Teamwork Gamification

A designer's perspective

Vegt, Niko

DOI
10.4233/uuid:743c88e9-c74c-4cbc-baad-adc336fc9cc8

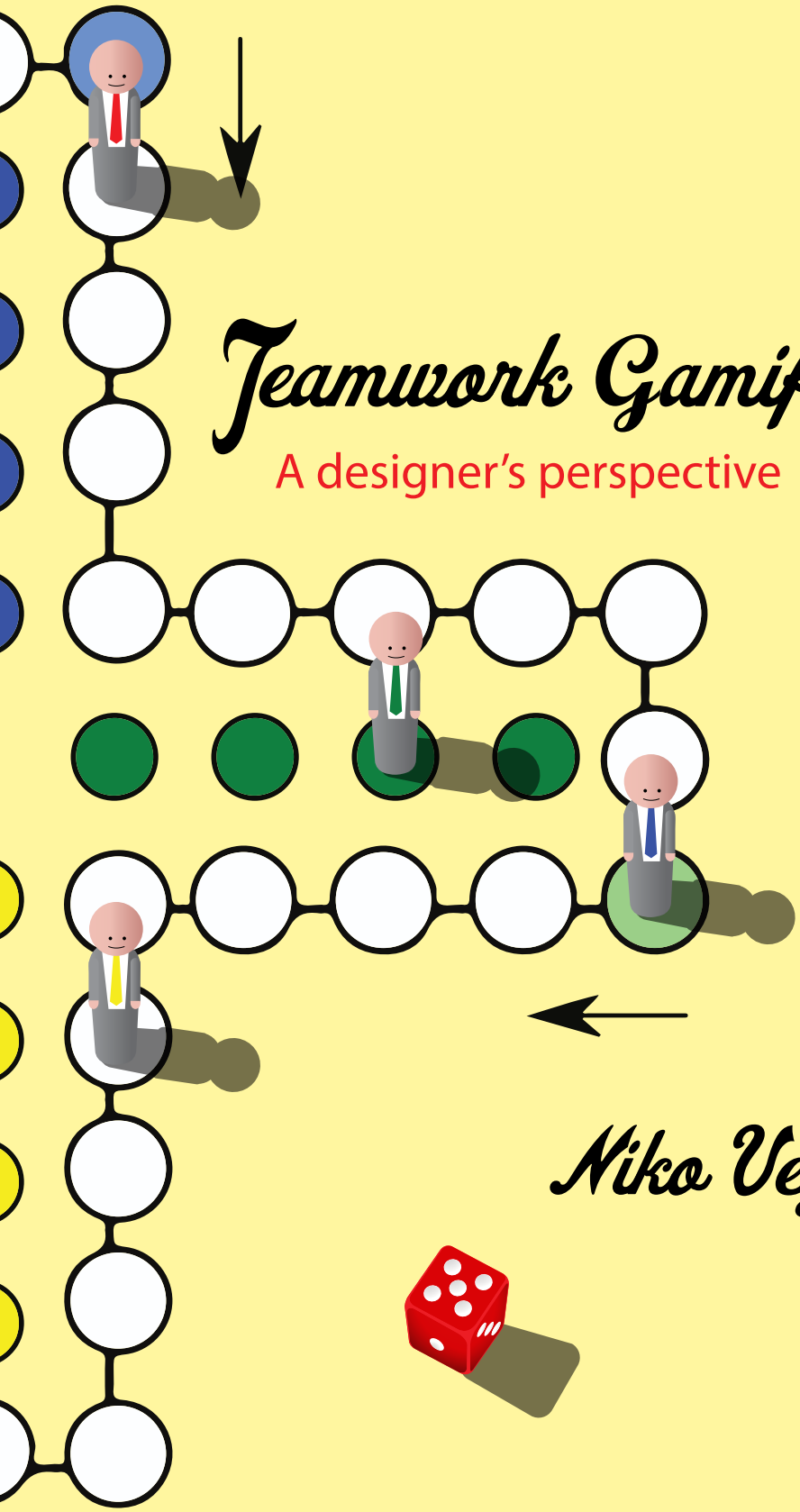
Publication date
2018

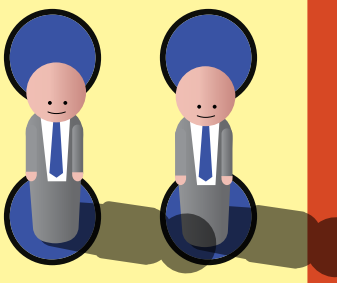
Document Version
Final published version

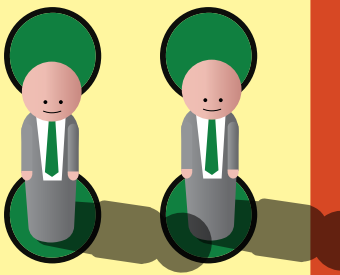
Citation (APA)
Vegt, N. (2018). *Teamwork Gamification: A designer's perspective*. [Dissertation (TU Delft), Delft University of Technology]. https://doi.org/10.4233/uuid:743c88e9-c74c-4cbc-baad-adc336fc9cc8

Teamwork Gamification

A designer's perspective







Niko Vegt

Teamwork Gamification

A designer's perspective

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology
by the authority of the Rector Magnificus prof.dr.ir. T.H.J.J. van der Hagen
chair of the Board for Doctorates
to be defended publicly on
Monday 11 June, 2018 at 15:00 o'clock

by

Nikolaas Joachim Hendrik VEGT

Master of Science in Industrial Design,
Eindhoven University of Technology, the Netherlands
born in Tilburg

This dissertation has been approved by the promotor: Prof.dr. H. de Ridder,
and copromotors: Dr.ir. A.P.O.S. Vermeeren and Dr. V.T. Visch

Composition of the doctoral committee:

Rector Magnificus	chairman
Prof.dr. H. de Ridder	Delft University of Technology, promotor
Dr.ir. A.P.O.S. Vermeeren	Delft University of Technology, copromotor
Dr. V.T. Visch	Delft University of Technology, copromotor

Independent members:

Prof.dr.ir. J.H. Eggen	Eindhoven University of Technology
Prof.dr. I.S. Mayer	NHTV Breda University of Applied Sciences
Prof.dr. C.M. Jonker	Delft University of Technology
Dr. J. Hamari	Tampere University of Technology, Finland
Prof.dr.ir. R.H.M. Goossens	Delft University of Technology, reserve member

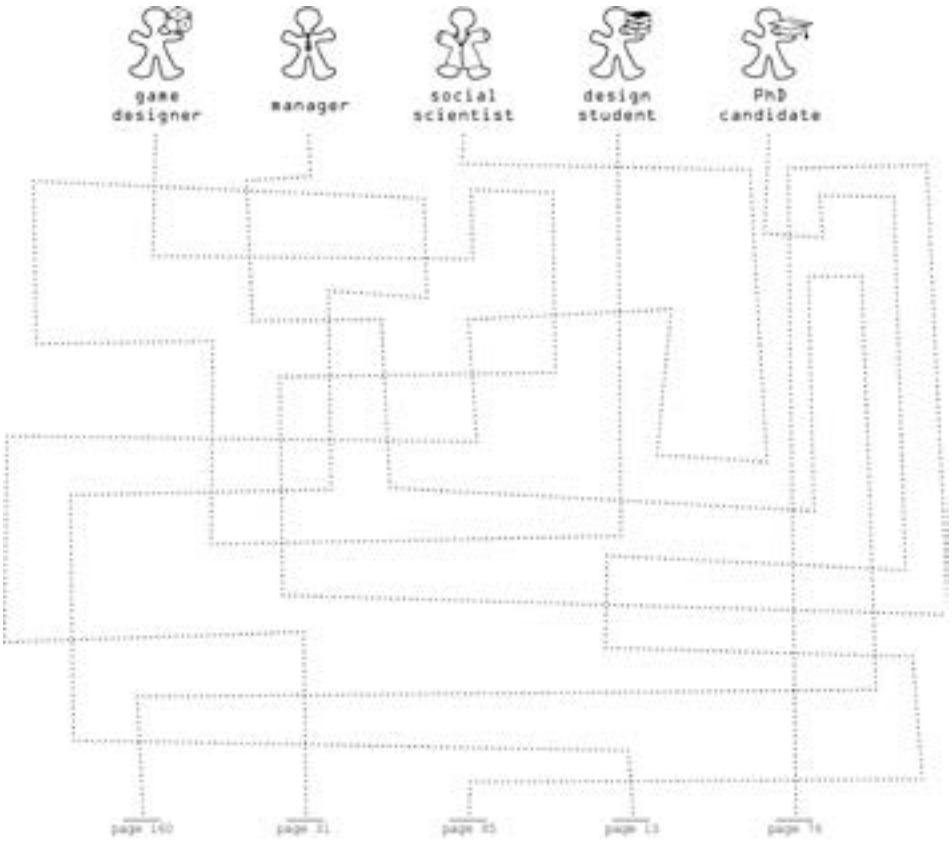
This research was funded by the Dutch Ministry of Education, Culture, and Science
as part of the Creative Industry Scientific Program (CRISP)

Niko Vegt
n.j.h.vegt@tudelft.nl

ISBN 978-94-6295-986-6

Cover by: Remco Wetzels
Printed by: ProefschriftMaken || www.proefschriftmaken.nl

Table of Contents


game designer
manager
social scientist
design student
PhD candidate

Preface

I had an idea about gamifying my dissertation. My idea was to introduce a team of five heroes that represent the people for whom this dissertation may be of interest: the game designer, the manager, the social scientist, the student, and the PhD candidate. Each hero makes his or her individual journey through the book, collecting gems of knowledge and inspiration. The game designer would travel along all design decisions that we took in the development of our gamification designs. The manager would visit all recommendations for organizing teamwork. The social scientist would be guided towards all descriptions and lessons learned of the research processes. The student was meant to pass through all theory. And the PhD candidate would go through the book in chronological order. By collecting all gems for each hero you could become "king of reading my dissertation".

Unfortunately, except for the cover, there was no time to gamify this book in proper quality. Still I would encourage you to pick a hero and browse through this book to collect gems of knowledge and inspiration. To give you an idea, I will describe the journey of the PhD candidate, my story.

My story starts in Eindhoven. I was a student research assistant. Marco, whom I assisted, brought this position in Delft to my attention. Looking back, I would like to thank him for pointing it out to me. In Delft, I found a dedicated group of people, eager to start a challenging research project: CRISP G-Motiv. Academia, creative industry and application partners were brought together to investigate the motivational power of games in other contexts. The term 'gamification' had come to life only one year ago. So to get to applied design research on teamwork gamification we had to develop our own theories, team up with pioneering companies, design our own games and game elements, and compose our own research methods. We wanted to translate the psychology behind games into applicable game design principles. Unpack the black boxes that games generally are.

When I say we, I mainly refer to Huib, Arnold, and Valentijn. They are largely responsible for the researcher that I've become and I'm very grateful for their support and collaboration throughout the years. Valentijn, thank you for arranging the right combination of partners to do research like this and commenting on most of my writings, which probably came close to a hundred. Arnold, thank you for challenging my thinking and advising me in all larger and smaller daily problems that I encountered as an apprentice researcher. And Huib, thank you for expressing

your confidence in me and maintaining a motivating atmosphere at the end of each discussion.

In the beginning of the project we had to develop our own theories. Fortunately I was not alone in this quest. Ellis, Hester, Katinka, Marieke, Susana, and Alessia, it was a pleasure exploring new territories together. Our intense and often fun discussions formed the basis of the work that I present in this dissertation. Based on our initial discussions, my first intuition was to gain game design knowledge. So the journey of the PhD candidate starts with the development of multiplayer Breakout on page 85.

Our journey continued to the Persuasive Game Design model (p. 20). A combined effort of all G-Motiv members. At the same time, the multiplayer Breakout experiment ran, requiring us to run back and forth to page 87. Based on the experiences with designing multiplayer Breakout, we developed the framework for teamwork gamification (p. 72-73) and published it. In parallel, I passed through pages 89-97 of doing the analysis of the multiplayer Breakout data.

Then, the steel factory Wuppermann crossed our path. Thanks to Michael (creative industry partner, &RANJ) we could join their gamification project, and design and investigate teamwork gamification at a real factory (p. 30). Peter (&RANJ) thanks for the collaboration on developing the concept. The collaboration with the factory's management was great as well. I would like to thank Giuseppe and Ruud for the open discussions about their organization and fully supporting the study. Also a big thanks to all operators of Wuppermann Steel Netherlands. It was truly inspiring to hear your stories about your work.

Approximately in the same period, Marco and I developed and hosted gamified workshops at several conferences and institutions. Unfortunately, these workshops did not make it into this dissertation but did contribute to my growth as a design researcher and are therefore worth mentioning in the PhD candidates journey.

What did make it into this dissertation is the game theoretical analysis of the Breakout data (p. 97). This completed the story of the multiplayer Breakout experiment, which will be published later in our journey. First, we started a new experiment at Berenschot. With the help of Ludwig and Filip (application partners, Berenschot) I could attend Red Team meetings to develop the gamification of team meetings (p. 141-143). In order to not needlessly disturb their meetings with pilot tests, we decided to perform a lab experiment with students first (p. 115-120). I want to thank Zsolt for carrying out this study. It allowed me to keep the other experiments running, because at the same time I gathered data at the steel factory (p. 46).

With our experiences in the lab experiment we could further develop the

gamification of Red Team meetings (p. 145) and at the same time keep on gathering data at the steel factory (p. 46). Then, the experiment at the Red Teams was executed (p. 149), again with the help of Ludwig. I would like to thank him for making the necessary arrangements at Berenschot, so that I did not have to be present, in order to avoid confidentiality concerns. While the Red Team experiment data was slowly coming in, I could continue my journey with analyzing the data of the steel factory experiment (p. 49). Panote and Marierose, thanks for your advice and discussions during this period.

Then the writing started. My first piece of work was the introduction chapter. It had already lain dormant in the back of my mind for a while (p. 13-26). The Wuppermann article followed (p. 27) with intermediate review steps and I could also finally finalize and publish the article about the Breakout experiment (p. 81). I would like to thank all reviewers of the published articles and the committee assessing my dissertation. They greatly contributed to its quality.

As a break from writing, I went through a severe struggle of making sense of the data from the lab experiment with the students (p. 120-128) and what followed was the chapter about the lab experiment (p. 107). I continued the writing vibe by finalizing the Red Team chapter (p. 137), ending the PhD candidate's story with the general discussion (p.159-178).

Next to the people that I directly collaborated with, I would like to mention the people that influenced my work indirectly. For example, my fellow PhDs and colleagues in the StudioLab (my workplace). Thanks a lot for the lively atmosphere. You made me take the train to Delft with a smile every day. The colleagues I worked with in education also deserve a great deal of credit for this smile. My educational duties made me discover that teaching and coaching is part of who I am, which might also resonate in my writing in this dissertation.

Than there are the people that kept me from going insane when the work pressure was high. I would like to thank all my friends for making sure I got through all this unharmed, with special thanks to Myra, Maarten, Sylvia, Michiel, Fred, Thomas, Dirk, Niels, Laurine and Leo for pushing, cycling, painting, running, talking, playing, discussing, drinking, listening, and many other activities that helped me finishing this work. And finally I want to thank my parents and sister (with husband and children) for supporting me unconditionally in everything I do. My mother once said that I am married to my dissertation. I would rather say that, while my sister produced two lovely girls, I produced this book, which I can proudly present to the world and let go now.

