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Chapter 9

Gamification of Workplace Activities

Michael Meder, Brijnesh Johannes Jain, Till Plumbaum, and Frank Hopfgartner

Abstract Gamification – taking game design patterns and principles out of video games to apply them in non-game environments has become a popular idea in the last four years. It has also successfully been applied to workplace environments, but it still remains unclear how employees really feel about the introduction of a gamified system. We address this matter by comparing the employees’ subjective perception of gamification with their actual usage behavior in an enterprise application software. As a result of the experiment, we find there is a strong relationship visible. Following up on this observation, we pose the gamification design problem under the assumptions that (i) gamification consists of various types of users that experience game design elements differently; and (ii) gamification is deployed in order to achieve some goals in the broadest sense, as the problem of assigning each user a game design element that maximizes their expected contribution in order to achieve that goal. We show that this problem can be reduced to a statistical learning problem and suggest matrix factorization as one solution when user interaction data is given. The hypothesis is that predictive models as intelligent tools for supporting users in decision-making may have the potential to support the design process in gamification.

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Procrastination

Steven lifted his head from the office desk and instinctively looked at the clock at the wall. 5 o'clock in the afternoon. Once again, he had fallen asleep at his desk. It was the eighth time already that this had happened this month. Well, at least he had an individual office for himself so that his colleagues did not notice when he was sleeping at work. Feeling excessively miserable, Steven started reading short news articles on the internet, thinking it would make him feel better (but as usual, it did not). Starting to transform his bad conscience into energy to change his work attitude, he realized that his boss had send him an e-mail during his short nap.

"Hi Steven, we need an overview about the requirements management system. Could you bring it upstairs to me by 6pm today!" Steven frowned. "By six o'clock! This is less than one hour from now", he realized. "Writing such an overview in only one hour is impossible... for me at least."

Trying to calm down, Steven opened a new tab on his browser and started reading some short news. Irritated, he stopped. "I really should reconsider my online behavior", he thought. "I am way too often procrastinating". Yet again, he felt excessively miserable. Concerned about what he should send to his boss, he suddenly remembered the old enterprise bookmarking system that was deployed in his company. The system was designed to allow employees to collect and share links to documents. "It was actually quite nice", he thought. By adding a document link to the system, one could also provide a short description and categorize the document using short terms, so-called tags. "Maybe someone shared a link there that can help me to write this report." He searched for the system announcement e-mail, because he could not remember the web address to the system. After Steven found and opened it in his

browser, he was surprised by the small number of overall bookmarks stored in the system. The system was announced three years ago and there were only 148 bookmarks in them (in a company with around 200 employees). “Whatever”, he thought and started to search for all bookmarks with the tags *requirements* and *management*. Within the blink of an eye, the system displayed the one bookmark it had found. This was very disappointing for Steven. With a slight *whoomph* sound, his head struck on the desk and stayed there for a couple of seconds. “What shall I do now?” He already imagined sitting in front of his boss and apologizing again for missing yet another internal deadline...

This little scene happened two years ago. Steven had already forgotten it. It didn’t have any consequences for him anyway since his boss actually had already left the office and hence didn’t even notice that Steven didn’t deliver this report on time. Just suddenly, Steven had a little *déjà vu*. He had just woken up from yet another short power nap at work – disturbed by the loud buzzing of his email client. It was an e-mail from the enterprise bookmarking system which was recently enriched with some game design elements. A point system, virtual badges for special activities and a leader board. Especially recommending bookmarks to colleagues are rewarded with the highest number of points but only if the colleague confirms the bookmark as an interesting one for him. Steven had heard that they call it gamification, meaning applying game techniques to non-gaming environments.

Steven had a closer look at the message that he had just received. Scott, one of his colleagues, who was also a good friend, recommended Steven a link about procrastination research and the top anti procrastination smart phone apps. Scott knew about Steven’s problem with getting things done and also falling asleep at work. “Interesting”, Steven thought bemused. “I never thought that this bookmarking system would ever be of any use.” He smiled when he remembered that one day when he hoped that this system might help him in preparing a report. What a deserted piece of software it was back then. No comparison to today at all. Ever since they gamified the bookmarking system, he and his colleagues used it extensively. It was a fun competition in his office. Who would end up on top of the leader board at the end of the month? He smiled again and clicked on the link that Scott had sent him. “Okay Scott, you can have these points for recommending the link to me. But be assured, I will find something to return to you.” After all, it was a tight race for the top leader board position. He also made a mental note to complain about bullying at the workplace the next time he would meet Scott.

9.1 Introduction

User engagement, participation, crowdsourcing, the “Wisdom of the crowd”. In the beginning of this century, the ever-growing number of users online stimulated the hopes of many Web application developers that with the help of their users, great interactive online archives could be created. Although various popular portals (e.g., Wikipedia, Youtube, or Flickr) exist in the Web that are built around user content,

Nielsen [26] and Stewart et al. [31] argue that many companies suffer from the participation inequality problem. Based on this observation, we assume that in almost every company, at least one software system exists that needs more user activity to provide a remarkable benefit for the employees and the management.

This leads us to the question what kind of software or system is engaging and motivating to its users, especially in the long-term. Long-term motivation also plays an important role in the gaming business. Well designed board and video games provide various means to incentivize their players to continue playing. Considering the success of such games, it is worth investigating whether these methods and principles can also be exploited to promote long-term usage of enterprise systems. In fact, since 2010, the application of these methods and principles, also referred to as gamification, is a trending topic for marketing and business oriented services. Deterding et al. [7] define gamification as “*the use of game design elements in non-game contexts*”. A rather benefit oriented definition was provided by Huotari and Hamari [16] who define it as “*a process of enhancing a service with affordances for gameful experiences in order to support user’s overall value creation*”. In today’s online world, one stumbles upon gamification elements on various sites. Stackoverflow¹ uses a reputation leader-board where users get points for helpful answers. Dropbox² rewards users who spread the word with more space and LinkedIn³ is motivating users to complete their profiles by presenting progress bars. Not only in the Web, but also in the biochemistry [19] and education domains [22], using game elements becomes a non-neglectable part.

A common objective of gamification is to enhance motivation. In an enterprise setting, for example, the goal is to motivate employees to participate in a certain task. If, for example, a project requires constant documentation of project activities which is not a very popular task, gamifying the documentation process should address this lack of motivation. Finding the right means to increase motivation is a non-trivial task though since motivation is mainly driven by human-centric factors. For some people, being on top of a leaderboard can be motivating, but what about people who are not in the top N ? Are these people really motivated to rise up on the leaderboard? Also, what does their position on the leaderboard say about their work performance? Does it show that they are not working enough and do they have to fear negative consequences by the management? These questions indicate that especially in an enterprise scenario, it is of uttermost importance to measure challenges and risks that occur due to these differences before introducing gamification methods. On the one hand, we expect gamification to increase user participation within an enterprise. On the other hand, the visibility of user interaction (or lack thereof), e.g., the position of the employee on a leaderboard can increase the stress level of employees or even cause fear that their activities on a gamified system will be used as an indicator of their engagement with the company. Gamification could have some

¹ <http://stackoverflow.com/>

² <http://dropbox.com/>

³ <http://linkedin.com/>

negative side-effects (negative manipulation, denunciation, blaming) but while it could also have positive effects the implications needs to be carefully investigated.

