CHAPTER V: HUMANITIES, SOCIAL AND SCIENTIFIC POTENTIAL OF E-LEARNING AND STEM EDUCATION

E-learning and STEM Education
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THE PROJECT "INCLUSIVE CLASSROOM-PLAY AND LEARN - CONCEPTION, DESIGN AND SOFTWARE ARCHITECTURE"

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***Abstract**: The article presents an ongoing research project aiming to produce an innovative educational application for mobile devices, addressed to students with special educational needs, their teachers and parents. The software architecture including intelligent assistant and the process of conception, design and implementation of the App is described. The focus of the methodology is to provide a child centered approach to learning considering an individual's interests, cognitive ability, strengths and challenges. The app consists of games and resources supporting development of skills to process information, problem solving, planning and organizing, and expanding knowledge about science objects and phenomena, ecology, human body and health.*

Keywords: mobile educational app, inclusive education, intelligent assistant, SEN students

INTRODUCTION

The recent policy of Bulgarian Ministry of Education promotes comprehensive implementation of electronic educational platforms and resources at all schools

and centers for personal support and development. Investment in ICT and digital resources and implementation of new policies and good practices in the area of inclusive education for SEN (Special Educational Needs) students, aims to provide equal access and quality of education to all students. Special needs is a broad term that encompasses children who have physical, emotional and/or intellectual disabilities, causing learning difficulties. These children may need help in a variety of areas depending upon their conditions and a range of needs. Special needs typically address at least some or all the following: academic assistance, help with language/verbal skills, help relating to others, behavior management, organizational skills, sensory needs and/ or physical assistance.

The article presents project in progress targeting to design an innovative educational application for mobile devices, addressed to students with special educational needs, their teachers and parents. The language of instruction is Bulgarian.

1. BACKGROUND AND ARGUMENTATION

Smart mobile digital devices represent a new generation of technological tools that offer phenomenal access to content as well as opportunities for creative use by users belong to any age and ability groups. A key reason for the popularity of smart mobile devices is related to technological features of these devices as large screen displays, high resolution, lightweight, user-friendly and ergonomic design, short start-up time and multimedia content viewing ability (Papadakis et al., 2016). The same author concludes that while there are thousands of apps available today, choosing the most appropriate educational ones for children is difficult and problematic for both teachers and educators. (Papadakis et al., 2017).

A very specific feature of devices is undrained by Perez ″The device enjoys a high degree of social acceptability that appeals to students and parents. With the iPad and similar consumer devices, individuals with special needs are using the same technology as their peers. The importance of this dimension cannot be underestimated, as it can dramatically impact the level of device use.″ (Perez, 2018)

A theoretical background of the methodology of this project design is constructivist theory. The key points in constructivism are given by the direct link between learning and experience, by the active role of learners in constructing knowledge for themselves and by the application of knowledge onto realistic problems to solve. The best way of implementing the constructivist approach is to embed the learning content into the context; the learner has to actively deal with it to advance in the game. (Catalano, 2014) The learner builds his/her knowledge actively, opposite to get them as a ready product taught by the educator. To learn constructively means to learn actively, to develop skills to transfer what is

learned by solving a variety of authentic tasks. The learning process flow in a stimulating environment with focus on acquisition of personal experience, meaning and encouraging critical thinking.

Information was gathered about available Apps for SEN students, and the use of some specific applications with people having various conditions was studied. The research includes materials presented in English and Bulgarian languages.

According to Cohen et al. (2011, p.9) the 'world of apps' currently designed for children includes three general types: gaming apps, creating apps and e-books.

- In gaming apps, the activity includes a range of challenges, actions and reactions that lead to skill acquisition and achievement as levels are played and mastered.
- In reading apps or e-books, the story or the reading of the story is the activity. Playful features or mini activities are integrated into a familiar schema of reading a book. The curriculum is in this context either explicit in the text or implicit and embedded in the activities.
- Creating apps provide tools, workspace and activities (e.g. robots, painting, etc.).

Our project subsumes games targeting skills as planning, organization, task initiation, time management, following directions, sequencing, working memory, self-control, attention, taking turns, flexibility and perseverance. The target age group is 2 to 12-year-old people with ASD (Autistic Spectrum Disorder), ID (Intellectual disability) and some other conditions that may prevent students from learning in inclusive educational settings. In order to benefit from the motivational potential of games we used a "gamification" approach. The application design consists of various games for students and information for parents and teachers.

