Learning with games in a professional environment: a case study of a serious game about levee inspection

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Abstract

Serious games are an increasingly popular field and this has resulted in a large number of serious games so far. Despite this growth, relatively little gaming research is focused on professional environments. In particular, a lack exists in reflecting on the design and learning experiences. To take a step in this desired direction, this paper examines learning with games in professional environments. This is done by looking at the design and the learning experiences of a game about levee inspection called *Levee Patroller*. Based on this case study six valuable learning lessons are identified; games need to be a single whole, function as discussion-support-tools, simplify and emphasize aspects in reality, request a complimentary learning style, are motivation-enhancers to those interested, and require a change in curricula.

Keywords

Adult learning, case study, levee inspection, professional environment, serious games

1 Introduction

Serious games are an inspiring area of research and development and have received tremendous media attention all over the world. An important reason for this attention is the understanding that games are able to change (partly) how we learn [Gee 2004; Prensky 2001]. Using games within education and training is a step away from the post-industrial way of learning and thinking, the *traditional paradigm*, toward a more interactive, entertaining and authentic way of learning and thinking, the *gaming paradigm*. It is however unclear how this gaming paradigm should be implemented to create an effective learning experience [Shaffer, Squire, Halverson, Gee, 2005].

Many studies are currently aimed at finding an answer to this question by looking at classroom or informal settings of children and students [Egenfeldt-Nielsen 2005; Mitchell, Savill-Smith, 2004; Moser 2000; Shaffer 2006; Squire 2004]. In contrast, few studies have stressed how games could foster learning in *professional environments*, such as those encountered by architects, politicians, emergency personnel, and fire or medical workers. This is very striking, as the development of serious games is quite staggering in this area [Bergeron 2006; Michael, Chen, 2006]. To name but a few examples; *Pulse!* and *Unreal Triage*, both aimed at medical personnel, *Hazmat: Hotzone*, aimed at emergency response training and, of course, *America's Army* and any other game that is used to train the military. Apparently, research is foremost oriented at developing the game, and not so much at reflecting on the design and the learning experiences.

This is pitiful as practice cannot exist without theory, and the other way around [Lewin 1946]. To take a step in this desired direction, we examine in this paper learning with games in professional environments. This is done by looking at the design and learning experiences of a

serious game called *Levee Patroller*. Before explaining this particular case in the third section, the next section looks into adult learning and how this relates to games. The fourth section discusses the lessons learned from this case study. The fifth and final section summarizes the main findings of this paper; that games need to be a single whole, function as discussion-support-tools, simplify and emphasize aspects in reality, request a complimentary learning style, are motivation-enhancers to those interested, and require a change in curricula.

2 Adult learning and games

Games have always been used for learning. The still widely popular game *Chess* for example has been used by war leaders throughout history to learn about strategies to defeat an enemy [Brewer, Shubik, 1979]. In our last century countless business and management games have been developed and deployed for educational as well as business settings, such as Richard "Dick" Duke's *Hexagon* and *Harvest* [Meadows, Sweeney, 2001]. Lately, in the past decennia, we have seen another development, that of using digital games to teach content, skills and/or attitudes. The first batch of digital games with an educational aim is nowadays commonly referred to as "edutainment" and is largely considered to be a failure [Egenfeldt-Nielsen 2005]. The second batch of digital games broadened its scope beyond the classroom by stating that anything that uses entertainment techniques for a non-entertainment purpose can be considered a game for learning. These latter types of games are most frequently referred to as "serious games" [Bergeron 2006; Michael, Chen, 2006; Sawyer 2002].

The reason for the increased interest in using games for learning is because of the growing awareness that games intrinsically involve learning. Nonetheless, a large gap remains between getting players to learn inside a game and successfully apply this inside a game, and getting players to learn inside a game and successfully apply this in reality. This immediately stresses the fundamental difference between serious games and entertainment games: serious games need to educate the player about something in reality, whereas entertainment games need to enjoy the player for the time being. We currently know slightly how we can let players learn inside a game [see Gee 2004], but we do not know how games could foster "education".

