How to Develop Serious Games for Social and Cognitive Competence of Children with Learning Difficulties

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Abstract: In this paper what we discovered is presented, starting from gathering requirements to design and implementation in the European project called "Intelligent Serious Games for Social and Cognitive Competence". Our main goal with the project is to make serious games with the aim to develop social and cognitive competence of children with learning difficulties and to educate them about social skills, basic skills, key cognitive competence skills and work skills. With the help of 3D simulations and these serious mobile applications which are interactive, the social integration and personal development of the young generation is assisted. Serious games and 3D simulations are utilised by this project so teaching and learning can turn into something interesting, playful, engaging and efficient.

Keywords: serious games; social competence; cognitive competence; intellectual disabilities

1 Introduction

People with intellectual disabilities often face more hardships in their lives than people without disabilities. Having a lack of control and less job opportunities than people without disabilities, less than 10% of people with intellectual disabilities is employed which can be considered a very low level of employment [1]. People with intellectual disabilities often face difficulties (often called barriers) in order to be employed. The UK Valuing People Report [2] and the Learning for Living and Work Report [3] both have given attention to the increasing demand to support and to create suitable training and employment opportunities for the intended audience.

Social competence is a basic skill, which is required in most socially oriented businesses. It is one of the most required skills as it provides the building blocks of complete and effective working relationships and achievement of objectives. Well working relationships and achieving objectives provide positive feelings, e.g. good work-morale and motivation which help not only in building, but in maintaining positive intimate relations. Social Competence (SC for short) is part of both personal, individual growth and professional growth in all fields of work. The effects of the abilities that are found in SC can be seen in some previous, earlier studies. For example, these effects are like having empathy with other people and understanding and accepting their opinions about social activities and about relationships. The effectiveness of many professional activities in the social sphere depends on the level of construction of SC. However, SC is a quite indefinable concept, since healthy social development requires several skills and behaviours, although these may differ if several situations and age differences are considered.

This paper will deal with questions in connection with design and evaluation of certain serious games and the solutions for these questions will also be presented. Serious games are primarily designed to serve as simulations of real-world events. Even if the mentioned games entertain the users, their main aim is to teach the users how to solve a problem. It can be used by a wide range of audiences, including in education (not only for learners, but also for teachers) and in multiple fields by professionals and by other consumers. To reach maximal accessibility and usability [4], it is necessary to design a user interface which will help to minimise the load placed on the users while they are using the software. To achieve the determined goals, previously published design guidelines were followed, while laying a special emphasis on visible animations, displaying graphical elements and auditory output in order to not only promote, but to increase user engagement and provide different alternatives to simple text-based applications.

Media, information technology and communication originally were three separate fields, but they are gradually becoming one by every passing day. Cognitive info-communications (CogInfoCom) [5] is an interdisciplinary field, which is the

amalgamation of the three fields mentioned before. This new field mainly targets engineering applications that are based on emerging synergies between ICT and the cognitive sciences. The cognitive info-communications field can be found in the intersection of cognitive informatics and cognitive communications fields [6]. It should be noted that games which develop SC can be considered as a part of both cognitive media and cognitive informatics.

Development of these games will also be presented in this paper. These games are in the wings of the project called "Intelligent Serious Games for Social and Cognitive Competence" (ISG4competence) (2015-1-TR01-KA201-022247) [7]. The introduced project is European founded.

The project has an aim, which is to develop or expand on certain competences and to help children with intellectual disabilities. Regarding this, the following competences are the main factors in the project:

- Self-esteem and self-confidence,
- Anger management and stress management,
- Keeping a track of the time and also time management,
- Working together as a team,
- Communication with other people in different situations,
- Solving different types of problems where each problem requires a different type of method to be solved.

The games that are planned will help in order to develop or further expand on these aforementioned competencies.

2 Before the Development Started

2.1 The Questionnaire Phase

The first steps in the project were to collect the characteristics of the audience, the tasks, the environment and the materials needed to develop a collection of serious games for children of the young generation with mild or moderate learning difficulties. To gather the necessary information, a survey was needed to be made. This survey was designed to be reachable in an online form and the surveyed audience was also contacted during face-to-face meetings.

As a result, the project members gathered data that could be used for both qualitative analysis and quantitative analysis. As the survey was conducted in five countries, it was available in multiple national languages, so it could reach more

than 500 respondents, including people with disabilities, professionals from educational sectors, special education trainers, etc. A few pages of this survey are shown in the figures below (Figures 1-3).

