Organization of the interface of games and applications, developed for children with intellectual disability

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Abstract. In this article will be discussed the issues related to the requirements for the development of digital games for children with intellectual disability. We proposed structured requirements for the design of different types of games in terms of interface, design technologies, color models, object shape and brightness, scope in applications of sound, game duration, and so on.

1. Introduction
In this article will be discussed the issues related to the requirements for the development of digital games for children with intellectual disability. In the course of our research, we came across a wide variety of facets concerning the study of the impact of digital games – whether from a computer, tablet or mobile device. They encompassed elements such as: measurement of physiological responses (parameters – brain activity, blood pressure) in the human body; manner of use and internalisation of the games – additional hardware devices; impact on the emotional state and feedback response of children with intellectual disability; conclusions about their development after using a certain methodology in visualization, etc. [1,2,5].

We hypothesised structured requirements for the design of different types of games in terms of interface, design technologies, colour models, object shape and brightness, scope in applications of sound, game duration, and so on [6]. There are indeed scientific publications on various features of the aforementioned already, but it is noteworthy that they deal with exceptionally specific cases, both for the specific diagnosis and for its spectrum with additional variation of the diagnosis or for specific syndromes, and for the aspects of the impact of a given game model on the child and their specific needs. We did not expect to find a definitive compilation of criteria related to the development of digital games for this purpose, nor is it possible in a broader context for children with developmental disorders to be met with a single overarching solution. This challenged us to try to structure an abstract, which can help app designers who create games for children with similar problems.

2. Perception aspects for children with mental retardation
Today’s development of the computer science and technology can be used as means for education and social adaptation. For many children with mental retardation playtime activities are crucial. In the process of mastering the play, the child is thought how to take decisions, how to finish something it has started or use the play as an attempt to teach a child about focus and systematical behavior. Motivation is increased using the play as a strategy. The child receives feedback through approval or a
praise from the software the pay is using (digital game), it sees the results of his actions (step by step) on the screen which is an important aspect of these lessons. The usage of educational computer games may optimize the process in this way [7].

Authors-practitioners point out the aspects of the use of game technologies [8,9]:
- Didactical, which form certain skills and habits needed for the day-to-day activities;
- Educational, which are linked to self-dependence, cooperation and build up communicational skills;
- Advancing, which will help develop the speech, reflexes, thinking and attention;
- Socializing, which are linked to accepting the norm and values of our surroundings, adapting to the social environment and self-regulation.

For some children with mental retardation, by using similarity or analogy, we cannot achieve the transfer of an act from one subject to the other. They are not inclined to use digital objects that are copies of the real world objects. Children can be thought how to use an object not only for its real purpose but for other purposes as well. The inability of a child to use other objects as substitutes is connected to the lack of visual thinking and imagination or with the lack of experience with such objects. They prefer to play with known objects as their interaction with them is already known. From the one hand the goal of the teacher is to present objects that are already known and on the other hand to show them how they can be used in a new way so that he/she can achieve a transfer towards similar objects of shape, color, material, purpose and etc. The idea for education through digital means and instruments can be included in a single plan of the subjects to be discussed and every digital game to have a specific purpose linked to a child specific problem. The end goal would be to have positive influence for development through the game, to stimulate its accomplishment with next moves, using different play techniques which the digital game offers. It is possible to have evolving storyline where the goal would be at certain point the child to do on its own without the support of the teacher.

While studying the current state of the issues we review in our article we couldn’t find many described experiments with children with mental retardation. In the evaluation of affective states during the gameplay two methods were applied: a controlled experiment and a questionnaire. Here are part of the conclusions:
- It is important what prevails when using digital game-positive or negative conditions;
- More often positive conditions are reported by people of female gender;
- The emotions triggered by the events in the game are diverse;
- There is a possibility to observe stressful events;
- Is it possible to classify the participants into three groups based on physiological signals: highly reactive, low-reactive and medium-reactive;
- Until what extent in our observation the reactivity is linked to the events in the game and the change in the physiological signals.

As a result if this observation we can conclude that the research will allow the hypothesis that the emotional diverse between the subjective characteristics of those reactions do not allow us to define the emotional model of the game-player [10].

3. Principles of game creations and applications for children with mental retardation.
Technological aspects and basic applications.
The play is the mechanism throughout which the children learn how to interact with the surrounding environment and to build and understand the social relationships. The physical and psychological development is realized through play. Below you can see some basic concepts.
- Visualization of the objects- recognition of outlines, shapes, connection between content and particular form or figure;
- Interface – position of objects, forms, change in position, graphic representation, sound fragments, content animation, etc.;
- Color patterns- recognition degree of colors, nuances, stages of coloring – basic ( full coloring, in norms), and additional ( plus black outlines, outside norms- a degree of colored blindness);
Peculiarities in game structuring and applications - from psychological and physiological point of view.

