Gamification and Accessibility

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Abstract. There are many software requirements for the development of accessible applications, in particular for elderly people or people with disabilities. In particular, user interfaces have to be sufficiently abstract to cover required adaptations. In this paper, we introduce a gamification approach for teaching, connecting and engaging developers on accessible design of applications. A particular challenge hereby is combining gamification patters with the requirements of accessibility. As many gamification patters build on visual representation or usage metaphors, they are not suited for adaptation. Instead, we derive a representation-agnostic set of gamification patters from actual game design of commercial games. We identify and illustrate five categories of representation-agnostic gamification patterns, based on a games survey: action space, reward, challenge, progress, and discovery.

Keywords: Human computer interaction · Gamification · Accessibility · Elderly · Game development · Serious games · Game design · Game mechanics · Game theory

1 Introduction

A particular challenge for computing and aging is supplying applications that are adaptable and configurable enough to support simplified or modified user interfaces or usage metaphors. Adaptations can be quite simple, for example coloring or size, but can also be very complex modifications on content, such as simpler text or altered usage metaphors and timeouts [15].

There are various technical approaches to adapt an existing application, either through the application directly or through interface abstraction layers as supplied by the operation system or window manager. Yet, adaptations regarding usage metaphors or deeper adaptions regarding the visual representation can usually not be covered by those approaches, as they require an application to have a sufficient API to inject new interface models.

The Prosperity4All project [11] therefore aims at software developers, supplying them with resources, documentation and online help texts to integrate such approaches into their software project. An important piece of the Prosperity4All approach is the community server, which serves as a platform for developers interested in providing the necessary adaptations for their application. The community server uses gamification to increase acceptance. The challenge herein is to combine gamification techniques and

J. Zhou and G. Salvendy (Eds.): ITAP 2015, Part I, LNCS 9193, pp. 145–154, 2015.
DOI: 10.1007/978-3-319-20892-3_15

accessibility constraints. As most common approaches of gamification focus on visual representation, those are unsuited for an accessible platform. Our approach is derived from analyzing gameplay and game mechanics patterns of popular games, deriving representation-independent gamification models.

2 Gamification

Gamification has been described as using elements of game design in non-game contexts [1]. The core idea is to identify the mechanics that make people enjoy a certain process [2]. It has been shown that people enjoying a process are either more productive in executing said process, or more careful in maintaining external constraints [3]. As such, gamification is not a single, precisely defined method, but rather a methodology to transfer knowledge from the games industry and utilize it to optimize and enrich non-game processes [1].

Both physical and computer games offer patterns that are supposed to make player actions enjoyable [5]. Some patterns, such as clearly defined rules, are often shared between both categories of games. Some are unique to either environment. As our research is focused on creating a purely virtual platform for software developers and combining this virtual platform with accessibility for virtual devices, we will focus on computer games and the metaphors used for gamification in virtual worlds.

Since first research in the 1980s, such as [4], gamification became a powerful and popular tool for both academia and industry. Nowadays, gamification is often introduced as a method to add additional benefit to a business process without actually altering the business process itself [8]. Following this logic, it is important to note that gamification should always be optional [7]. As soon as a user is forced to participate in a gamification system, the gamification system becomes part of the actual process gamification is trying to improve. For most applications, however, the business process should remain as fast and efficient as possible, without taking gamification elements into account. Gamification aims at the user, not at the underlying process. Yet, deploying gamification to a business process can lead to the discovery of shortcomings and ineffective sections of the respective business process and should then lead to alterations and improvements.

Our research focuses on three aspects of gamification: gamification used for teaching, gamification in complex application interfaces and gamification used for self-organization and coordination. We will illustrate the problems of combining gamification used for teaching and accessibility in this paper.

2.1 Gamification for Teaching

Gamification can be used to improve the process of learning, resulting in faster or more reliable knowledge consumption [5, 6]. This is of particular interest to us, as many developers have to be familiarized with the problems and issues of accessible software design. The GPII [11], for example, requires a software developer to express their application settings in a certain way, or to integrate interfaces to GPII components for runtime adaption.

Particularly for learning, gamification and serious games blend [9], and there is no clearly defined, sharp line between them. Many learning systems or games build on reward messages (for example by using success messages, such as used by Anki [10]) or extrinsic motivation via measurable reward points (such as school grades). The process of learning is very individual and not tied to specific software or patterns. Reward in learning applications often comes in the form of high-scores, badges, unlockable achievements or other features like customizable avatars. Reward-based gamification approaches – or serious games – have to face various problems when combined with accessibility, as described in the following chapters.