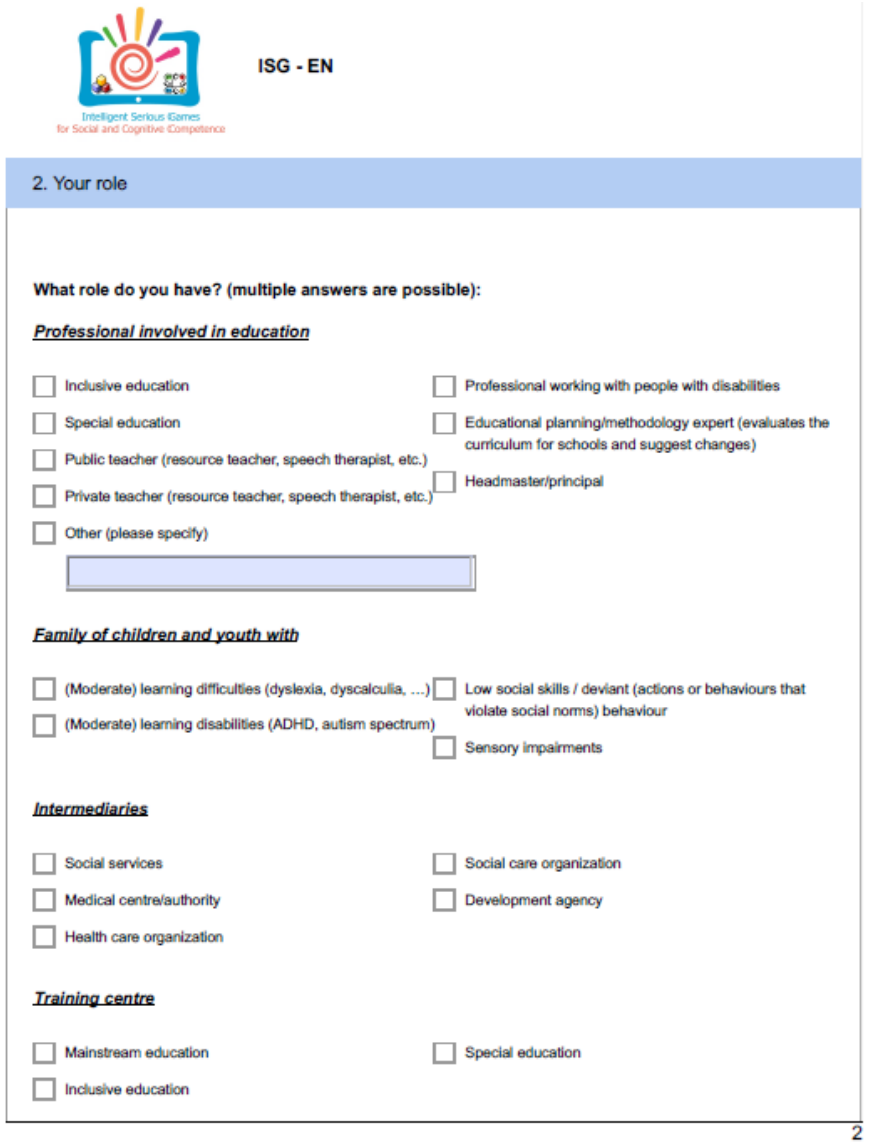

Figure 1
The second page of the survey which asks questions about the role of the respondent