Playing a game is the voluntary attempt to overcome unnecessary obstacles.
(Suits, 1978)

1 Introduction

1.1 The promise of gaming

Game designers seem masters in motivating people to start playing, continue playing, and return to playing games. Occasionally, this even leads to game addiction. The extensive collection of resources they deploy to achieve such strong motivation (e.g. fantasy worlds, levels, avatars) is not exclusively available in game worlds. Game elements may be applicable to motivate people in many other contexts as well. To experience the power of games myself, I gamified my daily walk from the train station to the university. In accordance with Suits' (1978) definition of gaming, I came up with some "unnecessary obstacles". I added restrictions to using the most recurrent element on the route: street tiles. On sidewalks with square tiles I could only stand on two tiles per step and if the tiles were laid out alternately my feet had to be placed diagonally outward. This 'game' caught my full attention and after finishing a long flawless streak, I felt a sense of accomplishment. Moreover, it felt as if I arrived at the university in no time.

Using game elements in non-game contexts is referred to as gamification (Deterding, Dixon, Khaled, & Nacke, 2011). The rise of video and computer games led to a renewed interest in the motivational affordance of games. In the last three decades, many scholars have theorized the promise of using the motivational power of computer games for purposes other than entertainment (Malone & Lepper, 1987; Egenfeldt-Nielsen, 2006; Reeves & Read, 2009). According to McGonigal (2011, p. 346) the commercial game industry has consistently proven itself, and it will continue to be, our single best research laboratory for discovering new ways to reliably and efficiently engineer optimal human experiences.

As elements typical for games can also be found in the real world (e.g. sensory stimuli, narrative, simulation, challenges), they can be used to motivate behavior in any type of context. For example, interactive animations are applied in care homes for dementing elderly (Anderiesen, 2015). The elderly can play with projections on

a table. This stimulates them physically and socially, which reduces the detrimental effects of dementia. In cognitive behavioral therapy, boring repetitive tasks are gamified. For example, in Changamoto, a robot war narrative was added to increase the patient's motivation for keeping a diary (Kooij, van der, Hogendoorn, Spijkerman, & Visch, 2014). Moreover, gamification has raised much interest in enterprises as a new way of making jobs more satisfactory and motivating (Silverman, 2011). For example, game elements are used in business organizations to motivate self-managing teams by using a coffee shop metaphor (Berendsen, 2014) or to encourage employees to get in touch with each other through a multiple-choice quiz (Hsieh, 2010).

These examples provide a wide variety of applying game elements in non-game contexts. However, recent applications of gamification seem too narrow to live up to the promise that the use of game elements in non-game contexts bears (Bogost, 2014). Most gamification applications conceptualize game elements as incentive mechanisms in the form of points, badges, and leaderboards (Hamari, Koivisto, & Sarsa, 2014). To fully utilize the power of games and accomplish goals of businesses we need a better understanding of what game elements are and how they fit non-game purposes. Business organizations are adopting gamification on a large scale, yet theories regarding the motivational elements of games remain scattered. Until today, few studies have addressed the actual implementation of game elements in business contexts (Farzan, DiMicco, Millen, Brownholtz, Geyer, & Dugan, 2008; Thom, Millen, & DiMicco, 2012; Eickhoff, Harris, Vries, & Srinivasan, 2012; Mollick & Rothbard, 2013). Hence, there is little fundamental knowledge about enterprise gamification (Mollick & Werbach, 2014). In particular, knowledge about the use of game elements for social interaction and teamwork is missing, even though business organizations increasingly rely on collaboration and teamwork.

1.2 Game elements for teamwork

Achieving optimal performance with a team is complex, because many factors can influence the teamwork process (Kozlowski, Grand, Baard, & Pearce, 2015). The team's composition, the time they work together, or their hierarchical structure, amongst other things, can strongly differ. A common problem is that employees do not experience their individual tasks as teamwork. In many cases, teams are present in work documents, but not in practice. For example, at large companies, different departments should collaborate, while in fact they just provide outcomes to each other. Even if, in practice, employees actually depend on each other, they

tend to choose to focus on their individual jobs. In such situations, individual and collective concerns conflict easily. This may cause employees to lose interest in the collective goals and thereby reduce their motivation for collaboration. If individual concerns predominate, this may even result in failing to form a team, because no one is interested to participate.

Game elements seem a promising tool for improving the teamwork process. In many games, players are strongly motivated to achieve a team's goal. Such enthusiasm for a collective goal can be the result of competitive and cooperative game elements. In sports games, often the players are motivated to perform for the team score because they want to beat another team. In other games, such as World of Warcraft, players cooperate to achieve a goal they cannot accomplish alone. In this way, game elements often align individual goals with collective goals. By adequately designing game elements for collaboration within teams in business contexts, we may be able to achieve the same engagement with collective goals in work teams.

In this dissertation, we therefore explore the application of game elements in teamwork situations and investigate their effect in real-life work contexts. We will develop theoretical models for teamwork gamification and design prototypes to explore and evaluate methods and effects of game elements in teamwork contexts, gradually shifting the implementation from lab to field settings. This design research through practice (Koskinen, Zimmerman, Binder, Redström, & Wensveen, 2011) should lead to fundamental knowledge about the design of game elements for teamwork as well as to empirical evidence regarding their effect on team performance. First, however, we will summarize the game design literature that frames our investigation. The following section presents a composite theory of game design as the basis for the studies discussed in the course of this dissertation.

Research questions

To what extent can game elements improve the performance of teams?

a. What game elements can be identified that may improve team performance?
b. How can the identified game elements be used to improve team performance?
c. What is the effect of the identified game elements on team performance?

1.3 A composite theory of game design

In order to structurally test the gamification of teamwork, we looked for the fundamental building blocks of games, i.e. the constructive atoms, next to a game's fundamental motivational affordances (Cook, 2007; Deterding, 2013). However,

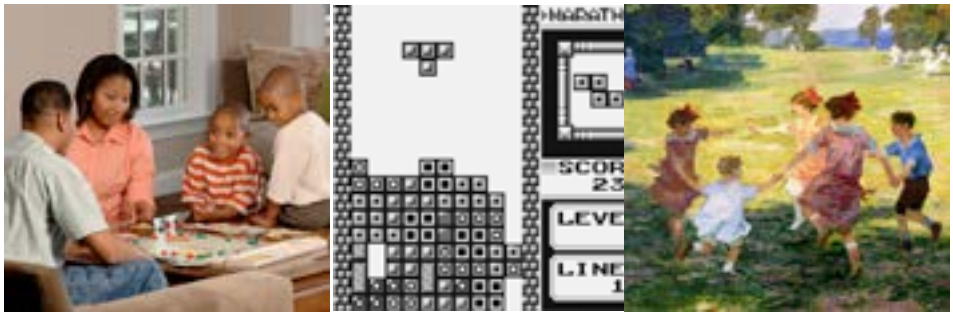


Figure 1.1. Examples of three completely different games: Monopoly[1], Tetris[2], and Ring around the rosie[3].

determining constructive elements unique to games seems impossible. Game is a basic category that we are all familiar with, yet the term game appears hard to define, as elements typical for games can generally be found as real world elements as well. For example, the principle behind a dice (one of the most prototypical game elements) is also used when guessing a number to decide who will get the last piece of pie. Moreover, Wittgenstein (1953) came to the conclusion that there are no properties shared by all games; they rather share resemblances in a variety of properties. For example, Monopoly, Tetris, and Ring-around-the-roses (see Figure 1.1) are all considered to be games, yet they do not seem to jointly share any building block. Suits (1978) does suggest common properties however. These properties are not aimed at defining games as a construct. They rather define the experiential properties of playing a game: it should feel voluntary and unnecessary (like a non-instrumental activity).

Following Suits' definition, it seems more fruitful to determine the experiential outcome and deduce the fundamental components for achieving such experiences, instead of using the construction of games as a starting point. Huotari and Hamari (2012) adopt a similar approach by defining gamification as a method that should lead to the same psychological experiences as in games. Also McGonigal's (2011) proposition of invoking gameful experiences to "fix reality" has an experiential starting point. She suggests that the real world has become too easy and that we can make it more rewarding by adding goals, rules, direct feedback, and voluntary participation.

1 Branson, B. (2007). Family Playing a Board Game [Online image]. Retrieved April 3, 2014 from https://visualsonline.cancer.gov/details.cfm?imageid=4505

2 Game Boy (1989). Tetris.

3 Potthast, E. H. (1910). Ring Around the Rosie [Painting].

Figure 1.2. Emotional experiences evoked by goals and rules: (left) a frustrating buzzer beater in basketball[4], (right) an awe-inspiring scene in a theatre game[5].

1.3.1 Goals & rules

The first constructive atoms of a game experience that are often mentioned are goals and rules. Emotional gaming experiences arise from the goal the player pursues and his or her success or failure in (anticipation of) achieving it (Tan & Jansz, 2008, p. 535). We can, for example, feel extremely frustrated when the opposing team scores the winning three-pointer in the final seconds of a basketball game, a so called buzzer beater. Or we can feel awe while performing a deep and profound scene during a theatre game (Figure 1.2). More generally, Tan and Jansz (2008, p. 532) describe the game experience as an emotional experience that is intrinsically rewarding and dominated by interest. They refer to the state of flow: a fully absorbing and enjoyable experience in which people feel optimally challenged (Nakamura & Csikszentmihalyi, 2002), like my above-described experience of the 'street-tile-game'.

Caillois (1961) distinguishes between ludus, i.e. rule-based play, and paidia, i.e. freeform play, as two types of game play that represent opposite poles of a continuum. They differ in the extent that a player's actions are governed by rules. For example, professional soccer is at the ludus side of the spectrum and rhythmic gymnastics on the paidia side (see Figure 1.3). In both sports, the goal is to obtain points and they both use a ball to achieve that. Yet the actions of a soccer player are much more bound to rules (e.g. not using the hands) than the gracious movements of a gymnast.

Hence, we conclude that games and gamification should at least contain a goal

4 Buzzer-beater [Online image]. Retrieved January 21, 2016 from http://www.lovemytool.com/blog/2010/07/buzzer-beaters-by-paul-w-smith.html

5 [Untitled image of a theatre sports game] (2013). Retrieved January 21, 2016 from http://www.covenant.nsw.edu.au/christian-school/second-place-for-theatre-sports-team

Figure 1.3. The interaction with the ball is more strictly prescribed with rules in soccer[6] (left) than in rhythmic gymnastics[7] (right).

(or end) and be governed by one or more rules. Scholars generally agree on these two building blocks as being crucial for a game experience. Juul (2003) summarized all classical game definitions into one overarching definition in which rules and outcome are the basic building blocks. Moreover, in Salen and Zimmerman's (2005) collection of game design theories, goals and rules are mentioned in nearly every definition. Thus, we assume that goals and rules are required to evoke a game experience. Take for example car driving. Inside a city center with dense traffic, staying safe can be challenging enough. Yet driving on an empty motorway can be very boring. In such situations we sometimes invent little challenges to keep our focus. For example, by attempting to continuously drive exactly 100km/h (a goal) without using cruise control (a rule). Imposing a goal and rule to oneself in such a situation evokes a gameful experience as it generates an unnecessary obstacle. Especially in cars where you get feedback with an exact figure on a digital speedometer, it can become an absorbing challenge and truly feel like a game.

1.3.2 Objects

Interactivity is another frequently mentioned element in game design theory. After all, it is eventually the player playing the game that evokes game experiences, either alone or with other players. Some theorists mention interactivity in general (Salen

6 Getty Images (2014). [Online image]. Retrieved January 14, 2016 from http://i.dailymail.co.uk/i/pix/2014/01/11/article-2537293-1A90F73000000578-219_634x422.jpg

7 Yulia Barsukova-2 – RG [Online image]. (2009). Retrieved January 14, 2016 from https://www.flickr.com/photos/43245258@N08/3978556964.

& Zimmerman, 2004; Elias, Garfield, & Gutschera, 2012), others refer to it as mechanics (Hunicke, LeBlanc, & Zubek, 2004) or feedback loops (Dormans, 2012; Deterding, 2013), and others stress the embodiment of rules into objects to facilitate interactive gameplay (Järvinen, 2008). In computer and video games, embodiment into objects is indeed necessary, yet many social games do not require any physical artifact. For example, guessing-games sometimes consist of just one goal (e.g. name the person I have in mind) and one rule (e.g. if someone names the person the game ends). Another example: tag just requires the players themselves as objects. In tandem with interactivity and objects, feedback is commonly mentioned (McGonigal, 2011), yet this does not seem to be a crucial element either. The guessing-game experience would indeed become more engaging if the thought-owner replies to every guessing attempt. However, in tag, it is actually the lack of feedback, i.e. not exactly knowing who is 'it', that makes the game exciting. Needless to say, players at least need 'something' to play with, be it a thought or other players or cards. For the sake of definition, we call this 'something' objects.

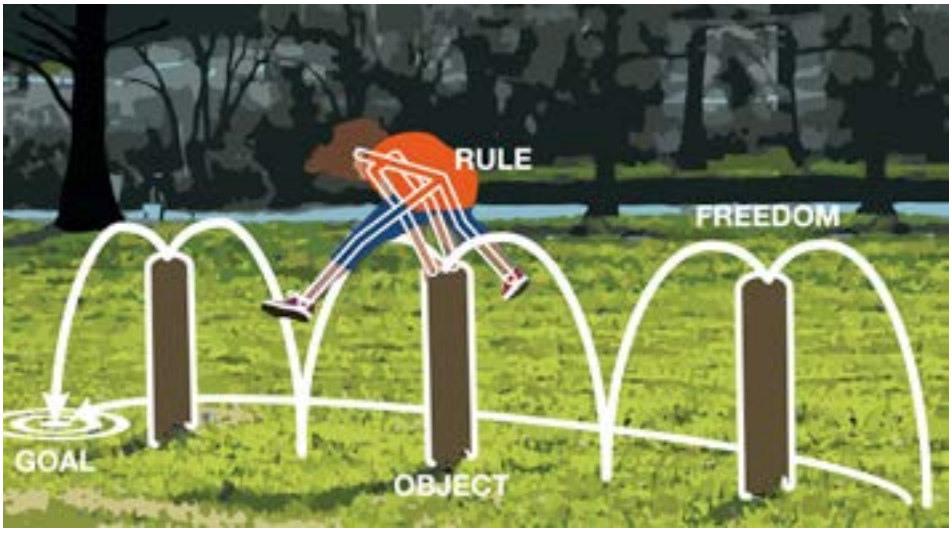


Figure 1.4. The leapfrogging girl's goal is to get to the other side of the row of poles. She has the freedom to walk past the poles or get to the other side in many other ways. Though she chose to use the poles as objects to play with, including the rule prescribing her to jump over like a frog[8].

8 Original: Compton, J. R. (2010) Little Girl Leapfrogging [Online image]. Retrieved February 4, 2016 from http://www.jrcompton.com/photos/photographingArt/s90shots/Little-Girl-Leapfrogging-Posts_0911-2.jpg

1.3.3 Freedom

Goals, rules, and objects seem a proper set of elements to generate unnecessary obstacles and to construct a game. Game objects are the elements players interact with, rules can raise obstacles and we need a goal to determine to what extent the obstacles are unnecessary. Yet to achieve intrinsically rewarding experiences one important component is missing: freedom.

