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Proffesional article

ONE APPROACH TO THE DEVELOPMENT AND APPLICATION OF ASSISTIVE MULTIMEDIA LEARNING TOOL IN WORK WITH CHILDREN WITH DEVELOPMENTAL DISABILITIES

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Aleksandar Spasić[1], Nevena Babanić[1], Jelena Nikolić[1], Dragan Janković[2], Aleksandar Milenković[2]

[1]Academy of Technical and Educational Vocational Studies Niš – Pirot Department, Serbia
[2]Faculty of Electronic Engineering, Laboratory for Medical Informatics, University of Niš, Serbia

Abstract. *The possibility of applying modern multimedia technology as an assistive tool in working with children with learning disabilities is truly immense. The aim of this paper was twofold. Firstly, either to confirm or disprove a view that children with learning disabilities can accept educational content intended for the children of regular population and secondly, to design a learning tool, a multimedia video game especially developed for this occasion. The method of work consisted of the following phases: analysis of developmental limitations of a child and group in the kindergarten, selection of activities and suggestions of models of learning, design and development of the means for the realization of learning, working (playing) with the child in the group in several iterations and analysis of the obtained results. The results obtained indicate that the use of multimedia tools as a help in working with children with developmental disabilities can be crucial for achieving visible results in the mastering of topics usually intended for children of the regular population.*

Key words: *assistive multimedia, learning tool modelling, inclusion, video gaming*

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Corresponding author: Aleksandar Spasić
Academy of Technical and Educational Vocational Studies Niš – Pirot Department, Ćirila i Metodija 29, 18 300 Pirot, Serbia
Phone: +381 10 345 237 • E-mail: spale66@gmail.com

1. INTRODUCTION

In an effort to introduce inclusion to regular kindergartens, educators and caregivers face new challenges every day. A large number of children with developmental disabilities have difficulties in following methodological activities provided in a form intended for children from the regular population, and many educators try to introduce various sensory and cognitive aids into their daily activities to bring activities closer to children with disabilities.

When performing a regular integrative practice in an educational group with a child with a certain developmental disability, it is possible to resort to a pre-designed learning video game as an assistive tool to master a certain part of the educational programme, such as colour and shape recognition, for example, intended for children from the regular population. This paper provides a brief overview of theoretical foundations, applied practical modelling methods and tools, as well as the obtained results for this model - a learning tool, a multimedia video game especially developed for this occasion.

According to a study conducted in the United States, one in five children surveyed has some form of disability and learning difficulties (Turkington & Harris, 2006), which is characterized by a wide range of problems with speech, language, reading, mathematics, concentration and reasoning.

Inclusive education implies that children with disabilities are full members of institutions in their neighbourhood and they attend classes that are appropriate for their age, with adequate additional help and support services. The initiators of inclusion believe that good educators, teachers and caregivers are able to teach all children, as well as that all of them can be provided with quality education, without being classified into traditional categories of special education.

Play is a basic activity of human childhood (Vygotsky, 1967). Children play for pleasure. For them, play is not merely a matter of fun, but an activity that satisfies their basic needs. Play ensures the unity of a child's physical, intellectual and socio-emotional development in the most comprehensive manner. The nature of children's play is complex, which implies the existence of numerous functions. The first one is educational because a child acquires knowledge, skills, abilities, and experience through play, and adopts hygienic habits, language, cultural and social characteristics of the group in which they live and whose behaviours they accept. Developmental functions refer to the stimulation of a physical, cognitive and socio-emotional development of a pre-school child. According to Jung and Sainato (2015) for the children"play provides opportunities to acquire critical developmental skills as well as to engage in activities with peers during daily routines" (p. 198), and numerous studies resorted to play as a context to enhance the social and communication skills of children with autism spectrum disorder, while others investigated the effects of interventions that directly taught and assessed play skills.

However, due to their inability to participate regularly and in the same way, children with disabilities are often isolated from joint games, and they also face a lack of communication with peers. One of the goals of this research is the need to test the possibilities of digital play as a means of helping children with developmental disabilities.

Assistive technology (AT) implies equipment, product, or system, which is modified and adapted to increase, maintain and improve functional abilities of people with disabilities. All types of assistive technologies have one thing in common, and that is that their goal is to strengthen an individual's ability to live and act. In other words, assistive technology is used to

meet and supplement deficiencies that prevent a person from functioning normally and smoothly (Robittaile, 2010).