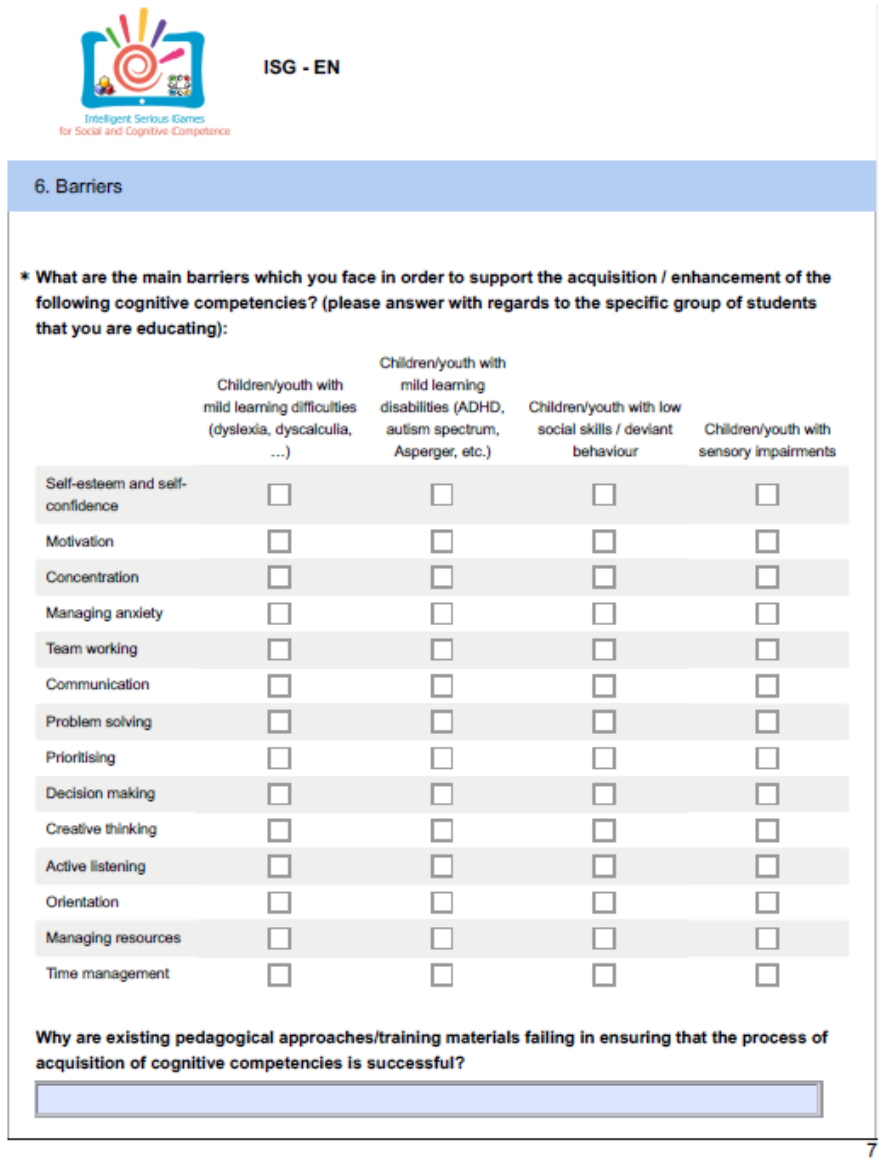

Figure 2
The seventh page of the survey which is questioning about barriers

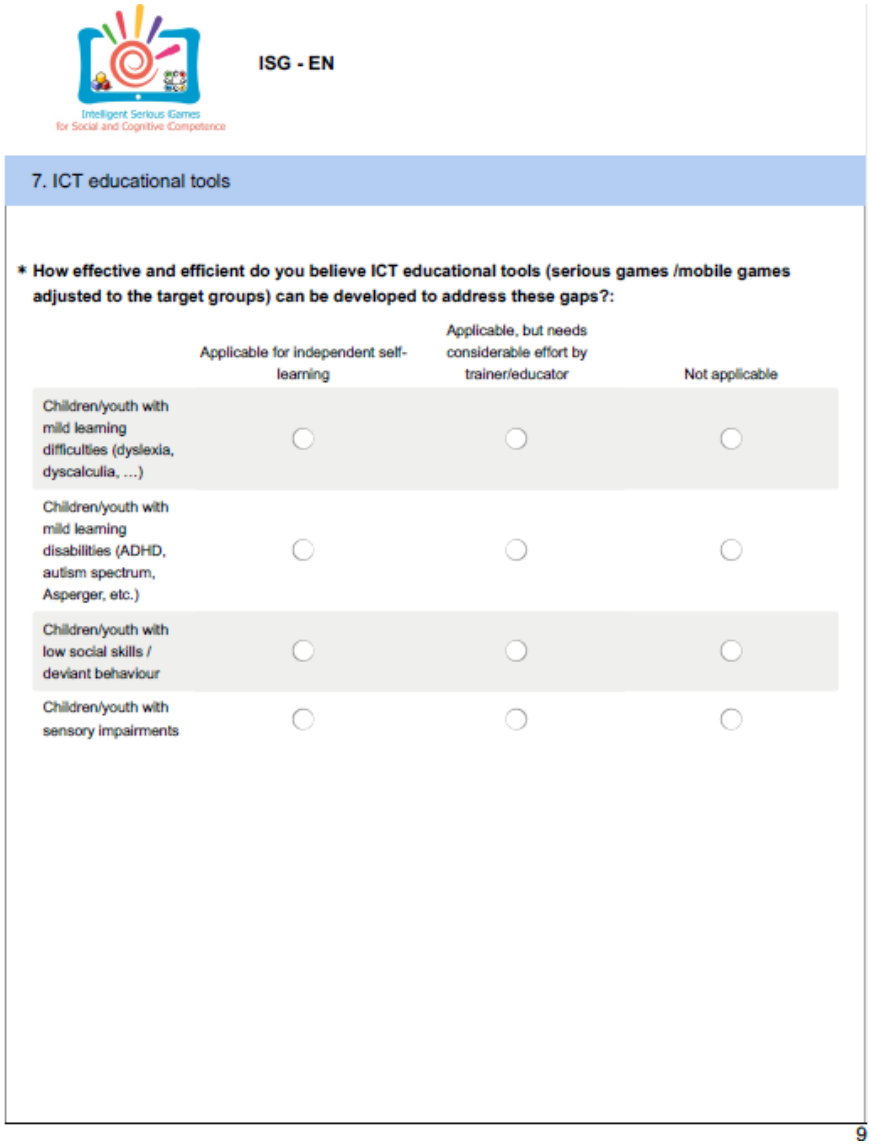

Figure 3
The ninth page of the survey which is about ICT educational tools

As the questionnaire had several pages, it took a while for the people to answer the questions. In the end, questions were answered for multiple interesting topics in this survey. These topics cover (from the CFP) the potential of videogames to support disabled learners, accessibility and usability related issues of serious games for children with learning difficulties, and also asks for the impression of educators about serious games.

Not only the questioned topics were interesting, but the results are interesting as well. The results are the following:

In the formal definition sense, the most basic definition is not the same among countries: The definitions of children and the young generation with learning problems and difficulties are different. Even though the definitions differ, the identified target groups are exactly the same in practice. However, when comparing different countries (for example comparing Bulgaria to Belgium), the degree of inclusive education significantly differs between them.

Regarding pedagogical methodologies there are existing ones which support the acquisition of social and cognitive competencies, but these are mostly diversified and often dependent on the needs of the specific target audiences as every target audience has their own, different needs.

Children and the young generation with learning difficulties face learning challenges every day. These challenges are approximately the same and they can be found on educational and social levels in every country. The basic and key competences (on educational level) like task management skills, social learning skills, self-presentation skills are on the same difficulty level.

2.2 Development of the Content which Allows for Learning

Collaborative blended learning involves a student or just a person who would like to learn with learning difficulties and a trainer or a teacher. The European curriculum of the ISG4Competence is based on the principles of the said type of learning and it is also personalised for each person. It is expected for people who took part to have better social skills and especially better cognitive competence after completing the aforementioned curriculum.

As the curriculum is personalised, the interaction between the trainees with learning difficulties and the trainer is on a conceptual basis. This means that the frequency and the duration of the activities and learning processes differ from person to person. Thus, there are no recommendations for the frequency and for the duration.

Not only there are no recommendations, the “one fit for all” method does not work with this curriculum. As mentioned before, personalisation is the key. Therefore, localisation and customisation is required in everything to ensure that the ICT educational tools (serious games/mobile games) carefully meet the needs of the target groups.

2.3 About the Curriculum