In intrinsically rewarding experiences, players perform activities for their inherent satisfactions such as eating chocolate or being creative, rather than for a separable consequence such as earning money or avoiding punishment. Self-determination theory (SDT) explains that the satisfaction of basic psychological needs of autonomy, competence, and relatedness facilitates intrinsically motivated behavior (Deci & Ryan, 2000). SDT is grounded in real world situations, yet it also applies well to video games. The satisfaction of autonomy, competence and relatedness was found to strongly predict preference for games and enjoyment during gameplay (Ryan, Rigby , & Przybylski, 2006). The need for autonomy can be satisfied through provisions of choice, informational feedback, non-controlling instructions, or intuitive controls. Game design scholars address autonomy as voluntary participation (Suits, 1978; Avedon & Sutton-Smith, 1981) freedom (Huizinga, 1950; Caillois, 1961), or negotiable consequences (Juul, 2003). We pose freedom as the most appropriate term, because it designates the experience evoked by the voluntary choice to participate, the affordance of autonomy within games as well as the negotiability of consequences outside a game.

The affordance of autonomy, i.e. making the player feel autonomous in his or her actions, is best explained by Burgun's definition of games (Burgun, 2013). He suggests that "a game is an interactive system (or toy) with the problem quality of puzzles, the competition quality of contests, and ambiguous decisions". Toys (or interactive systems) reflect the object that you can freely play with. Examples are SimCity and Minecraft. By adding a solution or goal to an interactive system we get a "puzzle". Examples of puzzles are mazes and Super Mario Brothers; they have only one optimal solution. The next step is to add opponents, leading to "contests" such as arm-wrestling and Guitar Hero. And finally, Burgun arrives at "games" by adding ambiguous decisions. Examples of games according to his definition are Tetris and Chess. In these games, players have several degrees of freedom. They can arrive at their goal in several ways, thereby evoking a sense of autonomy. From this definition we can also further specify the rules that we are interested in. Interactive systems contain rules (e.g. algorithms). Yet we will be investigating rules that govern goal

achievement such as restrictions and procedures, as these directly influence a player's actions, like the leapfrogging girl in Figure 1.4.

1.3.4 A toolbox for magic circles

In summary, our composite theory of game design suggests that gameful experiences arise from goals, rules, objects and freedom. We consider these elements to be the fundamental components to evoke the voluntary attempt to overcome unnecessary obstacles. Combining these building blocks often leads to complex systems and ambiguous situations. For pure game experiences, complexity and ambiguity are enriching qualities that could increase a player's interest in the game and extend the interest over a longer period of time. For example, becoming a chess master takes decades. In complex and ambiguous games, players can feel strong emotions with the game activities and feel completely immersed in the game world, which is popularly referred to as the magic circle (Salen & Zimmerman, 2004).

Johan Huizinga (1950) described it as "a state in which the player is bound by a make-believe barrier created by the game". This barrier suggests an impenetrable 'what happens in the game stays in the game'. The consequences of a player's actions stay within the boundaries of the game, which provides players a safe environment to explore and learn. For example, in soccer you can explore the boundaries of the rules within which you can annoy your opponent, and after the game shake hands and drink a beer together. In another example, performing a romantic scene in a theatre play does not mean that artists like each other in real life. Yet sometimes the boundaries blur. For example, when football supporters get frustrated and start to smash the surroundings. Pure game experiences however, contain a strict magic circle where most consequences of actions only exist while playing the game.

1.4 Game design for serious applications

1.4.1 Gamification

We developed the persuasive game design (PGD) model (Visch, Vegt, Anderiesen, & van der Kooij, 2013) to better understand the process of evoking game-like motivation for non-game consequences. As explained before, games are best understood by considering their experiential outcomes. Hence, the user experience is central to the model, which travels along an experiential dimension between the extremes of a 'real world' and a 'game world' experience (see Figure 1.5). As a consequence, gamification implies the increase of feeling as if participating in a

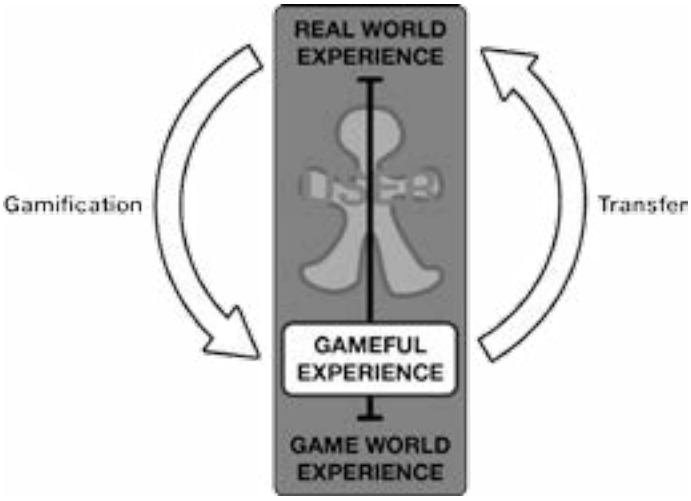


Figure 1.5. Derived from the persuasive game design model (Visch, Vegt, Anderiesen, & van der Kooij, 2013)

game. For example, the above-described case of driving in dense traffic is on the real world side of the continuum, whereas the attempt to continuously drive 100km/h transports the driver more towards the game world side. The experience may reverse if one enjoys slaloming through traffic or drives 100km/h to save fuel.

Thus, to what extent a game world experience is evoked strongly depends on the user and the context. For example, a debate about financial support may feel like a game for politicians aiming to 'score' at the expanse of other politicians (Verhaeghe, 2015, p. 221), yet feel very real for the people that cannot pay their bills when the support is not granted. For example, this is a quote from the president of the European Council in a speech about the negotiations regarding EU support for Greece: "The game of chicken needs to end. And so does the blame game. Because this is not a game and there is no time for any games. It is reality with real possible consequences." In this example, the EC president appeals to the Greek government to stop gamifying the negotiations, referring to a reduced sense of consequences.

A reduced sense of consequences is a motivating quality in games. Yet for game elements in non-game contexts this can be undesirable. For example, my gamified walk to the office became more engaging, yet continuously gazing at the street tiles also made me feel isolated. This exemplifies how a strong game world experience can become a problem when applying game elements to non-game contexts. The street tile rules were so powerful they diverted my attention away from traffic, down to the street tiles. The evoked magic circle reduced my sense of consequences in relation to the traffic around me.

This effect is in line with motivation psychology theories. According to Ryan & Deci (2000), to be motivated means to be moved to do something. In SDT, people are either moved to do something because it is inherently interesting or enjoyable (i.e. intrinsic motivation), or because it leads to a separable outcome (i.e. extrinsic motivation). A similar distinction can be found in reversal theory. Products or ends drive people that are in a telic (serious) motivational state. In a paratelic (playful) motivational state, people live inside the moment and are motivated by enjoying the process (Apter, 1989). Henricks (2011) suggests that people work when they are extrinsically motivated and play when they are motivated by inherent enjoyment. Game elements seem to mainly afford a paratelic motivational state, such as making walking on street tiles interesting. Non-game situations, however, often demand a focus on consequences rather than enjoying the process. Hence, the effect on the real world situation is as important as evoking a gameful experience when designing a gamification concept.

1.4.2 Transfer

As the Greek negotiations show, using game world experiences to achieve something in the real world is not new, yet consciously designing games and game elements for a particular transfer effect is. When generating a pure game world experience there is no effect in the real world, because it evokes an impenetrable magic circle. However, in gamified contexts, a gameful experience is evoked. In gameful experiences, the

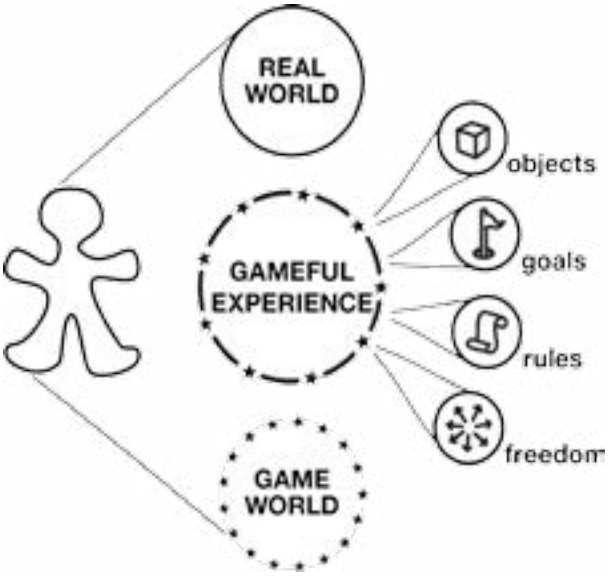


Figure 1.6. Fundamental components of a gameful experience.

user is drawn towards a game world experience yet finds oneself somewhere between both extremes (see Figure 1.5). This allows for an effect in the real world, i.e. the transfer effect.

In general, we suspect that the more a user is transported towards a game world experience, the more difficult it is to accomplish a transfer effect. For example, in Cruel 2 Be Kind (McGonigal, 2011), a so-called "pervasive game" (Montola, Stenros, & Waern, 2009), amusement is the primary objective, yet it does have a weak transfer effect. The game is played with two groups in a crowded public area. The goal is to 'kill' members of the opponent group with an 'act of kindness', such as complimenting someone. However, the players do initially not know the members of the other group. As a result, many passersby that do not participate in the game receive an act of kindness. In this game, the game experience is probably strong. Players might even perceive passersby as a game element and the transfer effect is probably weak, even though it was purposefully designed. In gamification design, the transfer effect is often clearer and stronger because the users are drawn less deep into the game experience, such as the effect of the earlier described interactive table for elderly (Anderiesen, 2015). In such cases, the real world is basically enriched with game elements that directly affect the real world situation.

Another way of achieving a transfer effect is by using the "procedural rhetoric" of games: "the art of persuasion through rule-based representations and interactions" (Bogost, 2007). By defining the rules of a game, game designers can make claims

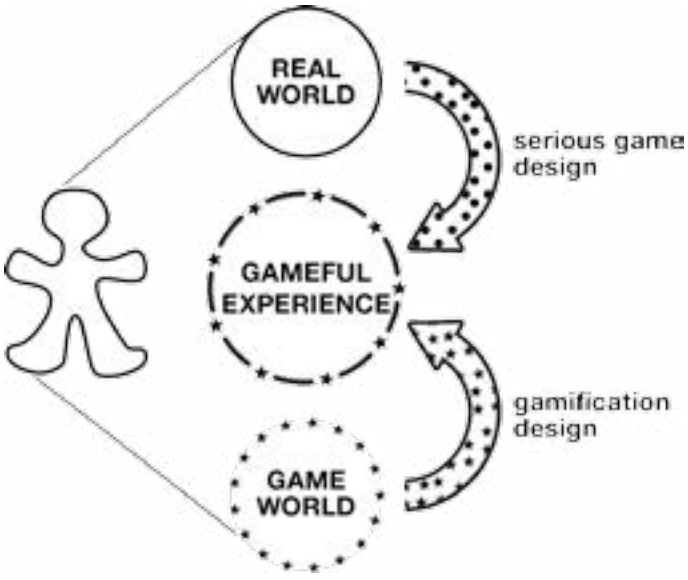


Figure 1.7. Gamification design vs. serious game design.

about how things work. For example, the US army recruits soldiers by distributing a serious game (America's Army) that lets players experience how it is to be a soldier. Naturally, the game does not contain the full complexity of being a soldier. Instead, a selection of real world elements is implemented in the game to create a motivating experience and persuade youngsters to enroll for the army (Kennedy, 2002).

Instead of exploiting the procedural rhetoric in games, we could also make use of the procedural rhetoric in non-game contexts. Teamwork for example, contains many implicit goals (e.g. hidden agendas), rules (e.g. social norms), objects (e.g. words and thoughts) and degrees of freedom (e.g. personal approaches). By strategically selecting certain real world elements and explicating them in a game-like manner, we might be able to lay bare implicit teamwork processes and procedures. For example, in an organization, the social norm could be that you never criticize senior colleagues, even though you know they are wrong. Imagine a betting mechanism on claims or decisions with 'experience points'. During a meeting each member can use his or her experience points to vote for or against certain claims or decisions (from others or one's own). Seniority could than be explicated by the speed employees regain experience points. The betting mechanism thereby exposes to what extent one agrees about a claim or decision and allows junior employees to criticize them if they have saved enough 'experience points'.

Next to a transfer effect such as stimulating bottom-up critique, Bogost (2007) suggests that the main transfer effect of persuasive games is the production of discourse. This may be true for gamification as well. By exposing the logic behind operations and providing opportunities for new configurations, users may start to deliberate the system itself. In the case of a betting mechanism with experience points, we may expect discussion about the value of the points and the rate in which one regains them; thereby actually discussing how important experience and seniority is within the organization.

1.4.3 Exploring transfer effects of gameful experiences

The use of game elements seems so promising because within the overall intrinsically motivating experience of playing a game, goals and rules have a crucial role. Thus, by defining the right goals and rules, the motivational power of games may be exploitable in non-game contexts to achieve particular transfer effects. In the example of the gamified walk, the game goal made me stare at the street tiles, resulting in reduced attention for other traffic. To achieve a more responsible transfer effect, such as increasing my attention for other road users, we could adapt the game. First of all we could change the object of the game. Instead of using the street tiles, we

could take the other road users as the objects to play with. A goal could be to keep 2 meters distance from others as long as possible. A positive effect would be that I do not collide with someone, though it could also reduce my attention for the route I am taking and result in getting lost. Hence, in order to achieve a positive transfer effect, the gameful experience needs to be properly balanced to avoid negative side effects.

We use the above-described fundamental components of a game experience to investigate the balancing of gameful experiences (see Figure 1.6). From Figure 1.5 we can deduce two strategies to evoke a gameful experience (see Figure 1.7). One strategy is to introduce motivating elements from the game world into the real world, i.e. gamification design. As explained before, recent cases of gamification design mostly use game-inspired incentive mechanisms, yet adding simple game rules as in the driving and walking game are also examples of this strategy. The other strategy is to introduce real world elements into a game world. This generally happens in serious games: "games that are not intended to be played primarily for amusement" (Abt, 1970). Hence, we refer to this strategy as serious game design. An example is Juf-in-a-box (RANJ Serious Games, 2011), in which children practice the motor skills that are necessary to learn writing by hand. Real world writing assignments are integrated in a game world of monsters.

1.5 Thesis outline

This dissertation is aimed at broadening our understanding of gamification design (i.e. designing game elements for a non-game context) for teamwork. We will explore the use of goals, rules, objects, and freedom and investigate their transfer effect on the real world (see Figure 1.8).

Chapter 2 explores the gamification of goals and objects. It describes our first attempt of applying game elements in a real-life teamwork situation at a steel-processing factory. In collaboration with a serious game design agency, we partially follow the gamification process and measure transfer effects. Firstly, we wanted to know if game-like interventions actually have any effect on the workers' real world teamwork experiences. Secondly, the aim was to find crucial factors that may have influenced the (lack of) transfer effects.

After this first attempt of applying game elements in a real-life context, we return to theory in chapter 3. This chapter describes a theoretical framework for evoking particular gameful experiences in teamwork contexts. The framework originates from the overlap between game design theory and theory from organizational

psychology. It suggests that interdependence, competition and cooperation are important basic factors for the gamification of teamwork. These factors frame the transfer effects we aim for in the experiments described in following chapters. Moreover, the framework explains how this may be achieved with goals and rules.

