Development of educational game for children with dyslexia

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***Abstract*—This paper will describe the development of an educational game designed for children from 4 to 10 years old to help them learn the letters, writing and reading if they are dyslexic. If people with dyslexia have a proper way of learning letters, writing and reading, then their condition can be corrected up to 80%. Also, if learning patterns for dyslexic children are applied to all children, it helps the children to develop their own logic and conclusions. In this paper will be explained how learning style is correlated with methods for correction of dyslexia, how educational games could be used as alternative learning methods and how several findings on dyslexia are used in the process of defining the functionalities and design of the educational game presented in this paper. If this game is added to the elementary school curriculum, this game could be an additional tool in the teaching process. This game will be helpful to teachers and parents to present the process of learning the alphabet, reading and writing to the children in an interesting way, where children will have the opportunity to learn and have fun at the same time. With the development of this educational game for children with dyslexia, I will contribute to increasing the availability of assistive technologies designed for Macedonian language.**

Keywords—educational game, dyslexia, assistive technology.

I. INTRODUCTION

Dyslexia is a disorder that can affect reading (learning to read), writing (interpreting words, letters, and other symbols) and spelling of a person, but may also affect other areas such as working memory, sequencing, time management, orientation and much more [1, 2]. Worldwide, 5-10% of the population has dyslexia (or 1 in 10 people), but this number can reach as high as 17% depending on the language area [3]. Thus, in people from the English language area dyslexia is present at 15% and in the Slavic language area at 10% of the population [4]. People with dyslexia have difficulty to read fluently and they often read slowly and with errors. This can affect how they understand the text, but if someone else reads the text they have no problem with understanding the content [5]. When it comes to people with dyslexia, great attention should be paid to the learning style. In the beginning, it is good to find the learning style that suits them the most, so that later the teaching style can be adapted to their learning style. When children with dyslexia are given the right method of learning, they learn and progress constantly [6].

II. LEARNING STYLE

Learning style is a term that describes the factors that influence all aspects of learning. We all have different preferences for the way and style of learning. Multiple learning styles are defined, but the primary three types of learning styles are: visual learning, auditory learning, and kinesthetic learning [6, 7]. The multisensory learning style incorporates all of the above learning styles: visual, auditory and kinesthetic learning [8].

III. METHODS FOR CORRECTION OF DYSLEXIA

Multisensory learning style applies to all methods of correction of dyslexia.

A. Ron Davis Method

So according to Ron Davis's theory, people with dyslexia often think and understand with the help of images, that is, they think multidimensional and use all senses, which gives them the opportunity to see the world from a different perspective. The pictorial way of thinking provides them much more information than the verbal way. The pictorial way of thinking is 400 to 2000 times faster than the verbal way in which picture and speech take place at the same speed [9].

B. Orton-Gillingham method

The Orton-Gillingham method is also based on multisensory learning. Dr. Orton was the first doctor to make a miraculous and unexpected finding back in 1920. He found that children who were considered retarded because of reading difficulties often had average or above-average intelligence. He further predicted that by applying kinesthetic and tactile techniques, supplemented by visual and auditory techniques in learning letters and voices, the state of dyslexia could be corrected. Using these findings, talented teacher and pedagogue Anna Gillingham created a multisensory reading program, so in 1936 the first Orton-Gillingham Dyslexia Correction Program was introduced which included systematic and explicit study of sounds (phonemes), syllables, root of the word (morphemes) and spelling. This program is intended for English language, but also is in preparation of adaptation for Macedonian language [10].

