculiar ways of processing information and psychophysiological mechanisms. The most popular kind of dysgraphia is mixed- Dysgraphia meaning to the lack of development of phonetic-phonemic, lexical and grammatical components of oral speech, cognitive functions.

2 Diagnostic technological tools

This study [6] focuses on discrimination characteristics of dysgraphia due to a new tool “Support Vector Machine”. More specifically, the article detects characteristics in dysgraphia similar to Developmental Coordination Disorder. The diagnostic tool divides the patients into three categories, light, moderate, and severe. The division is based on the characteristics such as holding a pencil in wrong ways, the size of letter, the letter writing form, how slow is the writing process and how quickly children getting tired. Moreover the tool detects the form of time, pressure, the distance between letters, ideal or not the size of a letter, the position of letters (up or down), consistency of the boundary line, and text form. The tool compared with other similar tools in order to show the construction of the tool. After that the researchers show how they collect the data throughout the application.
Dimauro et al., consider which dysgraphia may be related to dyspraxia, characterized by a difficulty to reproduce alphabetical, numerical signs. The article focuses on “TestGraphia”, a software system that can support doctors in making diagnoses. The software analyses specific characteristics in writing that show difficulties in writing process. The size of some letters is above the norm, in others, letters are so close to each other that is difficult to figure out the meaning. Pictures also present texts with insufficient spaces between the words, texts with collisions between two letters, texts with sharp angles, texts with irregular size of letters, texts with broken links between words, and texts with sharp angles in letters, texts with traced letters or letters with innocent heights. The main purpose of TestGraphia is to automatically evaluate certain features and easily set the remaining features to simplify the diagnosis. Doctors must check only a few features that need to be interpreted. At the conclusion of the evaluation procedure, the final report describes anomalies, features score and total score and lead to a specific diagnosis [7].

Asselbom et al., are interested in the diagnosis of dysgraphia by a new tablet program. As long as handwriting is a complex task which involves attention, perceptual, linguistic, and fine motor skills is difficult to achieve. Handwriting is the basis of core educational activities, such as taking notes, composition, and self-expression. So it is very important to detect and remediate any handwriting difficulties as early as possible. The design of the diagnostic tool relies on previous work and clinical relevance in pediatrics. The data which have been collected came from children who have been clinically diagnosed with Dysgraphia. To validate the test researchers measured more than one time the participants in order to predict correctly characteristics of Dysgraphia. The tablet tool includes 53 criteria of a child’s handwriting to make a specific writing profile. This specific tool explores the handwriting pathology in order to analyze the handwriting characteristics and bring a special treatment more closely [8].

Rosenblum & Dror describe a diagnostic tool for Dysgraphia. Two groups consisting of 99 third graders aged eight and nine years old, 50 proficient handwriters, and 49 non-proficient, all came from Israel. The aim of study was to develop and test a statistical model for discriminating between dysgraphic and prescient handwriting based on writing characteristics. They used a ten-item questionnaire and a computerized evaluation tool. They observe whether the pen is “writing” or just “moving” above the paper by using the value of the pressure as long as all the participants wrote the same text. Four tasks also were used to extract feature and different information of hand-writers. This tool enables not just identification of Dysgraphia but also indicates the individual’s features for an effective intervention [9].

Raza et al., propose a new testing mobile tool to detect characteristics of dysgraphia in early childhood. As long as Smartphones and tablets have become an enormous part of our daily routine there is a need to use them for actual problems. The article, furthermore, provides an overview of software tools and mobile applications to help children with Dysgraphia such us series of games, digital notepad device called JollyMate, mobile application, computers and a Fuzzy Expert System. On the other hand the article describes the mobile application which they promote. It is intended for kids specifically of ages 5 to 12. It has animations for fun. The user uses a stylus to write spelling of words on the screen, a handwriting-recognition software technology analyzes the user’s handwriting and recognize the spelling. There is a test with twenty words and after that there is a score which detect the type: phonological or surface Dysgraphia. Technologies such as HTML 5, CSS3, Javascript, Cordova and MyScript were used in the development of the application [10].
3 Intervention technological tools

A. Children’s handwriting

Harris focuses on children with autism who have also Dysgraphia and propose a Video self-modeling (VSM) intervention. Along with other positive effects VSM improves academic performance. Participants are between five to nine years old with the same diagnoses. The ability to write is often problematic for children with ASD because handwriting requires simultaneous processing of motor and cognitive demands. VSM improves learning through observation by teaching the observer with a video recording. The study describes the intervention where participants asked to write his or her name, as well as the word cat and the word apple. The intervention phase lasted 5 days for each participant. The results prove that VSM is an effective teaching tool for children with Dysgraphia [11].