Next, we gradually shift from lab to field studies and from implementation in the game world to implementation in the real world. In chapter 4, the framework from chapter 3 is applied to a simple multiplayer computer game. The aim was to investigate to what extent rules can steer players towards competitive and cooperative behavior in a game. Next to proving that players indeed mostly behave according to the rules, the experiment provides lessons about designing the rules. The rules that govern goal achievement appear to influence the players' behavior most. Moreover, a game theoretical analysis demonstrates that these goal-driven rules not always lead to behavior that you would intuitively expect.

Thus, before implementing goals, rules, objects, and freedom in a real-life teamwork context, chapter 5 further investigates the use of game rules in a non-game lab setting. In a half-hour brainstorming challenge for student groups, a game with coins and varying rule-sets had to influence the meeting process and improve brainstorm output (the transfer effect). The results from the experiment demonstrate that freedom is not only crucial for evoking gameful experiences but also for achieving a transfer effect. Moreover, it teaches us that the quality, rather than the quantity, of the gamified rules influence the transfer effect.

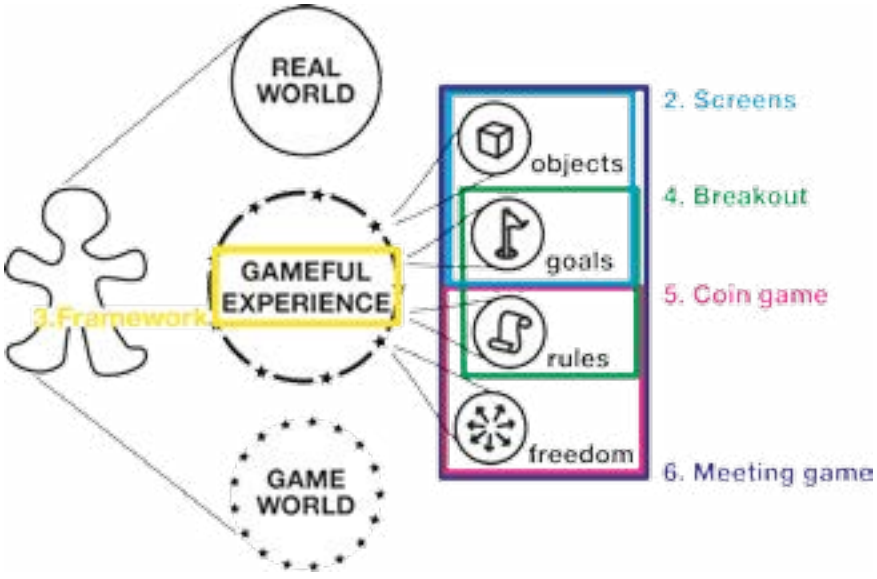


Figure 1.8. Chapter overview

In chapter 6, we accumulate the insights from the previous chapters in a second field study: the gamification of team meetings at a consultancy firm. This final case addresses all aspects of the persuasive game design model. We describe in detail the gamification design process as well as a small experiment to measure the most immediate transfer effects. The chapter describes the crucial phases and considerations while designing and evaluating game elements for teamwork in the field.

In the concluding chapter we reflect on the effects of gameful experiences on non-game teamwork. Our experiences with designing the gamification of teamwork lead to a refinement of the composite theory of game design and lessons for gamification design in practice.

2

Exploring gamification design at real-life production teams

In the previous chapter, we introduced our theoretical understanding of gamification, its possible transfer effects, and the basic components of a game experience. In this chapter, we dive into a real-life case in order to gain a practical understanding of the design and implementation of game elements for teamwork on the workfloor and study its effect. A framework for game elements for team cohesion is developed and the effects of two gamification interventions (team performance feedback and personal profiles) on team cohesion are examined in a steel-processing factory. The results suggest that gamification mainly raises attention for factors that are explicitly addressed. The chapter concludes with lessons learned regarding the development of gamification interventions and measuring the transfer effect. Moreover, we propose a novel gamification strategy: making implicit real world elements explicit through game elements.

This chapter is accepted for publication as: Vegt, N., Visch, V., Vermeeren, A., & de Ridder, H. (in press). A Case Study on Gamified Interventions for Team Cohesion in Factory Work. *Human Technology*.

2.1 Introduction

2.1.1 Gaming at work

Gaming at work is not new. Factory workers in the 1950s (Roy, 1959) and 70s (Burawoy, 1979) were observed to relieve stress and break the monotony of their jobs by inventing game-like motivations for their work. This increased the workers' satisfaction as well as their productivity. Roy (1959) described "a game of work" (p. 160) that made the operation of an industrial punching machine more satisfying, with rules such as "as soon as I finish a thousand green ones, I'll click some brown ones" (p. 161) Moreover, he suggested that informal non-instrumental interaction (e.g., small talk) is one of the key sources of job satisfaction for monotonous operating jobs. Years later, Burawoy (1979) did observations at the same machine production factory. He described similar game-like strategies to keep the jobs interesting as well as game-like motivations for reaching production quota. This motivation led to a high work pace and sometimes even to operators clashing with management to defend conditions for the profit of the company.

Factory jobs often lack the characteristics known to increase employees' performance, motivation, and satisfaction, as described by the job characteristics model (Hackman & Oldham, 1980): skill variety, task identity, task significance, autonomy, and job feedback. Nonetheless the operators in the above-described factory exhibited game-like engagement with their jobs. The workers transported themselves from a monotonous and tedious work experience towards a more fulfilling game experience, which can be defined as "the voluntary attempt to overcome unnecessary obstacles" (Suits, 1978, p. 54). Roy's (1959) game of work and informal non-instrumental conversations with colleagues are good examples of this.

Transporting a user experience from a non-game experience to a more game-like (or gameful) experience is referred to as gamification (Green, Brock, & Kaufman, 2004; Huotari & Hamari, 2012; Visch, Vegt, Anderiesen, & van der Kooij, 2013). Instead of leaving gamification to the workers, the current trend is to apply game elements more consciously (Deterding, Dixon, Khaled, & Nacke, 2011). Currently, most applications of gamification rely on game-like incentive mechanisms with points, badges, and leaderboards (Hamari, Koivisto, & Sarsa, 2014). However, when taking game design as an inspiration for non-game contexts, we find many more opportunities. According to McGonigal (2011, p. 346), the game industry has consistently proven itself, and it will continue to be our single best research

laboratory for discovering new ways to reliably and efficiently engineer optimal human experiences. For example, game-like metaphors (Berendsen, 2014) or challenges (Hsieh, 2010) that are developed by the game industry often are used to improve employees' work experience. By introducing motivational elements found in games, workers may become more satisfied with—and motivated toward—their jobs (Mollick & Werbach, 2014), typically leading to better performance.

2.1.2 Game elements for team cohesion

Although many games are individual and competitive, they often rely on collaboration and teamwork as well (Salen & Zimmerman, 2005). For example, many sports games contain competition between teams and in massively multiplayer online games, players form teams to overcome challenges and defeat virtual opponents. The elements that motivate players to put much effort in achieving collective goals, such as defeating opponents or achieving difficult challenges, might also be applicable for operating teams in a factory. Providing a game-like goal is one way to achieve this, yet games contain many other elements that stimulate collaboration such as roles, discussion forums, and exchange of resources (Warmelink, Mayer, Weber, Heijligers, Haggis, Peters, & Louwerse, 2017). Hence by analyzing the teamwork process and selecting the appropriate game elements, individual motivation for collective performance may increase.

Organizational psychology provides inspiration for the design of game elements for teamwork. The literature suggests many conditions for high team performance (Ilgen, Hollenbeck, Johnson, & Jundt, 2005). Among other things, interdependence and cohesion frequently are mentioned in relation to team performance (Beal, Burke, McLendon, & Cohen, 2003). Interdependence is a precondition for individuals working as a team (Brounstein, 2002). The extent to which team members feel interdependent correlates positively with the extent to which they collaborate (Frenkel & Sanders, 2007), which in turn positively affects team performance. Team cohesion reflects the extent to which team members feel part of a team. Literature on team cohesion suggests several factors that lead to stronger cohesion: commitment to goals and tasks of the team (i.e., task cohesion), and interpersonal interaction and individual attraction to the team (i.e., social cohesion; Kozlowski & Ilgen, 2006). Interdependence, task cohesion, and social cohesion provide a fruitful starting point for the development of game elements for team cohesion.

2.1.3 Game design interventions at a factory

This article presents a case of designing, implementing, and evaluating game design interventions for team cohesion within production teams at a strip galvanizing plant (Wuppermann Steel Netherlands). At this factory, unprocessed coils of sheet steel come in and shiny, coated, and cut coils of sheet steel come out. The production process is largely automated and optimized. Operators mainly sit throughout their shifts behind screens, monitoring and maintaining the production line. Consequently, keeping the operators engaged in their jobs has become the major concern. Their jobs are segmented into sections, which reduces the teamwork experience. In this context, enhancing interdependence and team cohesion through game elements may be helpful in increasing the operators' satisfaction with and motivation for their jobs.

Three years ago, a process was initiated to increase workers' engagement with team performance at one production department. In collaboration with a serious game design company (&RANJ, the Netherlands), LED displays with production figures were replaced by touch screens in the factory hall and canteen (see figure 2.1). These screens displayed a dashboard with real-time game-like infographics about the operating team's key performance indicators (KPIs) and click through pages with detailed information about the KPIs. According to the managers, as a

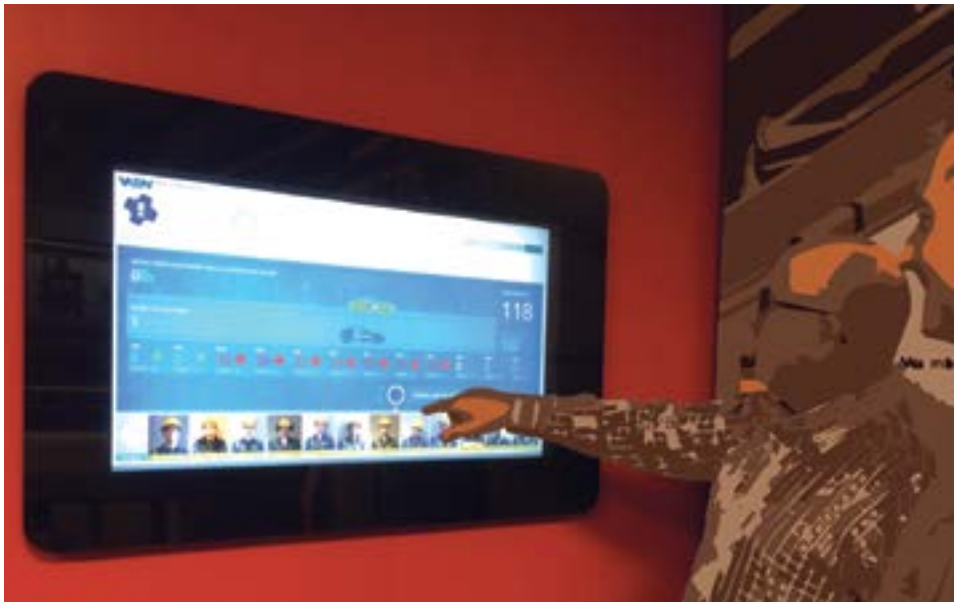


Figure 2.1. Touch screen at the canteen of the galvanizing department, displaying the team's performance (upper racing car) and target (bottom racing car).

result of the display, the KPIs became a more dominant topic of discussion among the operators of that department.

In this chapter, we describe two studies on the effect of two new game design interventions for team cohesion in two separate production departments of the factory (galvanizing and cutting). At the galvanizing department, interactive personal profile pages of all workers within that department were added to the already present screens. At the cutting department, the still present LED display was replaced for a touch screen displaying gamified performance information in the factory hall. Besides measuring the effect of game design interventions, we aimed to discover general guidelines for the design and implementation of game elements in non-game teamwork contexts. We therefore describe the theoretical as well as practical considerations within the design process. In the following section we first introduce our perspective on gamification, then summarize organizational psychology literature about teamwork, concluding with the theoretical framework that served as the basis for the interventions. Next, the context of the factory and perspective of the operators will be addressed. The theoretical framework and user/context factors were used to inform the design process as well as to form hypotheses regarding the intervention studies.

2.2 Theoretical background

2.2.1 Gamification

The rise of computer games has increased the interest in consciously implementing games at companies (Edery & Mollick, 2009; Reeves & Read, 2009). Gamification, the use of game elements in non-game contexts (Deterding et al. , 2011), is increasingly applied and investigated in business environments (Reiners & Wood, 2015). Currently, gamification is mainly operationalized as game-like incentive mechanisms (Hamari et al., 2014). For example, participants could gain points for tagging photos (Mekler, Brühlmann, Opwis, & Tuch, 2013), badges could be earned for specific activities at a peer-to-peer trading service (Hamari, 2013), and sales-achievements were displayed as a basketball game (Mollick & Rothbard, 2013). These implementations demonstrated marginal positive effects on productivity, effort, and job satisfaction that, to a large extent, depended on the compliance of the users.

However, as Bogost (2014) critically claims, current gamifications mainly seem to exploit the motivational elements of games instead of inherently motivating

employees for particular tasks. Rather than just adding game-like incentive mechanisms, we suggest to gamify a worker's experience of his job. Research on self-determination in games (Ryan, Rigby , & Przybylski, 2006) demonstrates that successful games derive their motivational power by tapping into basic psychological needs. As a result, gamers shift more easily towards internalized and intrinsic motivational states, which are often related to increased commitment and performance in work contexts (Ryan & Deci, 2000).

This does, however, not mean that gamification should solely be aimed at intrinsic motivation (e.g., simply enjoying an activity). Instead, gamification should provide a variation of motivators, intrinsic as well as extrinsic (e.g., enjoying the outcome of an activity), because different player types can experience the same affordances differently (Huotari & Hamari, 2012). A good example of combining intrinsic and extrinsic elements is the coffee shop game that supports self-managing service desk teams at a banking company to organize their work (Berendsen, 2014). Their work activities were communicated through a coffee shop metaphor, thereby strengthening the employees' understanding of their activities. Next to increasing enjoyment in their work, it also raised motivation for extrinsic elements such as acquisition and sales. Another example is a multiple-choice quiz that encourages home workers of a service desk to get in touch with each other (Hsieh, 2010). In the quiz participants were extrinsically motivated (i.e., wanting to win) to get to know colleagues better and the activity of getting to know colleagues better in the online chat area was inherently satisfying.

The coffee shop game was added as a gamification layer on top of the non-game teamwork situation, whereas the multiple-choice quiz was integrated in the already available online communication functionalities for home workers and their profile information. These examples demonstrate that gamification can imply either addition of a game layer on top of the real teamwork or adding some game elements and making existing non-game elements more game-like. In the development of game design interventions for production teams, we took both strategies into account. Note that the coffee shop game and quiz about colleagues are aimed at teamwork, whereas most gamification literature is concerned with individual motivation for individual performance. Thus, to inform the design process of game elements for teamwork, organizational psychology literature was reviewed.

2.2.2 Conditions for high team performance

In organizational psychology, team performance is investigated extensively. Much of the work emphasizes conditions for high team performance (Ilgen et al., 2005),

because conditions (e.g., organizational impact, defined focus, knowledge and skills) show more significant effects than process variables (e.g., conflict management and communication) (McGrath, 1997). Team performance is defined in several dimensions: effectiveness, efficiency, learning and personal growth, and team member satisfaction (MacBryde & Mendibil, 2003). Of course, the organizational goal of operating teams is to be effective and efficient, yet without learning and team member satisfaction, teamwork is hard to sustain.

