The move beyond edutainment: Have we learnt our lessons from entertainment games?

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Abstract. Serious games (SGs) have been used in the education of students and professionals for decades, but still have not reached their full potential, despite the large consensus they have gained recently. The entertainment game industry is a rapidly developing phenomenon, with a high market potential, enabled and enhanced by technological innovation. The question examined in this paper is: Did serious game designers learn from Entertainment Game (EG) designers in building a successful game? This paper presents three case study examples of games that have good learning outcomes to explore this question. This paper discusses the salient aspects and the differences between the examples and suggests how SGs could learn more from successful EGs.

1 Introduction

Entertainment Games (EGs) are defined as games that are developed and applied in different contexts and settings solely for the purpose of entertainment. This contrasts to SGs, which are (digital) games designed for purposes other than mere entertainment [1,6]. For example, SGs with educational purpose include explicit learning objectives and aim to achieve specific learning outcomes. This asks for a different design process, one that pays particular attention how educational content is represented and learning takes place. Yet, SGs also require the qualities that hallmark EGs.

SGs are required to learn from the entertainment industry in order to develop a captivating and engaging game environment. To do so, SG designers were asked to take the following criteria into account [5]:

- **Engagement:** The design should encourage wider and repeated use, and amplify learning opportunities and strategic thinking among users. Earlier work [8-10] on what makes players so engaged with games resulted in the identification of five factors: challenge, fantasy, curiosity, control, and interpersonal motivation.
- **Quality:** The design should have appealing visuals and graphics and an intuitive interface. Although at first, emphasis was placed on using the cutting edge in the game industry, the rise of the casual games industry and the low SG budget models led to adopting standards that are at least equal to those of casual games.
- **Balance:** The design should have models with the right amount of accuracy and have a solid integration of the educational material with gameplay. Others have later elaborated on this need for a well-balanced design, based on their own experiences in designing SGs [6].

Not much later after Rejeski's and Sawyer's report, Gee [11] published his now seminal book on what we can learn from EGs. He listed 36 principles, which range from the active, critical learning principle to the insider principle. As Gee describes, some of the best games have implemented the best theories on learning. So although EGs may not have been intentionally designed for an educational purpose, by learning from EGs and harnessing their identified principles in the development of SGs (or other educational activities), learning through SGs becomes more meaningful and effective.

Unfortunately, few to none SGs developed in the last decade have reached the viral diffusion power of EGs. *Whyville* [12] and *Quest Atlantis* [13] are one of the few exceptions. This is a possible indicator that we have been unable to achieve the desired engagement. This could be due to many factors and we should keep in mind that many SGs have a much more limited target group, but it at least begs the question if we actually have been able to implement the target qualities which were posited as initial conditions for making SGs learn from EGs. In this paper we have taken an introspective approach to the question if we, as SG designers, have learned from EGs in building successful educational games. We have taken three of our own case studies to explore this: *ELU*, *Seconds* and *Levee Patroller*. Each of the responsible authors reflected on the development by discussing the major successes and failures with regards to the target qualities that each, as an SG should learn from EGs, and the results are discussed in the next section. Based on this, we draw a number of lessons that the SG community can use in the next decade of SG development.

2 Case Studies of Serious Games

2.1 ELU: An Interactive TV Serious Format

The first example is from the *ELU* project. The *ELU* experience is an interesting example of the added value provided by introducing gaming mechanics into existing

processes and materials to create new educational supports [14]. The idea is to build a SG format for interactive Television (iTV) by enhancing existing TV movies and videos through play-along digital games. *ELU* developed an iTV application format and corresponding development and deployment tools. At a high level, the *ELU* format involves:

- A linear AudioVisual (A/V) stream–the original video
- Non-linear interactive contents on the video that users control

The idea is to exploit a linear story (that can be viewed also by non-interactive users) and provide enhancements to improve the interactive user's experience. The *ELU* format allows multimedia content designers to build an interactive program as a sequence of educational units, named cards, that are displayed either at full-screen or partially overlapping the A/V program (or including it as a quarter picture). Each card provides one or more services, such as Multimedia Pages (MP), Interactive Edutainment Elements (quizzes, games, questionnaires, etc.), or a Virtual Teacher (VT). Cards may be synchronized with the A/V stream and are triggered at a specified time or may be asynchronous with the A/V stream.