C. AFS method

Also, the AFS method incorporates elements of multisensory learning, this method includes three basic help priorities: Attention, Function, and Symptoms. For people with dyslexia is more difficulty to have deliberate attention to letters and numbers, so most often dyslexia is considered with medical diagnoses such as attention deficit disorder, concentration deficiency and hyperactivity. Because people with dyslexia perceive differently and have a very fast thinking process, they need more time to recognize and learn symbols and letters. The AFS method determines which sensory perceptions function in a different way, because the dysfunction is not always synchronous at all sensory perceptions function. To establish a process that provides a gradual increase in attention and sensory perceptions, it is necessary to work with all the senses [11]. From this we can conclude that everywhere through dyslexia correction methods a multisensory learning style is found, it can improve memory and attention and increase the performance of cognitive and sensory abilities.

IV. USE OF EDUCATIONAL GAMES AS ALTERNATIVE LEARNING METHODS

Educational games are also increasingly used as alternative learning methods. Fun-guided learners are more easily motivated to continue the learning process by fulfilling meaningful activities and / or tasks that are defined in the context of the game. Before several years, the project "Grandma's games" was conducted in five primary schools located in different areas in Macedonia, where in classroom environment were integrated traditional games. The results in this research showed positive change for the learning outcomes, increased collaboration, teamwork and increased level of interest and interactivity among children [12]. Also, in other research was shown that educational computer games with multi-sensor interfaces, could improve the quality of the learning experience and facilitate the acquisition of knowledge and understanding of the content through seamless integration between virtual and physical environments. [13].

V. FINDING USED IN THE PROCESS OF DEFINING THE FUNCTIONALITIES AND DESIGN OF THE EDUCATIONAL GAME

Therefore, in this educational game for children with dyslexia, several findings on dyslexia are considered in the process of defining the functionalities and design of this educational game [14].

- As all dyslexia correction methods are all adapted to a multi-sensory learning style, in the educational game for children with dyslexia is payed close attention to the game to have a multi-sensory playing environment.
- The choice of background and text colors plays a big role in reading ability when it comes to people with dyslexia. A specific combination of text and background colors should be selected to facilitate the reading process. So, for background colors it is the best to use pastel colors and the text to have less brightness and contrast than the background.
- The DyslexicFZF font, which is an adaptation of the DISLEXIE font, is created to allow writing in Macedonian and this font represents a type of assistive technology for people with dyslexia [14].

VI. THE EDUCATIONAL GAME DESCRIPTION

Because this educational game is designed for children from 4 to 10 years old, guided by their wishes and interests, we all know that children love cartoons. Therefore, in this educational game will be used illustrations and animations that will be presented as in a children's cartoon. To achieve authenticity, the design of the illustrations is specifically tailored to fit a story. Storytelling is an important element in creating a game where players are constantly involved and active. The educational game for children with dyslexia represents the story of the parrot Ricky. This story is about animals, because children love animals, and some keep them as pets and care for them.

So, in this educational game we need to take care of the parrot that is very hungry. The moment when the player approaches the game is late autumn. The parrot Rickey is worried that he will not have enough food to survive the winter. At the last minute, he asks his friends for help if they can gather food together to suffice for the winter until spring comes. Ricky is not just a usual parrot, he is a talking parrot, so he has a very specific taste for food, his favorite foods are being the letters that allow him to speak. In addition to talking, he wants to learn the process of read, and his friends can help him by collecting food from all possible letters in the alphabet. So, by playing the game, the players collect food for the parrot Ricky, and they unconsciously learn the letters.

VII. TECHNOLOGIES USED IN THE GAME DEVELOPMENT PROCESS

The technologies used in the development of this educational game for children with dyslexia are:

- Scratch - a block-based visual programming language where the entire educational game is programmed and
- Adobe Illustrator - vector graphics software that was used to create digital illustrations for the educational game.

According to the elementary school curriculum, in the subject of Informatics, the basics of programming are taught through the Scratch - working environment [15]. If students are already familiar with the game for children with dyslexia, they will be able to easily recognize the game and associate it with the Scratch working environment. Projects created in Scratch that are published are open source projects and anyone can view, modify and download them. If children in fifth or sixth grade show an interest in learning computer science and programming, with the help of teachers, they can modify the game and make changes as they wish. With that in mind, this educational game could have a dual application. Students in the early grades can learn the alphabet by playing the educational game, and students in the older grades can learn the basics of programming by modifying the same educational game.