Main difficulties which the children with mental retardation face when using computer as a means for play and education are:

- Means for entering the data, control over the computer system and specific peripheral devices for coactivity with interactive environment
- Basic skills needed to use keyboard and mouse – more time and efforts are required for mastering of basic activities, new specific approaches and methods, or specific software to help in the process
- Usage of auxiliary technology (adaptive and alternative devices and software) - representing equipment or system whose application aims at increasing, help or improve specific functional abilities.

These problems and difficulties play the main role in formulating the goals and tasks for planning and building interactive applications and games.

For people with specific needs, different researches proves that with the existence and usage of proper hardware, software and auxiliary technology, the computer remains the main and irreplaceable means for work, study, and communication.

3.1. Development of educational games

Information technology (in particular games and specific applications) in development and education, along with the generally accepted view of the harm to children's mental and physical health, has some indisputable advantages over other computer technology. It is proven that the use of computer games:

- Helps to speed up the transition from visually effective to visually figurative thinking, which is an important stage in the development of logic;
- Contributes to the formation of the ability to analyze or evaluate situations;
- Leads to the acceleration of the process of managing one's own - personal external activities (such as simultaneous performance of actions with specialized peripherals and observation of images and interactive content on the screen), etc.

In this way, computer games allow children to make the transition from simple to complex forms of thinking much faster.

Educational and learning games that support and facilitate the acquisition, understanding, and processing of specific and structured information must meet the following requirements:

- To be used for mastering skills for working with different computer configurations and specific devices, to learn various actions - free movement, positioning, holding, the active selection, dragging and moving, the need to use and memorize repetitive positions and actions, distributions and activities.
- Simultaneously with the acquisition of skills, to provide new knowledge and understanding to develop children with mental retardation in various aspects, mainly related to the individual problems and difficulties of each person.
- To offer varied and diverse activities to retain attention and maintain interest.
- To have a different level of complexity and step-by-step upgrading, starting from easier to more difficult activities, to gradually acquire skills and upgrade knowledge.
- To be related to the use of known and recognizable objects from the immediate environment and the natural environment, to predispose to actions and confidence in the set of skills and personality development, both physically and psychologically.
- To have a wide range of different multimedia elements - text, sound, the impact of more channels for perception and acquisition of quality visual information, for awareness, understanding, and assimilation of the presented information.

3.2. Types of games and applications

Description of types of games which can be used in digital learning when working with a computer and to use additional devices (special mouse, joysticks, etc.):
• **Training games for actions with additional devices.** The aim is to form hand movements by moving the special device. The size of the pointer, its speed, and color (or combination of colors) should be selected appropriately. When providing positive feedback - the correct choice of the required object within the work area, appropriate sound can be included. For example, when selecting letters, the corresponding object appears, and the reverse relationship is possible.

• **Active involvement games.** They contain the components of the first type and the main goals are added with activation of the visual attention, expansion of the working field, recognition of the whole and its parts, recognition of the whole image. For example, when you press a button and activate the cursor, a "hidden image" appears in the form of a photo or picture with an image, which causes positivism in the child.

• **Games with adding components and tracing.** It contains the basic components from the previous ones and the goals are added with additional activation of the attention, tracking of the cursor position, provision of positive feedback during the task performance. For example, a puzzle of 6 squares arranged in 8 covered similar shapes. The correct choice of a square can lead to a complete solution to the problem - the image to be activated and "turned" into a dynamic graphics - animation.

• **“Find the same” games.** The goals are to attract visual attention to provoke comparison operations; to establish the indirect connection between the action of the hand and the resulting changes in the work area. Such a task can have the following content: it starts with two different geometric figures in different colours, respectively located on the left and right. With each selection on the left, either the colour or the shape of the figure on the right changes, the goal is either two identical figures or two identical colours for the different figures to appear. The reward can be sound activation or animation. The same can be applied to food types - vegetables, fruits, etc.

• **“The halves” games – on the left there is a statically positioned element - half of a fruit, and on the right, there is a changing part of the element, and at each choice, a replacement is performed to reach the correct element with an exact position, dimensions and shape for the finished look of the object. The prize is again a song or animation, or a combination of both. The aim is to focus the attention on the two parts of the screen, to make a connection between the actions of the hand and the change of the images on the screen, to recognize the whole by its parts, and to identify the image.