The curriculum has an inductive approach. This means that it begins with the specifics first. It is based on the Taba Model [8] and has the following sequence:

- The needs of the student have to be identified. Keep in mind that the student has mild learning difficulties (which are the gaps in social and creativity skills). Also, the needs differ from person to person.
- Personalisation is essential: Person-driven aims and objectives have to be developed.
- Content that matches the aforementioned aims and objectives has to be selected.
- Sessions that take into account the experience and the abilities of the learner has to be organised.
- An instructional method that is fitting for the person and also promotes the engagement of the student has to be selected.
- After six months, a review is due for the mid-term progress.
- The balance and sequence between different types of activities has to be under regular review.
- Complete the monitoring and the evaluation forms.
- In the end, report to the training coordinators in their respective countries.

2.4 Pedagogical Principles

The ISG4Competence curriculum envisions that the three pedagogical principles which work with activity and exploration techniques are merged into a more extensive range of learning principles that define a better, a more complete learning process while containing an integrated curriculum and problem-based learning.

To include serious games in the education and to achieve the most benefits of the implementation process, it is advisable to consider the following aspects:

- Train the school staff members: The pedagogical staff will be involved in the implementation of serious games. As every game is different, and as every target group is different, it is advisable to train the pedagogical staff beforehand.
- Make the implementation easier: Ask for a technical person from the school staff members who will support and help with using the desktop computers, smartphones and tablets during the implementation phase.

- The more feedback the better: Have at least a second teacher or a member from the pedagogical staff (if possible) who can write observations during the session or help the primary teacher if it is needed.
- Encourage the trainees working together as a team: Have a group of 4-6 students (which is mixed students with and students without disabilities) that could implement a collaborative session.
- Know when to focus on tasks: Choose a session with serious games and the session should have an average time of 8-12 minutes. For educational purposes, exceeding that average time is not advisable as students tend to focus less after that.
- Make it easier for the human eye: Choose an environment (probably the classroom) with at least average, suitable lighting conditions in order to have a better visibility of the screens of computers, tablets and smartphones.
- Noise is an important factor: Avoid noisy environments as much as possible since it has the possibility to distract the students. Encourage the use of a quiet room, far away from the noises, e.g. as far from the traffic as possible.

