2017-1-ES01-KA203-038370

Section 2
Chapter 6 - Educational Videogames: An overview

Theoretical Framework

6.1 Genre and technology of educational videogames

In general, the classification of videogames is usually based on criteria set by the game developer, such as the target audience, the characteristics or underlying objectives of the videogame. Therefore, when it comes to the classification of videogames in general, and educational videogames in particular, it should be noted that the publishers of a newly released game rarely place it to a specific game category or genre. Moreover, it is possible that a videogame that was initially classified in one category on the market, to fit into other genres as well (Kirriemuir & McFarlane, 2004).

In the following sub-sections, classifications based on various aspects of an educational videogame are presented.

6.1.1: Classification based on game type

One of the early classifications of entertainment videogames was carried out by Herz (1997) and was based on the type of a videogame. More recently, in an attempt to synthesize all the opinions expressed in previous classifications for educational videogames, Richards, Stebbins, & Moellering (2013) came up with the following genres, which might have some degree of overlap:

1. Drill and Practice
2. Puzzle
3. Interactive Learning Tools
4. Role Playing
5. Strategy

Co-funded by the Erasmus+ Programme of the European Union

6. Sandbox

7. Action/Adventure

8. Simulations

1. Drill and Practice

This genre includes educational videogames related to the acquisition of factual knowledge or skill development through repetitive practice. These games can be used autonomously or at the end of a learning module as a kind of reward through gaming. Teachers could also use these games as a feedback method in order to record students' performance in class. *MathBlaster*[1] is an indicative example of this genre.

2. Puzzle

These videogames focus on solving problems by manipulating shapes, colours, or symbols that should match according to specific standards. Indicative examples of this category are *Tetris* and *Foldit*[2].

3. Interactive Learning Tools

These kind of activities are learning objects with gaming features and mechanics that can be integrated into an online learning environment. Short animations, videos, interactive quizzes, etc, can fit into this category. Indicative example is *BrainPOP*[3].

4. Role Playing

The educational videogames of this genre have a narrative. They offer the player the possibility to interact with the game environment through a digital character (avatar) and support various ways of interaction. During a role-playing game, players can revisit times of places they had previously

[1] http://www.knowledgeadventure.com/games/mathblaster/

[2] https://fold.it/portal/

[3] https://www.brainpop.com/

Co-funded by the Erasmus+ Programme of the European Union

explored (Hitchens & Drachen, 2009). Indicative examples of educational games in this category are *iCivics*[4] and *Martha Madison*[5].

5. Strategy

The videogames of this genre offer gameplay based on traditional strategy board games, allowing players to have full access to the game environment and its resources. Usually, these games are multiplayer and players need to follow carefully developed strategy and tactics to overcome challenges. Indicative example is the *Civilization* series.

6. Sandbox

Videogames of this category are also known as open-architecture or open-world games. They include exploration features rather than a linear development. Players can create their own virtual worlds or follow a storyline chosen by the game designers or create their own story in a virtual world created by the game designers. Indicative examples of this genre are *Scratch*[6] and *MinecraftEDU*[7]

7. Action/Adventure

Action/adventure games put the player in unknown virtual environments where they have to participate in long quests and overcome obstacles using an item that they found and collected while exploring the environment. Indicative example of a educational videogame of this genre is *Lure of the Labyrinth*[8].

8. Simulations

The videogames in this genre have one thing in common—they are all designed to emulate real or fictional reality, to simulate a real situation or event. Many simulations are not as dynamic as

[4] https://www.icivics.org/

[5] https://www.secondavenuelearning.com/products/martha-madison

[6] https://scratch.mit.edu/

[7] https://education.minecraft.net/

[8] https://labyrinth.thinkport.org/www/

Co-funded by the Erasmus+ Programme of the European Union

videogames of other genres, but some of them largely overlap with strategy and sandbox games. Indicative examples in this genre are *EcoMUVE*[9] and *SimCityEDU*[10].