The importance of multimedia educational tools is unquestionable today, whether they are children of regular or special population (Gray et al., 2011).

Bodine (2013) stated that:

"Most individuals in this group have not had the benefit of using AT devices because relatively few products to date have been specifically developed addressing intellectual impairments. In addition, families, teachers, and others providing support services for individuals with cognitive impairments have generally not been aware of AT's usefulness" (p. 27).

The previous statement is directly related to the third goal of this research - to check what influence on the world of a child with developmental disabilities can be achieved by assistive multimedia, and through the child's interaction with a specially made video game.

2. METHOD

The basic idea of this research was to confirm or disprove the opinion that children with learning disabilities can master the content of educational programmes intended for children from the regular population. This idea has inspired authors to resort to some of the "Design for All" principles (Borblik et al., 2015) the main characteristics of which are as follows: any group of users should be able to use the product (Equal use); the design should be adapted to a wide range of individual preferences and abilities (Flexibility); the product should be simple to use and understand, regardless of the user´s knowledge, experience, skills and level of concentration (Simple and intuitive); the product must minimize the risks and adverse consequences of accidental or erroneous actions perpetrated by the user (Error sensitivity); the product must ensure easy and comfortable use with minimal effort (Low physical activity); the product must provide sufficient space for the user to manipulate and use it, regardless of the body size, posture, or motor abilities of the user (Size and space for the scope and application) and the software need to take into account the needs of people with impaired vision, hearing, or physical and mental disabilities (Requirements for hardware devices and software).

Baloian, Luther and Sánchez (2002) propose a unified model for creating educational software for people with disabilities. The modelling pipeline is divided into seven sections. According to their proposal:

"The modelling process starts with the definition of cognitive skills the learner has to acquire; then it considers the creation of a virtual environment composed by a navigable world and built by using an adequate modelling language, dynamic scene objects, and acting characters. Scenic objects are characterized by graphic and acoustic attributes; character's actions are based on deterministic and non-deterministic plans as in an interactive hyper story" (p. 119).

Bearing in mind the above mentioned principles, our method of work consisted of the following phases:

- Analysis of the developmental limitations and cognitive skills that learner has to acquire
- Selection of activities and proposal of learning models and
- Design and implementation of tools for the realization of learning

2.1. Analysis of the developmental limitations and skills

Green (2018) stated that:

"Students with challenges with cognition and executive functioning may display the following characteristics:

- reduced attention and difficulty concentrating during a task,
- inability to sequence and organize information,
- poor analytical skills and judgment,
- difficulty figuring out solutions to problems,
- a hard time learning and retaining new information,
- inefficient time management skills,
- slow processing of new information,
- difficulty planning and initiating goal-oriented behaviours,
- lack of motivation,
- limited ability to initiate activities,
- impulsive behaviours, and
- faulty awareness and denial of deficit areas" (p. 138).

During this research, we assumed that children in our target group have mild to moderate difficulties from the autism spectrum disorder (ASD) (Coleman and Gillberg, 2012) such as Asperger syndrome (Mesibov, Shea and Adams, 2002; Gillberg, 2002).

2.2. Selection of activities

As to thematic activity, a combined recognition of colours and shapes was chosen - an activity that is basic and necessary for the realization of more advanced educational concepts (development of speech and verbalization, development of initial mathematical concepts, development of artistic skills, etc.). Additionally, the activity is complemented by recognizing everyday objects that are of specific colours or similar shapes.

2.3. Tools for realisation of learning

As a means of realization of a learning model, the video game "Smart Giraffe" ("Žirafica pametnica" in Serbian) was proposed. The GameMaker:Studio IDE (Figure 1.) was used for the video game design and programming (Tyers, 2018; Cossu, 2019; Vinciguerra and Howell, 2016; Auckett, 2015).

Fig. 1 Game Project in GameMaker: Studio IDE

3. RESULTS

The achieved results are presented and discussed in this section.

3.1. Learning Principles

In the process of design and development, general rules of adopting new concepts and connections have been applied. The primary aim was to make sure that a child was not faced with a task that might be too demanding for his/her current abilities, which would lead to dissatisfaction, frustration and loss of interest to learn.