Fig. 1. Snapshot of an *ELU* application with the Navigation Bar in the bottom of the screen, a PerformanceMeter and a ProgressBar at the top of the screen.

For every single application, the cards' flow is specified by the multimedia content designer, who is responsible for writing a script program through an ad-hoc designed high-level language. The script specifies the cards (see also below), the user interaction possibilities and user profile elements according to which different personalization options are provided (e.g., in terms of card flow, contents and appearance). User profiling and assessment are fundamental aspects of serious gaming [15]. In the *ELU* system, the user profile is characterized by the learners' competences that are tracked and estimated in real-time by the system. This is achieved as the designer specifies the mapping between the user choices/responses/actions and the related competency levels [14].

In a typical program, synchronous cards are only partially overlapping the video, as the viewer should also continue following the A/V stream, while asynchronous cards appear at full-screen. Synchronous cards are typically aimed at strengthening the message of the A/V stream, helping the learner to better understand it, also through personalization, while asynchronous cards are typically available at the end of the movie, as summative tests, or to provide more information.

Another important aspect concerns the provision of feedback to the player about his performance and position in the learning space [16]. The *ELU* iTV application includes a *Progress Bar* module that is displayed on the top of the screen and schematizes the sequences of the cards in the program (Fig. 1). When a card has been completed, its outcome is shown as a green tick or red cross. Performance feedback is provided immediately just after the end of every interactive element (e.g., quiz or game). The system provides various possible types of user feedback–from jingles to VT comments, to a complete display of results and corrections–that may be chosen by authors for different needs. The overall user performance level is displayed through the *Performance Meter* that shows the player's global performance, obtained by summing the score of the cards. Performance is expressed as a percentage of the maximum score (Fig. 1, on the black stripe, on the bottom right), in order to provide an objective value.

TVSerGames is the library of game templates from which the *ELU* play-along games are instantiated (Fig. 2 shows some examples from the interactive version of Walt Disney's Snow White movie). We group them in three clusters:

- **Games and Quizzes:** *Quiz*: sequences of questions and answers; *VisualQuiz*: Q&As in images; *Couples*: join the matching elements; *RightPlace*: put icons in their right place; *RightOrder*: order a sequence of items; *Puzzle*: build an image from shuffled pieces; *Memory*: remember the cards; *Stop it!* stop the animation at the right time to answer the question; *RepeatedTrials*: statistic outcomes from experiments.
- **Simulation**: *Stock Exchange simulation*: statistics and business.
- **Clusters**: *Menu*: Cluster of games from a menu (with the replay option); *Millionaire*: Millionaire-like difficulty-escalation game/quiz cluster.

Qualitative and quantitative results on a test group of 40 university students from Italy and Latvia show the potential of the system for informal education [14]. For example, on the experience questionnaire, users reported high values for pleasantness (3.9, on a 0-5 scale), enjoyment (3.7) and usefulness (3.5) of the application

Fig. 2. Snapshot of two synchronous games (*VisualQuiz* and *TextQuiz*) played along the Disney Snow White movie and one asynchronous games played at the end of the movie stream (*RightPlace*)

The *ELU* system reflects some important elements of the learning principles defined by Gee [11]. First of all, the system is highly and intrinsically multimodal (No. 3 and 20), adding multimedia interactivity to video clips. As apparent from Fig. 2, the cards also involve a strong interaction with texts that is not purely verbal (No. 18).

The achievement principle (No. 11) is highly addressed through the above presented feedback elements, such as the *Progress Bar* and the *Performance Meter*.

