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GlyphReader App: A support game for the application of the Orton-Gillingham Method with DataMining Techniques.

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Abstract

Attention Deficit Hyperactivity Disorder, known by its Spanish acronym as ADHD, is a topic of great interest to professionals in psychology, psychiatry, and neuroscience in general, due to the negative impact it has on social functioning, personal, work, academic and family of those who suffer from it. This research aims to become a new contribution to the problems that ADHD represents in the world. Regarding its structure, this study starts from a detailed review of the existing theory about ADHD (from a historical perspective, neurobiology, neuropsychology, etiology, epidemiology, treatment, prognosis, among others) and reviews about cognitive development in the stage of childhood, to move to a methodological approach that allows obtaining data on the prevalence of ADHD symptoms in a sample of children, as well as analysis of results that establish the usefulness and reliability of different scales and / or diagnostic criteria in exploring symptoms adjusted to current definitions of this disorder.

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1. Introduction

Attention Deficit Hyperactivity Disorder or ADHD has been considered one of the most prevalent pathologies in the child and adolescent population worldwide [2] and although their externally visible symptoms usually decrease over the years in adulthood, they tend to remain hidden, behind manifestations that affect personal stability and the adequate development of the human being [3]. Studies show; that of the patients diagnosed with ADHD in childhood, 30% to 70% continue to present symptoms that generate difficulties during adolescence and adulthood, in addition; at the age of 19 years, 38% still fully meet the diagnostic criteria for pathology (without remission); and 72% present at least a third of the symptoms required for their diagnosis (with partial remission) [4].

In [5], maintain that the prevalence of ADHD in children is between 4% to 12%; and that of these, two thirds will continue presenting the symptomatology in adulthood; where 15% will maintain the complete diagnosis and 50% will do so in partial remission. The author estimates that the current prevalence of ADHD in adults is 3-5%, making it an additional concern to find that the prevalence rises between 10% -20%, being associated with other psychiatric disorders such as depression, anxiety, and substance abuse disorders, among others. Basic research competencies in all students will be a long-term objective, so that pedagogical models will be included progressively by inquiry. Project learning will be a strategy that will allow you to acquire skills to observe, investigate and find solutions to productive and social problems. In the short term, experience in the training of the Techno-Academies of SENA - Colombia will be used to implement models that articulate the processes of basic and secondary education with issues of CTeI and entrepreneurship. Likewise, the coverage of the Waves Program for children and young people will be increased, allocating a percentage of its resources to the population in extreme poverty, beneficiary of the Red Juntos Program and the other percentage for the training of trainers". The high comorbidity of ADHD with other disorders has been a permanent reason for study, due to its high impact on the functionality of patients. In this regard, [6] show that of the majority of adolescents with ADHD diagnosed from childhood, 71% of cases present comorbidity with anxiety disorders (46%), problems behavior (31%), mood disorders (9%), tics (10%) and enuresis (12%), with academic performance and interpersonal relationships being significantly affected. During adolescence; Although the clinical manifestations of ADHD are still present, the confusion of its symptoms with those of other mood and personality disorders, make the initial diagnosis more difficult to identify; because those aspects that represent the greatest deterioration in the individual's life are usually taken as clinical symptoms [2] Similarly in the adult, ADHD diagnosis is often masked by comorbidity with antisocial personality disorders, anxiety, depression and substance abuse [7-9], leading to a timely diagnosis being issued based on the recognition of the manifestations of the disorder and their permanence from childhood.

The objective of this research article is to be able to validate the implementation of data mining techniques associated with dyslexia problems. Understand the pathology of dyslexia, as the one that is generally identified in school-age children, which is evidenced in the deficiency by confusing certain phonemes. Through the development of the GlyphReader application, it is possible to combine a friendly interface that supports children to interact with the Orton Guillincan method, to establish a baseline of the state of children and to be able to classify their progress through mining techniques. data, specifically with the J48 algorithm.