Learning by using a video game as a tool encompasses five levels (Spasić, 2010):

1. The first level is how to do something, i.e. how to interact with the system.
2. Subsequently, a child must learn what to do and to understand the rules of the game.
3. The third level of learning occurs when a learner understands the causes and effects and begins to develop strategies to achieve the goal of the game.
4. The fourth level of learning through video games is when a child understands the context of the game and its internal system of values.
5. The fifth level in learning occurs when a child is able to make decisions based on the above mentioned system of values.

The main learning principle is based on the system of increasing the requirements and connecting the concepts that are presented in the game.

A digitally synthesized female voice (55 different sentences or words) is used to interact with a child. To interact with the game a child uses the basic mouse/touchpad moves and the left click.

Each level starts with a simple recognition of the pronounced colour, blue for instance, and then a child should recognise the pronounced shape (circle) from the set of moving shapes (Figure 2).

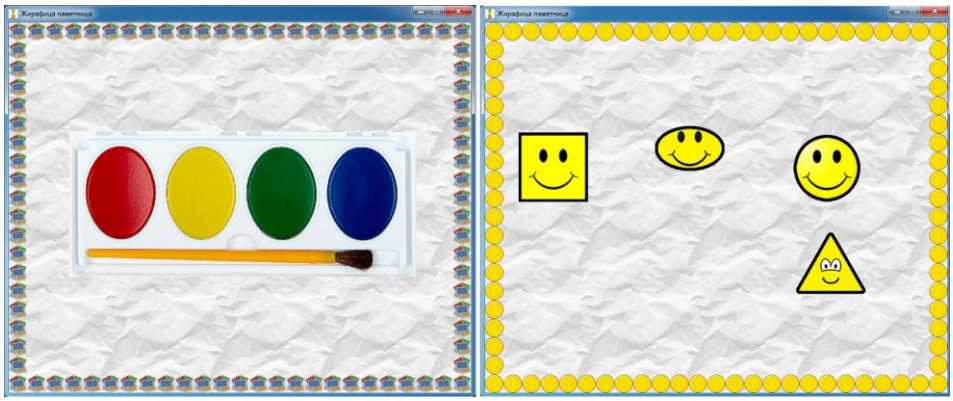

Fig. 2 Colours and shapes

Then, a child should recognise the pronounced shape of the specific, previously recognised colour (blue circle) from the set of the same moving shapes with different colours, as shown in Fig.3.

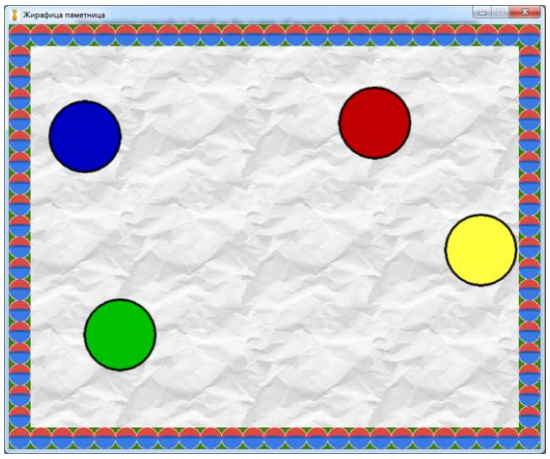

Fig. 3 Same shapes with different colours

As one proceeds from one level to another one can see how simple shapes are placed in a specific context. For example, at the initial levels children acquire the notions of shapes (a yellow triangle from a set of yellow shapes), then colours (a yellow triangle from a set of triangles of different colours), and go further and try to recognise this shape and colour among the real yellow objects such as a sandwich, the Sun, a book or a lemonade (Fig. 4).

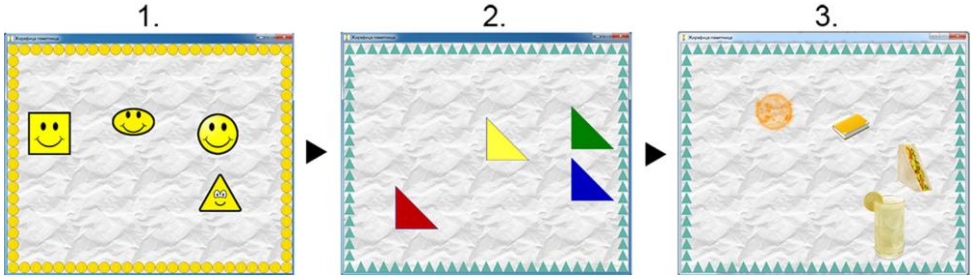

Fig. 4 Shapes and colours placed in concrete contexts

3.2. Design Principles

This video game is designed under the name “Smart Giraffe”. The game currently has 24 levels. A different drawing of a “wise” giraffe appears at the beginning of the game and before each new level, which signals to the child that she/he can start a new level by clicking on the appropriate button when ready (Figure 5).