To get an answer on how games can facilitate education, it is necessary to delve into the world of pedagogy, instructional design, and the like. For the education of professionals it is also relevant to examine the field of "adult learning". Unfortunately, despite a large amount of research in these fields, we can say that we still do not know how human beings exactly learn. Prensky [2001] for example mentions that we have over 40 different ideas on learning. This diffusion led Schwandt [2005] to decide that "adult learning, like learning in general, is one of those concepts that everyone understands – that is, until someone tries to define it" [p. 178].

What we do know is that the context of acquiring knowledge for adults has become "life situations" [Lindeman 1926] and that pedagogical processes (e.g., teacher instructing students) and contexts (e.g., formal classrooms) associated with the traditional educational settings no longer fully meet the learning needs of an adult in a complex world [Schwandt 2005]. Furthermore, adults want to learn by choice and freedom [Freire 1968], they want the topics to be of immediate value [Knowles 1973], they want to learn according to their previous experiences and learning styles [Hartley 2000], and they want learning to be linked to the real world [Schank 1997]. Try to motivate for instance fire workers to learn about our solar system. Although it is possible to come across a few who are interested, most of them will not participate as it does not fulfil their specific needs and desires.

The above-mentioned characteristics of the adult learner show two remarkable aspects: i) adults pose a different design challenge in comparison with children and students, and ii) games seem a powerful instructional method to teach adults, since they are capable of modeling complex, authentic, real world situations, and allow for control and personal preferences. Hence, games involve learning, fit the way adults learn, but it is yet unclear how such a game needs to be

implemented to create an effective educational experience. For this reason, we decided to develop a serious game in close collaboration with professionals and try to learn from them by reflecting on the development process. Before we get to the "lessons learned" of this experience, the next section introduces our case study.

3 The Levee Patroller case

The game *Levee Patroller* intends to train "levee patrollers", who are the first line of defence in preventing the adverse effects of water crises, to inspect "levees" [Harteveld, Guimarães, Mayer, Bidarra, 2007]. Levees (or dikes) are the natural and artificial barriers that protect the land from flooding. Especially in the Netherlands these fulfil a crucial infrastructural role. The failure of a levee would lead to large societal consequences as the Netherlands is a densely populated country, and an important economic center for Europe with its many distribution channels, ports and industries. As such, ensuring that levee patrollers are trained to perform their job is one of the main preventive measures for safeguarding the Netherlands from flooding.

The job of a levee patroller consists of inspecting levees, at regular times, but especially during emergencies. The inspection involves recognizing failure symptoms on time and communicating relevant findings to the central field office. The field office can then issue further directions or can initiate procedures to take corrective measures. Practicing these skills of recognition and communication is difficult in reality, as levee failures are quite rare. For this reason *Levee Patroller* was designed. A game makes it possible to visualize and interact with the unexpected; in this case with what levee failures look like and how they evolve over time. With such training, patrollers are better prepared to assess possible problems in reality, and consequently, they are able to prevent considerable disasters from occurring.

Figure 1: Screenshots of failures in *Levee Patroller*

We developed the game, which can be categorized as a "single player 3D first-person game", in close cooperation with a number of Dutch water boards, the institutions that are in charge of the water infrastructures and levees, experts from GeoDelft, a soil engineering research institute, and an expert panel consisting of levee patrollers, in 9 months. It was implemented using the commercial game engine *Unreal Engine 2 Runtim*e, a simplified version of the "Unreal Engine 2". In practice, it can be considered as a "total conversion mod", as all digital assets in the game have been created from scratch, similar to the essential gameplay elements.

Not very surprisingly, in the game the player plays the role of a levee patroller. In the main menu, a player can choose to go to training for getting familiar with the controls and procedures, start a complete scenario, in which multiple scenarios have to be completed, or start a single scenario. If the latter is chosen, a *scenario generator* is presented that allows the player to choose a region, the weather, a number of failures and the type of responsibilities. The basic purpose of

the game is to find every failure and report it. Upon finding a failure the player has to fill out a report and, depending on the state of the failure, return to the failure to see if it has worsened. If not, the computerized central field office should be told that the failure has stabilized. If so, the office should be told that it is getting worse and depending on the severity that measures need to be taken. The game ends whenever the player has found all failures and has either reported that it is stable or has taken an appropriate remedial measure. The game also ends when a player cannot find a critical failure. In this case it will lead to a levee breach that will flood the whole region.