Also, the *ELU* iTV format, that can be instantiated in several different serious games, structurally supports three fundamental Gee's principles, such as:

- The multiple routes principle (No. 16), in particular for the runtime automatic personalization and for the possibility of the user to choose different options and games;
- The incremental principle (No. 24), which is again supported through the personalization and multiple path options;
- The transfer principle (No. 29), which concerns in particular the games available in the menu shown at the end of the video, where users have more time to play, applying the concepts addressed during the video.

The *ELU* format supports all the Malone and Lepper's individual motivational factors [8-10]. While challenge, curiosity and fantasy depend on the actual game contents and graphics, the control factor is supported by the fact that the SGs spur the user to take decisions both on the path and the choices available for assessment. Concerning the interpersonal factors, the iTV technology is typically unidirectional. Thus cooperation, competition and recognition is not possible through that medium alone. In order to allow users to have a reference, their performance is stated as a percentage with respect to the optimum. To achieve a full support of the interpersonal factors, other means such as ancillary (mobile) web applications should be considered.

2.2 Seconds: A Role Playing Game to Improve Decision-Making Skills

Seconds is a role and simulation based, multi-player game used to train students in decision-making [17]. It has been developed for workshop settings, using a blended learning concept. The gaming environment aims at increasing the awareness of how a participant's own decision-making impacts the supply chain, training strategic thinking and applying different methods for strategic decision-making. *Seconds* is scenario based, and the teacher can define the starting level of difficulty by using an authoring tool for adapting the scenarios to the expected competence level of the participants.The gaming scenario mirrors a typical production environment, in which complex products have to be produced in collaboration (own supply chain) and in competition (different supply chain) with stakeholders. The game features a generic simulation model, with reduced complexity and accuracy compared with reality, so that the students do only need to cope with a limited numbers of variables. It is based on the disjunction of time and space and has been developed at Bremer Institut für Produktion und Logistik (BIBA) for use at the University of Bremen.

Fig. 3. GUI in the Seconds Game

The figure above shows the graphical user interface (GUI). It gives players the information they need to take decisions. In *Seconds* curiosity and fantasy (see Section 1) of the players are fostered through only providing a starting scenario. The path of the game depends on the co-creation of players, which leads to a high degree of engagement. This is in line with Gee's idea on empowered learners and his "insider principle" (No. 36). By actively letting the students influence the gaming scenario and the outcome, they are encouraged to design their own learning experience and support active learning (No. 1)

The interface also indicates the performance of each player, by showing graphs on cost-benefit, profit, quality of delivery etc. These indicators are both used for giving immediate feedback to the students on their achievements (No. 11), as well as an element for motivation. The student and the "supply chain" team that at given points have achieved the "best" performance indicators are the winner. Players have lost the game when they get bankrupt. Teams can continue after a player's bankruptcy, but need to find a new supplier. These indicators also help players control the game and commit them to the game play (No. 7). As the scenario advances, players can improve skills, and thus achieve better quality and price. Their improvement is based on their performance in the game and their experience. Players can observe this, either by looking at the KPI as numbers or at a graphical presentation. In this way, the KPI changes will show players their success or failure. The game is designed to support co-operation. The success of each player depends on their ability to build products in production networks.

During game- the game	---	--	-	-/+	+	++	+++
The game helps in understanding theory	1	2	3	4	5	6	7
		2	1	2	21	17	27
The game is suitable for awareness of decisions	1	2	3	4	5	6	7
		1		1	21	19	28
The game supports Understand the theory	1	2	3	4	5	6	7
		1		4	9	35	21
The game mediates the complexity of SC	1	2	3	4	5	6	7
		1	1	9	19	21	19
The game supports applying theory	1	2	3	4	5	6	7
		1	1	3	35	15	15