Fig. 5 A Smart Giraffe character for different levels

The voice communication offers information about the chosen object even when a wrong answer is chosen.

The game can be used by children from the regular population as well as by children with developmental disabilities. It is possible to add new levels or to make the existing ones more complex or intricate.

4. Experiment and Discussion

In order to check the effectiveness of the designed learning support assistive tool, testing of the assistive product was performed in a group of children in the kindergarten in which there is one child with developmental disabilities, and under real exploitation conditions.

4.1. Analysis of Child Developmental Limitations

N.M. is a 5.5 years old boy with developmental disabilities. He has been in the group for two years, and before that he attended a special school. He does not have a precise diagnosis, so the assumption is that he has mild to moderate difficulties from the autism spectrum, probably Asperger's syndrome.

It often happens that young children have no precise diagnosis and Gillberg (2002) explains the reasons as follows:

"Symptoms in younger children are often somewhat more vague and it can be difficult, even for the experienced clinician, to decide which diagnosis within the autism spectrum – or, for that matter within the spectra of attention and tic disorders – is the most appropriate. There is sometimes a need to wait until the school year for 'classical' symptoms to emerge. This is one of the most important reasons why a diagnosis of Asperger syndrome is rarely made with confidence before school age" (p. 40).

Based on his educators' claims, the targeted boy did not interact with other people in his environment, he did not join activities, he did not play with other children, and he mostly looked for a place to isolate himself or a place where he could jump.

He has made significant progress in the period after enrolment in the educational group and at the time when the experiment was conducted he was characterized by the following:

- He addresses words or simple sentences if he needs something; he approaches children to see what is happening with them; he likes to play dice, if he has the opportunity he likes to hug people around him;
- He can answer the question "How are you?" and greet people;
- He enjoys looking at picture books;
- When doing group activities, he participates in a way that suits him, e.g. likes to be in a circle of chairs when playing the game "Music Chairs";
- He does not name all objects, shapes and colours;
- He does not like music if it is too loud, in which case he puts his palms on his ears and leans aside;
- In his group he prefers contact with adults to his peers;
- He was not interested in having any communication with us at the beginning of the research, but two weeks later he started interacting with us.

In order to correctly choose the method and implement the learning tool, the child was first monitored and observed, as was the study room, interactions among children and between children and educators, as well as routines and activities, after which data analysis was performed.

4.2. Course of Activities with the Child

First, it was necessary to set up the environment, furniture and the computer. As all children in the group were naturally interested in planned activities, they were initially given access to the work environment located in the middle of the study room so that all children could see what was being done (Figure 6a).

The targeted boy was not specifically invited to join the group – we wanted to see if preparations were attracting his attention. The child soon came alone and placed himself right in front of the computer, in the lap of the educator involved in the experiment.

The plan for the first time play was that the educator control the computer and video game while the child points his finger to the correct answers on the screen.

The other children expressed their enthusiasm for the game and made noise, which made the targeted boy difficult to concentrate, but he did not show that it bothered him and he wanted to continue interacting with the video game.

In order to determine with certainty how the child copes, what he overcomes with ease, and what slows him down and disturbs him, the educator, the boy and the computer

were isolated from the group and relocated to another room. This time the educator was next to the boy again, and he was at the table in front of the laptop (Fig. 6b).

a) Initial phase within the group b) The phase with isolated environment

Fig. 6 Working environment

During the next session, the child was suggested to try to control the game independently by using the built-in synaptic touchpad on the laptop, which was an additional challenge to his motor skills. He was helped in parts where he would stay longer and he was not sure what to do.

The interaction was interrupted by explaining to the child that the device's battery was empty - by pointing to the laptop's battery status icon and explaining that the game could not work if the battery was not charged enough. The child accepted it immediately and educators involved in this research and the targeted child went back to the group without any problems.