The game has been designed to be used both in workshops that are completely focused around the game, or in workshops in which playing the game is interchanged with lectures on levee inspection. In both types of workshops we consider the presence of an experienced facilitator as extremely important as solely playing the game will not yield an effective transfer of the learning goals [Egenfeldt-Nielsen 2005]. The facilitator debriefs players in between and after playing the game by relating the game to their real world experiences and by showing and explaining examples of failures that have occurred in the past. Up till now the game has successfully been used in more than 10 of these types of workshops.

4 Lessons learned

Based on the development of *Levee Patroller* we can enumerate some important findings for developing serious games for professional environments.

4.1 Games need to be a single whole

During the design of *Levee Patroller* we worked closely together with a number of Dutch water boards, their employees and many experts. This collaboration proved to be fruitful, but also highlighted numerous challenges that may be found in many professional environments. First of all, it became clear that the participating water boards have different perspectives, needs and expectations about the use of the game. The main reasons for these distinctions are that i) each water board faces specific problems, ii) each water board has region-specific characteristics, and iii) each water board has a different organizational structure. Due to this, it was hard to get all water boards to view the game in a similar fashion. In addition, the differences made it difficult to make the game applicable for every water board. This difficulty arose, because games are systems [Salen, Zimmerman, 2004], and like any system they like to be consistent and coherent: they like to be a "single whole". This contrasts with the variety of perspectives, needs and expectations of the water boards.

On top of this, experts disagreed about what failures look like and how they develop over time. A major cause of this disagreement is a lack of theory and evidence in the area of soil engineering. Only a few pictures, videos and other material exist to rely on. This may have been the reason why experts revised their original statements after seeing how failures were visualized in the game. All of this means that it is highly possible that failures develop much differently in reality. This, of course, endangers any relevant transfer of content, skills and/or attitudes from the game to reality.

More importantly, it shows that games only provide one type of image. This singular image can hurt the learning experience as it might not be relevant for certain people. It might also cause people to overlook certain aspects in reality. Therefore, in designing a serious game it is important to keep in mind how this single wholeness should be dealt with. Incorporating flexibility is one, but an expensive way (e.g., the scenario generator in *Levee Patroller*). Teaching with several methods and embedding the game in a broader curriculum is another way.

4.2 Games function as discussion-support-tools

That games need to be a single whole is not necessarily a bad thing. It forces people to start a dialogue about the subject and to reach a consensus. As such, the game design process ensured a

shared understanding of levee inspection was created among the water boards and experts. This shared understanding will be helpful outside the game environment, such as in exchanging information. Hence, games provoke a discussion; they stimulate to think and talk about issues.

These discussions do not only take place during the design process. Learning especially takes place after the game, during the debriefing [Egenfeldt-Nielsen 2005], but also in-between playing the game, when players discuss game-related problems. The reason why learning takes place during these phases is that players are triggered during the game, but are frequently unable to "connect the dots". Facilitators or peers are needed to achieve this. In this way, games can be seen as "discussion-support-tools" on two levels; i) in designing, and ii) in playing.

This idea of a discussion-support-tool can even be found with entertainment games, such as *World of Warcraft* or *Starcraft*. Diverse Internet fora exist where players discuss strategies and other game-related issues. In South-Korea even a number of TV stations are devoted to talk about the game *Starcraft*. This desire of discussing game content exists, because games are rule-based systems that provide content in a complex and indirect way. To grasp what the game is all about it is necessary to reflect about the experience, in-game as well as before or after.

This functionality of games, to support discussions, is important to keep in mind. In embedding the game, time and space should be allocated to allow for discussion. This can be done by for example having the ability to pause the game, by providing an Internet forum and by having a facilitator who provokes a discussion in-between and after playing the game.