3 Gamification and Accessibility

One of the core requirements of gamification is to be optional and not distracting from the gamified core task [7]. In graphical user interfaces, this is often achieved by placing the visual representation of reward in a sidebar where it is not visually distracting. Further visual techniques can be used, such as color-coding or visual styles to clearly mark the gamification part of the user interface. As argued in [13], this can work well for two-dimensional user interfaces. Yet, it is obviously tied to a specific form of representation. Even simple modifications, such as zooming, can cause the sidebars to consume a more significant portion of the screen space; altering the color settings, such as contrast, can render color coding ineffective; icons and symbol graphics can be meaningless to some audiences. For more complex modifications, such as using a screen reader, the drawbacks of gamification relying on visual representation become obvious. A screen render uses a one-dimensional representation of a document, such as a web page, to read it to the user. In contrast to a two-dimensional user interface, there is no simple way of arranging a user interface element in a way so that it is present, but not distracting. A gamification interface previously placed on a sidebar will end up at the beginning, the end, or somewhere else in the one-dimensional stream of representation. This will force a user to either skip those parts when reading a document, clearly violating the prerequisite of optional gamification.

One approach to overcome those limitations is to create explicit gamification alternatives for each possible interface modification. Taking the vast amount of possible interface modifications into account, such an approach becomes impractical. Yet, there are gamification approaches that work without relying on their visual representation. These representation-agnostic elements of gamification are typically of a more abstract nature and are harder to identify.

3.1 Identifying Representation-Agnostic Gamification Patterns

In order to derive gamification patterns that do not rely on their visual representation, we analyzed a collection of 21 commercial PC games for their game play and game design. The analysis was conducted through interviews of a variable number (2–6) of experienced players per game. The findings were further categorized into gameplay patterns. Game design and game mechanics considerations were taken into account

where feedback from the game developers was present. An interesting finding was that similar or even identical patterns can occur in variable contexts for different effects. Instead of forming a fixed set of gamification patterns, we therefore assembled a pool of patterns that can be applied to different scenarios. The following chapter will highlight some of them with a respective game example.

4 Gamification Patterns

The representation-agnostic gamification patterns derived from the games survey can be grouped into five major categories: action space, reward, challenge, progress, and discovery. This chapter will illustrate each of them with an example from the survey.

Fig. 1. Tetris on the Nintendo Game Boy (1989)

4.1 Action Space: "Tetris"

Tetris is popular puzzle game dating back to 1984. As such, it formed the foundation of gameplay mechanisms for many generations of puzzle games to come. Both the gameplay and rules of the game are very simple but addictive. Due to the simplistic game design, the mechanisms that make Tetris fun to play are clearer to identify. One category in which Tetris shines is a fully observable and small action space (Fig. 1).

The action space of a problem is the number of options per decision a user can select from. There are multiple aspects to the action space that are relevant to making a game enjoyable. First off, the action space of Tetris is fully observable: The player is aware of all possible actions they can do at a given point of time: rotating blocks clockwise or counterclockwise, moving blocks left and right or accelerating their descent. More importantly: A player knows that they know the complete action space. This is a sharp contrast compared to many business tasks, where the action space is typically vast (filling out documents has a giant action space, but even the average document processing software offers dozens of options just to style the text). In our survey, users enjoyed selecting from a small collection of options. In many office applications, one can observe a trend of shifting programming problems into the action

space of a user. A typical example are dialogues like "You are performing an action that you cannot undo, are you sure?". Instead of implementing a reliable undo function, the problem was moved to the user, unnecessarily expanding their action space.

The other interesting aspect of the action space of Tetris is that users not only know the complete action space, but they are also aware that they know the complete action space. There are no advanced or hidden commands in Tetris that allow any other interaction, besides going to the menu and ending the game. In many applications, on the other hand, user actions are grouped into actions a user often wants to do, and advanced settings only used for specialized tasks. Yet, this seems to reduce the joy in performing those actions, probably as users are uncertain if they actually picked the best possible action, or if there would have been a smoother way to solve a problem hidden in some advanced menu. Applications should therefore be designed in a way to require as few actions as possible, so that all can be presented to a user. This is unrealistic for complex software, like an image editing program, but interface structures could be arranged in a way, so that for a certain problem – like applying a blur-effect to an image region – all possible actions are presented.

A small and fully observable action space, with the knowledge of being fully observable, is a base principle in all the games mentioned in this paper.

4.2 Reward: "Diablo III"

Diablo III is a hack'n'slay game where a player ventures through a dark fantasy world and slays demons and other creatures and solves challenges. As with many examples of this genre, one of the most important gameplay concepts is acquiring new equipment to defeat stronger foes. Many games use specific reward models to distribute and handle rewards for players. Reward in games fulfills a few important characteristics different from real-life: being immediate, measurable and expectable (Fig. 2).

Fig. 2. Diablo III from Blizzard Entertainment (2012)

In games, reward is usually given right after the action that caused it, unlike real-life examples, where rewards – or penalties – are often distributed a long time after the action that triggered it. That makes it hard for users to associate the reward with the actual action and therefore decreases the probability to trigger a positive feedback cycle. Defeating a difficult enemy in Diablo III will immediately reward new equipment, similar to the lines in Tetris immediately disappearing once they are filled.