Following these dimensions, Castka, Bamber, Sharp, and Belohoubek (2001) suggest system factors and human factors for the development of high performance teams. One of the system factors is "information about performance measures", which directly relates to the real-time performance feedback on the KPI screens. Regarding the application of direct performance feedback, research is not well developed yet, although current technology systems have the potential to assess team member behavior and performance in real-time (Kozlowski, Grand, Baard, & Pearce, 2015). The available literature suggests that the balance between individual and team feedback is delicate. Individual feedback improves individual performance at the expense of team performance and vice versa (DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004). Additionally, teams tend to focus mainly on measures that are used for providing rewards, ignoring any other measures (Mendibil & MacBryde, 2006). Hence, rewarding, for example, team productivity may lead to undesirable neglect of side-tasks such as cleaning. Moreover, when employees are rewarded individually, implementing a team performance measurement system is found to be less effective for the same reason.

When projecting these insights on our case, the galvanizing factory seems mainly organized to support system factors. The production teams are at the heart of the production process, they have a clear goal, the distance with the management is short, and the KPI screens provide real-time information about the team performance. Yet the support of human factors could be improved, such as recognition for each operator's individual contribution (Zigon, 1997) and the knowledge and skills to work at every section of the production line. Hence, our study aims to improve human factors.

2.2.3 Team cohesion

To specify human factors in relation to team performance, we tap into literature on team cohesion. Team cohesion is the most extensively investigated construct underlying team processes (Grossman, 2014; Kozlowski & Ilgen, 2006). More cohesive work groups displayed greater amounts of courtesy (Kidwell, Mossholder,

& Bennett, 1997), efficiency (Beal et al., 2003), viability (Chang & Bordia, 2001; Mello & Delise, 2015), co-worker assistance (Frenkel & Sanders, 2007), and satisfaction (Voulgari & Komis, 2015). Team cohesion generally shows stronger correlations with efficiency than with effectiveness measures (Beal et al., 2003). This is explained by the fact that team cohesion includes task cohesion (i.e., commitment to the team's goals and tasks) and social cohesion (i.e., interpersonal interaction and personal attraction to the team) (Kozlowski & Ilgen, 2006). Task cohesion increases team performance (Carless & De Paola, 2000; Chang & Bordia, 2001), yet social cohesion is more related to collaborative behavior (Beal et al., 2003) and the viability of a team (Chang & Bordia, 2001; Mello & Delise, 2015). In fact, social cohesion could deteriorate team performance due to the pressure to conform (Rovio, Eskola, Kozub, Duda, & Lintunen, 2009).

Techniques for enhancing team cohesion in favor of team performance are not well developed yet (Grossman, 2014; Kozlowski & Bell, 2013). Team performance itself was not found to directly influence team cohesion; instead cohesion reinforces performance (Chang & Bordia, 2001). A recent study on team cohesion in massively multiplayer online games (Voulgari & Komis, 2015) suggests social and achievement-related forces. Among other things, social forces entail identification with the interests of group members and social interactions. Examples of achievement-related forces are successful cooperation, relevancy of group goals to individual goals, and linking individual success to group success. This relates to workflow interdependence, which is an important moderator for the cohesion-performance relationship (Beal et al., 2003; Gully, Devine, & Whitney, 2012). Workers help each other more when tasks are more interdependent (Frenkel & Sanders, 2007) and when they help each

Figure 2.2. Theoretical model: team cohesion and interdependence positively affect team performance and team cohesion consists of task- and social cohesion.

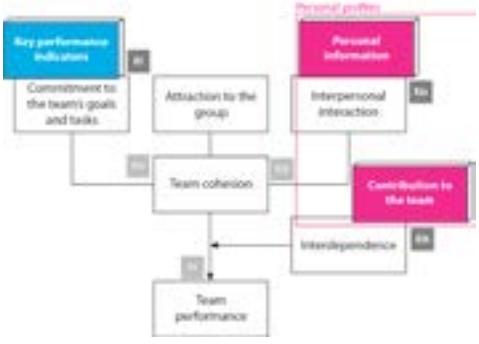


Figure 2.3. Our research framework: introducing game elements (colored boxes) that address aspects of task cohesion, social cohesion, and interdependence, and primarily measuring the direct effect (R1, R2a, and R2b).

other more they have a stronger desire to continue working together if the team performs well (Spataro, Pettit, Sauer, & Lount, 2014).

In conclusion, strengthening task cohesion (i.e., targeting behaviors that enhance commitment to the group task) seems the most important factor for improving teamwork (Carless & De Paola, 2000). Yet stimulating social cohesion (i.e., attraction to the group and interpersonal interaction) and emphasizing on interdependence may improve team performance in the long-term (see figure 2.2).

2.2.4 Research framework

As explained in the introduction, the operating team's performance has become a key factor for the factory's output because the automated production process has been largely perfected. Team cohesion and interdependence are key factors for achieving high team performance according to literature (see figure 2.2). Hence, we developed game elements that were meant to influence factors that enhance team cohesion and interdependence. Figure 2.3 shows how the game elements on the interactive screens were based on the described theoretical model. Introducing real-time feedback regarding KPIs was expected to increase task cohesion within the production teams. To increase social cohesion, game elements were aimed at stimulating interpersonal interaction. More specifically, personal information (such as birthdays and hobbies and interests) had to stimulate informal conversations. By showing one's contribution to the team, we expected to increase perceived interdependence. The personal information and contribution to the team would be displayed in personal profile pages.

As a first step in investigating game elements for team cohesion, the present study was aimed at measuring the direct effect of introducing game elements (see figure 2.3). That is: the effect of real-time KPI feedback on commitment to the team's goals and tasks (R1), and the effect of personal profiles on interpersonal interaction (R2a) and interdependence (R2b). Of secondary interest was the effect on team cohesion (R3a & R3b) and performance (R4).

2.3 User/context analysis

The decision to translate KPIs, personal information, and contribution to the team into game elements on the screens was not only grounded by literature. The research framework was also based on a review of human factors and system factors at the galvanizing plant. System factors such as production line, task division, and KPIs, served as input for the design of KPI graphics and contribution to the

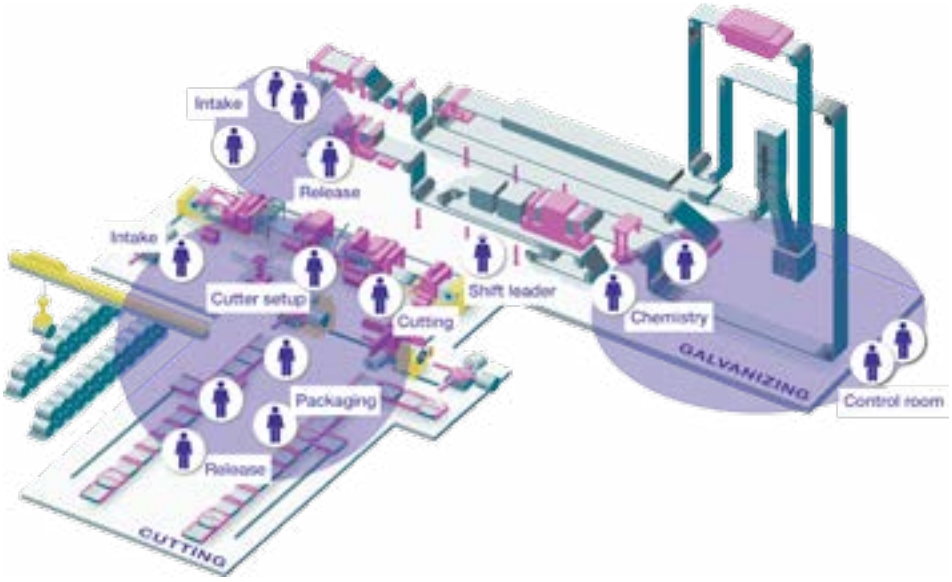


Figure 2.4. A map of the two production halls of the strip galvanizing plant with a galvanizing department (top-right part) and cutting department (bottom-left part). Each department consists of sections (labels) with a certain number of operators (puppets). Galvanizing operators experience division within the team (two purple circles at the top), cutting operators do not feel this separation (bottom purple circle).

team in the personal profile pages. Through exploratory talks with operators from different sections of the production line, we gained insights in their experiences of human factors (e.g., job motivation, team cohesion and interdependence) prior to the intervention. Moreover, the game elements for personal information and contribution to the team were selected on the basis of these talks.

2.3.1 System factors: production line, task division, and KPI's

As figure 2.4 shows, the production line of the galvanizing plant consists of two departments based in separate halls: galvanizing and cutting. At the galvanizing department, unprocessed sheet steel is galvanized, flattened, and sometimes chemically processed. Next, the cutting department cuts coils into prescribed sizes and packages the coils for shipping. This process is running continuously, 24 hours a day and 6 days a week. At each department, a team of operators runs the line for 8 hours, thus there are 3 shifts a day.

The galvanizing department is divided into four sections: intake, release, chemistry, and control room. At the intake section, operators position the unprocessed coils and weld them to the ongoing production line. Galvanization takes place in a tower at the other side of the hall, next to the control room. Control

room operators are responsible for the speed of the line and the galvanization process in the tower. Before and after galvanization, several chemical processes take place. Chemistry operators are responsible for the proper set of chemicals. At the end of the line, release operators verify the quality of the galvanized steel and make sure that the processed coils are transported to the cutting department. Most operating positions are equipped with several monitors and a button panel.

The galvanizing teams are assessed on four KPIs: production, first time rights, standstills, and days without injuries. As explained before, two touch screens display real-time infographics about the output (figure 2.5 & 2.6 show two example pages). One screen is placed in the canteen and one in the hall near the intake section. The production refers to the tonnage of steel that they process, and first time rights is an efficiency measure, referring to perfect processing without any loss of material and time. Reducing the number of standstills is a major concern of the operators. A standstill happens when the line blocks or when the steel sheet rips. This not only leads to delay, but also costs a lot of steel, because all steel in the line needs to be replaced after a standstill. For each KPI, the management provides targets that the teams need to hold on to. Depending on the team, the priority for particular performance indicators may differ. One team might be focused more on reaching maximal production, whereas another team is also concerned with leaving a clean workplace to avoid injuries.

The cutting department is divided into five sections: intake, cutter setup, cutting, packaging, and release. At the intake section, the galvanized coils are stored. This section is largely automated and thus not always manned. The operator at cutter setup is responsible for the knives that cut the coils and the cutting operator

Figure 2.5. Overview page of the screen at the galvanizing department: (left) production line, (right) real-time KPIs, (bottom) current team.

Figure 2.6. Detailed information about production targets on the screen of the galvanizing department.

does the cutting. Packaging and release operators make sure that the coils are made ready for shipping. The jobs at the cutting department are not dominated by a continuously running production line, yet they do have production targets. Next to reaching production targets, they are concerned with client satisfaction. Coils need to be cut neatly, without deforming the coil or fraying the edges. Clients are asked to give feedback on the quality. The feedback results are all available in the factory's data system, which could be shown through graphics on the screen.

2.3.2 Human factors: team cohesion and interdependence

In the exploratory talks, most galvanizing operators mentioned a division within the team operating the galvanizing department. They stated that the team consists of "islands". In figure 2.4 these islands are visualized. At the galvanizing department, the operators at intake and release are far away from the control room, and the chemists work in the middle of the hall. The operators explained that the physical proximity cuts the team in half. Moreover, even though intake and release operators work close together, they do not often speak to each other, because the release operator needs to continuously concentrate on the line. The operators use handheld transceivers to communicate. Yet if everything runs properly, there is no communication to keep the radio line available for emergencies.

Next to physical separation and little communication, differences in tasks and hierarchy separate the operators. For example, control room operators control the speed of the processing line, thereby being responsible for the production target, whereas intake operators need to insert and weld the coils properly to reach the first

time right target. When the line runs fast, intake operators need to work harder to keep up and make no mistakes. If they fall behind, they contact the control room to slow down the line. Consequently, control room operators admitted they sometimes complain about the slow intake operators and intake operators sometimes complain about the control room operators pushing them too much. Moreover, there are hierarchical differences between operators. New employees generally start at intake and work their way 'up' towards becoming a control room operator. Ideally, all operators should be able to take over at every position, yet due to differences in education and experience, chemistry and control room operators hardly ever work at the intake or release section.

Overall, the continuous production line dictates the galvanizing operators' work experience. They expressed to be mainly motivated to keep the line running and the physical separation was mentioned regularly, which can be expected to be obstacles to feel interdependent and 'part of a team'. Thus, we had to temper our expectations regarding increasing interdependence and team cohesion at the galvanizing department. Yet some operators expressed they would appreciate more personal contact with colleagues. Hence, game elements for social cohesion could be a valuable intervention at the galvanizing department.

The cutting department would probably benefit most from game elements for task cohesion, as it contains fewer obstacles for social cohesion. The teams work closer together and they replace each other more often. Hence, we expected that interdependence and social cohesion is already felt more strongly by the cutting operators. Consequently, introducing real-time feedback on KPIs and thereby raising task cohesion is expected to have a stronger effect on overall team cohesion and performance than raising social cohesion through personal profiles.

2.4 Study design

Following the different situations in the two departments, we executed two separate intervention studies (see figure 2.12). Study 1 examined the effect of introducing a new screen with game-like KPI infographics on commitment to team goals and team tasks (R1) at the cutting department. At the same time, intervention 2 was executed at the galvanizing department, where the already present KPI screens were updated with improved graphics, including personal profile pages. Thus study 2 examined the effect of additional gamified personal profiles on informal conversations (R2a) and interdependence (R2b).

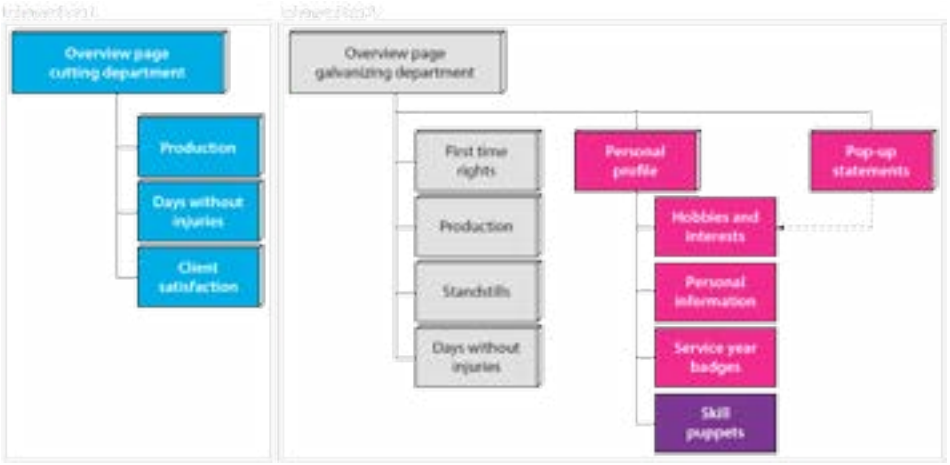


Figure 2.7. Content of the screens for both studies: (blue) new pages to stimulate task cohesion, (red) new pages and features to stimulate informal conversations, (purple) new feature to increase interdependence, and (grey) existing pages.

2.4.1 Page design

Figure 2.7 shows the pages and features on the screens at both studies. The development of pages for the new screen for study 1 was a straightforward process. The managers provided KPIs and game designers at &RANJ translated these into game-like infographics. The development of game elements for personal information and contribution to the team for study 2, asked for a more elaborate approach. Based on the talks with operators, we selected the features that are shown below. Moreover, pop-up statements about colleagues (see figure 2.11) were introduced to allow for play with the personal profiles and stimulate informal conversation. The following sections describe the pages and features in more detail.