We argue that user specific gamification design could reduce participation inequality. We aim to show that better knowledge on how to motivate each user by which game design elements can increase chances for converting a lurker into an active, regularly participating user. Furthermore, we reason that a user specific application of game design elements can also prevent cross-cultural problems since automatic user type determination can address cross-cultural habits. More specifically, with this chapter and future studies we intend to answer the following research questions:

1. Is it possible to reliably predict game design elements in enterprise systems from click stream data analysis?
2. Is user specific gamification feasible? Which game design elements could be used simultaneously in one gamified system without negative impacts on others?
3. How to evaluate the improvement of user specific gamification design?

In this chapter, we examine the gamification design process in detail. The chapter is structured as follows: Section 9.2 provides a literature survey on gamification and its application in enterprise systems. In order to move one step closer to answering above research questions we performed a two-part experiment in a workplace environment described in Section 9.3. The first part of the experiment is an online questionnaire about users' expertise and perception of gamification methods. In the second part, we introduce a gamified social bookmarking system and analyze the participants' engagement with this system over a period of one week. We then compare the actual system usage to the answers users submitted in the questionnaire. Building on this, we propose a statistical approach to solve the gamification design problem in Section 9.4. After discussing the implications of this chapter, we conclude this work and provide an overview of future research directions in Section 9.5.

9.2 Related Work

In this section, we provide a detailed overview of the concept of gamification. Section 9.2.1 first provides an overview of the history of gamification and outlines established definitions. In Section 9.2.2, basic elements of gamification, namely game design elements, are introduced. Section 9.2.3 outlines the role of the user in the gamification process. Gamified systems that are applied in a workspace environment are presented in Section 9.2.4.

9.2.1 History and Definitions

In 1886, S&H Green Stamps, a United States company, started one of the first retail loyalty programs by offering stamps to U.S. retailers. In the following years, the idea to bind customers to companies spread to other domains, e.g., by the introduction of airline frequent flyer, hotel loyalty and car rental programs. Over the years, games started to conquer our living rooms. As early as 1990, 30% of American households owned at least one of Nintendo's NES⁴. The *Generation Gamer* was born. In 1996, Bartle published his four player types taxonomy [2] in which he suggests to classify gamers into different categories – socializers, killers, achievers, and explorers. It is a starting point for many game design tasks. Thanks to the Serious Game Initiative, the term serious game became more known and as a link between video games and non-entertainment purposes like training, education, health, policy and management issues. In 2002, Pelling coined the term gamification, “by which [he] meant applying game-like accelerated user interface design to make electronic transactions both enjoyable and fast”⁵. Bret Terri⁶ and James Currier⁷ also wrote about the term gam(e)ification in 2008 as a new marketing instrument to increase engagement by using game mechanics. Since 2010, the application of gamification [7, 16] is a trending topic for marketing and business oriented services. In 2012, Gartner Inc. predicted that “over 70 Percent of global 2000 organisations will have at least one gamified application by 2014.”⁸ Given this industry focus on gamification, the concept also received more attention from academia. In 2011, two definitions of gamification were published. Deterding et al. [7] define gamification as “*the use of game design elements in non-game contexts*”. Huotari and Hamari [16] define it as “*a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation*”. We interpret both definitions as implying a goal as the utility of gamification. Both describe elements of the game design world which could change a user's experience in a different context (non-game [7], service [16]). Interestingly, for Deterding [7] “[...] the term ‘gameful design’ – design for gameful experiences – was also introduced as a potential alternative to ‘gamification’.” Summarizing, in Deterding's definition the goal is rather geared towards the (improved) user experience itself, in Huotari and Hamari's definition it is the outcome driven by the user experience.

⁴ According to “Fusion, Transfusion or Confusion / Future Directions In Computer Entertainment”. Computer Gaming World. December 1990. p. 28. <http://www.cgwmuseum.org/galleries/index.php?year=1990&pub=2&id=77>. Retrieved 12 September 2014.

⁵ The (short) prehistory of ‘gamification’ <http://nanodome.wordpress.com/2011/08/09/the-short-prehistory-of-gamification/>. Retrieved 12 September 2014.

⁶ <http://www.bretterrill.com/2008/06/my-coverage-of-lobby-of-social-gaming.html>. Retrieved 12 September 2014.

⁷ <http://blog.oogalabs.com/2008/11/05/gamification-game-mechanics-is-the-new-marketing/>. Retrieved 12 September 2014.

⁸ <http://www.gartner.com/newsroom/id/1844115>. Retrieved 12 September 2014.

9.2.2 Game Design Elements

An important aspect of successful gamification is the selection of game design elements. Game design elements determine what type of gameful experiences are generated for the users. In [7], Deterding et al. provide five levels of game design elements. They distinguish between game interface design patterns, game design patterns and mechanics, game design principles and heuristics, game models and game design methods (Table 9.1). Robinson et al. [29] propose a taxonomy built on levels of expected engagement and the required commitment of the user. This taxonomy has been conceived as a decision support for game element selection.

Table 9.1: Levels of Game Design Elements by Deterding et al. [7]

Level	Description	Example
Game interface design patterns	Common, successful interaction design components and design solutions for a known problem in a context, including prototypical implementations	badge, leader board, level
Game design patterns and mechanics	Commonly reoccurring parts of the design of a game that concern game-play	Time constraint, limited resources, turns
Game design principles and heuristics	Evaluative guidelines to approach a design problem or analyze a given design solution	Enduring play, clear goals, variety of game styles
Game models	Conceptual models of the components of games or game experience	MDA; challenge, fantasy, curiosity; game design atoms; CEGE
Game design methods	Game design-specific practices and processes	Playtesting, playcentric design, value conscious game design

9.2.3 User Types

Designing gamification is also always a user-oriented process. This is due to the fact that users are all individuals driven by different input factors like age, gender, education, social skills and cross-cultural influences [12, 18, 35, 36, 37]. In the game world this is considered by several player typologies developed on user observations and in-game behavior. Hamari et al. [15] list existing game player typologies. They state that player types have their legitimation because of the different behavior and motivation of players. It is a widespread assumption that also for the gamification scenario such types of players respectively users can be applied. Although many player typologies exist we argue that it is hard to map them to one or more specific game design elements. Beyond that, such types could change over time which seems to be a central criticism on player typologies [15]. Furthermore, we argue that

applying a set of game design elements to cover all different types in a gamification scenario could have negative influence to each other.