[9] http://ecolearn.gse.harvard.edu/ecoMUVE/overview.php

[10] https://www.glasslabgames.org/games/SC

Co-funded by the Erasmus+ Programme of the European Union

6.1.2: Classification based on time

Any discussion about the use of videogames in the educational process should take into account the time dimension, which concerns the duration of school hours and the total time devoted to a specific lesson unit. Based on this, educational videogames can be distinguished in short-form and long-form (Richards, Stebbins, & Moellering, 2013).

According to this distinction, short-form educational games or interactive activities can have a duration of around 10-20 minutes, thus can fit within a single class and focus on practicing particular concepts or skills or be used for demonstration reasons. Short-form games include drill and practice, brief simulations, visualizations, or simulated training tools. They are aimed at the acquisition of factual knowledge through repetitive practice, such as memorization of vocabulary word definitions, math facts, or typing skills.

Long-form educational games extend beyond a single class period and game playing is spread over multiple sessions or even several weeks. Long-form games have a stronger research base than short-form games, are more immersive and focused mainly on higher order thinking skills that align to skill sets such as critical thinking, problem solving, collaboration, creativity, and communication.

Towards the same direction, Squire (2008) included the factor of time that is required to complete a videogame as one of the categorization axes in his classification framework (see Table 1). He considers the time required to complete a videogame critical for the entry of the game in the educational process as well as for the evaluation of the learning outcomes that occur.

Co-funded by the Erasmus+ Programme of the European Union

Table 1: Framework for Examining Different Games *(source: Squire, 2008)*					
Game Genre	**Time to Completion**	**Timescale**	**Openendedness**	**Modes of Creative Expression**	**Educational Examples**
Targeted games (puzzle, mini-games)	1-4 hours	Weeks	Low	Style of completion, level creation	Supercharged
Linear games (Viewtiful Joe, Ninja Gaiden)	20-40 hours	Month	Low	Style of completion, machinema	Full Spectrum Warrior, epistemic games
Open-ended, sandbox games	100-200 hours played over multiple months	2-24 months	High	Style of completion, multiple solution paths, modding	Civ, Sim City
Persistent worlds (WoW, Everquest)	500+ hours	6-48 months	High	Modding, social engineering, game play	Quest Atlantis

6.1.3: Classification based on game technology

The technologies used for game development are common both for educational and leisure videogames. A sample of these technologies as well as the interaction devices and game platforms that are utilized, are briefly presented in this Section.

1. Technologies for game development

The majority of games are written in some form of C (C, C++, C#, Objective C). The first few generations of game consoles were using mostly straight C (and Assembly/machine code) for performance reasons. C++ is a very powerful language that became popular in the early 2000's and is now the predominant language of PC/console games. Objective C is an Apple variant of C which is similar to C++ but is the native language of iOS. C# was developed by Microsoft as a Java alternative. It was originally used for making Windows applications, but has gained popularity for games development.

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Java is mostly used for the development of Android games, while Javascript is typically used for web browser-based games. Python is a simpler language that can be used in everything from web development to desktop applications. It is good for developing simple games but not really suitable for real time games.

There are also software packages that help with game development, such as Adobe Flash, Android Studio, Adventure Game Studio, GameMaker Studio, and others. Nowadays many videogames are made using 'Game Engines'. A Game Engine is a software-development environment that allows game developers to build their game without worrying about the underlying code. Some popular Game Engines are Unreal Engine, Unity3D, CryEngine, Godot and others. Game Engines offer possibilities to construct games for consoles, mobile devices, and personal computers. Their core functionality typically includes, among other features, a renderer for 2D or 3D graphics, a physics engine or collision detector (and collision response), sound, scripting, animation, artificial intelligence, networking, scene graph and may also include video support for cinematics.