Fig. 4. Example of evaluation results of Seconds for 2012-2013 classes

Around 300 students played *Seconds*, mostly in groups of around 24 students. The learning outcomes have been evaluated through questionnaires, analysis of student lab reports, as well as observations by facilitators/teachers and by examining the results in the database later. The current learning results are good, but the game has undergone continuous changes in order to increase the usability and the learning outcome. Several former students, now working in the field of Supply Chain Management (SCM), report that what they experienced and learned within the game has been

useful and transferable to their new working environment (No. 29). Figure 4 shows some of the results from the students' questionnaire from years 2012 and 2013. The complexity of the GUI is still an issue, and for some scenarios we also see a need for a more accurate underlying simulation model. We have been analysing why several SGs need to have hand-on practice sessions and use facilitators, whereas EGs do not. One main outcome is that many SGs have focused too much on the learning outcome and thus have an unbalanced design concept. This is also the case for *Seconds*. Another observation is that if the starting scenario does not fit the competence level of the students, it has a major negative impact on the engagement level and motivation.

If the starting scenario is too complex (i.e. requires a higher level of SCM understanding than the students have), they are not able to take strategic decisions based on the feedback delivered by the game and take their decisions intuitively (No. 15).

2.3 Levee Patroller: A 3-D Action Game to Make Sense of Flood Risks

Levee Patroller is a single-player 3D first person game, aimed at training levee (or dyke) patrollers working for Dutch water boards, which play a crucial role in national security [18]. In the game, a trainee has to locate every levee failure occurring within the domain entrusted to him, report about it and possibly, depending on the state of the failure, return to the location to see if it has worsened. The game was designed to be used in workshops during which playing the game is combined with a lecture on levee inspection, or in workshops that focus completely on the game. It is played against the clock, ending either when all the emerging failures have been satisfactorily found, reported and handled, or when the player's negligence leads to a levee breach that floods the whole region. The game was developed in 2007 by Delft University of Technology, Deltares and several Dutch Water Boards [18].

Adhering to the SG criteria mentioned in Section 1, the developers made use of the cutting edge game technology at that time, the commercial game 3D engine "Unreal Engine 2". Throughout the development, the designers spent much effort and dedication into making a well-balanced game, which led to a SG design philosophy [6]. For example, the designers made sure that all the aspects of the learning environment were interactive, which is in accordance to Gee's active, critical learning principle (No. 1). When players want to know the length of a crack, they do not get a popup screen with information. Instead, they have to actively measure the crack by placing a "measuring marker" on one end of the crack and a second marker at the other end. Making the failures appear randomly in scenarios ensured a challenge. This further increased the repeatability of the game, which is importance for letting players practice with the game (No. 12).

Unfortunately, the game ended up being used primarily for demonstrations during workshops. In an effort to apply the game as envisioned, significant evidence was found [19]. After three weeks of distance training with the game, participants starting with limited practical experience performed as well as experts (No. 4) and their learning transferred to real world situations (No. 29). It was also engaging (No. 7): 80% of the 147 participants played almost all exercises and spent over 10 hours voluntarily and enjoyed doing this. During interviews and discussion, participants

mentioned that the game helped them to identify what it means to be a levee patroller and became better aware of their knowledge regarding the topic.