9.2.4 Gamification in the Workplace

Various studies have been performed that indicate that gamification has a favorable effect on the use of enterprise systems. In [4], Dugan et al. describe the transformation of an enterprise bookmarking system into a guessing game called Dogear. In this game, bookmarks and their tags are displayed on screen and the players have to guess, *who* created this bookmark. If they guess the correct creator of the bookmark, the players can gain points. The Dogear game is inspired by von Ahn's ESP game [34] where users gain points when they use the same tags to describe the content of an image as their teammates. Differing from the ESP game, which exploits "human computation" for the annotation of images, Dogear is focusing on providing methods to learn more about colleagues and their expertise, hence increasing familiarity within a company. They report that within the first month of the release of the system, they had 87 active players from 10 different countries. A detailed analysis is still missing though.

Farzan et al. [11] examine the impact of game mechanics, more precisely the introduction of a points system, on a social enterprise network system (Beehive, IBM). They evaluate the impact of this points system by performing A/B testing, i.e., one half of all users are made aware of the points system, while the other half (i.e., the control group) cannot see this feature. They observe that overall, the introduction of the points system increased the activity level of the users within the system. However, they also report that 72% of the users in the experimental group never visited the page which describes how to earn points. Besides, they argue that a large portion did not even notice the existence of points.

Addressing this issue further, Farzan et al. [9] also studied if there is any noticeable effect on the usage when the points system is explicitly explained to the users. Therefore, they provided further details via email and repeated the experiment. They conclude that points systems can successfully be employed to motivate users to contribute more in an enterprise social network system, especially if combined with email notifications. Further, they conclude that the type of contribution can directly be controlled by the type of gamification applied, i.e., increasing the points for certain types of contributions will indeed result in an increase of contributions of this type. In a follow-up experiment, Farzan et al. [10] increase the social interaction and diversity of content even further by introducing a badge based approach on promoting content. Although they observe an increased activity due to the introduction of gamification methods, the authors argue that they cannot make any statement about the quality of the contributions. Further studies are needed to examine this in detail.

Evaluating the effect of gamification methods from a different perspective, Thom et al. [32] study whether the *removal* of gamification features from an enterprise

social media system has any measurable effect on user activity. They report a significant decline of user activities after removing gamification features, concluding that extrinsic rewards influence user behavior. Interestingly, the authors also noticed some relation between user activity and their geographical location. This supports our premise that there are many factors that can have an impact on the success of workplace gamification.

Hamari [13] evaluates the use of badges in a peer-to-peer trading service. He observes that the introduction of gamification mechanisms does not automatically result in an increased use of the system by all users, but that those users, who actively inspect their own badges become more active. This supports our assumption that individual behavior plays an important role in the successful application of gamification methods in an office scenario.

Summarizing, previous research reports an increase of users' activity in an enterprise due to diverse game mechanics. However, these studies also indicate that individual behavior has a significant influence on the success of gamification. To the best of our knowledge, there currently exists no study about employees' perception of gamification. Therefore, we attempt to better understand employees' behavior in more detail.

9.3 An Enterprise Gamification Experiment

Gamification methods have been applied in various environments and for different purposes such as enterprise workplaces, education, pervasive health care, e-commerce, human resource management and many more (e.g., [1, 5, 27]). Although these studies indicate that gamification can lead to increased user activity, a detailed analysis of users' perception of gamification principles has hardly been studied. We are all individuals and are driven by different input factors such as our personality, as well as social or cultural differences [12, 18, 35, 36, 37]. Especially in an enterprise scenario, it is of uttermost importance to measure challenges and risks that occur due to these differences before introducing gamification methods though. On the one hand, we expect gamification to increase user participation within an enterprise. On the other hand, the visibility of user interaction (or lack thereof), e.g., the position of the employee on a leader board can increase the stress level of employees or even cause fear that their activities on a gamified system will be used as an indicator of their engagement with the company. Although gamification has successfully been applied in office scenarios, it remains unclear how employees really feel about the introduction of a gamified system at their workplace.

In this section, we address this issue from two directions. First, we present the outcome of an online survey where we analyze users' opinion about gamification in a workplace environment. Then, we analyze the interaction logs of a re-designed gamified enterprise bookmarking system to compare the employees' subjective perception of gamification with their actual behavior when using a gamified system.

Results indicate that there is a strong relationship between employees' perception of gamification and their actual interaction with such system.

We examine the role of gamification in a workplace environment from an employee's point of view. More specifically, we aim to answer the following research questions:

- Do employees perceive gamification as positive or negative factor?
- How is the perceived role of gamification reflected by actual usage patterns?

Aiming to address these questions, we defined an online questionnaire on users' expertise and perception of gamification methods, distributed it among employees of a technical research institute and evaluated their responses. In order to evaluate whether their subjective answers are on a par with their actual interaction with a gamified system, we further introduced a gamified Social Enterprise Bookmarking System and analyzed the participants' engagement with this system over a period of one week.

9.3.1 Questionnaire

In order to address the first research question on employees' perception of gamification principles, we created an online questionnaire where participants were asked to judge various statements on a Five-Point Likert scale. In the remainder of this section, we provide further details about the participating subjects and their responses.

9.3.1.1 Subject recruitment and details

We recruited participants by sending a brief introduction and a link to the online questionnaire to a mailing list of our research institute at an electrical engineering and computer science department of a major European technical university. Subscribers of this mailing list are over 140 members of this institute, including faculty members, administrative staff, postdoctoral researchers, PhD students and student research assistants. Given that all subjects are members of a technical research institute, we assume that all participants are highly familiar with using computer systems. To the best of our knowledge, none of the participants has professional experience with gamification in an enterprise setting. In order to participate, subjects had to authenticate using their institute account. We received a response from 53 subjects (6 female, 47 male), i.e., over one third of all subscribers of the mailing list. As part of the questionnaire, they were asked to provide their age in a pre-defined range. 23 subjects claim to be between 18–29 years old, 26 subjects are between 30–39 years old, 3 subjects are between 40–49 years old and one to be 50 years or older. Since this distribution roughly matches our institute's age and sex distribution, we argue that the participants are a representative subset of the institute's workforce.

9.3.1.2 Participants' responses

In the remainder of this section, we introduce all statements that the participants had to answer on a Five-Point Likert scale.

In the first question (Q_1 : “contribution”), we asked them to state how often they share or contribute content on enterprise systems such as Wikis or Enterprise CMS. Here, we could observe a rather conservative pattern, i.e., 33.9% (18 in total) of all subjects said that they sometimes contribute content, 33.9% (18) said that they seldom contribute and 11.3% (6) never share or contribute on such systems. Only 20.7% said that they often (8) or very often (3) contribute content. These answers are in line with our own (subjective) observations and the analysis of Wikipedia contributions by Ortega et al. [28], showing that content is often contributed by few individuals.