2. Brief Literature Review

From the literature review, different applications can be identified that promote the reading habits of children using the resources of language topics, details of these applications focused on the use of intelligent mobile devices are detailed then:

- **CreAPPcuentos[10]:** Step-by-step guide in the preparation of stories, which are made from the templates included in the app. Thus, in the first place, it invites you to choose the title of the story, and then select the setting and the characters (it includes some packs with different protagonists), in addition to the text that will appear in the bullets. All the stories can be saved in the personal library to see them at any time and, although it is free.
- **Storyjumper[11]:** It is aimed at Infant and Primary students and offers the possibility of starting with a blank document or with predetermined templates. It has multiple functions, such as inserting text, different characters, and objects, adding your own images, a narrator in audio format, sharing the story with other members of the community or through social networks. It also allows printing and downloading the story.
- **My Story School eBook Maker[12]:** It helps to create the stories with animations, photos and text in a very simple way, making it suitable for Infant students. It has the function of adding a narrator to the stories and different authors, an option that is useful to work collaboratively within the classroom and to encourage each student to create their own. It is compatible with the iOS operating system.
- **TeCuento[13]:** Framed between the resources created by the Colombian Ministry of Education, Culture and Sport and the CNSE Foundation for the promotion and encouragement of reading among deaf people, with this application you can edit and create your own stories in sign language or in Spanish. The stories can be illustrated with their own images and incorporate those that have already been edited in the personal library.

- **Scribble: Kids Book Maker[14]:** Allows you to draw characters and settings directly from the screen of the mobile device. This option joins the ability to add default scenes, characters, and text. Recommended for Primary students, it has 35 templates and more than 250 stickers with which to illustrate the story. It also allows you to add music and you have the option to share in two different ways: as a video or as a book.

Based on the literature review, it can be seen that some authors have worked on processes of intentional disturbances using data mining. Itani [21] uses magnetic resonance imaging of the brain to detect the pathology associated with dyslexia, making use of algorithms based on decision trees such as C45 and J48. Heller [22], developed a methodology based on data mining techniques to be able to face attentional problems in children, obtaining good quality metrics. Morrow [23] carried out an experimentation process with a significant sample of children to identify disorders associated with inattention through machine learning techniques, using the non-parametric algorithm based on decision trees called CART. Zhang-James [24], shows the use of vector support machines as an alternative for the analysis of biomarkers and brain magnetic resonance images, for the analysis and identification of pathologies associated with attention disorders in children. Chen [25], also uses SVM (Vector Support Machines), in a dataset discriminated by 14 characteristics, achieving an acccuracy of 84.59%.

3. Methodology

To carry out the present investigation, a procedure described in 7 phases was established:

Phase 1: Theoretical review and state of the art in ADHD childhood. In this phase, the conceptual delimitation,literature review and research reported so far on the central topic to be investigated are carried out.

Phase 2: Selection and delimitation of the sample. This phase was carried out through non-probability sampling, byexpert criteria, considering the designated inclusion and exclusion criteria.

Phase 3: Completion of informed consent. The total of the sample participants; In this phase, they filled out the informed consent form, within the framework of the Deontological and Bioethical Code that governs the psychologyprofession in Colombia.

Phase 4: Administration of the instruments. In this phase, 4 instruments chosen for the study were administered (the Exploratory Inventory of ADHD Symptoms; IES-ADHD, Wender - UTAH Rating Scale, ADHD Scale - ICD Criteria 10, Symptom control list for the ADHD self-report scale) and 1 clinical history survey. Considering the cross-sectional nature of the research, the application was carried out in a specific period, in an adequate physical space, free of distractors (large rooms of each of the universities), under the ecological conditions specified by each author, for the administration of each of the tests. The application was carried out by the main researcher with the support of psychologists graduated from the Universidad de la Costa actively linked to the Sinapsique seedbed, who received training and education-

Phase 5: Capture, processing, and validation of the information. After identifying the sample space, we proceed to generate scenarios in which individuals can interact with the software in order to carry out the data capture process. These data are exported by the application in excel format, which is the input for the application process of the classification method configured in Weka.