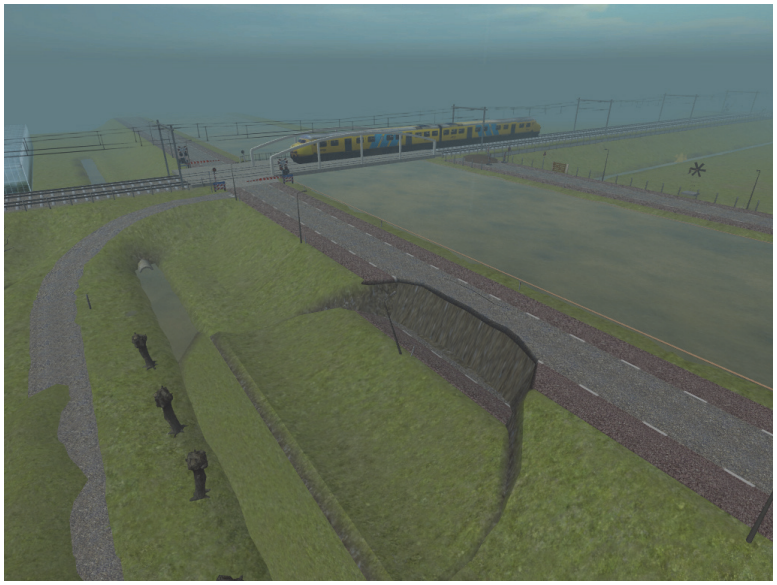

Fig. 5. Screenshot from Levee Patroller showing a levee failure

These are unexpectedly positive results, yet the study highlighted many shortcomings. First, participants complained about the difficulty and incomprehensibility of navigating the menus. The game clearly did not fulfill the quality standards of interface design. Second, the game had little interpersonal motivation and certainly lacked an affinity space (No. 35) in which players could converse about the game. Participants indicated that they wanted to have more interaction among each other. Third, participants indicated that they had trouble understanding the vocabulary of the game and found the learning curve of the game too steep, despite the inclusion of a tutorial. Fourth, the game applied no differentiation among and adaptation to players, meaning that some players experienced frustration and others boredom. Although more shortcomings are discussed in detail elsewhere [19], the final shortcoming we want to highlight is that of feedback (No. 27). The game has several sorts of feedback. The feedback during a scenario was not direct enough as players had difficulty in understanding what they did right or wrong. Then players often skipped or did not understand how to read the feedback at the end of the scenario.

3 Discussions

Both SGs and EGs rely on the innovative fusion of digital technologies and cultural creativity [3]. Even if EGs and SGs answer to different objectives and

performance criteria, there are significant lessons that SG communities can learn from the EG industry, as well as significant resources that can be adapted for reusability between the two communities. In this paper we introspectively assessed whether the games we have developed abide by the SG criteria posed at the beginning of the 21st century; in doing this, we illustrated how we can learn from EGs in developing SGs. Such an assessment is inherently limited and biased. The games presented here are a small slice of all the SGs that have been developed and we cannot draw conclusions on behalf of all of them. However, for the SG field to mature and become as pervasive in society as EGs, it is important to reflect on what has been done and how we can move forward into the next decade of SG development. We see this paper as the start of an important discussion and encourage others to reflect on their games too. The criteria and insights discussed here will foster this discussion.

As for the three cases, each one of them found success, providing evidence for games' educational potential in different domains and through different types of games. The three cases widely differ on their topic, target group and implementation. *ELU* uses existing game formats (i.e., quizzes) on top of video material for children; *Seconds* is an interactive spread sheet simulation for SCM students; and *Levee Patroller* is a fully immersive 3-D action game for practitioners dealing with flood risks. Based on the reflections, it becomes clear that all cases tapped into the affordances offered by games, such as multimodality, feedback, active learning, scores and progression indicators, rewards and practice opportunities, and integrated the educational content into the game, which is a step forward compared to most edutainment titles [3]. *Seconds* and *Levee Patroller* differ from *ELU* in providing players an opportunity to become part of a "semiotic domain," that of SCM and levee inspection, respectively. Players become acquainted with the vocabulary and practices and learn to think like a supply chain manager or levee patroller. *ELU*, on the other hand, includes scaffolding, personalization and incremental progression, aspects that the other cases are lacking. And unlike *ELU*, *Seconds* and *Levee Patroller* reported interface problems in addition to problems with the learning curve. The fact that *Seconds* as well as *Levee Patroller* needed hands-on practice sessions to be used is an indicator that these games are not intuitive enough. This might be due to the increased complexity of these types of games, which require more iterations and development efforts to be done right. Nevertheless, these observations show that in terms of quality and balance these SGs still lack behind compared to EGs. We think this is general problem. SGs rarely re-enter the development cycle and their performance is usually assessed based on a singular development attempt. Largely due to limited budgets, SGs are because of this not thoroughly redesigned. Even if multiple iterations are made, such as with *Levee Patroller*, this is far less than the necessary number of iterations made by EGs to be competitive (e.g., *Angry Birds*: it was Rovio's 46th attempt to develop an entertainment game, and they almost went bankrupt in the process). SGs also need good quality Human-Computer Interaction to be really successful.