Giordano & Maiorana present an intervention for Dysgraphia. The article analyzes the design of a mobile web-based serious game for improving children’s handwriting. The specific game mentioned as “runner game” is recommended because the players have to design the letters with digital tools. This is very important according to the article because handwriting activates the left fusiform gyrus, the inferior frontal gyrus and the posterior parietal cortex of their brain since children have to plan and execute the action. The game’s design based on Montessori methods and on the Visual, Aural, Read/write, Kinesthetic (VARK) theory. The game addressed to children between 4 and 12 years old. The game was tested by three children and the results shown that the game activates the willingness of writing [12].

Rahim & Jamaludin describe a Dysgraphic application which support children with Dysgraphia. This technological tool contains activities and exercises which provide an interactive experience for writing skills. Write-Ride can help children enhance their self esteem and create motivation. Firstly the application can help teachers produce exercises for individual needs. More specifically the tool keeps scores and stores writing data, has level difficulties and personalized activities. The participants are five children aged 7 to 12 with Dysgraphia. The intervention, which took place in schools with tablets, was an alphabetic exercise that focuses on letter formation, direction, size of the letter, spacing and punctuality between the lines. The researchers observe the children before and after intervention to see eventually that the effectiveness of this application program was up to 80% [13].

This study [14] focuses on web game environment. This game is able to diagnose and provide treatment to learning disabilities. Dyslexia, Dyscalculia and letter-numeric Dysgraphia supposed to be detected and treated. To detect symptoms and produce intervention, researchers adapt strategies based on multisensory approach, e-apps, levels, graphical cards, action via playing, training through pictures and satisfactory screen for children. The application was tested on pre-diagnosed children with those disabilities. The game was presented through tablets. According to the results both detection and intervention were precisely right for these three learning disabilities.

Abid et al. display a mobile-android application called Peppy using augmented reality to assist children with Dysgraphia. This tool is useful for children as it combines paper-based exercises and game. It makes an enjoyable educational environment and the aim is to improve hand dexterity, motor skills challenge, concentration, cognitive strength and attention. The participants were 60 children from different schools aged 3 to 5. The game based on 4 aspects including visual guidelines, complete the task, how neatly are the lines and the coloring done and how well does the student understand the task. The design also incorporates video, audio, touch and 3D presentation to make the application easier and more interactive. The results show
that, users felt that the application was effective and highly pleasing as the children were interested in using the application both at home and school [15].

John and Renumol analyze how Dexteria, digital software for computer and tablets can provide a scaffolding education to Dysgraphic children. This software based on touch paper-pen and pencil activities. The participants were nine elementary school students in an age group of 5 to 10 and they had writing difficulties (Dysgraphia). They were given 3 tasks such as Alphabet recognition from white board, written by their teacher, copy the alphabets (from ‘A’ to ‘Z) written in the first line of each page of the given tablet-notebook. Retrieve the letters from memory. According to pretests and protests the application helps in handwriting legibility, speed and motor skills [16].

Obatta et al., prove that Dysgraphia is a neurological disorder and concludes inability to express oneself in writing which scaffolding strategy seeks to solve. The study focuses on adolescences and students in academic level, who have Dysgraphia. The experiment took place in Nsukka Education Zone. A structured instrument titled: “Creative Writing Test (CWT)” developed by the researcher and used for data collection. In addition, 59 secondary schools participate. The results show that the use of scaffolding strategy helps adolescents improve creative writing abilities and become self-regulating learners and problem solvers. That leads to the suggestion that Special Education teachers and curriculum planners should plan a program of intervention based on scaffolding strategy for in-school adolescents [17].