A variety of Apps for SEN students are available in English language. The apps are classified according to their purposes: communication (e.g. Go Talk, Talk Board), acquisition of digital content as music, video, stories (e.g. Kids videos, Niki Music, Do2Learn), learning by playing (e.g. Professor Garfield, Math Square), apps for time management and daily schedules (e.g. Tiimo, Magnus Cards, My Video Schedule). Many of the Apps are created to support learning in content areas such as writing, mathematics, logic, science or develop sensory, digital and other skills. Unfortunately, it is not possible to use them in inclusive classroom settings or special centers for personal support and development because the language of instruction is not Bulgarian.

Our research shows that for SEN students there are few digital applications, portals and software using Bulgarian language. The application Together at school is created especially for SEN students and is a good example of the description of the software, design and links to the educational purposes laid in. The domains

contain mathematics, reading and logic. Comprehensive information, links, educational methodology and study tasks are well presented in special portal Dyslexic children. It is interactive and provides educators and parents with latest news on training and educational materials and varied tasks for students as well. Another useful software translated in Bulgarian language is Tobii Dynavox Communicator 5 intended to support and help people with communication difficulties to reach a better level of independency. This software offers three main groups of applications: emerging communication, symbol communication and text communication. The special feature in this software is the possibility for the educators to use different languages of instruction including Bulgarian and to modify the content, task and other features in the program. This software offers possibility for eye control, which makes it useful for students with limited mobility.

From the research targeting to inform the conception, design and development of our project named "INCLUSIVE CLASSROOM-PLAY AND LEARN' we may conclude that good examples coexist and at the same time there is necessity to create and implement a specially designed digital educational application for SEN students with Bulgarian as a language of instruction and domains: ecology, human body and health as science objects and phenomena. The app is targeted for differentiation, personalization and additional support for students with special educational needs educated in inclusive classroom settings.

2. GAME-BASED LEARNING ENVIRONMENT

Figure 1. presents the general architecture of the game-based learning environment. The core of the environment is a multi-agent system that includes two types of assistant, implemented as intelligent agents.

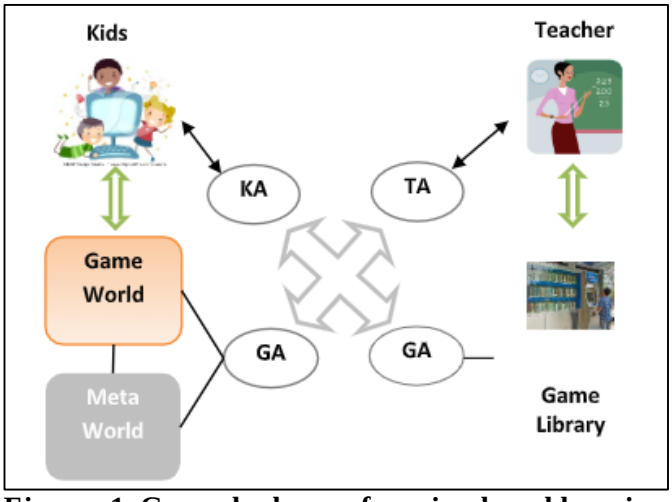

Figure 1. General scheme of gaming-based learning

Source: Our work

The first type is the so-called personal assistant (PA), the purpose of which is to support the work of users (children, students, teachers) within the environment. Primarily, PA assists two user groups - gamers (children, students) and evaluating game results (teachers).

The second type is the so-called Operational Assistants (OA). Typically, these are server agents that provide the game. OAs are transparent to gamers. Basic OA is the game assistant (GA), which implements the logic, management and control of the game. In addition, GA can, individually for each player, collect different information about the course of the game, the result and the chosen approach. This information is accessible to the teacher's personal assistant, who can plan appropriate corrective actions. Other Operations Assistants serve a Game Library.

The environment of operational assistants includes the following three basic components:

- **Game World** - Virtual 3D or 2D world, visible and accessible to players. It activates the currently selected learning game.
- **Meta World** - This storage, transparent to the players, stores information that is not directly related to the content of the game. Data recorded in Meta World can be considered as a specific protocol that reflects the course of the game, including the reactions and mistakes of the players. This protocol can be used for later personal analysis of the game.
- **Game Library** - This is a game storage where OPs can choose and activate the game in Game World. The games are divided into three main categories - for beginners, for experienced and for advanced players.