Except for *Seconds*, which is a multiplayer game, *ELU* and *Levee Patroller* lack any social features, which are important in today's EGs. In fact, all three failed to build what Gee coined "affinity space" surrounding the game. This is a space where learning happens about the game outside of playing the game itself and this is considered instrumental, if not crucial, for deep learning to occur. *Seconds* and *Levee*

Patroller may have a debriefing, but if a community of learners emerges surrounding a game, this will have a much stronger effect, on learning and also on the game's longevity and dissemination. This lack is largely attributable for problems in structurally implementing SGs and the constraints SGs work with such as having a specific target group. EGs exploit global networks of production and distribution, and although they need to consider local cultural practices, tastes and social structures if they are to succeed across major markets, most SGs focus on specific cultural practices and rarely benefit of massive market production and distribution, which can lead to obscurity and failure in large-scale dissemination and the building of a community. Of course, if SGs are reasonably successful, they can gain a certain level of popularity and can be deployed on a larger scale, even if the GUI has not been refined. Very few SGs have made this leap. Most have remained prototypes and are used in forced evaluations or in local practices only.

5 Conclusions and Future Work

In reflecting on whether we have learned our lessons from the entertainment industry, it becomes clear that in developing SGs we got the 'basics' right. We moved away from edutainment and started tapping into the affordances that games offer by providing instant feedback, allowing for multiple routes to progress, and so on. It further becomes clear that although we know what is needed, it is still not as refined, user-friendly, and geared toward the player compared to EGs, as illustrated by the interface and balance issues reported in the cases. The more complex the game, the more likely this will be the case. Various causes account for this: limited budget and time, few iterations and difficulty balancing the multiple objectives needed for SGs [6]. Another insight is that the games failed to build a learning community, largely due to being able to implement the games in any structural way. This means the SG community learned from previous mistakes and from the entertainment industry, but SG designers can still learn a lot more from EGs.

So what does the SG community need to do in the next decade? First, as stressed in the previous section, we encourage others to reflect on their SGs and join this discussion. Hearing that SGs are "awful" or "bad" compared to EGs is not very helpful. We need to know what is exactly wrong with them and take the necessary steps to make sure future SGs do abide by the ideals once set forth. Second, we need to learn more about how EG developers balance their games and we need to prioritize usability and user experience as part of the development. Methods and insights from Game User Research (GUR) and game analytics should be considered for achieving this [2,20], as they provide heuristics for how games can be fine-tuned. Successful EG designers rely heavily on this (i.e., the large success *Candy Crush Saga* is based on analysing player data). Third, customization and personalization require more attention. This is needed to enable teachers to personalize the game according to the students' performance or implementing specific educational and technical requirements related to pedagogical constructs, learners' assessment and standardization [7]. It would further extend the use of a particular SG beyond a local practice, which is important for larger-scale distribution and dissemination. Fourth, as

a community SG developers need to start finding a way of sharing best practices and insights. The community is fragmented [4], largely because it is applied in so many different domains and contexts. It does not have dissemination platforms and venues of the likes of 'Gamasutra' and the 'Game Developers Conference', places where many EG designers share and discuss their experiences. In Europe the Games and Learning Alliance (GaLA) network attempts to change this and in North America the Learning Game Network with its Playful Learning initiative is trying to accomplish this, but currently we are still far away from a thriving, collaborative community. Fifth, we need to start moving beyond the stage of (experimental) research to proof that SGs work, and instead work on issues of implementation, business models and community building, which are essential for having sustainable products.

For achieving these goals in the next decade, future work should especially consider bridging the gaps between the SG community and the EG industry, and between academia and industry, with the purpose of enabling joint game development efforts that would benefit all communities. In addition, other areas of interest for collaboration can include content interoperability standards, architectures to support interoperability, procedural level construction and networking protocols. The release of *SimCityEdu* in Fall 2013, the educational version of the latest *SimCity* franchise, which has been developed in collaboration with Electronic Arts, is a hopeful promise that we are moving into this direction.

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