VIII. GAME ANALYSIS AND DESIGN

In this section will be shown the game analysis and design. Thus, figure 1 shows a use case diagram where you can see the actions that trigger an event. When a player accesses the game's website, two options for starting and leaving the game are displayed. If the player chooses to exit the game all activities are terminated and the game is closed. And if the player chooses to start the game, in the background this action accesses the database and retrieves information from the database to create backgrounds, to create the character through which the player can control the game, create the necessary levels and create objects. The player can choose one of the offered game levels. When a player's character is in the activated level, there are two options for closing the level: when the player chooses the option to exit the level, or when he has accumulated a total of 20 points to open the next level.

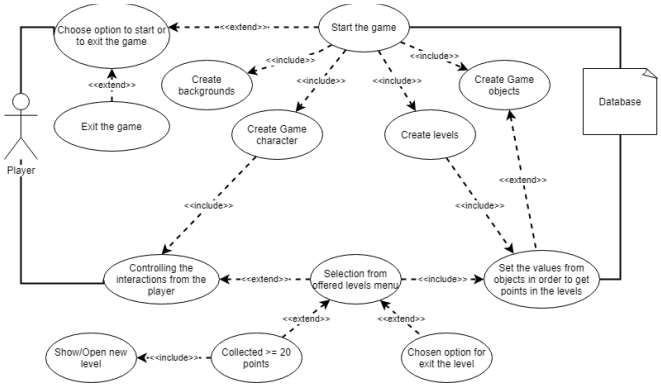

Fig. 1. Use Case diagram - User access to the game [14]

Figure 2 shows a class diagram, showing how the classes are linked, what data is stored in them, and what functions are used.

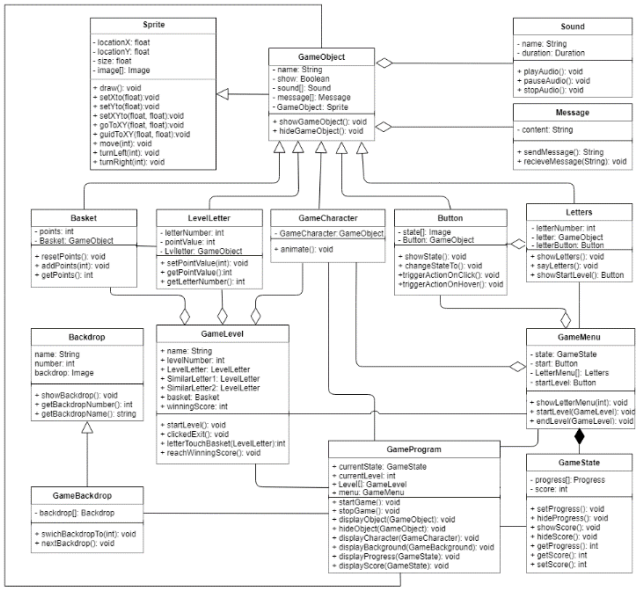

Fig. 2. Class diagram for the online-game the parrot Ricky [14]

Figure 3 shows the sequential diagram. From this diagram we can see how certain interactions the player undertakes, affect the activation of certain functions of objects, and how the activated functions facilitate the data exchange across objects in the sequential order in which these interactions take place.