After asking the subjects to assess their current contribution and share activities on enterprise systems, the subjects were asked in question (Q_2 : “familiarity”), to state how familiar they are with the term “gamification”. This was also the first time we mentioned the term gamification in the questionnaire. 66% of all participants claimed that they were either to a great extent (10 subjects) or somewhat (25) familiar with it. 14 subjects said that they have very little knowledge about it while four subjects were not familiar with it at all. We conclude from these responses that there is a general awareness of gamification principles (especially amongst those colleagues who closely work with the authors of this paper), while many lack further details to describe these principles.

In the following question Q_3 (“motivation”), we were further interested in their own attitude towards gamification. Therefore, we asked them to judge whether gamification would motivate them to participate even more in enterprise systems. In order to guarantee that all subjects had the same understanding of gamification, we also provided a brief definition (as stated on Wikipedia) that should help to better understand this question. 43% of all participants stated that they were undecided on how to judge this statement. 34% of them agreed to this statement while 22% disagreed (9) or strongly disagreed (3). Although only a few more than those who disagree tends to agree with this statement. With 43% answered undecided it is evident that the subjects are not very convinced of the role of gamification in an enterprise environment. This goes in line with Q_2 which indicates that the subjects are not too familiar with the concept.

In the next question (Q_4 : “positive effects”), we asked the participants to state whether game mechanics like points, badges and leader boards have a positive effect on the enterprise and its staff. While 33.9% were undecided, a majority of over 50% either agree (26) or strongly agree (1) with this statement. Only eight participants disagreed (4) or strongly disagreed (4). This distribution of judgements seems to indicate that the majority of participants have a rather positive perception of gamification principles.

In the last question (Q_5 : “negative effects”), we wanted to know whether the participants believe that there are negative effects on the enterprise and its staff caused by game mechanics like points, badges and leader boards. Here, a clear preference

can not be observed. 49% of all subjects were undecided, 22.6% either agreed or disagreed with this statement while only 2 participants strongly agreed with it.

Summarizing, in this section, we aimed to evaluate whether gamification is seen positively or negatively within an enterprise context. The analysis of our online questionnaire revealed that although many participants of the study are (to some extent) familiar with gamification and are convinced that it can have a positive effect on an enterprise and its staff, they are not convinced that it can serve as intrinsic motivation for themselves to contribute more on enterprise systems. Addressing this question further, we present a gamified enterprise tagging system in the next section which shall shed further light on the difference between the perceived and the actual role of gamification on users' behavior in an enterprise setting.

9.3.2 Gamified Enterprise Tagging

Following our first research question on employees' perception of gamification, we were further interested in comparing this perceived role with users' actual interaction with a gamified system. In the remainder of this section, we first introduce such a system, i.e., an enterprise bookmarking system. Then, we introduce the gamification elements that have been added to the system. An evaluation of the users' interaction with this system is provided in the next section. Later in this section, we provide usage statistics of the system *before* and *after* we enriched it with gamification functionalities.

9.3.2.1 Legacy Enterprise Bookmarking System

Using tags to manage items became a common tool on the internet, among Delicious⁹ to tag bookmarks, Flickr¹⁰ uses tags to manage photos or Youtube¹¹ for video and LastFM¹² for music. Enterprises adopted tagging to manage and structure knowledge in an enterprise and to provide an alternative approach to helping employees find needed information. IBM for instance created the 'Enterprise Knowledge System' (ETS). The main idea of this system is that bookmarks can be annotated using tags and shared with others. The system allows tagging of documents, people and other resources, thus linking the items to extra knowledge. People for instance can be tagged with their expertise.

In 2009, we developed a social bookmarking system (Figure 9.1) in close cooperation with a large company. Social bookmarking systems became popular in the early years of this century with the rise and success of Delicious. Providing

⁹ <https://delicious.com/>

¹⁰ <http://flickr.com/>

¹¹ <http://youtube.com/>

¹² <http://lastfm.com/>

similar functionalities as the well-known Delicious system, our system additionally allows to create bookmarks for files on internal file server, taking into account existing rights management and the possibility to share bookmarks not only with other people but also with people having a certain tag.

Fig. 9.1: The main view of the bookmarking system, displaying all publicly bookmarked items.

The system has two main views, the personal site showing all bookmarks of a user, public and private ones (a user can mark bookmarks as private being only visible to them and not appearing in public searches) and a general view, called 'What's new' showing all public bookmarks. Bookmarks and users can both be tagged and searched. The system also offers a set of tools to ease the bookmarking process. We developed a JavaScript based bookmarklet, allowing people to easily bookmark web pages and a Windows tool to bookmark files. Also integrated is an automatic tags recommendation system recommending tags based on the bookmarked item (extracting the most important words from the describing text) and the most used tags by the user. We also integrated a so-called "Most Popular" section, showing the most frequent used tags of the week and of all time to help users see what topic is currently trending in the company, pictured in Figure 9.2.

Our bookmarking system was intended to be a prototype to test the usefulness and acceptance of such a tool within the enterprise. Hence, the developed bookmarking system was not intended to be a full featured, product-like, bookmarking system. Nevertheless, the system was well accepted among the employees of the enterprise (test group was one department), and led to the management decision to install such a system enterprise wide. Consequently, the system was made available to 100 employees. However, since its introduction in 2009, the number of active users reduced significantly. The main reason is probably usability flaws since the

Top 10 most used bookmarks this week

Click on a tag to search in bookmarks.

Fig. 9.2: Overview of the most used tags in the bookmarking system this week. The all time list is visualized accordingly.

system was never optimized with respect to user friendliness. Besides, changing staff lead to a slow oblivion of the system's existence.

9.3.2.2 Gamification Elements

In the context of this study, the existing system was carefully extended with three well known and researched gamification elements - *Points*, *Badges*, and a *Leader board* [24]. The three elements were chosen to cover different types of motivation and Gamification types. Rewards, with points and badges, for fulfilling different tasks, and a competition element with the leader board. While the points reward direct interaction with the system such as creating a new bookmark, badges are given for completing longer term goals such as continuously creating new bookmarks in a certain period of time. How to achieve points and badges is explained to the user by detailed descriptions of which actions score what points and what is needed to achieve a badge. The leader board, accessible only after the user logged in, is integrated in the main menu and within easy reach for the user. In the remainder of this section, we introduce the applied gamification elements in more detail.

Points: Almost every user interaction with the bookmarking system gives points, including daily login (200 points), adding a public/private bookmark (100/25 points), adding a bookmark with at least one tag (25 points), accepting a bookmark recommendation (200 points) and many others. Figure 9.3 shows an overview of the actions and the respective points.