2.1 Game play lifecycle in the above environment

- **Game suggestion** - depending on the teacher's requirements (via his / hers) OA defines the games that can be activated by the players in the next game session. The list of possible games is presented to the Game World player.
- **Game choice** - the player chooses a desired game (from the supply). OA registers the player's desire, selects from the Game menu and activates it in Game World.
- **Game play** - During the game, the GA collects data that will serve to evaluate the achievement of the player. When circumstances arise, such as need for help (if acceptable), violation of game rules, completion or inability to continue the game, GA is activated (proactive).
- **Game completion and assessment** - GA evaluates the player's performance (achievement), announces it to the player, and records the achievement in Meta World where they are available to the teacher for subsequent evaluation.

The assistants are realized as intelligent BDI (Belief-Desire-Intention) agents (Rao, 1995) using a model of human activity where:

- **Beliefs** - the effect of the acting student's actions.
- **Desires** - generated depending on the game. There may be different conditions where the agent should intervene in the game (become proactive).
- **Intentions** – depending on the case, one of the desires is transformed into a goal. The goal determines what the agent should do.

2.2 Game World

First, we will look at a game considered to be played by advanced players. Figure 2. presents the three main software components in a Game World prototype developed by the authors.

- **Web Administration** - Used by Admins and Teachers.
- **Graphics Editor** - Used by Admins.
- **Client side - Web & Mobile** - Used by students.

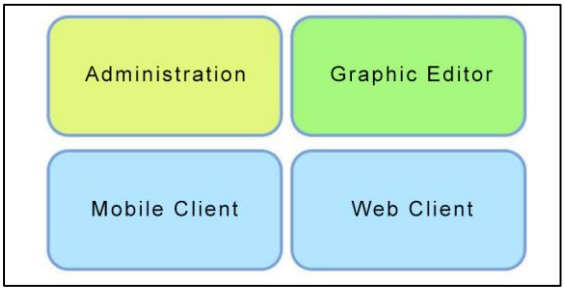

Figure 2. Software components in Game World
Source: Our work

2.2.1 Web Administration

Web administration is used by Teachers. Built with Vue.js - a modern JavaScript framework for building component-based web applications. In the administrative part, teachers have the opportunity to add new students, create exams or edit existing ones, and check the test results of the players (Figure 3).

2.2.2 Graphics Editor

The graphics editor is used by administrators. Built with Backbone.js framework and altered to create software agents environment. The Graphics Editor is designed to easily create different types of virtual worlds in which the student plays. It provides the opportunity to create random worlds, edit existing ones and save them. The graphics editor mechanism allows the user to add countless multiple objects as long as each of them is accompanied by a matching graphical resource.

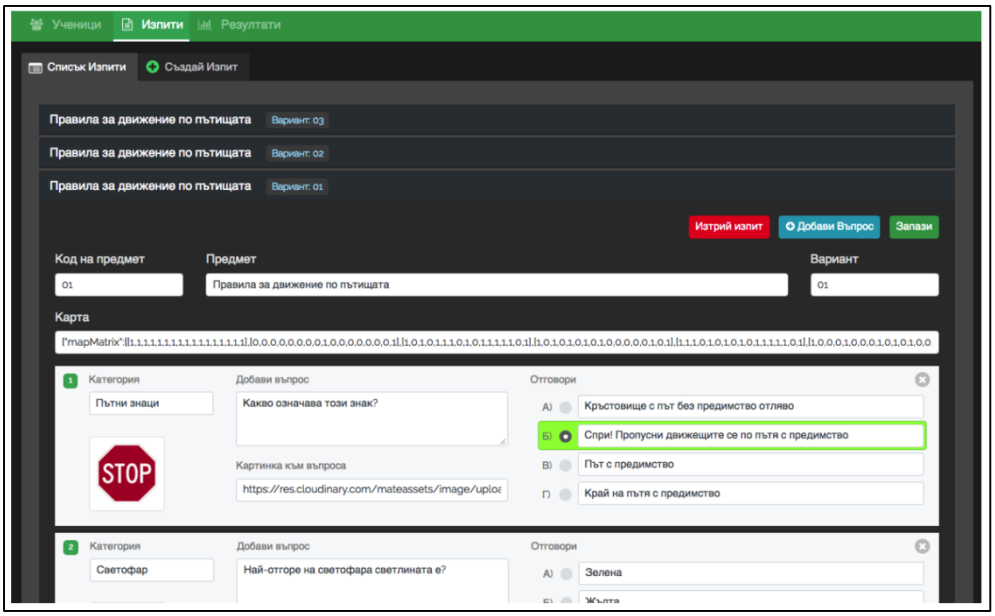

Figure 3. Web Administration - editing an existing exam

Source: Our work

Figure 4. Graphics Editor - Map Creation (Exam)