The next day, it was checked whether the learned information were retained and to what extent, and whether the child would ask to regain access to the game. When he finished with the picture book he was flipping through, he came to the educator, grabbed her hands and clearly said the word "giraffe" and asked to go to the room where he had played the game the day before.

4.3. Results Obtained During the Experiment

The experiment that was carried out during the active use of the learning tool proposed in this paper offered the results and the answers to certain assumptions, the most important of which are the following:

- The boy completed all 24 levels of the game.
- Based on the first test, it was noticed that it was easier for a child to give answers to the part about colours than to the part about shapes.
- On the experimental level of the game, where the character of an animal (giraffe, zebra, cow and dog) is chosen instead of the shape, he would always choose another animal (zebra) first.
- It was easier for him to recognize a circle and a triangle than a semicircle and a rectangle.
- When his choice of the answer was correct and when it was confirmed by the sound (a child's laughter), the boy would laugh.
- The shape painted with a certain colour was much easier to find.
- Even when he gave the wrong answer, the boy did not give up. Namely, the game offers a sound interaction even in the case of a wrong answer, so that one can hear the voice with an explanation of what was clicked on (the name of a colour, shape, animal or object).
- At the next attempt, he wanted to do everything by himself. He continued to be confident with the colours, while the giraffe always stayed behind the zebra in response. He continued to express his satisfaction with laughter.
- The return to the game for the third time was followed by a new appearance. The child wanted to know what would happen if he answered the task by marking the wrong answer - it is, by the way a natural reaction of children of the regular population when they master the play environment and when they feel safe interacting with the game. He would stay in certain places and choose the wrong answer until he repeated it frequently enough.
- At the fifth iteration of playing the game, he completed all levels without mistakes in cases where the shape is not connected with an object from everyday life. When connecting shapes and objects from everyday life, he would always choose what he knew first, and then he would concentrate on the correct answer.
- At no time did the child show a desire to stop playing the game or to miss check if he had answered the task well.
- After finishing all levels, he would always ask to return to the beginning.
- When the game was restarted, he would react with excitement each time.
- The boy's focus was completely placed on what was in front of him, and on several occasions we tried to offer him something else, but he would always turn back to the computer and the game.
- The smile and satisfaction one could see on his face while playing the game was an indicator that the initial idea was successfully realized.

5. CONCLUSIONS

The video game proposed in this paper enables the improvement of visual perception, better communication between a child and educator, development of visual-motor coordination and cognitive development.

The game can be used by children from the regular population as well as by children with developmental disabilities.

The results obtained in the kindergarten indicate that the use of multimedia tools as a help in working with children with developmental disabilities can be crucial for achieving visible results in mastering topics usually intended for children from the regular population.

Adding new topics and educational activities that can be taught in this way and the development of applications for other platforms that can be used to work with children (tablet, smartphone etc.) comprise additional possibilities for the continuation of this project.

Efforts towards developing modelling principles of assistive software learning tools are planned for the future.

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JEDAN PRISTUP RAZVOJU I PRIMENI ASISTIVNOG MULTIMEDIJALNOG ALATA ZA UČENJE U RADU SA DECOM SA TEŠKOĆAMA U RAZVOJU

Mogućnost primene savremene multimedijalne tehnologije kao asistivnog sredstva u radu sa decom sa smetnjama u učenju je velika. Cilj ovog rada bio je dvostruk. Prvo, da se potvrdi ili opovrgne stav da deca sa smetnjama u učenju mogu da prihvate obrazovni sadržaj namenjen deci redovne populacije i drugo, da se osmisli alat za učenje, multimedijalna video igra posebno razvijena za ovu priliku. Metod rada se sastojao iz sledećih faza: analiza razvojnih ograničenja

deteta i grupe u vrtiću, izbor aktivnosti i predlog modela učenja, osmišljavanje i razvoj sredstava za realizaciju učenja, rad (igranje) sa detetom u grupi u nekoliko iteracija i analiza dobijenih rezultata. Dobijeni rezultati ukazuju da upotreba multimedijalnih alata kao pomoći u radu sa decom sa smetnjama u razvoju može biti presudna za postizanje vidljivih rezultata u savladavanju tema koje su inače namenjene deci redovne populacije.

Ključne reči: *asistivna multimedija, modelovanje alata za učenje, inkluzija, video igre*