Added one public bookmark.	100
Bookmark with at least one tag.	25
Bookmark with three or more tags.	50
Added one private bookmarks.	25
Copy as a public bookmark.	50
Copy as a private bookmark.	10
Bonus: Recommendation accepted and copied.	200
Bonus: One of your bookmarks was copied.	25
Bonus: You tagged a User.	50
Daily Bonus: Login.	200
Daily Bonus: 1st bookmark.	100
Daily Bonus: 2nd bookmark.	50
Daily Bonus: 3rd bookmark.	25

Fig. 9.3: Overview of the actions one receives for performing that action.

Newbie You earned at least 1 point for actions like adding a bookmark.	Beginner You earned at least 500 points for actions like adding a bookmark.	Senior You earned at least 1000 points for actions like adding a bookmark.	Bachelor of Bookmarking You earned at least 5000 points for actions like adding a bookmark.
Bookmark-Master You earned at least 20500 points for actions like adding a bookmark.	Prof. Dr. Bookmark You earned at least 50000 points for actions like adding a bookmark.	First Bookmark You added your first public bookmark.	First private Bookmark You added your first private bookmark.
Bookmark-Copy You made a public copy of a bookmark.	Private Bookmark-Copy You made a private copy of a bookmark.	First Login You have logged in for the first time.	Recommendation accepted One user accepted your recommendation.
10 Bookmarks You added 10 public bookmarks.	30 Bookmarks You added 30 public bookmarks.	100 Bookmarks You added 100 public bookmarks.	300 Bookmarks You added 300 public bookmarks.
1000 Bookmarks You added 1000 public bookmarks.	Five accepted Recommendations Five of your recommendations were accepted.	Ten accepted Recommendations Ten of your recommendations were accepted.	30 accepted Recommendations 30 of your recommendations were accepted.
50 accepted Recommendations 50 of your recommendations were accepted.	70 accepted Recommendations 70 of your recommendations were accepted.	150 accepted Recommendations 150 of your recommendations were accepted.	Two Logins One user accepted your recommendation.
Five Logins You have logged in on five different days.	Ten Logins You have logged in on ten different days.	30 Logins You have logged in on 30 different days.	

Fig. 9.4: Set of achievable badges with a short description.

Badges: In the gamified bookmarking system, we introduced five different types of badges. For getting points, creating bookmarks, loyalty (regular usage), and positive recommendations. Figure 9.4 shows the badges used including the explanation of what has to be done to achieve them.

Leader board: In the leader board (Figure 9.5, users are ranked by points in decreasing order. Besides, achieved badges are displayed to promote them further. The board shows two rankings: the monthly leader board on the left-hand side which will be automatically reset every month and the all time leader board on the right-hand side. This is done to avoid frustrating new users and to create a new challenge every month.

Fig. 9.5: The leader board with the monthly leader (left) and the all time leader board (right). The values are the same because it is the first gamified month.

Feedback: To ensure that the user is aware of points and badges, we integrated a message system (Figure 9.6). From the first log in, users will get a small onsite popup message, also called toast message. These messages appear every time a user got a reward by points or badges and if the user reached a higher rank on the leader board. Moreover, the user gets a message when another user copied one of her bookmarks or accepted a bookmark recommendation. After ten seconds, the messages disappear automatically.

Summarizing, we enriched an existing enterprise bookmarking system with those gamification functionality that, according to our literature review, have been proven useful in an enterprise scenario, namely points, badges and leader boards.

Fig. 9.6: Messages appearing on the user's first log in.

9.3.3 Experiment and Results

In order to evaluate our second research question whether users' perception of gamification (as stated in the online questionnaire) matches with their behavior using a gamified system, we announced the re-launch of the gamified enterprise bookmarking system using the institute-wide mailing list and observed the users' interaction with the system. In this section, we provide an overview of the systems usage from 2009 till the introduction of gamification functionalities in mid June 2013 to provide insights into the usage of the system *before* it got gamified. Following that, we present the usage statistics *after* the gamified version was introduced.

9.3.3.1 System Usage Before Gamification

In the analysis of usage patterns we look at data from 2009 until the gamified version went online in June 2013¹³. The focus of the analysis is to look at two important aspects of the bookmarking system: The main feature, the creation of bookmarks, and the number of recommended bookmarks to colleagues, one of the main goals for enterprises to support knowledge sharing. Since a user-centric evaluation of this system was never intended for the legacy system, the (pre-gamified) system did not track any user interactions. Thus, only actions resulting in a database entry can be tracked. This was changed in the gamified version.

Table 9.2 shows the yearly distribution of created items and active users. Outliers, in this case a power user responsible for half of all system interactions, are removed

¹³ The gamified version went online on June, 19th. The presented analysis however only considers data till June, 1st, to prevent any influence of the data because of any office kitchen chatter about the bookmarking system.

from the statistics. After a solid start in 2009 with roughly one third of employees using the system, 2010 already showed a significant decline in the usage. While the usage number remained stable for the years 2010–2013, only 3% of people were using the system.

Table 9.2: Created items per year and the number of active users (* = until June 1st).

	2009	2010	2011	2012	2013*
Bookmarks	291	29	30	13	26
Users	30	4	4	3	5

Table 9.3 shows the total number of bookmark recommendations. Similar to the created items, the number peaked in 2009. From 2009 till 2013, they remained on a stable level. This comes as no surprise, as the system’s user interface (UI) supports the recommendation during a bookmark creation. Recommending an item at a later stage was still possible, but not as compelling as in the creation process. Noticeable is the comparison of the number of users. As shown in Table 9.2, we recorded a total of 30 users in 2009 with only 14 of them using the recommendation feature. This might be due to the mentioned UI flaws, but could also indicate that those users use the system only for personal managing purposes. From 2010 till 2013 usage numbers remain the same, suggesting that those users who use the system over a long period of time are well familiar with its functionalities.

Table 9.3: Recommended bookmarks per year and the number of active users (* = until June 1st).

	2009	2010	2011	2012	2013*
Recommendations	61	34	31	26	18
Users	14	4	4	3	5

The statistics show that the non-gamified version of the bookmarking system was used only rarely. In the next section, we present and discuss results of the gamified version of the bookmarking system. Then, we compare users’ feedback from the questionnaires with the actual usage patterns to answer our second research question. Finally, we discuss limitations and shortcomings of the presented study and discuss future steps for gamification in enterprises.

9.3.3.2 System Usage After Gamification

As mentioned above, we tracked user interaction to analyze their behavior while interacting with the gamified system. For tracking their behavior, we relied on the Open Web Analytics¹⁴ platform which captures users’ interaction with all HTML

¹⁴ <http://www.openwebanalytics.com/>

elements of the system. Using this software, we respect the “do not track” option that can be set in the browser, resulting in incomplete or no web tracking data for some users of the system. Besides, we had to interrupt the experiment shortly after announcing the re-designed system due to a software bug. Two days later, we re-announced the system. All user interactions that took place within these two days has been omitted from this evaluation.