2.5 Developing Objects for Learning

The next section will not only cover the creation of the learning objects and the serious games – mostly for mobile devices –, but will also analyse them from accessibility and educational standpoints. The next section will also contain answers arisen from research questions (from the CFP) and morals from the design and development of the games for educational purposes. Also, in the previous sections the user needs were identified which serve as the basis of these accessible learning objects. As we worked with the users very closely during development, accessibility and design for all concepts were also achieved in practice.

3 Initial Specifications of the Games

The mentioned curriculum serves as the basis for the serious games. The games below are developed and are available for desktop and mobile use.

- The “MATH” game –With the help of this game, basic mathematical operations can be taught for children. The advantage of this application is that the user or trainer can set the number of exercises and the used types of mathematical operations (Figure 4) [9].

Figure 4
Screenshot of the "MATH" game during a simple addition operation. It can also be seen in the figure that an incorrect answer is coloured red.

- The "Pair Cards" game – As the name suggests it is a card pairing memory game. Like standard memory games, after a while all cards flip to their backsides, and naturally, the user has to find all pair of cards. The customisability of the game is high as new information can be added into the game which opens endless possibilities for learning anything the user wants to learn.
- The "Labyrinth" game –The character in the labyrinth can be moved via rotating the mobile device as the game is controlled by the gyroscope of the device. Fine hand coordination can be practised or learnt. After gathering gems, the player receives letters which can be arranged into meaningful words in a bonus level.

Figure 5
Screenshot of the main menu from the "Cars Race" game

- "Cars Race" game –The user can move the car through a level by touching the screen with their two-fingers as the game is made for one hand play. There are rewards in the game, and the bonus level is a word collecting game. (Figure 5) [10]
- The "VR Shop" game – In this game the user can practice list and money management while shopping inside a virtual mall.

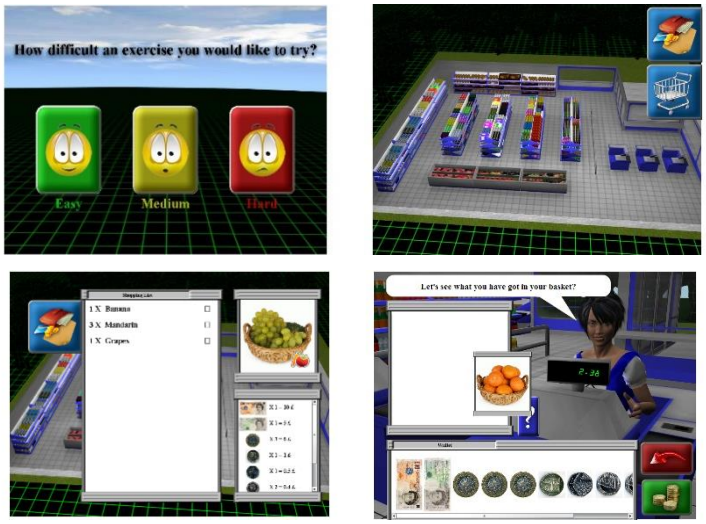

Figure 6
Screenshots from different parts of the"VR Shop" game

- The "Manage Yourself" game – The user in the game has an avatar which means "himself as a playable character in the game". The user has to look after his avatar. He has to keep his avatar healthy and happy by feeding him and giving him drinks. It is also possible to play memory games with the avatar. Furthermore, the game teaches the user with lessons. It is beneficial to take a shower at night in the game before going to sleep by tapping on the dirty spots. If the avatar feels sick, it is useful to see a doctor in the game to cure him.