2. Interaction devices

Initially, Cathode Ray Screens (CRTs) were used. In recent years, other technologies like Plasma - PDP, liquid crystal-LCD, thin-film TFT transistors, LED Light-Emitting Diodes, are being used. Also, 3D and 4D screens are being used. On 3D screens, the player's perception comes from the ability provided to each eye to see a different face of the world. To this aim an image is created for each eye. On 4D screens, the 3D screen is combined with natural effects like wind, rain, etc. In addition to monitors, special display devices that can be mounted on the head are also being used (e.g. Google Glasses, Oculus Rift, etc).

Today videogames which use special devices are available for sale. The player buys the **gaming device** or **home console**, such as Xbox, PlayStation 4 or PSP and Nintendo, and they can play the videogames for as long as they want.

Depending on the videogame platform, general purpose **input devices** such as mouse, keyboard, joystick, touch screen can be used. More recently, sensors like the Kinect, enable players to

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

control and interact with their game console through a natural user interface using gestures and spoken commands.

The rapid growth of smartphones and tablets has led to the creation of videogames only for such devices. Game design for **mobile devices** takes advantage of features such as touch screens, camera, geographic identification system and augmented reality possibilities. At this point it is worth mentioning the parallel development of microtransactions. In mobile games which are initially free of charge, "digital" assets are provided to players for a specific cost.

Another category of videogames that generally require special technology is that of **Virtual Reality (VR)** games. Components such as head-mounted units provide stereoscopic screens and motion tracking. Control units can also be attached to the player's hands or to other body parts. The player is immersed within a virtual environment that responds to their movements and can interact with it. Interactions are controlled by a specialized computer system that processes the data from the various VR components.

3. Game platforms

The electronic systems used in videogames consist of computer systems which are either general purpose computers or devices specifically designed for the specific videogame. These hardware systems in conjunction with the corresponding software form the so-called **platforms**. Platforms can vary according to their capabilities and the type of their information system, as well as the capabilities of the specific device in combination with the software used. Usually, videogames developed for a particular platform are not compatible with other platforms.

In the 1980s, **arcade** games were popular. These are videogames encased in a special, large coin-operated cabinet with built-in console, controllers (joystick, buttons, etc.), a CRT screen, and speakers. These machines were installed in public places.

Improvement in the internet access speed and programming tools such as Java and Flash, have made it possible to develop videogames that can run on a web browser. Internet access is the only prerequisite to play these games. They are characterized as **web-browser based** games and their

Co-funded by the Erasmus+ Programme of the European Union

functionality is independent of the hardware used by the players. A sub-category of these games are the **miniclip** games. Several miniclip games are educational[11].

Currently end users have direct playability of games across various devices without downloading or installing the actual game. This form of online game distribution is known as **cloud gaming**. It as a novel computer architecture that leverages cloud resources to improve gaming performance, such as rendering, response time, precision and fairness (W. Cai *et al*., 2016).

6.2 Learning theories and educational videogames

Apart from the integration of a videogame into a specific educational context, it is equally important to examine the underlying learning theory applied by the game designers. Various educational videogames have been created based on well-known learning theories. Some of them have embraced the constructivism principles. According to **constructivism**, learning is not directly offered to the learner, but it is a personal procedure of building the knowledge based on previous knowledge already obtained. An example of videogame which is based on constructivism theory is the SciCtr. In this videogame students create virtual worlds that their classmates can visit and explore.

Papert, expanding the positions of Piaget, claimed that, besides the knowledge building process that is developed internally, the learner can create "constructions" that their classmates can see and criticize. Thus, the theory of **constructionism** was created. Examples of videogames based on the principles of constructionism are *SuperCharged* and a community-supported constructionist version *Hephaestus*. Both games have been designed at MIT.

Experiential learning is another category of educational approach utilized in videogames. In this category we can include videogames in which learning is accomplished through action (i.e. learning by doing). These games are distinguished by the setting of goals, missions, roles and narratives. Players are provided with feedback and resources. Indicative games in this category are the *BioHazard*, *La Jungla de Optica* and *Daedalus' End*.