After announcing the system, a total of 18 users registered with the system. Seven of them, however, did not use the system at all. 14 of the registered users also participated in the online questionnaire, nine of these users logged in more than once. One user received a badge and 200 points for successfully recommending a document to another user. This user has left the institute over two years ago, i.e., he recommended this document a long time ago. Obviously, this user did not participate in the online questionnaire.

Table 9.4 provides an overview of the users’ activities with the system. They are ranked based on their position in the leader board after one week. Those users who are annotated with the * symbol did *not* fill in the online questionnaire. It can be seen, for example, that after eight days (from Wed to Wed) of use, the user with rank 1 (U_{rank_1}) gained a total of 5700 points, collected 12 badges, visited the leader board 58 times and other pages with gamification elements 7 times. In total, the user visited pages containing game design elements more than twice as often as the other users. Besides, U_{rank_1} participated in the online questionnaire.

rank	leader board		# page requests has game design elements		
	points	# badges	all	leader board	other
1	5700	12	130	58	7
2	4300	9	230	22	14
3	2625	9	-	-	-
4*	2100	9	-	-	-
5	1675	7	51	0	13
6	1360	8	47	5	7
7	1150	5	24	2	0
8	1125	7	-	-	-
9	450	3	15	0	0
10	450	4	7	1	2
11*	450	3	17	3	6
12..19	200	2			

Table 9.4: Leader board one week after email announcement of the gamified bookmarking system (* = user did not fill in the questionnaire, - = incomplete or no tracking data).

Based on these interactions, we categorize the users into four different types: The Top 3 users, a midfield (positions 4–8 in the leader board), users who use the system for a very short time only (positions 9–11 in the leader board) and Users 12–19 who logged into the system only once.

One question is how these users interacted with the system in detail. Table 9.5 shows the interaction of all users at different days of the experiment. As expected, the most interactions were recorded in the first few days of the experiment. Every day, the leader board was the most visited gamified page of the system. During the weekend, i.e., Day 4 & 5 of the experiment, no direct interaction with the gamification elements was recorded. The overall number of page requests declines over the course of the experiment, suggesting that the overall interest in the system declined as well.

day	# bookmarks		# requests all pages and element specific pages			
	create/copy	recommend	all pages	leader board	my points	my badges
1 (Wed)	13	1	371	32	19	9
2 (Thu)	25	1	135	26	1	0
3 (Fri)	11	6	126	12	3	4
4-5 (Sat/Sun)	0	0	7	0	0	0
6 (Mon)	4	3	72	16	0	0
7 (Tue)	4	0	58	10	3	1
8 (Wed)	9	0	32	4	3	0

Table 9.5: Bookmark contributions and page request over time.

9.3.4 Comparison to Questionnaire

After providing an overview of the system usage before and after the system got gamified, we discuss in this section the user interaction with respect to their feedback in the online questionnaire, hence addressing the research question whether the perceived role of gamification is reflected by actual usage.

Table 9.6 shows the mean average answers of all users who participated in the online questionnaire. In the first rows of the table, we segment this group in two parts: those users who logged into our system at least once (Group A, where # login > 0) and those who did *not* log in (Group B, where # login = 0). As expected, members of Group A reported a higher familiarity (3.07 vs. 2.56) with gamification than Group B. Further, they also (on average) stated a higher content contribution (3.00 vs. 2.50) to online systems, stated that gamification can result in higher motivation (3.29 vs. 2.94) and believed more in the positive effect of gamification (3.64 vs. 3.11) than their colleagues from Group B. Beyond that, the members of Group B had (on average) a stronger opinion about the negative effects than their colleagues from Group A. This seems to indicate that those employees who have a rather positive impression of gamification are also more likely to use such system at least once.

In order to further study whether this positive attitude is also reflected in the users' constant use of the system, i.e., addressing our second research question, we

	Group A ($\#login > 0$)	Group B ($\#login = 0$)
Q_1 (contribution)	3.00	2.50
Q_2 (familiarity)	3.07	2.56
Q_3 (motivation)	3.29	2.94
Q_4 (positive)	3.64	3.11
Q_5 (negative)	2.86	3.20

Table 9.6: Mean average answers in online questionnaire of users who participated only in the questionnaire (Group B) and users who, in addition, logged in at least once in the gamified bookmarking system (Group A). (higher value indicates higher assessment, higher frequency and stronger agreement)

split Group A further into two sub groups: the top eight users (according to the leader board) and the remaining 9 users who logged in at least once. Their corresponding answers are shown in Table 9.7. Surprisingly, the Top 8 users are more aware of negative effects caused by gamification than the rest. Similar to Table 9.6, we can observe a higher frequency, higher assessment and stronger agreement by those employees who were more active on the gamified system, i.e., those users to ended up on higher positions in the monthly leader board. This indicates that the perceived role of gamification is indeed reflected by actual user interaction with a gamified system, hence answering our second research question.

	Group A_1 (rank ≤ 8)	Group A_2 (rank > 8)
Q_1 (contribution)	3.14	2.86
Q_2 (familiarity)	3.14	3.00
Q_3 (motivation)	3.71	2.86
Q_4 (positive)	3.71	3.57
Q_5 (negative)	3.14	2.57

Table 9.7: Mean average answers in online questionnaire of top eight users (Group A_1) of the leader board and users on position 9–19 (Group A_2). (higher value indicates higher assessment, higher frequency and stronger agreement)

9.3.5 Conclusion

In this section, we studied the perceived and actual role of gamification in a workplace environment. We focused on two questions.

First, we were interested to know whether employees perceive gamification as positive or negative factor in an enterprise. Therefore, we distributed an online questionnaire amongst members of a large research institute where participants were

asked to judge and respond to different statements and questionnaires on a Five-Point Likert scale. Their responses indicate that although some employees were already familiar with the idea of gamification and are convinced that it can have a positive effect on their work. Nevertheless, a majority of participants stated that they are not convinced that it can serve as intrinsic motivation for themselves.

In our second research question, we were interested to evaluate whether this perceived role of gamification that is reported by the participants of the online questionnaire matches their actual behavior when using a gamified system. Therefore, we gamified an existing enterprise bookmarking system and introduced it in the same research institute. After one week, we analyzed the online questionnaire based on the users' interaction with this system. We observed that those employees who showed a positive tendency towards gamification also interact more with the gamified system. We conclude that there is a relationship between the perceived and the actual role of gamification principles in a workplace environment.