Phase 6: Analysis of results. In this selection, interpretation and description of the reports generated by the analysis with the Weka Software.

After the generation of the prediction model, an interface is made between the development in Weka, for the generation of the algorithm's quality indicators.

Phase 7: Preparation of the report, conclusions, and recommendations. At this stage, a contrast was made with the revised theory and the results obtained, to formulate new knowledge about the central problem of the study, its epidemiology and new knowledge in relation to diagnostic exploration with updated criteria.

4. Software´s Details

Glyph Reader is a cross-platform application that can be run from operating systems: Windows XP +, Mac OS X 10.7+, Ubuntu 12.04+, SteamOS +. For the optimal performance of this application, the devices must have the following configurations: Video card: DX9 capabilities (shader model 2.0); In general, anything that has been released since 2004 should work. CPU: Compatible with SSE2 instruction set.   The web player is compatible with IE 10+, Firefox, Safari and others (Google Chrome not included). iOS: Requires iOS 6.0 or later versions. Android: OS 2.3.1 or later; ARMv7 (Cortex) CPU or Atom CPU; OpenGL ES 2.0 or later.The Glyph Reader application [15], assumes as a mobile marketing strategy, the App Purchase or inApp payments, which is based on allowing that managers like Google play store can establish a free download of the application. The initial functionalities of the apps have a set of activities such as: Draw, Write and choose, in which an initial group of consonants, syllables and words are included, through which a set of exercises are developed to encourage literacy readiness [16]. The application's monetization strategy consists of the freemium model through free initial download with basic content. The application allows the user to obtain more content that they consider relevant to practice and / or self-evaluate at their own pleasure. Within the purchase options, the user will be given a choice between new groups of consonants, syllables (maximum 2 letters) and symphons [17].

In the application, each practice method is referenced with an image that helps its understanding as well as a specific color to create remembrance and a color-method-image relationship for users, thus facilitating the active participation of people of all ages who cannot read or write. Soft and pastel color scheme and bright at the same time within a combination of rounded shapes to make the experience of pleasant use from children to the elderly. The application is divided into 4 stages: 1 learning stage and 3 practical stages.: Listens, Draw, Writes and Choose. As well as an access to a store shown in usability, credits and basic configurations of the application (sounds, volume, among others) is also included.
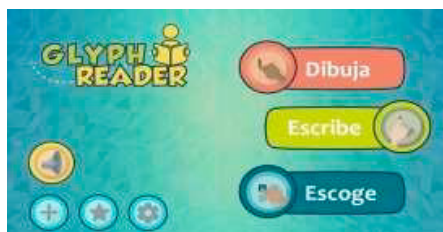

Fig 1 . Main page of the application

There is a help button to show the flow of what to do as well as a button that allows you to return to the main menu. The idea of this stage is for the user to relate and practice writing the letter (s). In the level I vowels and consonants with a stable graphic phonetic relation and syllabs / words training with vowels and consonants with a stable graphic phonetic relation. As can be seen in figure 2.

Fig 2. Level I Draw the GlyphReader application.

At Level II, activities can be developed with locked syllables. See figure 3 and 4
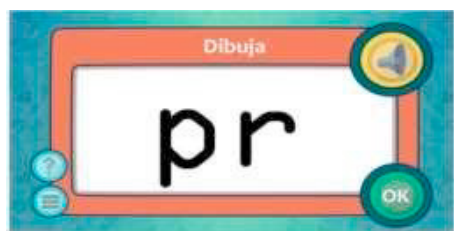
Fig 3. Level II Draw the GlyphReader application.

In level III, activities are carried out with words with syllables locked in the Spanish language. See figure 4
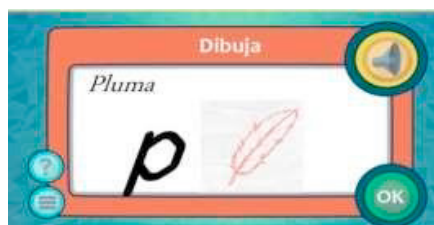

Fig 4. Level III Draw the GlyphReader application.