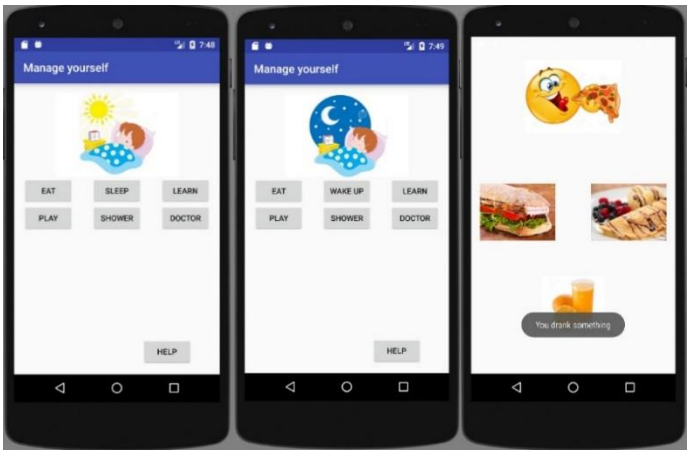

Figure 7
Screenshots of the "Manage Yourself" game during day, night and eating

- "Team Working and Team Building" game – The goal of team building is to develop good working relationships and a good working environment. It teaches how to solve problems, how to communicate with and without feedback, how to follow the instructions of the boss, and also helps with answering the questions.
- "Following the instructions to solve the problem" game – A special classroom will be built for communication. There is a problem in the game and two teams have to work on it, e.g. work on a construction of a building. The first team will give instructions to the second which will try to construct a building according to the instructions of the first group. Teamwork, and due to the boss/employee statuses, communication with and without feedback can be trained with these tasks.
- The "Sequence" game – The base of the game consists of team building while the user has to negotiate if possible. The game allows to increase communication skills and other social skills of the children. Every player has a picture in the game. Everyone has to describe their own picture while they can only see their own pictures as the pictures of the others are not visible to the different players. There is a sequence of the pictures. Keeping that in mind, the pictures have to be put in the correct order so that the mentioned sequence of the pictures will make sense for the players. There are multiple "group rooms" available where the users can log in, so they can play the game with their own friends.

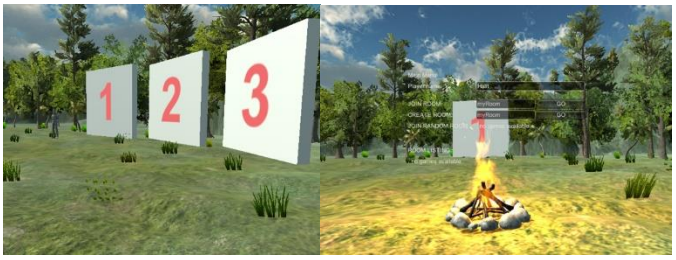

Figure 8
Screenshots of the Sequence game

- Weekend Wonderland game – The setting of this game is child friendly as it takes place in an amusement park. Tasks are presented in a playful way due to it. Weekend Wonderland is a story based game where the avatar of the player is the main character called Ash. As the name of the game suggests the game transpires on a weekend day. Ash is on a journey to the wonderland and player has to interact with the character and has to complete the levels by completing objectives. Aside from tablets and smartphones, this game is available on a computer as well.

Figure 9
Screenshots of the "Weekend Wonderland" game

4 Testing

At the time of writing this study, the aforementioned games are in the last phase of testing. To test the games as much as possible and as differently as possible, a series of classic usability testing techniques were used as a method. There have been many studies regarding this type of testing, for example the study of Lazar et al. [11] or the study of Albert & Tullis [12]. Similarly, in this type of testing there are other methods as well, e.g. the psychophysiology-based methods of Hercegfi which uses objectivity-aiming [13], or with the research of Lógó et al. it is possible to apply experiences of usability research of 3D environments [14].

The opinion about serious games from a special education teacher who deals with personal and small group development of children with special education needs/other pervasive development disorders is presented in this section.

The games that were tested are:

- The "MATHS" game,
- The "Labyrinth" game (where the children called the enemies ghosts, even sometimes called the main character the devil),
- The "Cars Race" game, which can be played by one hand.

The following are the experiences of the mentioned special education teacher about these three serious games developed for Android devices:

- Playing games are activities that we do for the sake of joy.
- Game is a source of joy, which is very important from a psychological point of view as it helps to create calmness, development and also helps to preserve health.

After hearing the experiences of the special education teacher, the following question might rightfully arise: Do computer (PC) games not look like games nowadays?

In case of children with autism spectrum disorder this cannot be as necessarily stated, since PC games can actually develop:

- spatial coordination,
- visual gathering or sometimes auditory gathering of information,
- attention skills /developing attention, keeping attention for long intervals of time, splitting attention,
- logical, deductive skills through solving puzzles or in some cases through connecting parts of the story.

Special education approach has changed very drastically during the past decade. The knowledge of using devices has helped not only for the teachers, but for the students as well. The students have to use these devices in order to develop their skills.

Using personal computers became an effective tool for teachers on different occasions. Computers might make the process of teaching and tutoring more effective and easier, as it might give the children with special education needs an opportunity develop them in a more effective, easier and a more playful way. It has to be noted that if a game feels like a learning game or a teaching game, the children do not want to play that game as much. Most children call that type of games boring or they simply call them bad games. On the contrary, however, if the game feels playful, they would like to play it as much as they can because they feel joy while playing and the game also motivates them to complete the goals within the game. When motivated, the children are more glad to play the games and are actually interested to see what they can do while playing: They try harder to achieve the goals in the game.

