SEAMLESS LEARNING IN SERIOUS GAMES

How to Improve Seamless Learning-content Integration in Serious Games

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Abstract: Although the concept of Serious Games and Digital Educational Games (DEGs) is not new, many of those are either not accepted as real games by players due to a lack of fun or they are not accepted by professionals - such as teachers or trainers - as a true alternative to traditional forms of learning due to insufficient didactic concepts and learning efficiency. A major reason for this is one of the grand challenges in Serious Games: Assessment integration, i.e. seamless integration of learning content and seamless and non-disruptive evaluation of learning success during play. Based on an analysis of the state of the art, we formulate a list of guiding principles for DEG design. Hereby the aspects of seamless integration of learning content into a game regarding game genre, the proper degree of realism, active and passive game elements, player evaluation and feedback, adaptation and personalization as well as learner types are considered. Furthermore, three award-winning Serious Games/DEGs are discussed with respect to these guiding principles and underlying methods and concepts for assessment integration are analyzed.

1 MOTIVATION

The concept of Serious Games in the form of DEGs has been proposed as a promising instrument to support traditional learning in addition to one-to-many learning as it is common in schools today. One of the major arguments for the use of games for education is the possibility to use the motivation which is inherited in games to motivate students to learn (Prensky, 2003; Gee, 2003). As soon as the authors and game designers succeed to wrap up the learning content in an exciting and playful game, learning could be rather motivating and fascinating than boring. However, as stated by Encarnacao (Encarnação, 2009), "Serious Games [...] lack both the public acceptance of being generally a value-add as well as large audiences to design and market towards. The proof of value-add so far has been stifled by the need for scientific evidence that a Serious Game had a skill augmentation or behavior change impact on its players." Therefore most of today's educational games are not considered as a good alternative or helpful instrument to support traditional learning. The reasons for this are twofold: First, many of those games are not accepted by teachers because they do not contain and present the learning content properly which results in games which may be fun but do not equip students with knowledge. Second, there is an amount of games which contain the proper learning content but students do not like to play them because they are not fun. The main problem is to balance the learning and the gaming portions of DEGs in a way such that the game is fun and at the same time the learning content is integrated in a meaningful way without a disrupture of gaming parts caused by the learning parts (seamless learning). Fabricatore states in (Fabricatore, 2000) that "[...] learning processes must not be framed by an entertaining activity, but rather embedded in a genuine gaming activity, with no unnatural barrier separating learning from gaming." Based on the literature review in Section 2, in Section 3 we propose a list of guiding principles for designing DEGs without an "unnatural barrier separating learning and gaming". Hereby, we focus on the problem of an insufficient integration of learning content into a game which leads to undesired disruptions in gameplay. Our guiding principles are a step towards making DEGs which are both appealing to students and also provide the learning content in the desired way. With this requirement met, future Serious Games for education may be more accepted both by players/students and pupils and by professionals/teachers. In Section 4 we discuss our approach in the context of three well known and award winning Serious Games/DEGs. Finally, Section 5

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concludes this work with a brief summary and outlook for further research activities in this field.

2 RELATED WORK

Recently, several approaches and design models for Serious Games and DEGs have been elaborated. Said proposed the engaging Multimedia Design Model for Children (Said, 2004). The model, which is based on a study with 24 children using the video game *The Sims*, presents five factors which are necessary to create an engaging experience for children. These factors are ”Simulation interaction”, ”Construct interaction”, ”Immediacy”, ”Feedback”, and ”Goals”. Simulation interaction allows children to roleplay, whereas Construct interaction allows them to build and create. Immediacy means that the system is transparent, feedback should be immediate, and goals should either be set clear or be set by the children themselves.

Barendregt and Bekker proposed a framework for design guidelines for adventure games addressing young children (Barendregt and Bekker, 2004). Based on the ”Interaction Cycle” (Andre et al., 2001), their approach provides guidelines for making a game easy to use and for creating an appropriate level of challenge for young children.

In (Kiili, 2005), Kiili proposed a model for designing and analyzing educational games facilitating the flow experience. The model is described as a loop of created challenges for which the player must find solutions in an unstructured idea generation phase (chaotic creativity) before testing those solutions and observing the outcomes. The problem is to balance the challenges and to increase the difficulty when the player is getting better (flow).

The Game Object Model (Amory and Seagram, 2003; Amory, 2007) by Amory represents a model which combines teaching theory and game design. Pedagogical elements and aspects like fun, drama, challenge, critical reflection and practical exercise are defined as abstract interfaces which are used by the game designers with pedagogic expertise. In contrast, the gaming objects like GUI, sound, and interactions are defined as concrete interfaces. These are integrated into the gameplay by the game developers.