5. Results

The theoretical review broken down throughout this study demonstrates that it is necessary for the academic and scientific community to have information about the behavior of tests or gold standard scales in different contexts and populations [18]; Knowing data about its validity and reliability, as well as having openness to new proposals for instrument designs that are based on needs or gaps present in the theory and clinical practice. Having pointed out the above, the analyzes of the results found are presented below, in relation to the objectives set, the hypotheses formulated, and the theory referenced. After the data collection process, the technique based on the J48 [19-21] algorithm was applied to identify the students who had problems in the proper selection of the phoneme to select. The results of this implementation are shown below in table 1 and figure 5.
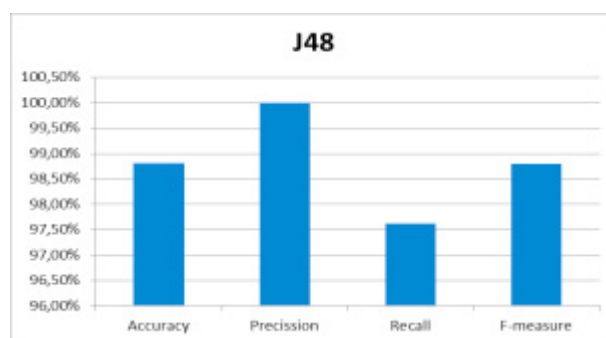

Fig 5. J48 results

Table 1. J48 results

Accuracy	Precision	Recall	F-measure
98,81%	100,00%	97,62%	98,80%

6.Conclusions

The implementation of data mining techniques proposes a good application scenario for the implementation in

literacy processes. As can be shown in the results of the implementation of the J48 decision tree-based algorithm, with the following quality metrics: Accuracy 98,81%, Precision 100,00%, Recall 97,62% and F-measure 98,80%.

References

[1] Miranda, A., Berenguer, C., Colomer, C., & Roselló, R. (2014). Influence of the symptoms of Attention Deficit Hyperactivity Disorder (ADHD) and comorbid disorders on functioning in adulthood. Psicothema, 26(4), 471-476.

[2] KJoffre-Velázquez, V. M., García-Maldonado, G., & Joffre-Mora, L. (2007). Trastorno por déficit de la atención e hiperactividad de la infancia a la vida adulta. Archivos en Medicina Familiar, 9(4), 176-181.

[3] PJC, J., Ramos-Quiroga, J. A., Chalita, P. J., Vidal, R., Bosch, R., Palomar, G., & Prats, L. (2012). Diagnóstico y tratamiento del trastorno por déficit de atención/hiperactividad en adultos. Rev neurol, 54(Supl 1), S105-15.

[4] Truffino, J. C., & Villamisar, D. G. (2006). Trastorno por déficit de atención e hiperactividad en el adulto: perspectivas actuales. Psiquiatría Biológica, 13(3), 86-94.

[5] Rodríguez Molinero, L., López Villalobos, J. A., Garrido Redondo, M., Sacristán Martín, A. M., Martínez Rivera, M. T., & Ruiz Sanz, F. (2009). Estudio psicométrico-clínico de prevalencia y comorbilidad del trastorno por déficit de atención con hiperactividad en Castilla y León (España). Pediatría Atención Primaria, 11(42), 251-270.

[6] Mannuzza, S., Gittleman, R., Konig, P. H., & Giampino, T. (1989). Hyperactive boys almost grown-up: VI. Criminality and its relationship to psychiatric status. Archives of General Psychiatry, 46, 1073–1079

[7] Young, S., Morris, R., Toone, B., & Tyson, C. (2007). Planning ability in adults with attention-deficit/hyperactivity disorder. Neuropsychology, 21(5), 581.

[8] García-Villamisar, D., Del Pozo Armentia, A., & Cabanyes, J. (2006). Educación de personas adultas con autismo. Madrid: Comunidad de Madrid..