Personally modifiable options are helpful and give safety for children to practice the mathematical operations. While practicing everything can be customised: For practicing the four basic mathematical operations, options like changing the sequence, changing the arithmetic comparisons (e.g. greater than or less than, equality relationships) and changing the type of arithmetic operations help the user learn mathematics and simple logic much easier. In the first and second grade, children like to play in the number range of twenties and hundreds, mainly due to the positive feedback and the shortening timeframe gives a kind of competitive characteristic to the game. In the case of children with mild or moderate learning difficulties, their main competitive desire is not to beat the high score of another student, but to beat their own. They want to complete the task with the least number of errors and within the shortest timeframe. This became the most important task for the children.

The "fill in gaps" type game is really hard for the students. In the most cases, they usually have chosen another type of mathematical task to solve. In the case of the game structure it would be practical to divide the "fill in gaps" type tasks from the simple "give the answer" type tasks. In the mixed tasks setting, the "fill in gaps" becomes problematic for the children. It is possible that if these were divided a better way, the children could be much more certain to know which kind of task follows the other and could more easily adapt to the solution of the game.

However, the game is of great importance, mainly because it gives a visual support for the children and the immediate feedback serves as motivation for completing more tasks even if the feedback is not positive. Feedback is the most motivating coefficient in case of children with autism spectrum disorder.

In third and fourth grade children with special education needs start to acquire written operations which serve as a great help for the children. Although since they do not have to play with big ranges of numbers, children would not choose the game since they do not see any challenges in it. Without challenges, games would feel shallow or simply just boring for the children.

In case of personal development for students in their first four grades of primary education these following tasks are of great importance:

- Developing attention, developing concentration skills (to stay engaged in the task),
- For the development of flexible thinking: accepting changes, developing adaptation skills to changes,
- Tasks supporting interaction.

To keep the attention of the children focused for the task the student needs the development of self-discipline, for which the "Labyrinth" game is a suitable type of games.

The "*Labyrinth"* game is a very popular game even in first grade. The children try the game several times before they are finally capable to finish the levels. They call the figure they have to control the "Devil" or "Elf". They love to play with the game as the game is challenging enough for them and a high score list is available for them to surpass their own scores every time. It feels competitive for them.

First, they choose the level that is easier for them, which is around level 8-9-10 as seen during testing.

They hardly ever play the levels which are marked by a key since it is extra hard for them. Even in the case of this game the children want to overpass their own high scores.

"Word puzzle" minigame testing results:

This mini game can be found inside the "Labyrinth" game. Here, the children have to form a word with a meaning from the given four or five letters. To put the letters in their right position the children need self-discipline, patience and a little logic as well.

The solution of the task is successful if the children are doing the task slowly with well-coordinated movements. If they try to be quick or they do not let the letters fall into the right position it is not possible to correct their mistake. The dictionary of the game should be updated, because it is lacking in some words: The children have found several meaningful words which were not accepted as a good solution by the game. Aside from this small de-motivating factor the game is beneficial; it helps the children with their language skills. We always need to strive for the successful completion of the game.

The game can be a good basis for other language based games, like expansion of active vocabulary or creating sentences.

The *"Cars Race"* game is a really good choice:

for development of keeping attention for a longer time,

for development of movement coordination of the hands,

for the practice of left-right orientation.

The game is very popular among boys in second and third grade. Only one of the students could solve all 16 levels. The students most usually control the game with two hands: right hand for controlling the acceleration and the deceleration of the car which is a way of moving forward and the left hand for making the car jump over some barriers and chasms.

This monitoring process proves that:

- Children feel joy, curiosity and sometimes even feel competitive while playing with the games,

- The information coming from different channels is a great help which means that it is always positive to have a teacher in the near vicinity of the children,
- Addressing children individually is very important and the games support this,
- Children are motivated, socially are more active and their communication becomes more confident,
- They are easier to reach while they are playing, and they can feel if the teacher is interested in their games.

The following are the clearly visible developments:

Individually general development	really fast development
Mostly developed skills	Keeping the instructions, co-working with peer and adults

Regarding future research in this topic, the aforementioned collaborative development can be a promising scope of research: Usability testing of team work capability of the different game engines is possible while also analysing the demeanour of the team through different types of collaborative work and the coherence of shared mental model and the success of the said collaboration (Geszten et al.) [15].

5 Using the Serious Games in an Educational Environment

Educational applications have been present for a very long time in multiple areas. Throughout the years their use differed in each school, in each hospital and in each country. Most serious educational games are antiquities from the past which represent a big challenge for the didactic field, as games nowadays break away from a large number of teaching and learning approaches in a school context. These types of games need to evolve into the current standard of the new generation to be effectively used in schools or in other areas.