[11] https://www.miniclip.com/games/tag/education/en

Co-funded by the Erasmus+ Programme of the European Union

Experiential learning is facilitated by previous learner's experiences. In addition to concrete experiences, experiential learning utilizes reflective observation, and active experimentation. This approach is followed in the 3D role play game *Global Conflicts: Palestine* in which a journalist collects information and writes articles about the Israeli - Palestinian conflict. When significant guidance is provided within an experiential learning videogame then the game is classified as **Guided Experiential Learning (GEL)**. The videogames *Full Spectrum Warrior* for combat strategy and *SLIM-ES3* for combat skills fall into this category.

The **good practices - cases** educational method is another form of experiential approach. It exploits real stories in which the player is asked to take the role of a leader who has to decide on various issues and experiment with different options (**case-method teaching**). The *Army Excellence in Leadership (AXL)* was created to train leading officers of the US Army. It combines experiential and inquiry-based learning rather than memorizing. The *Quest Atlantis* is a 3D multiplayer game for ages 9-12 that falls into this category. The inquiry process is triggered by observing, collecting and recording events.

One of the well-known learning theories is **discovery learning** which is based on searching for information through asking questions. This process is adopted by the 3D videogame *The Monkey Wrench Conspiracy* and the multiuser videogame for financial management *Gamenomics* (Kebritchi & Hirumi, 2008)

The **situated cognition** theory is related to the acquisition of knowledge and skills in original contexts as those students deal with in everyday life. Learning is considered to be a socio-cultural function that is better achieved in real environments rather than through a personal and internal process. For several researchers (Halverson *et al.*, 2006) this theory can provide a valuable framework for game design and study. An example of videogame which is based on situated learning is *Racing Academy*. This game teaches engineering principles through virtual car racing. It is also proposed to consolidate learning into an authentic context or a community of practice.

Cognitive apprenticeship belongs to the situated cognition theories. The additional element in this theory is the guidance offered by the teacher to the students. The teacher provides support and

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

guidance that gradually decrease to the point that students are encouraged to act independently. Indicative videogame in this category is the *simSchool* that trains teachers in improving classroom management skills and diversified teaching. Guidance is provided through prompts, feedback and help. The difficulty of the game gradually increases.

The aforementioned examples of educational videogames that exploit a particular learning theory are a small part of all educational games. A study by Wu, Hsiao, Wu, Lin & Hang (Wu *et al.*, 2012) notes that only around 14% of game-based learning is related to a specific learning theory. Indeed, the most prevalent learning theories that are utilized and are recorded in this study are experiential learning and situated learning.

Scientists, who study the learning theories and the ways they are applied in games, use the terms **game rules**, **gameplay** and **game narrative** (Ang *et al.*, 2008). Regarding game rules, Frasca (1999) indicates the following two types: ludus rules and paidea rules. The ludus rules exist in videogames that have a winner and a loser unlike games that contain paidea rules. Depending on the specific game rules, videogames can be distinguished in **ludus games** which operate on predefined rules set by their designers and **paidia games** which offer greater freedom and are considered to be more "open". An example of videogame that consists only of paidea rules is *Civilization III* (Squire *et al.*, 2008). In this game the player aims to conquer a status of happiness for the citizens. If this is not achieved, the city enters an anarchy state. Game play is not just the memorization of game rules but also the player's interaction with the game through the game rules and their emotional connection to the plot (Egenfeldt-Nielson *et al.*, 2015). Game narrative is the story that describes a sequence of events and also includes the game environment, the characters and the action.

6.3 Design of educational videogames

The disciplines involved in the development of educational games relate to the underlying learning theories and the design of the game. Each educational game should be related to a specific scientific area and should be integrated into the educational context of specific course(s). In addition, any educational videogame is itself a software application. Thus, the design and development of an educational videogame requires a multi-disciplinary team that includes

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

software programmers, experts in learning theories, game, interaction and graphic designers and educators on the specific learning subject addressed by the videogame.