Intervention 1: KPI screen

The new screen for the cutting department consists of an overview page and three 'more information' pages (see figure 2.7). The overview page, shown in figure 2.8, contains a static image of the production line on the left, real-time KPI data on the right, and the current team at the bottom. The KPI information is presented in a carousel that automatically shifts between KPIs. In figure 2.8, the number of tons and coils shows the team's current production. When clicking on it, details regarding the daily, monthly, and yearly targets appear in the shape of filling up ships, similar to the graphics for the galvanizing department (see figure 2.6). Days without injuries is also represented by a number. The detail page shows the results

of the past months and two racing cars represent the team's current performance and their target (similar to figure 2.1). Regarding client satisfaction, the overview page displays the overall score through a meter (as in figure 2.9) and the top 5 of clients. The detail page lists the separate assessment criteria, including the number of complaints, represented by an icon (figure 2.9 on the left).

The screen was installed next to the entrance of the hall where operators regularly walk in and out. In this way, the cutting operators could have a regular look at the overview page.

Figure 2.8. Overview page on the new screen at the cutting department: (left) production line, (right) KPI carousel, (bottom) current team.

Figure 2.9. Client satisfaction page on the new screen at the cutting department.

Figure 2.10. An example of a personal profile page that is added to the content of the screens at the galvanizing department: (left) contribution to the team, (right) personal information, (bottom) badges are added to the images of the current team.

Figure 2.11. An example of the pop-up statements about interests and hobbies of colleagues popping up at the end of each shift, serving as input for the above-shown personal profiles.

Intervention 2: personal profile pages

Additional to the already existing overview page and 4 KPI pages at the galvanizing department, 2 new types of pages were added on the screens: personal profiles (figure 2.10) and pop-up statements (figure 2.11). For each operator a personal profile page was added, containing personal information and one's contribution to the team. These pages are accessible by clicking on one of the operators' images at the bottom of the screen. The profile pages contain: date of birth, place of residence, hobbies and interests, service years, and role within the team. The service years are depicted as badges (shown upper-right in figure 2.10). On the day that an operator

has an anniversary or birthday, the badge also appears on the operator's image at the bottom. The operator's ascribed roles within the team are described in text and visualized through the colored 'operator puppets' on the production line on the left.

The displayed hobbies and interests are not static pieces of information. Instead they show what colleagues have answered about the particular operator through pop-up statements. At the end of each shift, four statements about colleagues pop up, such as 'Ruud likes to listen to jazz' or 'Ruud likes cycling'. These can be answered by pressing 'yes', 'no' or 'don't know' (see figure 2.11). In this way, hobbies and interests data is gathered and displayed on the operator's profile page. Thus rather than showing the correct hobbies and interests, the profile pages show what colleagues know (or think to know) about each other.

After implementation, several operators complained about the fact that their personal information (date of birth and hometown) was visible on the screen without being asked. They were allowed to opt for removal of this particular information.

2.4.2 Method

To measure the effect of 1) a new KPI screen on commitment to the team's goals and tasks and 2) additional personal profile pages on informal conversation and interdependence, all operators were asked to fill in a questionnaire 3 times (see figure 2.12). Next to measuring the direct effects, team cohesion and team performance were inquired. The questionnaires were the same for both studies in order to account for changes in the overall organization of the factory and the possible influence of the other intervention (see figure 2.13). Cutting operators could access the screens at the galvanizing department and vice versa. Hence, if we would find the same effects occurring in both departments at the same time this could indicate changes in the overall organization or the influence of the other intervention.

Figure 2.12. Scheme of the two intervention studies with (blue) the intervention for task cohesion within cutting teams, (red) the intervention for informal conversations and interdependence within galvanizing teams, and measurement times (t).

The first inquiry (t_{1a}) was implemented to check if the questionnaires themselves would affect the operators' teamwork experiences, because the experience of answering questions about teamwork could already increase the teamwork experience (Murphy & Davidshofer, 2013). The data from t_{1a} could also signify the current state of the operators' teamwork experiences and check if there were large differences between teams and sections, which could affect the influence of the screens on the operators' teamwork experience. To allow for the comparison of experiences of operators in different sections, the t_{1a} questionnaire inquired into the previous workday because, over a longer period, operators would be stationed at several sections. Moreover, the data could expose unanticipated extraneous variables.

As shown in figure 2.12, the first questionnaire-round (t_{1a}) was held in April 2014. The second moment of measurement (t_{1b}) served as the baseline measure. Unfortunately, a reorganization of the galvanizing department caused a delay in executing the baseline measurement (t_{1b}), which eventually took place in October 2014. The questions were the same as in t_{1a}. Yet instead of reflecting on the previous workday, the operators were asked to recall their experiences of the past weeks, to avoid influence of particular daily events such as a standstill (see Appendix A for the questionnaire). 3 Months after t_{1b} (in January 2015), the new KPI screen (at the cutting department) and personal profile pages (at the galvanizing department) were installed. 6 Months later (July 2015), the third questionnaire-round (t_2) was executed to measure the effect of the interventions. Next to filling in questionnaires in t_2, several operators were interviewed to evaluate the interventions. To better interpret the data from the questionnaires, we wanted to know the operators' opinions

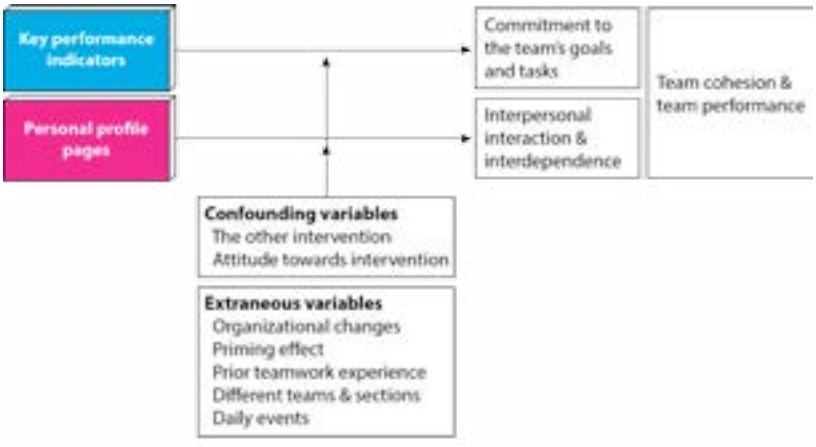


Figure 2.13. The interventions (boxes on the left) are assumed to directly enhance commitment and interpersonal interaction and perceived interdependence (direct arrows), thereby indirectly enhancing the operator's experiences of team cohesion and team performance, influenced by confounding and extraneous variables.

regarding the new features. We interviewed shift leaders and operators from the galvanizing teams, because they were familiar with KPIs as well as personal profiles.

2.4.3 Measurement

The questionnaires consisted of four pages (see Appendix A). Filling it in took approximately 20 minutes, thus shift leaders were instructed to distribute the questionnaires and make sure that every operator would fill it in without disrupting their work. The first page contained statements about team cohesion (i.e., islands and pride), task cohesion (i.e., task and goal commitment), social cohesion (i.e., non-work-related talk), and team performance. These were mainly individual-level statements, e.g., 'the goals of the team were important to me' or 'I talked about non-work related topics with my colleagues'. We did not measure group-level team cohesion (Gully, Devine, & Whitney, 2012), because the game elements were aimed at enhancing the teamwork experience of the individual operators. Regarding team performance and informal conversations, the operators were asked to describe the performances and topics in a blank box, to investigate if their interests would change. The second and third page inquired experienced and behavioral interdependence with operators from each section. For each section they had to fill in to what extent they felt dependent on colleagues and to what extent colleagues depended on them. Similar questions were asked regarding helping and hindering, resembling positive and negative behavioral interdependence (Deutsch, 2006).

On the fourth page, the operators were asked about the importance of the screen, one's attention for it, and some general information. As the operators' shift leaders would distribute the questionnaires, not much personal information was asked. Yet to allow for within-subject comparisons, we did ask for service years at the factory and the years they had worked in total. In combination with knowing the team and section, it would be possible to trace back individuals. The questionnaire in the first round included an informed consent form, announcing the two follow-up questionnaires.

2.4.4 Participants

All participants were male operators. The variation in work experience was high (1 week – 40 years) and all participants were full-time employees. According to Sanders and Nauta (2004), similarity in gender and percentage of full-time employees within a team has a positive effect on team cohesion. Thus we expected relatively strong cohesion to be present even before the intervention, that is in the prime (t_{1a}) and baseline measure (t_{1b}).

2.5 Results

Before discussing the results of the study we discuss the response rates in both studies, and analyze the possible effect of extraneous variables.

2.5.1 Response rate

Some of the questionnaires had to be left out of the analysis because they were filled in with the same score at all statements, indicating that the request of filling them in was not taken seriously. The resulting numbers of responses per measurement time are presented in table 2.1 and 2.2, next to the number of employed operators. The response rate at the cutting department (table 2.1) was relatively stable: 89% at t_{1a}, 66% at t_{1b}, and 69% at t_2. However, among the galvanizing operators, the response rate dropped drastically with every round (see table 2.2). In t_{1a} we received 39 (87%)

Table 2.1. Number of employed operators and respondents per measurement time in study 1.

Cutting department		**t_{1a} (Apr '14)**		**t_{1b} (Oct '14)**		**t_2 (Jul '15)**	
		operators	respondents	operators	respondents	operators	respondents
Total		35	31	35	23	35	24
Per team	A	7	6	7	4	7	?
	B	7	7	7	6	7	?
	C	7	7	7	4	7	?
	D	7	5	7	5	7	?
	E	7	6	7	4	7	?
	Unknown						24
Per section	Intake	5	0	5	0	5	1
	Cutting	5	5	5	2	5	1
	Cutter setup	5	8	5	3	5	1
	Packaging	15	10	15	4	15	5
	Release	5	5	5	2	5	1
	Several		0		4		4
	All		3		2		3
	Unknown				6		8

Note. Number of employed operators per section is based on work documents.

Table 2.2. Number of employed operators and respondents per measurement time in study 2.

Galvanizing department		t_{1a} (Apr '14)		t_{1b} (Oct '14)		t_2 (Jul '15)	
		operators	respondents	operators	respondents	operators	respondents
Total		45	39	44	27	44	12
Per team	A	15	12	11	?	11	?
	B	15	15	11	?	11	?
	C	15	12	11	?	11	?
	D	-	-	11	?	11	?
	Unknown				27		12
Per section	Intake	6	16	8	8	8	1
	Chemistry	6	5	8	1	8	1
	Control room	6	6	8	5	8	3
	Release	6	5	8	3	8	1
	Shift leader	3	2	4	2	4	0
	Several		0		6		5
	Unknown		5		2		1

Note. Number of employed operators per section is based on work documents.

responses, in t_{1b} 27 (61%), and in t_2 only 12 (27%). The response drop between t_{1a} and t_{1b} was probably caused by reorganization. Initially, the galvanizing department consisted of 3 teams of 15 operators and after the reorganization the operators were shuffled and relocated into 4 teams of 11 operators. This is what most likely caused the reduced pride with the team and perceived performance they reported in t_{1b} as compared to t_{1a} (see table 2.3). Most likely, this led to less willingness to fill in a questionnaire about teamwork. The drops in pride and performance did not recover in t_2, which might partly explain the continued response dropout. Moreover, some shift leaders were replaced by interim shift leaders due to holidays, which might have reduced the urgency of filling in the questionnaire as well.

Table 2.1 and 2.2 also show the incomplete data we received regarding teams and sections. From the cutting teams all data was available in t_{1a}, yet at the galvanizing department several operators had not filled in the section they worked in. In t_{1b}, the teams at the galvanizing department were not registered as well as some data about the sections. In t_2 the team data was not available at both departments. Due to the

missing data, we could not trace back individuals; hence we could only analyze effects of the interventions using averages of the whole department.

2.5.2 Extraneous variables

As explained in the method section, we did use the t_{1a} data to estimate the effect of extraneous variables, such as the above-described reorganization that seemed to influence galvanizing operators' pride with the team and perceived performance. Most data was not normally distributed and we assume that the participants in t_{1b} also participated in t_{1a}. Hence, Wilcoxon signed-rank tests were used to evaluate whether there were significant differences between t_{1a} and t_{1b} within the two departments. The results revealed no significant difference in any of the measured variables in both departments.

Overall, the t_{1a} data suggests that all measured variables are already high at the factory (see figures 14 & 15 and table 2.3). Consequently, we could expect a ceiling effect and thus small to no effects of the interventions. Only non-work-related conversation was moderate at the galvanizing department. Mann-Whitney tests were used to compare the questionnaire answers of the two departments in t_{1a}. As expected, the results indicated that in t_{1a} galvanizing operators had less non-work-related conversation (Mdn = 3) than cutting operators (Mdn = 4), U = 372.0, p = .019, r = .39. Thus we mainly expected to find an effect in non-work-related conversation at the galvanizing department.

Kruskal-Wallis tests were computed to evaluate whether operators from different teams and sections had different teamwork experiences in t_{1a} (and t_{1b} at the cutting department). At the cutting department, teams differed significantly in commitment to team goals in t_{1b}, χ^2 (4, N = 22) = 9.31, p = .037. Post hoc analysis, comparing goal commitment per team using Mann-Whitney tests, revealed that operators at one team reported significantly lower commitment to team goals (Mdn = 3) than operators from three other teams (Mdn = 4). At the galvanizing department, teams differed in pride with the team χ^2 (2, N = 35) = 9.24, p = .007, and perceived team performance in t_{1a}, χ^2 (2, N = 35) = 7.01, p = .024. Post-hoc analysis revealed that one team scored significantly lower on both variables (Mdn = 4) than the other two teams (Mdn = 5). At both departments there were no significant differences between sections. Thus, in conclusion, teams were expected to be an extraneous factor for measuring commitment to goals at the cutting department and for measuring pride and performance at the galvanizing department.

Figure 2.14a. ((Study 1) Average self-reported commitment to team goals among cutting operators.

Figure 2.15a. (Study 2) Average self-reported commitment to team goals among galvanizing operators.

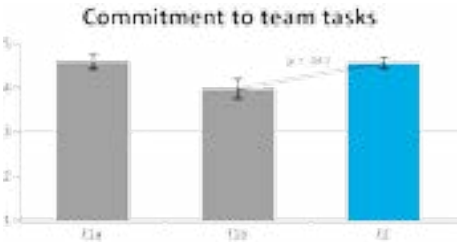


Figure 2.14b. (Study 1) Average self-reported commitment to team tasks among cutting operators increased significantly after implementing a screen with gamified KPI information.

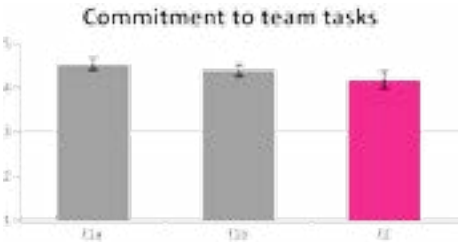


Figure 2.15b. (Study 2) Average self-reported commitment to team tasks among galvanizing operators.