![Figure 1. Interface of “The halves” game.](image)

• **“Building blocks” games.** The aim is to develop, as far as it is possible for the user, visual perception, spatial relationships, the activity of visual attention, and design ingenuity. On the left, there are 4 rectangles and the puzzle figures are arranged in them, the ends of which are fixed with additional frames. Thus, it is assumed that when a child places them in the right places, they will fit
and form the given complex geometric figure (the figures are automatically rotated by the functionality of the software, regardless of their initial location).

**Figure 2.** Interface of “Building blocks” game.

4. **Basic elements of Model in building the interface of games for children with mental retardation**

![Model Diagram](image)

**Figure 3.** Model to select the main features when developing the interface of games for children with mental retardation.

To build an interface and design of the environment for this type of game, each of the characteristics in the described scheme must have parameters that need to be selected for the final product – a game.

- The clarity of the image is important to understand the semantics and typography of the object, the visual ideas about the already formed primary objects in the child's mind.
- The presence of the boundaries of the objects are shown as mandatory, as very often it is possible to have a problem with colour recognition, and when part of the object merges with the background, it cannot be recognized, it is possible to be mistaken with another object.
• Colour layout consists of the correct choice of colours and the ability to dynamically change one
colour to another, which is a task of high difficulty. This is especially important in case of possible
concomitant diseases related to colour recognition.
• The number of objects in one window should not visually burden the child's work environment.
  Avoid clutter and follow the line for maximum clear space, consistent with the specifics of the type
of game.
• Clarity of the transitions is essential because it provides a series of steps that lead to a positive
result, which is perceived as a reward. This is important as a motive for replaying the game, and the
small number of steps with a quick result leads to an effective and high-quality application or
game.
• It is necessary to move consistently from one level to another with smooth and easy choices
• It is not necessary to have a high degree of interactivity of the environment. It should be consistent
with the structure of the game, the connections between the elements, and the ability of children to
successfully cope with the interface.
• The possibility for game levels is related to the management of the game resources and the
inclusion in the functional framework - roles of learner and trainer.
• Roles in the game content. After playing with a trainer, a child - in the role of a trainee, can learn to
choose different levels of complexity. On the other hand, the trainer can set the levels, control to
some extent some interactivity, and support the learning process with supporting questions.
• It is advisable to have a choice option to turn on and off the accompanying sounds, according to the
needs of the child, taking into account their reactions and make a preliminary study for this type of
feature.

5. Conclusion

Much of the available research shows that the effects of using digital games are more tangible than the
impact of watching TV, video with films or other content. Similar research has been the subject of
positive and social psychology, as well as of software developers themselves. The first digital games
date back to 1958, and this was followed by rapid technical and technological developments in the
following decades. Today, there are data that 80% of children aged five to eighteen play games in their
free time. Educational digital games can be considered both as a significant educational factor and as a
tool for the development of thinking, performing actions – a simulation through a guided sequence for
performing an activity.

For children with special educational needs, digital games can be a powerful tool for improving
social adaptation, learning, and professional activities. They can support the formation of skills for
observation, classification of objects, and building self-control. In some games, special peripherals can
be used, adapted to the child's respective height. For many children, play is a major activity, which is a
precondition for the development of digital games in this direction. As they play, the child learns to
make decisions and to be able to bring an action from beginning to end. Not to be overlooked is the
fact that the result of the game loop contributes to increased motivation, and the child also receives
feedback – the reward is acknowledgement from the device, to see the result of their actions on the
screen and in some cases with victory fanfare as aural confirmation. With a properly constructed
digital game, the assisted learning process can be optimized, which helps to trigger motivation and
interest on the part of children with special educational needs.

The suggested solutions and guidelines, related to the model are specifically discussed and
preliminary consistent with experts in three major educational organizations. The proposed
recommendations are purposely coordinated with the teams of speech therapists and psychologists
from these leading organizations. They give their positive assessment of the correct construction of
this type of variations of the game interface. Based on this assessment, we will develop a software
structure – interface designed for several game types with altered visual variants (especially in terms
of color matrix) and with the differentiations of heterogeneous combined functionalities.
There are three aspects that affect users: game content, game structure, and game mechanism. Each of these aspects must be taken into account when developing the game for children with intellectual disability to one degree or another.

Our team has plans to further research and develop this topic in future publications, in which we will examine the results of the acceptance and success in working with an application that retains the same functionality, but has differences in interfaces.

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