As mentioned in the previous section, when designing games, one method to approach this individuality is to regard well-known player typologies [15] to group similar player types, and to design gamification addressing all these player types. The most common technique to find out the user types is the use of questionnaires and interviews. However, this approach is associated with high efforts. Given the bias effect caused by questionnaires, we argue that it is hard to conclude on users' actual behavior in a gamified environment [23]. Recent studies also indicate that the effect of game design elements can change over time, which can end up with lower effects on a long-term [13, 11, 9]. In the worst case, positive effects might only be caused by the novelty effect. In the next section, we outline how player types could be identified automatically, hence reducing the risk of triggering negative gamification effects.

9.4 Towards the Automated Identification of Play-Personas

Existing gamification definitions pursuing the increase of user experience [7] and overall value [16] indicate that the application of gamification is goal oriented. Therefore, we usually look at gamification as the necessity to *maximize an overall goal*. However, the rich variety and individuality of the users results in different behaviors, preferences and motivating factors (e.g., [12, 18, 35, 36, 37]). In the worst case, negative effects can occur when applying gamification, as observed by Hamari et al. [14] and Mosca [25]. Hence, for a successful gamification, several factors need to be considered, which makes the design process difficult and expensive. Therefore, our extended look at gamification is the necessity to *maximize an overall goal with respect to the individuality of users*.

In this section we propose a new approach for gamification based on the automatic detection of play-personas. Dixon et al. [8] consider play-personas "as a useful tool that can be used to put player type research into practice as part of the design process of gamified systems". In order to automatically determine different

personas, we need to reduce the effort to determine relevant player types for implementing gamification. Why not skipping the determination of player types and directly suggest game design elements? Trying to achieve this with questionnaires and interviews can of course increase the design effort. However, what if a formula or tool that helps to select such game design elements based on experiences learned from user interaction data over time can be used instead? Under the assumptions that (i) gamification consists of various types of users that experience game design elements differently; and (ii) gamification is deployed in order to achieve some goal in the broadest sense, we pose the gamification design problem as that of assigning each user (at least) one game design element that maximizes their expected contribution in order to achieve that goal.

We suggest matrix factorization to create a generic model based on user interaction data as a suitable methodology which could help for the selection of most fitting game design elements. Parts of the treatment are based on [33, 30]. The hypothesis is that predictive models as intelligent tools for supporting users in decision-making may also have potential to support the design process in gamification. We argue that this does not only reduce the design effort, but that it also provides a better selection of game design elements since this kind of selection would not only be based on how users perceive gamification [23] but also on their actual interaction with game design elements. We are convinced that such data-centric tool can support the design process substantially.

9.4.1 A General Model of Gamification

We suggest a general model of gamification consisting of the following four components:

- A task T that need to be performed.
- A set of game design elements $g \in \mathcal{G}$.
- A set of users $u \in \mathcal{U}$ processing task T enhanced by $\mathcal{G}$.
- A task-dependent ground truth

$$f_* : \mathcal{U} \rightarrow \mathcal{G}.$$

- A function class $\mathcal{F}$ consisting of functions of the form

$$f : \mathcal{U} \rightarrow \mathcal{G}.$$

The gamification design problem is the problem of selecting a function $f \in \mathcal{F}$ that best approximates the supervisor f_* .

The ground truth f_* is a function that assigns each user u a game design element g that maximizes the expected contribution of u to achieve a pre-specified goal. For users that best perform without any of the game design elements contained in $\mathcal{G}$ we include a distinguished symbol ε denoting the absence of any design element.

Typically, the ground truth is unknown for most users and therefore need to be approximated by a function from some function class $\mathcal{F}$ based on a small subset

$$\mathcal{Z} = \{(u_1, g_1), \dots, (u_n, g_n)\} \subseteq \mathcal{U} \times \mathcal{G}$$

of training examples. The training set $\mathcal{Z}$ consists of n users u_i with corresponding design elements $g_i = f_*(u_i)$ for which the ground truth is known.

Note that we do not want to memorize the training examples but rather find (learn) a function $f \in \mathcal{F}$ that predicts the best fitting design elements for new users not considered in $\mathcal{Z}$.

9.4.2 Learning Problem

There are different ways to select (learn) a function f from $\mathcal{F}$ in order to approximate the ground truth f_* .

One approach describes users u by a feature vector x_u . The components of x_u measure different properties of that user such as, for example, click behavior, mouse movements and other features. Then a classifier such as the support vector machine [6] is trained to learn a model that predicts the best fitting game design element for new users.

Here we consider a second approach based on user interaction with different game design elements. We measure the utility of a game design element g for user u in achieving task T by means of a utility function

$$f_U : \mathcal{U} \times \mathcal{G} \rightarrow \mathbb{R}, \quad (u, g) \mapsto s_{ug}.$$

The utility-scores s_{ug} capture to which extent each user u together with design element g contributes to some overall goal. Given a utility function f_U , we select a classifier $f \in \mathcal{F}$ according to the rule

$$f(u) = g_u^* = \arg \max_{g \in \mathcal{G}} f_U(u, g).$$

Thus, f assigns user u a game design element g_u^* with maximum utility.

Table 9.8 provides an example of a utility function f_U shown in matrix form $S = (s_{ug})$. In this example, we would assign game design g_3 to user *Ann*. For user *Bob* the maximum score of 5 is achieved for design elements g_1 and g_2 . In this case, we can pick either g_1 or g_2 as design element for *Bob*.

In practice, however, the matrix S is sparse for various reasons. For example, users might not be willing to explore all design elements and may quit using the system. Table 9.9 provides an example for the case of a sparse matrix S of utility-scores. In this scenario, we aim at learning f_U on the basis of n observations $(u_1, g_1, s_1), \dots, (u_n, g_n, s_n) \in \mathcal{U} \times \mathcal{G} \times \mathbb{R}$ consisting of n users u_i together with corresponding game design elements g_i and utility-scores s_i .

The problem of gamification reduces to estimating a functional relationship

Table 9.8: Utility-scores for six users and seven game design elements. Scores are values from $\{0, 1, \dots, 5\}$. Higher scores indicate higher utility and vice versa.

	g1	g2	g3	g4	g5	g6	g7
Ann	0	2	5	3	1	4	4
Bob	5	5	3	3	4	1	0
Col	1	3	4	2	3	3	5
Don	5	4	2	4	3	3	2
Elk	5	5	4	4	3	0	1
Flo	2	1	4	4	3	5	4

Table 9.9: Sparse user-design matrix of utility-scores consisting of six users and seven game design elements. Higher scores indicate higher utility and vice versa

	g1	g2	g3	g4	g5	g6	g7
Ann		2			1		4
Bob					4	1	
Col		3	4	2			
Don				4	3		2
Elk	5	5				0	
Flo	2		4	4		5	

$$f : \mathcal{U} \times \mathcal{G} \rightarrow \mathbb{R}, \quad (u, g) \mapsto \hat{s}_{ug}$$

that *best* predicts the utility-score s_{ug} of design element g for user u by means of $f(u, g) = \hat{s}_{ug}$. To clarify what we mean by *best*, we introduce the notion of loss function. A loss function $\ell(\hat{s}, s)$ measures the cost for predicting $\hat{s}$ when the true utility-score is s . A common choice for a loss function is the squared error loss defined by

$$\ell(\hat{s}, s) = (\hat{s} - s)^2.$$

Our goal is to find a function that minimizes the expected loss

$$E[f] = \int \ell(f(u, g), s_{ug}) dP(u, g, s_{ug})$$

where $P(u, g, s)$ denotes the joint probability distribution on $\mathcal{U} \times \mathcal{G} \times \mathbb{R}$.