Didactic design has a concept which also draws on multiple different pedagogical approaches such as Computer Supported Collaborative Learning (CSCL).

When students with disabilities and students without disabilities engage in a cooperative work, their dialogue is very explorative. They are very curious about what to do with the problem and how to solve the problem. However, they propose hypotheses about the problem, explore and learn about the problem and they discuss their findings. The teacher or the trainer plays a critical role here as the progression of their work is based on a common acceptance of the different opinions and proposals which is facilitated by him.

This is a crucial part of the theory and it becomes very important when the ISG4Competence games get applied in the classrooms. The most important part of the theory is the design of the dialogues and contents in the game. Games are designed in a way that thanks to the dialogues embedded within them, the teacher becomes an important actor by encouraging the development of the explorative dialogue. The teacher is the one in the centre of the communication channels between the students and the games.

The ISG4Competences games generate new, dynamic learning opportunities, engaging students in productive classroom discussions by forcing the students to be engaged, to argue and reflect upon the learning goals. This way, the students are immersed in the world of the games. While they feel that they are inside the world of the games, they feel motivated to do the tasks presented in the games. Doing so, they do not realise that some of their skills are improving while playing the game as they are too focused on doing the tasks joyfully.

When games are discussed for example with a teacher in a school it is essential that the said teacher sees the advantages of trying out and using the games. If the teacher recognises, approves and realises that the students can be motivated to learn with the particular game while it is easy to implement in the classroom to support the goals of learning, then the whole class of students can see its benefits. If all standards and distinct goals can be achieved then the game has maximized its potential in the classroom. It has to be noted that gaming for fun vs. gaming for educational purposes is not the same. There is a great difference between the two as educators "start with learning goals, and gaming media choices will be made based on the games potential to meet those goals." (Dikkers 2015) [16].

The power of game-based learning lies in the fact that a teacher not only can teach content or information, but s/he can also incorporate 21st Century skills easily [17]. Through collaborative game play, building, problem solving, communication, and networking, students with learning difficulties could develop the necessary social and cognitive competences that will prove vital to their future. Education slowly starts to understand that it is not the content that matters as much as before, but the ability to use the necessary content to solve real problems. As we move toward educating the next generation of children, called the Z-generation in which the children rely on digital technology more than ever before, we need to understand that these children – even the children without disabilities – also require a different type of education than the generations before it [18]

When using games in a classroom, the teacher also needs to remember that the game is not the teacher, but s/he is. The game is just an activity whereas the teacher is not only a teacher, but the one who stands in the centre of the communication channel between the game and the students. As a teacher/trainer when using games, s/he should avoid intervening when students are figuring something out: The teacher has to know when to help and when to avoid helping the students. This offers the opportunity to the students to play with games as part of a system.

Conclusion

During the ISG4Competence project, ten games were designed and developed with the help of multiple universities and countries. Regarding the target groups for the games, there are two types of target groups who can use the collection of the serious games and benefit from it.

The first target group is made up from the learners who may take benefit from the collection of serious games. This target group is related to the following beneficiaries:

- *Students with mild learning disabilities* (slow rate of maturation, reduced learning capacity and unsatisfactory social adjustment),
- *Students with sensory impairments,*
- *Students with low-level social skills,*
- *Students with specific learning difficulties (dyslexia, dyspraxia, autism spectrum disorder, ADHD).*

The second target group is made up from those people who may take benefit from the exploitation of the collection of serious games and who are working with the above mentioned learners are:

- *Professionals that are involved in education* – Inclusive education; Special education; Public teachers (resource teacher, speech therapist, etc.); Private teachers (resource teacher, speech therapist, etc.); Professionals working with people with disabilities; Educational planning/methodology experts (evaluates the curriculum for schools and suggest changes); Headmasters/principals.
- *Families of children and young generation with disabilities* - (Moderate) learning difficulties (dyslexia, dyscalculia,…); (Moderate) learning disabilities (ADHD, autism spectrum); Low social skills / deviant (actions or behaviours that violate social norms) behaviour;
- *Intermediaries* - Medical centre/authority; Healthcare organization; Social care organization; Development agency,
- *Training centres* – in the context of mainstream education; Inclusive education; Special education,
- *Academicians* - (Special) pedagogy; Psychology; ICT / gaming /Assistive technologies, etc.

Every phase of the project, for example the development and the testing of the intellectual outputs had a certain target group of learners with the help of special teachers or trainers. In fact, every target group and beneficiary mentioned above were involved in all phases of the project including representatives in the national advisory boards in each partner country [19].

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