Elements that affect the design of an educational game are the manipulation of multimodal media, the usability of the game, reward mechanisms, player types as well as the fulfilment of the learning objectives set in relation to the learning subject. Research efforts have attempted to organize and record all the factors that need to be taken into account when designing and developing an educational game.

The role of rewards in educational games was examined by McKernan *et al*. (2015). They designed and developed two versions of an educational game. The high-rewards version contained tokens, prizes, badges, performance scores, audio-visual feedback, victory animations, sound effects, positive verbal feedback and cut scenes. All the above rewards were reduced in the low-rewards version. They conducted a repeated-measures experiment with their game as input. Subjects of the experiment were primary school children. According to their findings the quantity of in-game rewards did not affect children's learning or feelings. Players felt rewarded depending on their engagement or satisfaction.

Game players do not have the same interests and motivations. In order to design and create an attractive environment for all of them is necessary to recognize the different player types. According Bartle (1996) there are four types of players in virtual worlds: Explorers, Achievers, Socializers, and Killers.

Hamari, J. & Tuunanen, J. (2014), reviewing previous relevant studies, indicated that different types of game-players could be synthesized into five key dimensions concerning to motivation of the player: Achievement, Exploration, Sociability, Domination, and Immersion. All proposed player types in relevant literature, were based in Bartle's original work. Immersion is the only new dimension that added to Bartle's model.

Roslina & Azizah (2009) have created a design framework for educational games which, in addition to the learning theory on which the game is based, also considers other pedagogical issues and

Co-funded by the Erasmus+ Programme of the European Union

issues related to the game design and the modeling of the learning content. Their approach is illustrated in Figure 1.

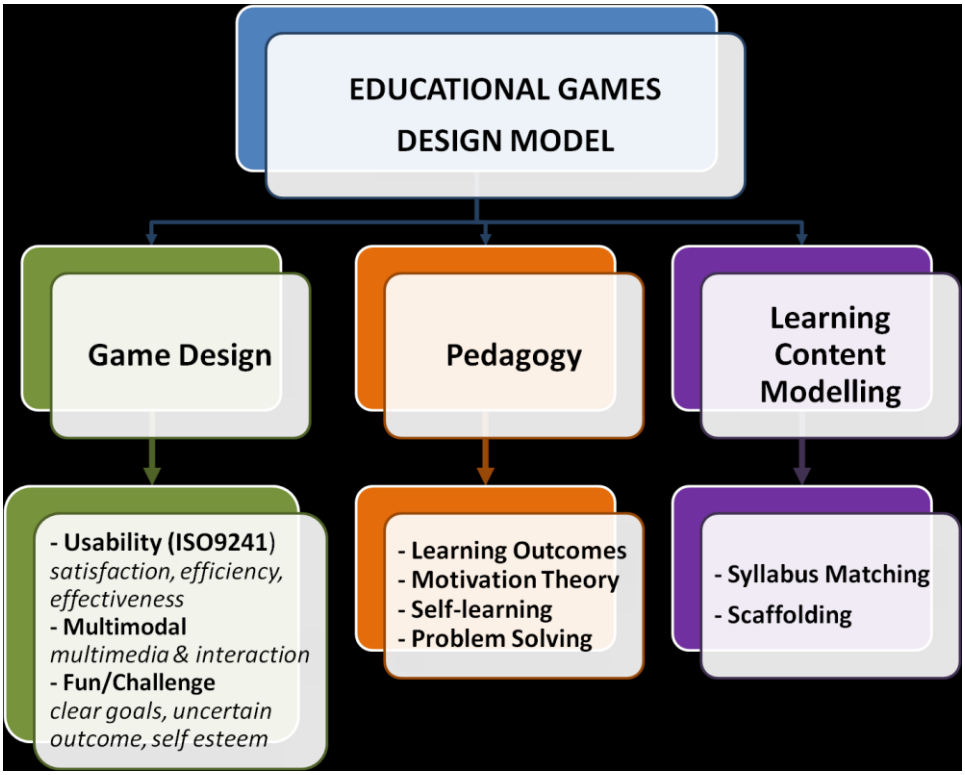

Figure 1: Factors for Educational Games Design (*source: Roslina & Azizah, 2009*)

According to this framework, **game design** includes issues such as **usability**, (satisfaction, efficiency, effectiveness), **multimodality** (multimedia and interaction), **fun - challenge** (clear goals, uncertain outcome, self-esteem).