Apart from the complete design models described above, several approaches and ideas can be found in literature on how to better integrate learning content in Serious Games. In (Kelly et al., 2007), Kelly et al. describe how to create a Serious Game for teaching immunology to high school students. In their game ”Immune Attack”, they try to make players learn by interacting rather than by reading. Additionally, players are able to ask questions or to view images and videos whenever they want to.

In (Kriz, 2003), Kriz states that simulation games are perfectly applicable to bridge the gap between theory and practice. By playing simulations, students can perform experimental learning. They can learn by themselves, try different ways and be able to find an own solution for a problem, thus applying the knowledge to be taught.

The models described above represent different approaches for a Serious Games design with different focusses, regarding various aspects of either game design, educational game design, or motivation in games. However, none of them takes all aspects of Serious Games design into account.

3 DIGITAL EDUCATIONAL GAMES DESIGN

The results of the related work emphasize the need to consider multiple aspects and design issues in order to achieve a seamless integration of learning and gaming. In this section, we look at the design issues concerning learning and gaming as well as personalization and adaptation in detail and provide guiding principles for DEG design supporting seamless learning.

3.1 Learning

The first design issue when creating a DEG should be the question of what will be the learning content to be taught within the game. This defines the later choice of an appropriate genre, the degree of realism, evaluation methods, and adaptation algorithms. Furthermore, it is especially important how the learning content is presented to the player and in which way it is tested. If it is presented too intrusive the gameplay may be disrupted, if it is integrated too seamless it may be overlooked (Wechselberger, 2008). The key to integrating the learning content seamlessly is to integrate it into the gameplay or to make it part of the story. In the ideal case, the player does not even notice that he/she is being taught (stealth learning).

Assessment of the learner’s progress is necessary both for the teacher/trainer and for the players themselves. The latter need an evaluation in order to recognize errors and to further improve. Feedback, e.g. in form of rankings, might be a motivation. Feedback is a very important element in the development of Serious Games. In (Johnson et al., 2005) they state ”Good games provide users with feedback on their actions, so that they know how well they are doing and can seek to improve their performance." To evaluate the player performance it is necessary to test him/her. This can be achieved by interjecting tests at certain points in the game like multiple-choice-tests, fill-in-the-blank texts or simple questions. However, most of these forms severely interrupt the gameplay and are a major source of displeasure. Therefore, it is absolutely necessary to integrate evaluation methods directly into the content of the game. For example, questions can be integrated into a dialog with another character in a historical roleplay game. To improve immersion, the player's answers could directly affect the other character's reaction and the further pace of the story. This can give the player the feeling of acting in a fictive world rather than being tested. In addition to this visible form of evaluation, an invisible evaluation in form of logging the player's behavior and performance is possible. For instance, a teacher can derive conclusions from the number of repetitions necessary for certain tasks or the time spent to solve them. Besides, providing feedback may not disrupt the game. Contrary, it should be wrapped up in the game. In a simulation, for example, the player needs to see that a decision was wrong by the consequences of his/her actions.

A promising concept for evaluating player performance and giving feedback is the concept of game mastering (Tychsen et al., 2005). A game master is a person which participates in the game in a meta role. The game master can observe, adjudicate, and influence the game. Being a human person, the game master has much more freedom in evaluating the performance of a player and giving useful feedback. Such a game master can evaluate innovative player solutions which the game itself cannot recognize.

3.2 Gaming

The game genre is essential not only for gameplay but also for the related learning content. As Yee showed in (Yee, 2006), there are age-related and gender-related differences why people play certain types of games. Additionally, various genres offer different advantages for different learning content. In a well designed roleplay game, the player immerses in the (fictive) world and identifies with his/her character. This makes the roleplay genre very suitable for teaching history. Historical scenarios could be created so that the player could "play" and experience history instead of just reading about it.

The simulation genre describes games which simulate (real) world procedures in a playful manner. Examples include flight simulators, city creation and administration simulations, and simulations for various business branches. Physical or technical learning content could be taught excellently using a simulation. Simulation of physical or technical facts offering options to adjust parameters and to view the consequences provides a very promising way of experimental learning. Furthermore, economy processes can be modeled best in a simulation, again enabling players to experiment and view the consequences.

Strategy games can be used to train teamplay and social interactions like negotiation and communication. In a strategy game, the players try to win by designing and applying a superior strategy. This involves a lot of creative work which, if the game is well designed, can be used for learning. Furthermore, the competitive nature of this game genre serves as an additional motivation.