4.3 Games simplify and emphasize aspects in reality

The thought that anything is possible with computer technology is a misperception. For instance, we needed to model levee failures. These failures have subtle and complex signals and it proved to be quite a challenge, despite the dramatic advances in the field of computer graphics, to achieve this. The implementation of grass textures – a simple addition to the game environment – on levee surfaces already appeared a difficulty. In the end, we achieved to get the textures aligned with the slopes of the levee, but it was impossible to automatically adjust these textures whenever a levee changed its shape due to the occurrence of a failure. As a result, grass textures were floating around at in-game failure locations. This made us decide to not incorporate any grass textures on levee surfaces.

As for the modelling of failures, it was quite a challenge to create realistic swamp terrains and slow water or mud streams. Despite being recognizable, they are certainly not realistic. In some cases, we knew that it was impossible to accurately simulate a particular signal. For instance, a game cannot – without using external tools, like haptic devices – let a player feel the difference between a dry and a wet piece of soil. On top of these restrictions and challenges, it appeared that the game engine could only support placing one specific type of failure at a failure location.

Due to all these restrictions, it could be questioned i) whether it is possible to model complex and subtle features of levee failures, and ii) whether the modelled failures still truly relate to reality. An argument against both of these objections is that we human beings learn from abstractions and simplifications of reality. As Aldrich [2004] finely points out, the best selling bird books are composed of drawings and not of photographs. Drawings can highlight the distinctions among the different birds, and this makes it easier to recognize one than by seeing a photograph of the same bird. Hence, the signals in *Levee Patroller* might not look as realistic, subtle and complex as in reality, but they might stress the necessary features to let a levee patroller recognize failures more easily in reality.

The point we want to emphasize is that games, like any method, have their restrictions. At the same time, these restrictions show the power of games: to simplify and emphasize aspects in reality. Games force designers to reveal reality in its most relevant way, without superfluous stimuli. The restrictions and opportunities of the game design can be found by keeping the purpose of the game in mind and by creating prototypes at various stages in the design process.

4.4 Games request a complementary learning style

We noticed a lack of game literacy [Gee 2004] among the levee patrollers. This is not surprising, as the average age of a levee patroller is around 50 years. This made a complex design undesirable, since otherwise a part of the levee patrollers would not be able to use the game. However, we did notice that despite their illiteracy levee patrollers showed a great willingness to learn how to play the game. In fact, they showed striking improvements after just 30 minutes of playing. Nevertheless, until the *digital natives*, the generation that has grown up with playing video games [Prensky 2001], become the professionals of today, game literacy remains an issue.

Another observation is the occurrence of "cybersickness" [LaViola 2000]. Some users get this type of motion sickness by playing the game, and are unable to play any further. A solution was to let these people sit next to other players who did not have any problems and let them play together. In addition, to reduce cybersickness and the complexity of the controls we are currently experimenting in using the *Wii Remote*.

A third relevant observation concerns the requests and frustrations of several players. It turned out that these differed significantly among players. Administrative oriented players wanted charts, detailed information etc., while more field oriented players wanted better visuals and communication. Also, those who had extensive experience with games thought much differently about the game than others. In particular, they missed some features that many big entertainment games have. For example, they wanted to jump over fences and ditches.

All of the above confirms that professionals want to learn according to their previous experiences and learning styles [Hartley 2000]. This shows that games in general are not necessarily suitable for everyone and that a specific design may not necessarily be suitable for everyone. Solutions to ensure that as many people can be satisfied can always be found, but it is wrong to think that games are the perfect method for teaching for everyone.

4.5 Games are motivation-enhancers to those interested

The hypothesis that games are motivating is not something new. Prensky [2001] devoted a complete book to explain that games stimulate people. However, the reasons why remain yet unclear. Malone [1981] mentions challenge, curiosity, and fantasy as some of the motivating factors in games, Gee [2003] talks about the structure of games, the use of levels and an increasing difficulty, to explain games' motivational power, and many other game scholars refer to Csikszentmihalyi's flow theory [1990] as an explanation. Most, like Prensky, keep it simple and say games are motivating, because they are fun.