Usability is related to technical issues of the user interface design in terms of player's satisfaction, efficiency and effectiveness.

Multimodality refers to the player's interaction with text, sound, graphics, animation or video.

With regard to the **pedagogical design**, the first issue addressed by this framework is the management of the learning goals based on the Bloom taxonomy framework. The learner-player becomes aware that they can **learn by themselves** beyond the school time. This is achieved

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

through **self-assessment** activities. Such activities can be incorporated into the videogame in order to evaluate learner's **motivation** to learn out of the classroom. Additionally, the game can include **problem-solving** activities to promote high order thinking skills.

The designer of an educational game must consider all aforementioned issues as well as how to convey the learning content that is to be included in the videogame. The course curriculum can be a useful tool in this direction. Moreover, as proposed by Amr (2012), an effective educational game must include three important features: **challenges, fantasy** and **feedback**. Fantasy makes the entertainment part. Challenge can be construed as both a pedagogical feature as well as an entertainment aspect. Feedback constitutes the pedagogical component.

On the other hand, Aleven *et al.* (2010) proposed a framework based on three components: Learning objectives, the MDA (Mechanics, Dynamics and Aesthetics) framework and the instructional principles. To determine the **learning objectives**, three basic questions need to be answered: i) what is the prerequisite knowledge, ii) what knowledge will be gained through the game, and iii) what potential knowledge can be gained that goes beyond the scope of the game. The **MDA framework** is one of the first frameworks proposed for educational games design (Hunicke *et al.*, 2004). According to this framework, the designer focuses on the game mechanics (turns, action points, auction or bidding, victory conditions, etc.) whereas the player interacts dynamically with the aesthetic part of the game. The **instructional principles** are determined by the learning theories on which the educational design of the game is based.

Another framework proposed by Van Staalduinen *et al*. (2011) can be used for both educational and serious games. In fact, their proposal can be used to initially design a game as well as redesign an existing game. According to this framework, the game designer has to follow three stages; during the first stage, where learning is the issue, the **learning objectives, learning content** and **player goals** must be identified. The second stage is related to the instruction, therefore **game engagement** elements such as user learning, user behavior, and player feedback should be identified. The final stage is associated with assessment so system debriefing and feedback is the goal here.

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

6.4 State of the art technologies and educational videogames

According online oxford dictionary, Virtual Reality (VR) is defined as a "… computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors". Through VR a real or artificial environment is simulated. Interaction with the virtual environment is facilitated through glasses or head-mounted devices on which the scene is rendered.

There are several reasons why virtual reality environments are considered to have advantages that can be used in education. Some of these are the active involvement of students in the educational process, providing students with authentic frameworks to build their knowledge through experience and the ability to incorporate features related to 21st century skills. For example, VR can make possible the exploration of planets, tours inside the human body, and visits in molecules or historical places. These possibilities would not be affordable with traditional teaching methods. For these reasons, adding VR features to educational videogames can enhance motivation and curiosity and increase the resulting learning effects.

In Augmented Reality (AR) systems, the view of the physical world is enriched with digital content that can include visual, tactile, acoustic, gustatory and olfactory stimuli. Portable devices such as mobile phones and tablets are commonly used, while physical objects are identified through indicators such as QR Codes or their Global Positioning Systems (GPS). As with VR systems, engaging students in the learning process and providing students with authentic frameworks to build up their knowledge are advantages that can be used in education. In AR systems, situated learning takes place not only in virtual but in real worlds too. In addition, the learning provided is assumed to be inquiry-based as students are required to look for and manage both virtual models and physical objects.