Shooters and Shoot-em-ups are very suitable to train cognitive skills, reaction, hand-eye-coordination and spatial skills (Subrahmanyam and Greenfield, 1994).

Logic/puzzle games are especially suited for teaching logical structures and ways of thinking by solving riddles, etc. This type of games can also be integrated in other games and genres in form of a minigame or by a native combination with other genres.

Apart from the choice of the right genre, the choice of the right degree of realism can have a deep impact on immersion. It should be chosen according to learning context and game genre. For logic games, a realistic look is not important. Instead an abstraction is often more sound. For historical roleplay games however, a higher degree of immersion is desirable. The player should experience flow and loose him-/herself in the game. A higher degree of realism in form of realistic graphics and appropriate sound might help to improve immersion. Regarding simulations it is necessary to differentiate between a degree of realism regarding the objects and processes to be simulated and the representation. The objects, concepts and processes to be modeled must be depicted in detail, whereas the overall degree of realism can be secondary and may be either realistic or abstract. The highest degree of freedom is given within strategy games and shoot-em-ups. In those genres the degree of realism is primarily used to achieve an appropriate atmosphere.

3.3 Adaptation and Personalization

In order to meet the expectations and characteristics of individual learners/players, methods for adaptation and personalization should be considered. For a player who is bored or overstrained, the "barrier" between gaming and learning is even more visible than for one who experiences a good degree of challenge. Therefore, it is important to measure the performance of the learner and to adapt the degree of difficulty to the player, so that the player is neither bored nor overstrained by the difficulty of the tasks. Also, a set of tasks/questions of various degrees of difficulty has to be created and an adaptation mechanism has to be designed. In (Göbel et al., 2010), an adaptation mechanism for player and learner models was proposed. It can be applied to adventures and other scene-based games and takes into account learning, gaming and narration simultaneously.

Moreover, it should be considered how individual learner types may be addressed. Some students prefer to learn on their own, whereas others need more guidance. This may also greatly depend on the learner's age. For example, children at the age between 6 and 12 prefer to make things alone or with friends (Slavin, 1997). For such children, an ingame guide providing help and tips may be disturbing, whereas younger children need a more direct guidance (Barendregt and Bekker, 2004).

3.4 Active and Passive Elements

We can divide the elements of a game into active elements which can be altered or influenced by the player and passive elements which can not be changed by the player. Active elements provide certain degrees of freedom. In a roleplay game the most important active element is the played character. The player usually can change the character's appearance, acquire skills, etc. In a simulation game, the simulation objects are active elements. Those can be adjusted by the player. Passive elements in contrary provide a constant setup for the game.

The learning content can as well be either active or passive. If it may not be altered, it must be passive. For example, in a historical roleplay game the story which teaches about historical facts should not be changed. Subsequently, it should be a passive element. Other parts of the story however may be changed. In a simulation, a player may experiment in the form of "what if...", thus also producing wrong facts. An interesting example is a *Sid Meiers Civilization IV* scenario[1], settled in the Roman age at the time of Vespasian, developed by Dr. Shawn Graham. It allows to shape history differently, clearly altering learning content in order to teach how easily the events of that time could have been different.

[1] http://planetcivilization.gamespy.com/View.php?view=Articles.Detail&id=33

A seamless integration of the learning content may be achieved by a balanced integration into active and passive elements. If the learning content is entirely embedded in passive elements whereas the player has a lot of active elements to interact with, the learning content will stand out and be a disruption of gameplay. If however the learning content is entirely embedded in active elements, there is a danger that the player changes important facts.

3.5 DEG Design Guiding Principles

Resulting from the analysis above, we summarize our experimental DEG design guiding principles. The guidelines are ordered in the way the decisions should be made.

- Define the learning content and the target group.
- Based on the learning content, the target group, the target group's age, and the desired gameplay, decide on which genre to use.
- Decide on the desired degree of realism.
- Decide which parts of the learning content may be integrated in active elements and which ones in passive elements.
- Define how evaluation will be performed (active, logging).
- Define the methods of feedback and if a game master is reasonable/helpful.
- Decide how the degree of difficulty can be adapted to the player.
- Decide which other adaptation and personalization algorithms fit best to the game (player modeling, ingame guide, etc.).

4 EVALUATED GAMES

In this section we examine three award-winning Serious Games/DEGs. We extract information about the learning content, the genre, active and passive elements, the degree of reality, the integration of evaluation methods and the addressed types of learners. Furthermore, we describe how motivation is generated and if there is a "barrier" between learning and gaming.