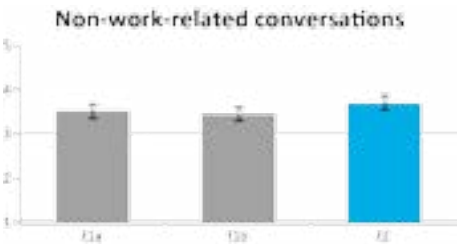


Figure 2.14c. (Study 1) Average self-reported informal conversations between cutting operators.

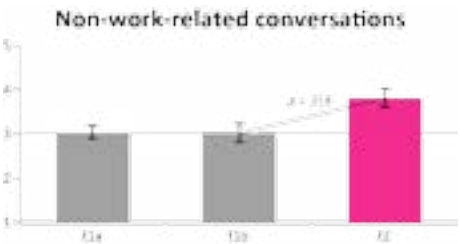


Figure 2.15c. (Study 2) Average self-reported informal conversations among galvanizing operators increased significantly after implementing gamified personal profile information.

2.5.3 Study 1: KPI screen for task cohesion

Figures 14a-c (with the intervention measure in blue and line indicating significant differences) and table 2.3 depict the data gathered by the questionnaires. To examine the effect of the KPI screen on task cohesion, commitment to team goals (figure 2.14a) and team tasks (figure 2.14b) in t_{1b} were compared with the commitment in t_2. As the data in t_{1b} and t_2 was not normally distributed, we used Wilcoxon

Table 2.3. Means of pride, interdependence, and performance in t_{1a}, t_{1b} and t_2 with significance of variation over time.

Cutting department	t_{1a}	t_{1b}	t_2	**sig.**
Pride with the team	4.41	4.18	4.29	n.s.
Perceived team performance	4.50	4.17*	4.61*	.021
Perceived interdependence††	2.95	3.14	3.53†	n.s.
Perceived hindering††	1.54	1.92	2.19	n.s.
Perceived helping††	3.72	3.60	4.04†	n.s.
Galvanizing department	t_{1a}	t_{1b}	t_2	**sig.**
Pride with the team	4.54	4.00	4.00	n.s.
Perceived team performance	4.54	4.13	4.18	n.s.
Perceived interdependence††	3.13	3.20	3.28†	n.s.
Perceived hindering††	1.59	1.95	2.23	n.s.
Perceived helping††	3.29	3.50	3.51†	n.s.

Note. * significant difference between t_{1b} and t_2 ($p < .05$); † significant difference between departments ($p < .05$); †† no significant differences between sections ($p > .05$).

signed-rank tests to evaluate whether task cohesion differed between t_{1b} and t_2. The results indicated that commitment to team tasks was significantly greater in t_2 (*Mdn* = 5) than in t_{1b} (*Mdn* = 4), $Z = -2.043$, $p = .041$. Figure 2.14a also suggests more commitment to goals in t_2, yet no significant effect was found, $Z = -1.852$, $p = .064$.

All other variables were also examined through Wilcoxon signed-rank tests, as they were not normally distributed as well. The results indicated that the median t_{1b} scores (*Mdn* = 4) of team performance were statistically significantly lower than the median t_2 scores (*Mdn* = 5), $Z = -2.308$, $p = .021$. As shown in table 2.3, non-work-related conversation, pride, interdependence, hindering, and helping revealed no significant effects. Thus, the KPI screen seems to have increased the cutting teams' commitment to tasks and perceived team performance.

2.5.4 Study 2: personal profiles for informal conversations and interdependence

To examine the effect of the additional personal profile pages, non-work-related conversation (figure 2.15c) and experienced- and behavioral interdependence (i.e.,

hindering and helping) (table 2.3) in t_{1b} were compared with non-work conversation and interdependence in t_2. The data on non-work conversation in t_{1b} and t_2 was not normally distributed, thus non-parametric Wilcoxon signed-rank tests were used to compare the scores of t_{1b} and t_2. The results indicated that non-work-related conversation was significantly greater in t_2 (Mdn = 4) than in t_{1b} (Mdn = 3), Z = -2.356, p = .018. Regarding experienced- and behavioral interdependence independent samples t-tests were computed, as the data was normally distributed; yet no significant differences were found. Thus the additional personal profiles seem to have only increased non-work-related conversation at the galvanizing department.

Because the cutting teams had not received the personal profiles, we could use their data on informal conversations and interdependence as a control measure. Mann-Whitney tests were computed to compare the data from the different departments. The results indicated that only in t_2, galvanizing operators experienced less help from each other (Mdn^{galv} = 3.3) than cutting operators (Mdn^{cut} = 4.25), U = 83.5, p = .041, r = .34. This suggests that either galvanizing operators perceived less help or the cutting operators perceived more help in t_2. When reviewing the means in table 2.3, cutting operators seem to show an increase in helping in t_2 compared to t_{1b}.

2.5.5 Opinions about the interventions

The analysis of the questionnaire data regarding the operators' attitudes towards the screens, indicated that galvanizing operators found the screen significantly more important in t_{1a} (Mdn = 4) than in t_2 (Mdn = 3), U = 121.5, p = .049, r = .29. Moreover, in t_2 the importance of the screen was rated significantly lower by galvanizing operators (Mdn^{galv} = 3) than by cutting operators (Mdn^{cut} = 4.5) U = 61.0, p = .017, r = .42. Among the galvanizing operators, the screens became gradually less important over time (M^{t1a} = 3.64, M^{t1b} = 3.08, M^{t2} = 2.73), whereas their attention for it remained stable (Mdn = 3; once a week). Among cutting operators, importance and attention (Mdn = 3; once a week) were the same at all measurement times.

After inquiring the operators in t_2, 11 galvanizing operators from different sections and teams were interviewed to gain a better understanding of their attitudes towards the game elements on the screens. In the interviews, shift leaders said they regularly browsed through the detail pages of KPIs; other operators sometimes browsed through them at lunchtime or before starting their shift but mainly just had a regular glance at the overview page. During the intervention period, 790 clicks on the details-button were measured, which is on average 6 clicks per day. All operators indicated that the KPI information was useful. One shift leader explained that the

infographics made him discuss the calculation of some KPIs with the management.

All interviewees also indicated to be familiar with the personal profiles (43 clicks per day were measured), yet not all knew every bit of information that it contained. Interestingly, the personal information was known by nearly all of them (10 out of 11), probably due to the complaints when they were introduced. The operators were generally negative about the information on their profiles, because they considered it to be incorrect. Most interviewees were not aware of the fact that the information regarding hobbies and interests came from answers that colleagues gave through the pop-up statements. Just one operator mentioned that he sometimes had a look at his profile to see what his colleagues had answered about him. However, most operators had not understood the link. This may be explained by the fact that no more than half of them had seen the pop-up statements, which is also reflected in the low rate of 4 measured clicks on average per day. Consequently, operators mentioned they would like to have more control over the information in their own profile. For example, to remove hobbies and interests that offended them.

The operators that had seen the pop-up statements indicated that they found it strange that the statements were about colleagues from the team that was leaving. At the end of a shift, statements popped up about the operators that had just done a shift, whereas operators that were starting their shift mainly took some time to look at the screen. As a consequence, operators from the arriving team often answer statements about operators from the departing team. Instead of using the statements as input for the personal profiles, operators suggested they would prefer questions that challenge their knowledge about each other.

Regarding the visualization of an operator's roles within the team, interviewees were generally positive. They considered it to be useful information, even though nearly all interviewed operators stated that they already know each other's skills and experience. One operator mentioned: "I wonder why some of my colleagues have so many colored puppets, even though they don't work here as long as I do. Why do I not get any additional puppets [referring to roles in the process]?" This suggests that the puppets were correctly understood and raise awareness about one's contribution to the team. The badges were also positively received. Operators that had seen them (4 out of 11) considered birthday and anniversary information useful to know. One shift leader recommended adding functional badges, such as an emergency response badge.

In general, all work-related information on the screen received positive responses and most personal information was received with indifference or a negative reaction.

2.6 Discussion

This article presented the explicit application of game elements at a strip galvanizing plant to enhance team cohesion within production teams. The effects of two game design interventions were measured in two separate studies. In study 1, a screen was introduced that displays real-time game-like infographics about KPIs to increase the operators' commitment to team goals and team tasks (R1). The study contained 3 measurement times: a priming- (t_{1a}), baseline- (t_{1b}), and intervention measure (t_2), in which operators had to fill in questionnaires regarding their teamwork experiences. The results revealed a significant increase of commitment to team tasks and perceived performance from t_{1b} to t_2 (see figure 2.14b and table 2.3).

At the same time in study 2, gamified personal profile pages were added to already present KPI screens at another production department. The profiles contained personal information (partly filled in by colleagues) and displayed one's roles in the team, aimed at stimulating informal conversations and the feeling of interdependence among the operators. To measure an effect, the same study setup as in study 1 was used. Results revealed that after introducing personal profiles, informal conversations increased significantly (figure 2.15c). Yet in both studies, overall team cohesion, interdependence and perceived team performance did not change significantly.

Overall, the quantitative results indicate no deterioration and possibly some improvement of the teamwork experience after implementing the game design interventions. Qualitative results suggest that the game elements affected some operators in their perception of their work within the production team.

2.6.1 Extraneous and confounding variables

To what extent the interventions can be accounted for the above-described effects remains uncertain, even though the analysis of variations between t_{1a} and t_{1b} did not reveal any significant variations that suggest other influences. The increase of informal conversations after the intervention in study 2 was the most convincing result. Yet the dropout rate (73%) during the intervention measure (t_2) reduces internal validity. Responses in t_2 do seem representative for the whole group, as results on other variables (e.g., pride with the team, and perceived team performance) resemble results from t_{1b}. This also suggests that the influence of daily events was probably negligible. When inspecting individual reports on non-work-related conversation among galvanizing operators, we mainly found an absence of low ratings in t_2, which might indicate selection bias. On the other hand, the number of subjects

reporting a high rating increased by 1. Due to incomplete data we could only trace back 4 individuals across all measurement times. Hence, significant correlations between measurement times could not be computed.

The fact that we did see effects of the reorganization in the drop in pride with the team and perceived team performance between t_{1a} and t_{1b} (see table 2.3) suggests that the self-reports were genuine. Due to the changed composition of the teams and less shifts per team to achieve their targets, performance obviously decreased. This was recognized by the operators and appeared to affect their feeling of pride with the team. Although the reorganization took place at the galvanizing department, it probably affected both departments, yet the cutting operators recovered in t_2.

As we clearly measured different effects at the two departments, the operators seem to not have been influenced by the intervention at the other department. Moreover, the attitude of the operators towards the screens seems to not have been a significant influence on the effects, because operators were relatively negative towards the personal information. Nonetheless non-work-related conversation increased.

In retrospect, it would have been useful to also ask for the operators' feelings regarding their contribution to the team. Initially, the corresponding game elements (operator puppets on the production line) were intended to increase perceived interdependence, yet it is probably the factory's system factors that mainly influence these variables. Consequently, contribution visualization did not lead to significant differences in interdependence, yet the interviews suggest that we could expect an increase in perceived contribution to the team.

The fact that no significant differences were measured in team cohesion and perceived team performance may have been caused by a ceiling effect or the timeframe in which they were measured. In both studies, the operators already gave high ratings for cohesion and performance in the prime and baseline measure, hence there was not much room for improvement. Moreover, the timeframe (6 months) and number of measurements (3) might have not been appropriate for these variables. To measure perceived performance and cohesion, more measures may be needed over a longer period of time to overcome the effect of daily events and changes in the organization.

Another way to better measure team cohesion would be to define all underlying factors by group-level statements (Gully et al., 2012) (e.g., "the team was committed to its tasks" instead of "I was committed to the team's tasks"). In this way, the underlying factors could provide an indication for overall team cohesion.

2.7 Implications for theory and application

Currently, the field of gamification mainly focuses on individual motivation. This article provides a framework for the design of game elements for collective motivation, which could pave the road for future research and applications of teamwork gamification. We suggest that team cohesion and interdependence are fundamental dimensions of teamwork that are well suited for gamification and thus important factors for investigating collective motivation in gamification research.

In two field studies, we showed how the theory could be translated into actual game elements at a factory work floor. The results confirm earlier studies, demonstrating moderate positive effects of gamification. Yet, as it is a young research field, drawing lessons from these applied cases is most important. As explained in the following section, our main finding is that gamification successfully draws attention to elements that are explicitly addressed. Hence, we suggest that transforming existing non-game elements into game elements is probably the best strategy for gamification at any type of workplace.

For a gamification design process, this implies finding relevant implicit behaviors and making them explicit through gamification. The decisions in the design of game elements may influence the implicit behavior, thereby achieving behavior change. Future research of gamified interventions should address the effect of specific design decisions on behavior change. Our study suggests that long-term exposure, individual acceptance, and adaptation to the context and users are crucial in studying the effect of gamification of teamwork. The extent of playfulness of the gamification seemed an important factor as well, particularly at a factory work floor where the costs of mistakes are high.

2.8 Conclusions & recommendations

2.8.1 Lessons learned: game design interventions for team cohesion

Although the significance of the results in both studies is debatable, all effects hint towards a similar conclusion. The game design interventions only seem to have affected the operators' perception regarding topics that were directly addressed in the game elements. In intervention 1, infographics about the team's performance improved the operators' commitment to their tasks and perception of their performance, and in intervention 2 informal information stimulated informal conversations. Hence, the game design interventions appear to be successful in raising attention for particular topics.

Consequently, we suggest that developing gamification concepts is mainly a matter of making implicit elements in the work, explicit in the form of game elements; like making performance explicit in the form of performance feedback. This is similar to what is done in most recent gamification studies (Hamari et al., 2014). Yet other elements, such as interdependencies within a team, could be made explicit as well. For example, one could try to make explicit the implicit conflict between intake and control room operators, as described in the user-context analysis. Presumably, such additional interventions could raise understanding for each other's situation.

The research framework in figure 2.3 proved to be a good basis for developing game elements for teamwork and suggests several opportunities next to the interventions that were investigated in the presented studies. For example, the framework suggests that to increase team cohesion, game elements should address attraction to the team. We suggested a number of solutions for that. For example, we proposed to relate individual interests with company interests by putting up banners in the production hall, displaying how the factory's clients use the coils and how this contributes to people's daily lives (such as relating km's of guardrail with saving thousands of lives each year). Another idea was to make operators clock in at the screen, so they could see their image at the bottom and operator puppets appear on the production line image. Moreover, displaying the implemented pages on the operator's monitors could have increased their attention for it. Yet, the company's management considered these interventions to be too invasive.

In general, the operators' engagement with the elements should be improved. The interview results suggest that only shift leaders browse through details regarding KPIs and that operators would prefer more control over their profiles. They could not directly play or interact with the introduced elements. As a result, the engagement with the elements probably was not optimal. The lack of interactivity is not only a problem in our study, but in most gamification studies. Gamification is often just meant to inform users in a more stimulating manner, rather than increasing the user's control over the presented elements (Mekler et al., 2013; Hamari J. , 2013; Mollick & Rothbard, 2013).

Moderate engagement with the screens might also be caused by the focus on team factors. As explained earlier, workers tend to focus on measures that they are directly rewarded for (Mendibil & MacBryde, 2006), which in this case, is not the team performance. Hence, introducing game elements that directly reward team performance could improve the operators' engagement with the screens. A more drastic approach would be to relate their salary to the team's or company's performance.