All these explanations are similar to motivation rather vague; what is challenging or fun, and when does a player experience flow? In addition, we are dealing with a chicken-and-egg problem. Is it motivating because it is fun, or is it fun because it is motivating? We will not give any answers, but we do want to share our insights of the game *Levee Patroller*. First of all, we noticed that "scores" engage people. For instance, players asked if it was possible to play the game at home, because they wanted to get a 100% score. The scores created a competitive atmosphere, in which players wanted to beat their own score or those of others. Scoring systems are a debatable issue in the field, since it is questionable whether it is possible to reflect progression in terms of learning with quantitative criteria. This shows that scores not necessarily need to reflect this type of progression. They can simply be used to foster motivation.

Secondly, we noticed that patrollers were fascinated by the game's environment. They could stare at failures for minutes and it was quite hard to get their attention while they were playing. Besides this, they took the game seriously. They measured every inch of a failure to make sure they would hand in a proper report. This contrasts with hardcore gamers who also playtested the game. These gamers ignored measuring, got quickly bored with the game's purpose, and did not really know what to do. For example, whereas levee patrollers would immediately go to the

levees, hardcore gamers would wander around till we had to point out that the game was not called *Levee Patroller* for nothing.

This shows that a game can be motivating if it is of immediate value [Knowles 1973], and that previous experiences [Hartley 2000] and a link to the real world [Schank 1997] are important to make sense of the game environment, but also to enjoy it. By developing a game specifically for professionals, it will be easy to motivate them. Furthermore, the motivation can be increased by building in "tricks", such as scores.

4.6 Games require a change in curricula

A big constraint turned out to be the time available for training. At most water boards the levee patroller squads consist of volunteers. These people only come together in case of emergencies or on training occasions, which are rarely organized. To use the game effectively, it was necessary to think about how the game could be integrated into the training curricula. Giving away the game to levee patrollers was not considered an option, for learning especially takes place during the debriefing [Egenfeldt-Nielsen 2005]. Eventually, it was decided to integrate the already existing lecture with the game, together with offering additional gaming sessions.

Nonetheless, this shows that the game currently has limited applicability. Only a few times a year patrollers get a chance to practice. This means professionals have little time to play, while games actually demand players to invest a lot of time. For educational settings this time issue is not any different. Extensive discussions have taken place of how to use games in the 45 minutes time slots that schools typically use. The answer to this problem is "change". For games to be effective, it is necessary to re-think how we educate. In designing a serious game it is thus important to consider how this change in curricula should take place. At the moment, GeoDelft is looking into this required change together with the water boards.

5 Conclusion

The increased interest in using games for professional environments is explainable; games intrinsically involve learning and fit particularly the way adults learn. At the moment, little is known about how such games need to be implemented to create an effective educational experience. A major reason for this knowledge gap is the lack of reflection on the design and learning experiences. To take a step in this desired direction, this paper examined what can be learned from the serious game *Levee Patroller*. The lessons learned from this experience are:

- Games need to be a single whole;
- Games function as discussion-support-tools;
- Games simplify and emphasize aspects in reality;
- Games request a complimentary learning style;
- Games are motivation-enhancers to those interested;
- Games require a change in curricula.

Although some of these lessons may be specific to this case, many others will definitely show up in other professional contexts. We think it is important to identify what may be the generic characteristics and challenges in designing serious games for professional environments. We hope that, with this case study, we have stimulated others to publish their observations as well. Only by establishing a sound scientific base, learning with games in professional environments will fulfil the huge expectations currently put on it.

As for *Levee Patroller*, the game can be considered a success in terms of use and satisfaction; the water boards are actually using it to train their levee patrollers, who indicate that they are enjoying to be trained in this manner. We are now working on the further development of the game, both extending the domain dealt with and investigating how to satisfy a number of new

desired features, conceptually as well as technically. Finally, future research will have to be made into the effectiveness of this application.

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