Similarly, reward in games is usually measurable and comparable. Reward is sometimes just awarded in non-measurable form, like a "Congratulations" message, but in most games, players gain score – as in Tetris – or measurable improvements to character attributes – as in Diablo III. This is important to compare different rewards between alternative actions. These metaphors are already used by gamification a lot, as high scores and reward points are a very commonly used gamification pattern.

Also, reward in games is often expectable. That means, that the rules that may yield a reward are clearly communicated to the players. This goes along with the fully observable and known action space discussed above.

4.3 Challenge: "Portal 2"

Portal 2 is a first-person puzzle game where the player has to solve a wide variety of physics puzzles, utilizing the conservation of momentum, gravity and fluid mechanics. The puzzles become more challenging throughout the game and are very challenging, if compared to other puzzle games (Fig. 3).

Fig. 3. Portal 2 from Valve Corporation (2011)

The design and dramaturgy of designing challenge is an essential part in game design. A common approach is game flow [14]. Game flow is a concept of keeping challenges offered by the game in check with the skill progression of the player. From a more abstract perspective, game flow is dealing with learning effects of the user. One example of applying flow to gamification for elderly was demonstrated by Korn [16].

Challenge in games and in gamification is very different. In games, challenge can be designed and planned, as the underlying game mechanics, story, and gameplay can be altered. A boss encountered deemed to be too difficult can be made easier by offering assistance to a user or reducing the capabilities of the other non-player characters. When dealing with challenge in gamification, the challenge is often implied by the business process being gamified. In that case, challenge cannot be designed freely. Yet, gamification approaches might introduce their own challenges, for example by adding mini-games, such as a puzzle where each solved work-task allows performing an action in the puzzle. In that case, the mini-game can be considered a full-fletched game, with all possibilities of game design, with the only difference that the action space of the mini-game is bound to a real-life business task.

If utilizing challenge in gamification, it goes along with action space and reward, as described above. A challenge in a game has to be solvable with a fully observable action space and should offer some kind of reward.

4.4 Development: "World of Warcraft"

The core principle behind Massively Multiplayer Online Role-Playing Games (MMORPGs), such as World of Warcraft, is the ongoing development of a character. This is very similar to many real-life scenarios, where most actions come with persistent, ongoing consequences (Fig. 4).

Fig. 4. World of Warcraft from Blizzard Entertainment (2004)

According to the survey, an important requirement for players to perceive a persistent development of a character as enjoyable is, that such a development is clearly measurable. This seems to be a consequence of measurable progress as described earlier. Persistent development shares most of its requirements and aspects with

progress, but does not require reward to be enjoyable. In a sense, the persistent development itself can be sufficient reward for players to continue playing, as they see constant improvements. Many MMORPGs exploit that to an extreme extend, as those games typically don't offer any kind of ultimate goal in the game. You can never win an MMORPG. Instead, the developer supplies new options to improve your character, and it is only possible to achieve a perfect setup by investing a lot of time (or money).

Persistent development is related to progress and challenge and can serve as a form of intrinsic reward.

4.5 Discovery: "Elite: Dangerous"

Curiosity and – associated with it – discovery can be very powerful and driving reasons to perform an action. Many open world games offer very fast virtual environments, which allow players to explore. In Elite: Dangerous, a player can discover our whole Milky Way galaxy with countless solar systems and planets, some of them inhabited (Fig. 5).

Fig. 5. Elite: dangerous from frontier developments (2014)

In order to be enjoyable, the survey showed that virtual worlds to be discovered have to be consistent both in regards to the rules they imply (such as gravity or the laws of magic) but also – and more importantly – in regards to their story. This can either be an overall story of the game universe, or just small stories originating from character interaction. Tailoring a vast consistent game world is a challenge.

While discovery can be very motivating, the underlying requirements of discovery – a vast virtual world – are usually not fit for gamification. Some serious games utilize this technique, but for the average gamification task developing a while virtual world is not an efficient approach.

5 Conclusion

In this paper, we have discussed the five primary gamification aspects that the game survey revealed: reward, action space, progress, development, and discovery. All of them are rather abstract concepts of game design and don't rely on a certain visual representation. One could, for example, think of an action space represented in a 2D visual display, or explained through a screen reader. Such representation-agnostic metaphors are the fundamental building blocks when setting up a gamification framework supporting accessibility.

Future work will focus on deriving discrete representations for the patterns we discovered. They will be utilized in a community server platform for the GPII helping developers finding and coordinating accessibility efforts, and also for teaching developers on how to implement basic accessibility guidelines into their work or using gamification themselves. As such, we will focus on action space representations, reward and progress.

Congrats for reading this far! You gain 100 points!

Acknowledgments. The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2011) under grant agreement n° 610510, Prosperity4All ("Ecosystem infrastructure for smart and personalised inclusion and PROSPERITY for ALL stakeholders"). This publication reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained herein.

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