B. Adults’ handwriting

Clark et al., explore the aspects of illiteracy in United States. As the causes and effects of illiteracy are analyzed, it is observed that Dysgraphia is a common phenomenon in adults. “When present in children, Dysgraphia is classified as a learning disability. When it occurs as an acquired condition in adults, it is typically the result of damage to the brain (as from stroke or trauma).” The article suggests a numerous of solutions to fill in the gap between adults and illiteracy. One of them is the use of technological tools and ICTS in their work. Technological tools seem to be innovative by providing text-to-speech, speech-to-text, organizational apps and vocabulary development. These achievements lead to improvement decoding, comprehension, and writing skills so adults can use them in their workplace when they need them the most[18].

Khan et al., consider which is it is necessary to discover innovative solutions. The article suggests Augmented reality. It is similar to virtual reality but this one integrates virtual object or virtual view in real object or real environment. The system called AR-DAWE and provides real-time spelling assistance based on user voice input. The system requires internet connection and then can convert easily speech into text. It is an alternative and ideal teaching, especially for students with Dysgraphia who usually get bored early and consider writing as a hard and uninteresting work. Except from augmented reality article suggest some other alternatives such us cloud computing, word processors and oral answer facility, remediation strategy with muscle training, daily practice of alphabets, voice-recorded notes, speech-to-text, simultaneous recording & typing handwritten notes, Pencil grip, Slant board, Raised Paper and highlighted paper. Therapeutic hand exercises are also a good alternative solution. Moreover, ICTS which include word processing, word predictions, spell check and speech recognition could help also students with Dysgraphia [19].

O’Halloran aims to determine the effectiveness of an app to treat Dysgraphia. Five participants took part in the experiment. Interviews and observations took place and the app based on an algorithm. The app, according to results, reduces written errors and enhances
memory. Training was given on the use of the iPad. The algorithm applies a step by step program and follows a path similar to a therapist’s interations. 52 words used in the test, the test has also homophone spelling, non-word spelling and a large assessment with words matched in pairs. Furthermore, it combined comprehension of spoken words and written words, repetition of words and naming objects and spoken picture descriptions. The positives effects of this app are: visual scanning, neglect, recognition of mistakes, sense of independence, self-esteem, feeling of liberation, and gaining free time for other activities [20].

Mullally describes the several types of Dysgraphia such us Deep Dysgraphia, Surface Dysgraphia, Phonological Dysgraphia and Peripheral Dysgraphia. But the question remains how we deal with this disorder? There is limited research into intervention approaches for writing disorders although computers, especially tablets and iPads in a therapy sessions appears to be advantageous to both clients and therapists and that is why they provide rapid feedback with screen options. Five adults participants and five iPads took part in the experiment. There were used also some tests such us CAT (Comprehensive Aphasia test) and CLGT (Cognitive Linguistic Quick Test), words based on pictures and words that verbalized by researchers. The therapy last for 5 weeks. They select interviews for each participant and the results analyzed through SPSS. The results showed that the app is an intervention tool for Dysgraphia [21].

Ahmed et al., present a writing aid in computer for intervention in Dysgraphia. The specific aid uses patterns according to a hand movement instrument which will stimulate the forearm muscles to carry out all types of finger movements and present them on computer. The most promising thing in BCI is that the individual does not have to actually perform the movement instead he has to imagine it. The article describes extensionally the function and the device’s mechanism and how it could help people with Dysgraphia express themselves through this new technological tool [22].

4 Conclusions
Concluding this article we should underline in information age era, the role of ICTs in general and special education and in other related domains [33-49, 77-92]. The mobiles play an important role [23-32] in making more accessible the educational procedures. The serious games make the educational applications more attractive to students and pupils [72-76]. The artificial intelligence is a powerful tool in procedures for diagnosis and adaptable interventions and moreover in design of educational applications [66-71]. Finally there are several applications that support educational procedures based on metacognition, mindfulness, meditation and emotional intelligence cultivation strategies [50-65, 93-108].

All the above mentioned applications of information age era, facilitate and accelerate both the assessment and diagnosis as well as the intervention and rehabilitation procedures within education. People with dysgraphia take a big advantage of all these applications and procedures as already has been presented in this article and this is a very promising situation for the rehabilitation of their special needs on dysgraphia.

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