In places like museums and parks, treasure hunt games with AR features could be used to make learners observe and draw information. These experiences can foster students' reflection on related knowledge acquired in class. The same systems can provide innovative ways of social

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

interaction through games. Although game environments generally provide possibilities of social interaction, in the case of AR this interaction occurs in coexistence of the virtual and real environment.

Kinect is a motion-sensing device that enables players to control videogames without touching a controller. Kinect accurately detects human body movements. Therefore, the movement of each part of the body (head, arms, legs, basin, etc.) and any part of it (e.g. knee, ankle etc.) is a different input signal that can be used by the software to create an extremely interesting interaction within a game. An example of an educational game which exploits Kinect is *Jumpido*[12], a game for mathematics which requires students to combine intelligent thinking with physical gestures in order to solve problems.

The wide use of mobile devices (tablets, smartphones) enables the development of educational games which can track players' location utilizing the GPS of the device. These games are called "mobile location-based games" and sub-category of them are the "urban games" or "street games". These games are multiplayer, played outdoors in urban environments and in different locations, and last for a long time (pervasive games) while others are played at specific time and place (e.g. during a visit in a museum).

The Internet of Things (IoT) is defined as a network of physical and digital objects that are inter-connected via standardized protocols. Therefore modern school laboratories, apart from computers, may have Arduino systems, tablets and other devices which can be combined with IoT applications in order to integrate physical objects in a digital game environment (Petrović *et al.*, 2017).

Haptic technology offers an additional way of interaction apart from visual and audio interactions. Through the sense of touch the user experience is enriched and becomes more immersive. Additionally, haptic interaction can be helpful for those with visual impairment. The devices used are distinguished in tactile and force feedback. Generally, the game experience can have multiple

[12] http://www.jumpido.com/en

Co-funded by the Erasmus+ Programme of the European Union

aspects such as physical, mental, social and emotional. Games that use force feedback haptic devices can improve user's physical skills by providing them with a more natural sense of play.

6.5 Insights on incorporating educational videogames in classroom

6.5.1 The role of the teacher

Teachers play a crucial role in the use of educational games in the classroom. They have to act as mentors in order to tie the implicit learning to the explicit. Therefore, they need to be able to draw attention to the learning taking place through the game and make students aware of the learning that they have experienced. This can be done through a variety of ways, such as discussions directed at pairing the learning content with the gameplay experience. This requires the teachers to have played the games and to be aware of the offered game experiences.

Teachers also have to align the game with the curriculum. This alignment can contribute to the partial use of the game in individual sections of the curriculum. Teachers have to decide at what stage of the learning process the videogame will be integrated. This decision should be taken in the light of the specific course curriculum and the learning outcomes of the specific module. For instance, videogames can be utilized before class in order to help teachers organize the learning content during class presenting relevant examples and using it for practice.

To be properly integrated in the educational process, an educational videogame should only be considered as an additional educational resource that needs to become part of an educational activity in the context of a broader design. Regarding the integration of a videogame in the educational process, it is important to mention the findings of the research carried out by Squire, Barnett, Grant, and Higginbotham (2004). This study concerned students who played videogame *SuperCharged*. Initially, the researchers found out that students were assisted in coping with their misunderstandings about various Physics concepts. At the same time, the researchers recognized the significance of the way that the game was integrated into the educational process. In particular, the teachers initially recorded students' reactions to specific aspects of the game. At a later stage, using a video projector, they presented snapshots of the game, prompting students to

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

interpret the content of the game and anticipate its evolution. In this way, students focused on Physics concepts and their reflection processes were improved.

In general, teachers must be prepared because adding games to the classroom can be a challenge as it changes the dynamic with students. When using games, teachers should avoid intervening when students are figuring something out. This affords students the opportunity to play with games as systems.