EnerCities[2] represents a Serious Game which is designed to call attention to energy-awareness in city planning. EnerCities is a SimCity-like game which claims to be the first Serious Game on Facebook and

[2] http://www.enercities.eu/

is nominated for ”Best ICT for Energy Efficiency Project Award 2009”. The learning content contains energy-awareness, energy economy, and energy conservation. The genre is a typical simulation. An active element is the space for decisions about what kind of building to place when and where. The learning content is integrated both actively and passively. Passive elements include hints and tips about energy (saving), active elements are contained in the building options. Deciding on using alternative energy technologies or to upgrade factories with improved isolation or recycling facilities in order to advance in the game implicitly applies the learning content. The (graphical) degree of reality is rather low which is common for simulations. Evaluation is performed by a stiff points system given for buildings and upgrades. Feedback is given by a highscore system generated from the evaluation. There are no adaptation mechanisms, but an ingame advisor works as a guide providing hints and tips without disrupting gameplay. An ongoing motivation is generated by a ranking. However, it is possible to get a very high score by violating some of the principles which are to be taught. This is an indication for an insufficient balancing of learning content and gameplay.

Winterfest[3] is the Serious Game/DEG which won the ”Lara Games-Award 2010[4]”. It was designed for illiterates and people with poor arithmetic. The game is a classical adventure set in a medieval environment. The graphics are comic-like (cf. Figure 1), which is a low degree of realism but is very common for adventure games and fits very good into the overall mood. Throughout the game several exercises have to be solved. Those contain basic mathematics, reading, and spelling. The learning content is entirely passive and cannot be changed or influenced. It is presented in the form of tests which are well integrated into the game and its story. Feedback is given instantly. Wrong solutions are corrected at once by marking errors so that the player may correct them instantly. The game is clearly made for a learner who prefers/needs guidance. The player has a companion (a rat) which gives much advice and often tells the player what to do next. An explanation is given before an exercise is performed so that the player is able to acquire necessary knowledge before he/she is tested. However, although the exercises are included in the game story, due to their rigid form they are still a disruption of gameplay. Motivation is provided by a suspenseful and immersive story making the player eager for the story's outcome.

[3]http://www.lernspiel-winterfest.de/

[4]http://www.lara-award.de/

Figure 1: Screenshot of Winterfest.

The ”Global Conflicts:”-series[5] is a set of games with the goal to draw attention to deprived areas all over the globe. The series won several awards in different categories. The genre is best explained as a 3D-adventure/roleplay game. In ”Global Conflicts:Palestine”, the player takes the role of a reporter preparing an article about the social problems in Jerusalem. Therefore, he/she can talk to different people and gain insight into the different points of view. The learning content is entirely integrated in the game and mediated almost subliminally. However, there are almost no degrees of freedom for the player. There are only few locations/people to deal with and interaction is limited on observation and dialogues with a very limited number of dialog options. The degree of realism is pretty high as the graphics are rather realistic. The setting on the other hand is rather unrealistic as the city appears to be nearly dead. There are no adaptation or personalization mechanisms. The player is guided by some ingame hints telling the player what to do next. At the end of the game, the player combines the collected facts to an article or argumentation. The article/argumentation is then evaluated and the result is presented to the player. The social topics are presented excellently and do not disrupt the gameplay. However, the gameplay itself is very sparse so that ”Global Conflicts” appears rather as an interactive education story than as a game.

5 CONCLUSIONS

In this paper we analyzed design guidelines and models for the design of Serious Games/DEGs found in

[5]http://www.globalconflicts.eu

literature. We then derived and formulated a list of guiding principles for DEG design which especially addressed the problem of a seamless integration of learning content in Serious Games without a disruption of gameplay. Three award-winning well known Serious Games were examined according to design issues compared to our design guiding principles. Although those games are well designed, they all still have drawbacks in the seamless integration of learning content. Either the game is disrupted in a disturbing way, the learning content is too invisible or the game lacks a deeper gameplay. More work is necessary in order to solve this issue which can be a substantial contribution to a broader acceptance of Serious Games both in public and among teachers. Currently our list is not intended to be exhaustive. Although we ultimately intend to create a design guideline for a seamless learning and assessment integration in DEGs, we do not believe that a universal "cookbook" for the design of DEGs is realistic. Next steps include the test of our model in various Serious Games to be created and to refine it if necessary. Also a user-centered evaluation in various specific fields of application is necessary.

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