Suppose that we know a function (ground truth) f_* that minimizes the expected loss $E[f]$. Then we are in a similar situation as in the above scenario, where each

user has explored all game design elements. The complete user-design matrix $S = (s_{ug})$ has elements of the form

$$s_{ug} = f_*(u, g).$$

We can assign each user u a game design element g_u^* according to the following rule

$$g_u^* = \arg \max_g f_*(u, g).$$

In practice, we neither know f_* nor the joint probability distribution $P(u, g, s_{ug})$. Therefore we can not find a minimum f_* of $E[f]$ directly. Instead we try to approximate f_* by a function $\hat{f}_*$ that minimizes the empirical loss

$$\hat{E}[f] = \frac{1}{n} \sum_{i=1}^n \ell(f(u, g), s_{ug}).$$

on the basis of a sample of observed data

$$(u_1, g_1, s_1), \dots, (u_n, g_n, s_n).$$

The sparse user-design matrix shown in Table 9.9 is an example of a sample of observed data.

According to the empirical risk minimization principle, this approach is statistically consistent [33], meaning that the approximation $\hat{f}_*$ converges to the true minimum f_* with increasing amount of data. The learning problem consists in predicting the missing values.

This setting reduces the gamification design problem of finding the best design element for each user to the problem of regression learning for which a plethora of powerful mathematical methods are available.

9.4.3 Matrix Completion

The gamification design problem as proposed in this section can be regarded as a special case of a recommendation problem [17] for which matrix factorization constitutes a state-of-the-art solution [3, 20, 21].

Matrix factorization characterizes users and game design elements by k factors (properties) inferred from the utility-score patterns hidden in the user-design matrix $S = (s_{ug})$. Users u and game design elements g are associated with vectors $\mathbf{x}_u \in \mathbb{R}^k$ and $\mathbf{y}_g \in \mathbb{R}^k$, respectively. The k elements in $\mathbf{y}_g$ measure to which extent design element g possesses these factors. Similarly, the elements in $\mathbf{x}_u$ measure to which extent user u prefers these factors. High correspondence between factors of user u and factors of design element g indicate high utility. Correspondence between user and design factors is modeled as inner product such that

Fig. 9.7: Matrix factorization. Approximate the user-design matrix S by low-rank matrices X and Y .

$$s_{ug} \approx \mathbf{x}_u^T \mathbf{y}_g \quad (9.1)$$

for all known utility-scores s_{ug} . In matrix notation, Equation 9.1 takes the form

$$S \approx X \cdot Y,$$

where X is the user matrix and Y is the game design element matrix. The rows $\mathbf{x}_u^T$ of X and the columns $\mathbf{y}_g$ of Y describe the users u and design elements g , respectively. Figure 9.7 illustrates how the user-design matrix S is factorized by low-rank matrices X and Y .

Figure 9.8 shows a fictitious example of how the six users and seven game design elements from Table 9.9 are associated to vectors from the two-dimensional vector space $\mathbb{R}^2$. The latent factors are inferred from the utility-score patterns hidden in the user-design matrix S . In this example, the two discovered factors refer to the preferences according to the player typology proposed by Bartle [2]. In practice, however, there may be additional ($k > 2$) or different factors, which may not be interpretable for humans.

After all users and all game design elements have been embedded into the joint latent factor space $\mathbb{R}^k$, missing values s_{ug} of the sparse matrix S can be predicted in a straight forward way by

$$\hat{s}_{ug} = \mathbf{x}_u^T \mathbf{y}_g$$

in order to complete matrix S .

To learn the embeddings into the factor space $\mathbb{R}^k$, we need to solve the following basic problem

$$(P) : \min_{\mathbf{x}_*, \mathbf{y}_*} \sum_{(u,g) \in \mathcal{P}} (s_{ug} - \mathbf{x}_u^T \mathbf{y}_g)^2,$$

where $\mathcal{P}$ is the set of all pairs (u, g) for which s_{ug} is known.

Fig. 9.8: A simplified illustration of the latent factor space generated by matrix factorization. The latent factors refer to the preferences indicated by the x - and y -axis. The six users and seven design elements of Table 9.8 are embedded into the factor space. According to Bartle's player typology [2], users fall into one of the four categories *achiever*, *explorer*, *socializer*, and *killer*. Similarly, the features of the design elements refer to characteristics of the user categories.

9.5 Conclusion and Outlook

In this chapter, we address the challenge of applying gamification in a workspace environment from two directions. First, we present a user study that focused on determining users' perception of gamification and their actual interaction with a gamified system. We conclude from this initial study that there is a relationship between the perceived and the actual role of gamification principles in a workplace environment.

Under the assumption that different users experience the same game design elements differently, we then focus on automatically identifying play-personas. This will allow us to create gamified systems that adapt the application of gamification elements based on users' types. In this context, we define the gamification prob-

lem as the problem of assigning each user a game design element such that their expected contribution to achieve some pre-specified goal is maximized.

One way to assign design elements to users is by means of customer segmentation. In marketing theory, segmentation aims at identifying customer groups in order to better match the needs and wants of customers. For games those customer segments correspond to different player types based on character theory. Once a user is classified into a customer segment, an appropriate design element for that segment is selected and assigned to that user. The hardest part of this approach is to design categories that correspond to various dimensions describing characteristic features of users such as the multiple motivations of varying degrees existing simultaneously across users and user types.

In order to avoid assignments of design elements to users via the indirection of customer segments and user types from marketing and character theory, resp., we aim at learning a predictive model based on statistical principles that directly classifies users to game design elements. Based on user interaction with game design elements, we suggest to solve the learning problem by means of matrix factorization. The latent factors discovered by a matrix factorization model may be interpreted as characteristic properties of game design elements. User factors describe to which extent a user prefers such characteristic features. Thus, the latent factors can be regarded as a computerized alternative to the aforementioned customer segments and user types.

Aiming to keep the gamification model simple, we ignore time dynamics of user preferences leaving this issue open for future research. In addition, learning classifiers based on user behavior characteristics is a second issue for future research. The main challenges consist in constructing a useful utility function when using matrix factorization and generating useful behavior features when learning classifiers. Due to lack of publicly available data, empirical evaluations are currently not possible. Therefore this contribution aims at directing the design process of gamification to a more principled way based on statistical grounds.

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