Play should not be graded; instead, assessment should be targeted only to the learning transfer from the game experience to the curriculum, which is something that teachers can facilitate. Assessment activities must not distract students from playing. This type of assessment is known as "stealth assessment". According to Shute and Ke (2012), *"Stealth assessment refers to evidence-based assessments that are woven directly and invisibly into the fabric of the gaming environment. During gameplay, students naturally produce rich sequences of actions while performing complex tasks, drawing on the very skills or competencies that we want to assess."* (p. 52)

6.5.2 Challenges and possible solutions

According to teachers that use educational videogames in the classroom, the greatest barriers are time, cost (game licenses, etc.) and the lack of technological resources in many schools.

Regarding lack of resources (e.g number of devices) a solution might be to have students play the game in groups, collaborating and working together. Then they could do a group writing project to describe how the game impacted their thinking about the subject matter. While one group plays the game, the others do non-digital activities and this process can be rotated.

There is not much that can be done to overcome the obstacle of cost. Though for motivated teachers, trying one of the many free educational games is a great first step.

Time insufficiency presumes that videogames would take time away from instruction. On the contrary, games can be integrated into everyday curricula because they enable teachers to present academic concepts in a contextualized, experiential way. Games are like activities or projects that can either reinforce or introduce new concepts.

Co-funded by the Erasmus+ Programme of the European Union
The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Other challenges exist when incorporating games into the classroom, beyond the technical difficulties that may arise. Many parents are skeptical about the increased use of digital media in the classroom. To gain the support of parents, teachers should prior inform them and explain why an educational videogame will be used and which are the expected benefits, but also encourage them to play the game with their children at home.

Selecting the appropriate game that could fit the curriculum continues to be a challenge for many teachers when they try to find digital games to use with their students. Still most of the teachers choose games either based on recommendations from colleagues, or their own experience with the game, or feedback from students. The best way to use games is as a supplemental tool for traditional teaching and avoid looking for games that teach the current curriculum. Instead, teachers should look for games that might approach the same subject area from a different perspective.

6.5.3 How to select games for the classroom

Whether creating an educational game or using a pre-made one in the classroom, there are a few criteria that a game must meet:

Firstly, a game needs to address and support standards and learning targets. Therefore, educational games need clear, robust ties to expected learning outcomes. If a game has built-in assessment and individual student progress reporting, that is a valuable addition.

Secondly, educational games should be used when the technology offers something the teachers cannot achieve without it. Therefore, games are ideal for experimentation with systems that are too fragile, complicated, expensive, or time-consuming to investigate efficiently in a hands-on style.

Thirdly, educational games have to provide a real fun challenge and yet safe-to-fail learning environment that is accessible to a wide variety of learners. Students appreciate and are engaged by interesting challenges that require them to think, collaborate and develop strategies to be successful. Well-designed educational games provide immediate learning and inspire students to keep trying to find solutions, even when they struggle.

Co-funded by the Erasmus+ Programme of the European Union

Another important issue that must be taken into account is that students have to realise from the very beginning why a game is being played in class and understand the learning objectives that the game is supporting. Students that are experienced in playing games may progress through an educational game much more quickly than less experienced ones. Teachers must have a plan for extending the challenge and learning for students who progress in and complete a game faster than other students.

However, during the procedure of experimenting with educational games, if teachers find something that is not working or is not appropriate, should not be afraid to change it or abandon it if needed.

Teachers that have picked an educational game and have not decided yet whether it is suitable or not to be used for specific subject in the classroom, might find useful this interactive online decision tree *"Should I Use Games in My Classroom?"*[13]

As a conclusion, with thoughtful choices during planning and flexibility in execution, teachers can successfully incorporate game-based learning into their teaching toolbox. Well-implemented game-based learning in the classroom can create more engaged and self-directed learners able to develop deeper understandings of complex systems, better collaboration skills and more effective problem solving strategies.

[13] https://d2kx2fvqbvh3da.cloudfront.net/sites/default/files/Should_I_Use_Games_in_My/index.html#/pages/54188362

Co-funded by the Erasmus+ Programme of the European Union