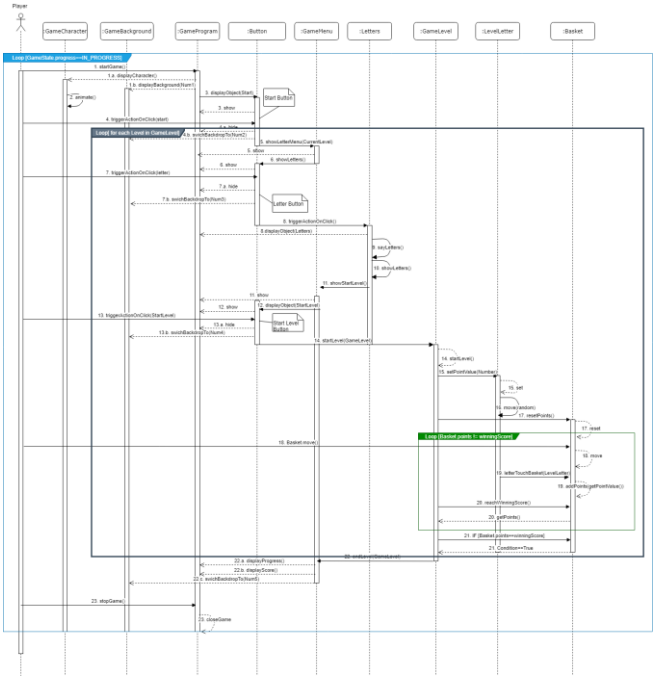

Fig. 3. Sequence diagram for the online-game the parrot Ricky [14]

IX. INTRODUCING THE GAME

When a player accesses the web site with the game, a screen shown in Figure 4 is displayed. To zoom in and out of the full screen, the player needs to click on the four arrow buttons pointing to the edges. Then by clicking on the green flag the game starts, it can also be stopped at any time by clicking on the red octagon. When the player has activated the game, the parrot Ricky begins to guide the players through the game.

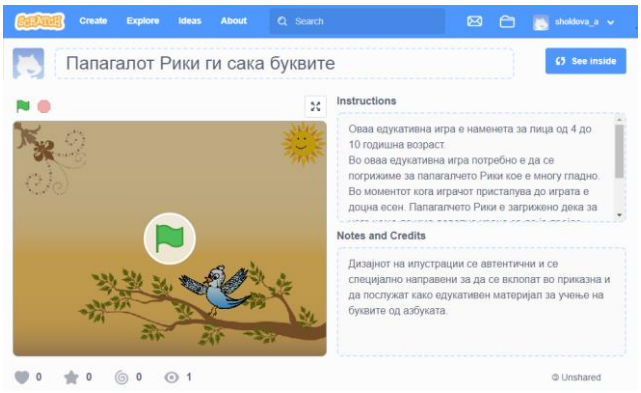

Fig. 4. Player accesses the web site with the game - the parrot Ricky [14]

Thus, the player first needs to press the "Start" button (Figure 5 on the left) in order to be displayed the first letter in the letter list from the alphabet (Figure 5 on the right).

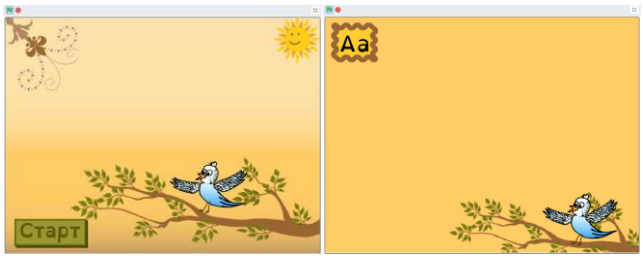

Fig. 5. Starting the game (left) and showing the first letter (right) [14]

When the player clicks on the letter button a new display opens, shown in Figure 6, where the parrot teaches the player the selected letter and needs to remember it well because it will be needed in the game level, then the parrot provides guidance on how to make it easier.