[9] CreAPPcuentos- Available online: https://apps.apple.com/es/app/creappcuentos/id777978879

[10] Storyjumper. Available online: https://www.storyjumper.com/

[11] My Story School eBook Maker. Avaliable online: https://apps.apple.com/us/app/my-story-school-ebook-maker/id449232368

. [12] TeCuento App. Available on: https://play.google.com/store/apps/details?id=tresandroides.tecuento&hl=es_CO

[13] Scribble: Kids Book Maker App: https://play.google.com/store/apps/details?id=com.fingerprintplay.scribble2paid&hl=es_CO

[14] Sonja O'Neill, Sarah ason, Guido Parente, ark P Donnelly, Christopher D Nugent, Sally McClean, Bryan Scotney, and David Craig. Video reminders as cognitive prosthetics for people with dementia. Ageing International, 36(2):267–282, 2011.

[15] Ariza Colpas, P. P., Leon Jacobus, A., De-laHoz, S., Piñeres-Melo, M., Guerrero-Cuentas, H., Consuegra-Bernal, M., ... & Collazos Morales, C. A. (2020). Glyph reader app: multisensory stimulation through ICT to intervene literacy disorders in theclassroom.

[16] Troussas, C., Krouska, A., & Virvou, M. (2020). Using a multi module model for learning analytics to predict learners' cognitive states and provide tailored learning pathways and assessment. In Machine Learning Paradigms (pp. 9-22). Springer.Cham

[17] Lara, J. A., Aljawarneh, S., & Pamplona, S. (2020). Special issue on the current trends in E-learning Assessment. Journal of Computing in Higher Education, 32(1), 1-8.

[18] Zagorskis, V., Gorbunovs, A., & Kapenieks, A. (2020). TELECI ARCHITECTURE FOR MACHINE LEARNING ALGORITHMS INTEGRATION IN AN EXISTING LMS. Emerging Extended Reality Technologies for Industry 4.0: Early Experiences with Conception, Design, Implementation, Evaluation and Deployment, 121.

[19] Cerezo, R., Bogarín, A., Esteban, M., & Romero, C. (2020). Process mining for self-regulated learning assessment in e-learning. Journal of Computing in Higher Education, 32(1), 74-88

[20] Nilashi, M., Ahmadi, N., Samad, S., Shahmoradi, L., Ahmadi, H., Ibrahim, O., ... & Yadegaridehkordi, E. (2020). Disease Diagnosis Using Machine Learning Techniques: A Review and Classification. Journal of Soft Computing and Decision Support Systems, 7(1), 19-30.

[21] Alihodzic, A., Tuba, E., & Tuba, M. (2020). An Improved Extreme Learning Machine Tuning by Flower Pollination Algorithm. In Nature- Inspired Computation in Data Mining and Machine Learning (pp. 95-112). Springer, Cham

[22] Itani, S., Rossignol, M., Lecron, F., & Fortemps, P. (2019). Towards interpretable machine learning models for diagnosis aid: a case study on attention deficit/hyperactivity disorder. PloS one, 14(4), e0215720.

[23] Heller, M. D., Roots, K., Srivastava, S., Schumann, J., Srivastava, J., & Hale, T. S. (2013). A machine learning-based analysis of game data for attention deficit hyperactivity disorder assessment. GAMES FOR HEALTH: Research, Development, and Clinical Applications, 2(5), 291-298.

[24] Morrow, A. S., Campos Vega, A. D., Zhao, X., & Liriano, M. M. (2020). Leveraging machine learning to identify predictors of receiving psychosocial treatment for Attention Deficit/Hyperactivity Disorder. Administration and Policy in Mental Health and Mental Health Services Research, 47, 680-692.

[25] Zhang-James, Y., Helminen, E. C., Liu, J., Franke, B., Hoogman, M., Faraone, S. V., & ENIGMA-ADHD working group. (2019). Machine learning classification of attention-deficit/hyperactivity disorder using structural MRI data. bioRxiv, 546671.

[26] Chen, H., Chen, W., Song, Y., Sun, L., & Li, X. (2019). EEG characteristics of children with attention-deficit/hyperactivity disorder. Neuroscience, 406, 444-456