Source: Our work

At present, 17 types of buildings and 20 types of traffic signs and traffic lights have been created, which the authors consider necessary to create a variety of maps covering the general cases and the matter studied by students in the field of Road Safety.

Figure 4. shows the creation of a game map matching a specific exam created within the **Web Administration**, which will be delivered to the students in the game environment.

2.2.3 Client Side - Web

That module is used by students. It is built using Backbone.js framework and is distributed as a browser application. The gameplay follows the cycle: First the student selects his profile, then selects a map (exam) and after that he has to move turn by turn in the provided virtual world (Figure 5). At each turn, the student moves forward by answering questions from the predefined categories corresponding to the virtual traffic situation in which he is located. At the end of the exam, the player receives a message of successful completion and a result of his game.

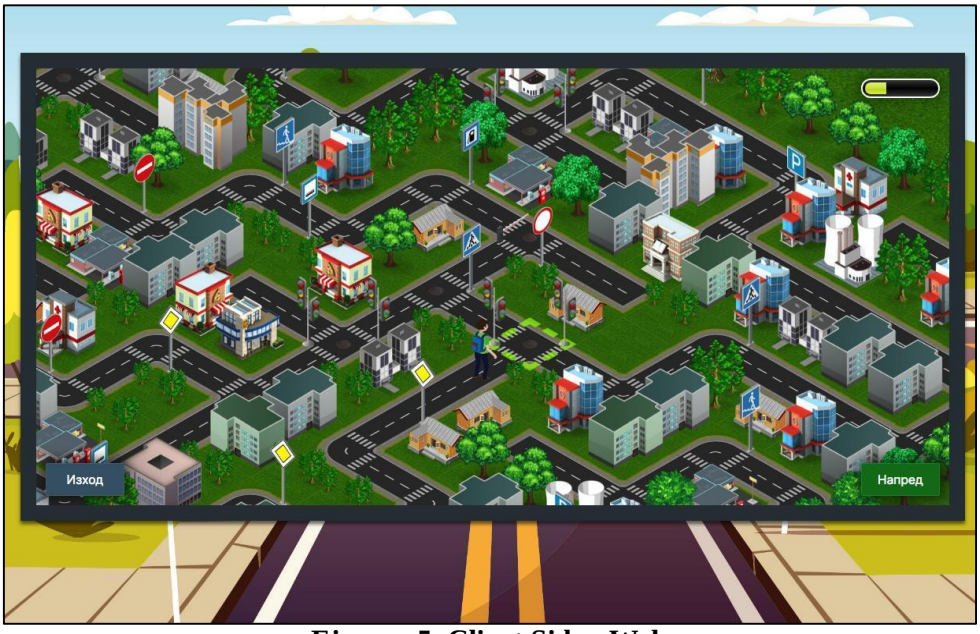

Figure 5. Client Side - Web
Source: Our work

2.2.4 Client Side - Mobile

The mobile client side environment (Figure 6) is designed for students and their parents. It is created with the React Native and exported for the two major mobile platforms currently in place - Android and iOS.

Figure 6. Mobile Client Side
Source: Our work

It stores information about the games provided in the **Game Library**, settings for the user, and a list of available games.

The architecture allows games to be added within the list without further update of the application. Figure 7. represents a game for beginners which is a simple card matching game.

Figure 7. Card Matching game delivered from Game Library
Source: Our work

CONCLUSION

The educational opportunities provided by game-based learning methods are rich and correspond to the child's nature of learning. The theoretical background

of the methodology implemented in our project is Constructivism and a child centred approach to learning considering individual's interests, cognitive ability, strengths and challenges. The created application aim to support SEN students and consists of games and resources supporting development of skills to process information, problem solving, planning, organizing and expanding knowledge about science objects and phenomena, ecology, human body and health. The detailed description of background, software architecture, domain and design of the software in this article provides an opportunity to discuss our project with academic community and share experience and good practice.

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