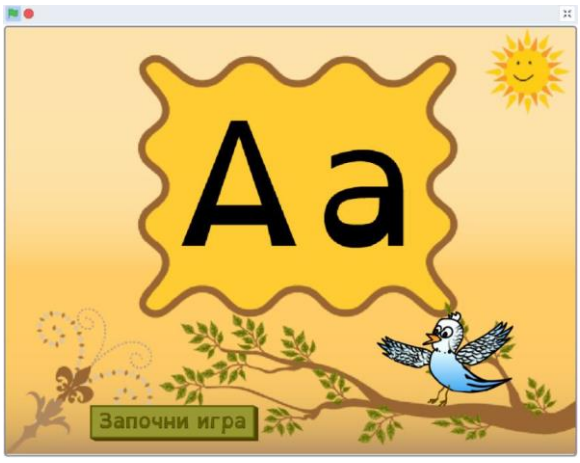

Fig. 6. Information about selected letter [14]

When the player clicks on the "Begin game" button a level for the selected letter is activated, shown in Figure 7. The player using the keyboard keys "Arrow Left" and "Arrow Right" moves the sack with food for birds where the player has to collect symbols from the selected letter. For every correct letter, the parrot says, "You're collecting a lot of letters, keep going." And for every incorrect letter, it says, "Play carefully, I'll be hungry." To complete a level, it is necessary to collect 20 symbols from the selected letter.

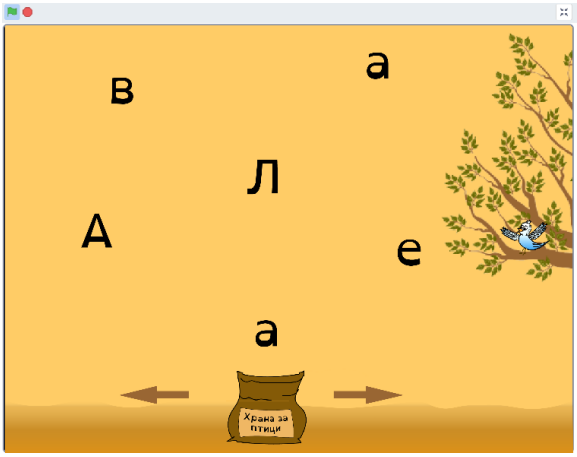

Fig. 7. Level in the game for the selected letter [14]

Upon completing the level, a new scene is shown, shown in Figure 8, where the parrot says "Bravo, you got the star of the letter A" and thus the player is rewarded for his hard work and successfully completed level.

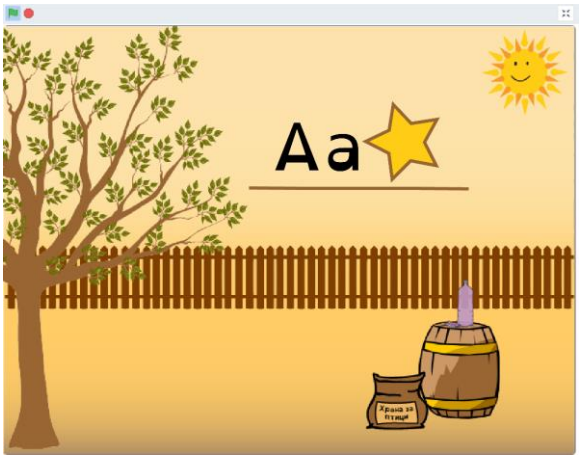

Fig. 8. Displaying won star for first letter [14]

After completing one level, the scripts are repeated for each next level, where the letter list is re-displayed and one letter from the alphabet is added to each subsequent level. When all letters are successfully passed the player can return to play all the letters if desired. If the player wants to stop the game, he can do so by clicking on the red octagon or turning off the browser by clicking the "X" button [14].

X. Conclusion

Playing the game presented in this paper is expected to make it easier for people with dyslexia to learn the letters and later the reading and writing processes. Also, through the process of playing the game, all students from elementary school, in the lower grades will be able to learn the alphabet very easily, while the students in the upper grades, in the field of informatics can rewrite the game because it is open source. Students can make their own versions of the game, and this may even apply to teachers, where they will be able to adapt it to their teaching styles and curriculum needs. Following the development of the game, it is planned to conduct a research and performance analysis in collaboration with the "Einstein" Dyslexia Association. If it is proven to be effective, it may find application in primary schools in our country, where all students would benefit, as mentioned before, the way that dyslexic students learn is much simpler for all students.

From this we can conclude that the proposed solution in this paper could contributes to increasing the number of assistive technologies available in Macedonian language for people with dyslexia and that this solution is of great value to society and can have further multipurpose use.

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References

[1] "Definition of Dyislexia" LEXICO powered by Oxford. https://www.lexico.com/en/definition/dyslexia (accessed Nov. 12, 2019).

[2] "How Can Assistive Technology Support Dyslexia?" dyslexic.com. https://www.dyslexic.com/blog/how-can-assistive-technology-support-dyslexia/ (accessed Nov. 12, 2019).

[3] "Dyslexia Facts and Statistics" Austin Learning Solutions. https://www.austinlearningsolutions.com/blog/38-dyslexia-facts-and-statistics.html (accessed Niv. 12, 2019).

[4] "Teachers need more education to work with students with dyslexia, (in Macedonian)" disleksija.org.mk. http://disleksija.org.mk/edukacija/ (accessed Nov. 12, 2019).

[5] "Dyslexia," mayoclinic.org. https://www.mayoclinic.org/diseases-conditions/dyslexia/symptoms-causes/syc-20353552 (accessed Nov. 23, 2019).

[6] "How Dyslexics Learn: Teaching to the Dyslexic Strengths," homeschoolingwithdyslexia.com. https://homeschoolingwithdyslexia.com/dyslexics-learn-teaching-dyslexic-strengths/ (accessed Nov. 23, 2019).

[7] "Learning Styles: Understanding How You Learn," BeatingDyslexia.com. https://www.beatingdyslexia.com/learning-styles.html (accessed Nov. 23, 2019).

[8] "How to Design a Multisensory Lesson," child1st.com. https://child1st.com/blogs/resources/113530247-how-to-design-a-multisensory-lesson (accessed Nov. 23, 2019).

[9] "Ron Davis Method, (in Macedonina)"www.dyslexia-info.com. https://www.dyslexia-info.com/4264-2/ (accessed Nov. 26, 2019).

[10] "Orton-Gillingham method, (in Macedonian)" www.dyslexia-info.com. https://www.dyslexia-info.com/orton-metod/ (accessed Nov. 26, 2019).

[11] "AFS Method, (in Macedonian)" www.dyslexia-info.com. https://www.dyslexia-info.com/%d0%b0%d1%84%d1%81-%d0%bc%d0%b5%d1%82%d0%be%d0%b4/ (accessed Nov. 26, 2019).

[12] Trajkovik V, Malinovski T, VasilevaStojanovska T, Vasileva M (2018) Traditional games in elementary school: Relationships of student's personality traits, motivation and experience with learning outcomes. PLoS ONE 13 (8): e0202172. https://doi.org/10.1371/journal.pone.020217

[13] Covaci, A., Ghinea, G., Lin, C. et al. Multisensory games-based learning - lessons learnt from olfactory enhancement of a digital board game. Multimed Tools Appl 77, 21245–21263 (2018). https://doi.org/10.1007/s11042-017-5459-2

[14] A. Sholdova, "Development of educational game for children with dyslexia, (in Macedonian)"B.S. thesis Faculty of Computer Science and Engineering, Ss. Cyril and Methodius University in Skopje. 2020. [Online]. Available: http:// https://www.researchgate.net/publication/339941543_Graduation_thesis_-_Development_of_educational_game_for_children_with_dyslexia.

[15] "Curriculum - Sixth Grade Informatics, (in Macedonian)" www.bro.gov.mk https://www.bro.gov.mk/wp-content/uploads/2019/08/Nastavna_programa-Informatika-VI_odd.pdf (accessed Dec. 23, 2019).