This leads to our final lesson in developing game design interventions for team cohesion. The game elements seem to expose the system and strategy of the company. For example, at the cutting department client complaints were explicitly visualized, but are referred to the KPI client satisfaction, instead of a more precise alternative such as client complaining. For the cutting department this was the first iteration of gamifying the KPIs. We conclude that it would be recommendable to redesign the page for client satisfaction so that it actually resembles 'satisfaction', which would probably be more motivating for the operators. At the galvanizing department such iterations have been made, resulting in the racing cars that are shown in figure 2.1. In conclusion, we propose that an important quality of gamification is to expose rather than cover up existing elements of work. In other words, we would recommend transforming existing elements into game elements, rather than adding game elements to a non-game teamwork situation.

2.8.2 Lessons learned: research design

Team cohesion was found to be a good source of inspiration for the design of game elements for teamwork. Yet measuring an effect of the designed game elements in the complex context of production teams at a factory was more difficult. First of all, we had to deal with a serious dropout rate. Following our lessons on gamification, a way to avoid dropout could be to transform the measurement tool into a game element. Not only by making it easier and more fun to fill in a questionnaire, but also by tailoring it to the context, for example, through pop up questions throughout the workday.

The fact that implicit elements were made explicit allows for the integration of evaluative procedures within game elements. Instead of measuring the effect externally, game elements themselves could then have provided data for evaluation. In KPI information this is already inherently present, yet regarding contribution to the team and informal conversation this would be possible as well. One suggestion would be that the operator puppets are also used as a measure to evaluate shifts in the operators' roles over time. To measure the operators' interest in a particular topic through game data, interactivity is crucial. The amount of interaction could say something about the attention for a topic, as the measured number of clicks in the present study demonstrates.

2.8.3 Future work

The research framework (figure 2.3) suggests several options for future work. As described above, game elements for attraction to the team could be investigated, as well as game elements that explicitly address team cohesion or team processes. We assume that by implementing more such interventions in a teamwork context, significant effects should trickle down to the team's performance.

Given the current status of research on gamification, an interesting follow-up question would be: can individual game-like incentive mechanisms increase engagement with teamwork processes? Most gamification experiments are based on individual incentives for individual activities (Hamari et al., 2014). However, at most companies the work is done by teams. Thus investigating game elements for teamwork is needed. When following the gamification approach of making implicit elements explicit, this would require an analysis of the dynamics in the teamwork context. If we would want to improve collaboration within teams, we need to select specific factors within the collaborative process and address them directly through game elements. For example, complimenting each other could be made explicit by giving each other points.

2.8.4 Final word

Nowadays, operators are already far more autonomous than the workers in the 50's (Roy, 1959), yet they are still supervised by a shift leader. Moreover, the automated production line challenges the operators' autonomy in their work. When all implicit elements in the operators' jobs become explicit, they could gain more control over their activities and become more accountable for their performance. Game elements can not only increase their feeling of autonomy and work engagement, but also facilitate a transition from a top-down organizational structure to a bottom-up structure. For factories like the one presented in this paper, it would increase their competitive advantage if a team of operators could run the factory by themselves. But first of all, the operators should get the mighty feeling of operating a huge factory and producing tons of steel with a small operating team. The game elements that are presented in this paper may be a small step towards this ideal experience.

3

Designing goals and rules to guide teamwork in theory

The previous chapter proposed that the gamification of teamwork is mainly a matter of using game elements to explicate implicit real world elements. This chapter explores what teamwork elements could be made explicit by combining organizational psychology and game studies literature. The resulting framework explains how goals and rules can evoke four basic interdependent experiences: dependent competition, dependent cooperation, independent competition, and independent cooperation. Goals define to what extent users are positively or negatively interdependent, leading to cooperation or competition respectively. Interaction rules define the extent that users can achieve the goals dependently or independently from each other. We explain how the framework can be used for analyzing teamwork as well as designing teamwork gamification.

This chapter is a slightly adapted version of: Vegt, N., Visch, V., de Ridder, H., & Vermeeren, A. (2014). Designing gamification to guide competitive and cooperative behavior in teamwork. In T. Reiners, & L. C. Wood, *Gamification in Education and Business* (pp. 513-533). Cham: Springer International Publishing AG.

3.1 Introduction

Imagine you are up to your neck in work when one of your colleagues comes in and asks you to join a meeting within two hours. The meeting is about a project proposal and project team formation for an important client and the problem the client wants to tackle is very interesting. You have to finish a report before the end of the day though. Still, you agree to attend the meeting but you don't want to waste your precious time just for the benefit of your colleagues. So you strive to get a personal gain from the meeting by aiming to become part of the project team. Most likely, others attend the meeting with the same intention. Resulting in a team meeting that aims to bundle forces and generate a collective and high quality project proposal but which is governed by individual concerns to become part of the project team, that might give rise to conflicts, resistance and sabotage.

The outcome of teamwork is almost never optimal due to conflicting concerns of individual team members. Factory workers, for example, don't want to get hurt. This individual concern contributes to the goal of the company to reduce the amount of accidents on the work floor. Over-cautious factory workers may, however, obstruct the productivity of the team by task avoidance or slow task completion. Differences in individual goals may block optimal collaboration and result in a sub-optimal collective outcome. Ideally, individual goals of team members are aligned in such a way that they effectively contribute to an optimal collective team outcome (Figure 3.1).

In practice, the outcomes of teamwork are generally sub-optimal due to conflicts, hidden agendas and group dynamics (Figure 3.2). Individual concerns may block the process towards achieving the optimal team outcome. These individual concerns and the resulting behavior tend to be implicit, resulting in a chaotic process and sub-optimal outcomes.

In order to deliver optimal outcomes the collaboration between team members needs to be improved, e.g., by structuring the collaborative process and aligning individual goals with collective goals (Figure 3.3). This may be achieved through gamification.

Gamification is generally defined as "the use of game design elements in non-game contexts" (Deterding, Dixon, Khaled, & Nacke, 2011). It has raised much interest in industry as a new way of making work more fun and motivating. Most gamification design and research is limited to increasing the motivation of users (Hamari J. , 2013). In business contexts however, it is equally important to investigate and design for the effectiveness of gamification in terms of employees'

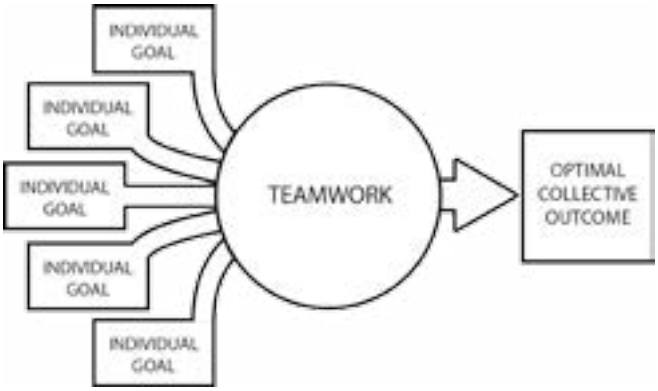


Figure 3.1. The ideal teamwork situation.

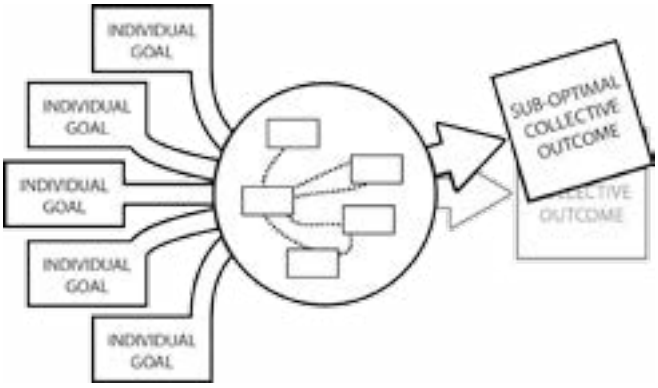


Figure 3.2. Teamwork situations in practice.

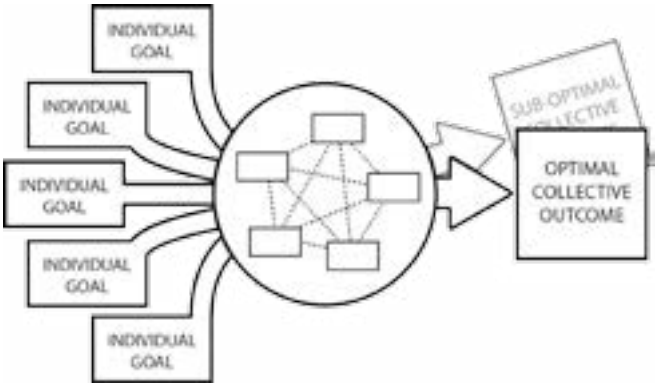


Figure 3.3. Structured teamwork situations

performance (Mollick & Rothbard, 2013). This may be learning, behavior change, or any outcome that is valued in the real world (such as project proposals as a result of business team meetings). In this chapter we present a framework for the gamification of teamwork.

Research on teamwork (cf. Salas et al., 2008) and research on games (Salen & Zimmerman, 2005) have been developed independently throughout history. It is only recently (Reeves & Read, 2009) that these two knowledge domains have been combined to theorize and design effective gamification of work situations. In order to understand and design the gamification of teamwork situations we need to decompose team processes into actionable elements, such as goals and tasks, as well as combine the theoretical knowledge from non-game teamwork and game design about these elements. In the next sections, a theoretical analysis of teamwork will be presented, before proceeding to the subject of how gamification can optimize teamwork. Throughout this chapter so-called Red teams will be used as an illustrative example, so these will be introduced first.

Red teams form an innovation in the process of developing project proposals at professional service firm Berenschot in the Netherlands. Red teams (originating from the military) are intended to boost creativity in writing a project proposal, and should result in a better proposal that increases the chances for receiving the project order. A Red team is assembled a few hours after a client request is received. The composition of the team is different every time since it depends on the availability of employees. In a meeting of one or two hours the team has to generate an advice for the content of the proposal. After which a writing-team that will further develop the proposal, is distilled from the Red team.

The Red team is a typical teamwork situation in which conflicts and individual concerns impede the optimal collective outcome. Before moving to the benefits of gamification for this problem, we will first analyze the teamwork situation in more detail in order to fit the right game design to it.

3.2 Goals, conflicts, and behavior in non-game teamwork

"*A team can be defined as (a) two or more individuals who (b) socially interact; (c) posses one or more common goals; (d) are brought together to perform organizationally relevant tasks; (e) exhibit interdependencies with respect to workflow, goals, and outcomes; (f) have different roles and responsibilities; and (g) are together embedded in an encompassing organization*" (Kozlowski & Ilgen, 2006). In many teamwork cases, like Red teams, it is mainly the first element of this definition that is formalized: a

meeting of more than one individual. Most other aspects are left to the collaboration skills of the team members. Factors that are known to influence team performance range from team composition, to work structure, and task characteristics (Salas, Cooke, & Rosen, 2008).

If a clear structure for teamwork processes is lacking, chaotic teamwork processes may result in sub-optimal outcomes. The design of a team (i.e. task structure, group composition, and group norms) should not be overlooked as it creates the conditions for effective team performance (Hackman, 1987). In short-term teamwork situations, like Red teams, it is mainly the task structure that affects team performance. Proper goal setting and good task design are important for effective teamwork and good team performance (Cohen & Bailey, 1997).

3.2.1 Goals and task design

Goals form an important part of a task design. Research shows that goals have been shown particularly important for motivation (Bandura, 1993). As a consequence the theory of goal setting is dominant in the field of organizational behavior, specifying the goal qualities and their effect on motivation. For instance, difficult and specific goals tend to lead to higher levels of performance than easy or vague goals (Mitchell & Daniels, 2003). Task performance is also affected by the type of goal orientation (i.e. learning-goals or performance-goals). When individuals or teams adopt a learning-goal they are concerned with mastering the task and this is found to increase performance when the task is complex. Adopting a performance-goal relates to the task outcome, regardless of mastery level, and increases performance if the task is simple (Winters & Latham, 1996).

Optimizing the goal qualities is, however, not enough to result in effective goal attainment behavior, since people need feedback to monitor the progress of their goal attainment (Mitchell & Daniels, 2003). Moreover, outcomes should be meaningful, visible, and have significant consequences for people that are not a member of the team (Hackman, 1987). Feedback is especially important for temporary teams, like Red teams, because there is not much time for group synergy to arise. For this reason detrimental processes should be avoided, like inappropriate weighting of individual contributions and focusing rewards and objectives on individual behavior (Hackman, 1987).

In relation to the overall task design an important distinction is to be made between assigned and self-initiated tasks. Although tasks may be well described in terms of stimuli, instructions about operations, and instructions about goals. The way people work might not directly be the result of prescribed tasks (Hackman,

1969). It is important to be aware that individuals may (and probably will) redefine a task, particularly in team processes. In fact, providing team members with substantial autonomy for deciding about how to do their work makes the team 'own' the task and responsible for the outcomes. This increases commitment and effort (Hackman, 1987).

To avoid individual goals obstructing the attainment of collective goals it is important to properly define the collective goals and tasks. In Red teams, for example, conflicting perspectives of individual team members easily result in lengthy discussions. However, if all team members are committed to the collective goal of coming up with good recommendations this should not be detrimental for the team's performance. If the conditions are right, team members themselves will come up with strategies to assure the team's performance. Theories on conflict management may provide insight into such strategies.

3.2.2 Conflict management

In organization psychology conflict is seen as one of the main drivers for team performance, making team management a delicate practice. Teams should be flexible, also in the use of performance strategies, and should be able to switch to new strategies if necessary. In many cases, however, teams have the tendency to decide on one way to approach a task early on in the process and stick to that approach. The chosen strategy becomes part of the fabric of the team and tends to prevail throughout the whole process (Hackman, 1987). Conflict stimulation can encourage the reconsideration of performance strategies. In order for conflicts to enhance rather than decline team performance several conditions need to be considered, including tension level, conflict orientation, and type of interdependence (Vliert van de & Dreu de, 1994). The tension level in conflict situations should be moderate because too much or too little cognitive-emotional strain is found to decrease performance and innovation (Dreu de, 2006). The orientation of the conflict should be task-based, instead of (personal) relationship-based, because only task-based or cognitive conflict is found to be beneficial for team performance (Jehn, 1995). Task performance and relationships are yet never fully separable in teamwork, making it important to guard for affective conflict. Conflict stimulation is only advisable if team members are positively interdependent in relation to the collective outcomes, as conflicts will take a destructive turn when one person's gain is the other's loss (Deutsch, 2006). This is not beneficial for team performance in the long run.

Conflicts can be handled either in cooperation or in competition, by pursuing either one's own and the other's goals, or one's own or the other's goals (Rahim, 2002). The respective values of cooperative styles and competitive styles of conflict management can be different for different situations. Cooperation is more appropriate for enhancing complex cognitive and behavioral changes (e.g. organizational learning), whereas competition is more appropriate for simpler changes where underlying policies, assumptions and goals don't need to be changed (Rahim, 2002). Ideally, team members use the right strategies at the right moment. In daily practice however, once a team has adopted a particular style, they tend to stick with it.

3.2.3 Compete or cooperate

Teams can be steered to work in a cooperative or competitive style. The need for choosing to compete or cooperate arises when people are interdependent in relation to their goals and tasks. Interdependence between two or more individuals occurs when a change in the state of one causes a change in the state of others. With shared goals, and collective recourses in teams, its members are by nature interdependent. In Red teams for example, team members depend on each other's expertise in generating good advice for a project proposal. Moreover, they depend on each other's time and motivation for composing a team that finishes the proposal.

In organization psychology several forms of interdependence have been identified. Its most prominent forms are task interdependence and outcome interdependence. Task interdependence is defined as the distribution of skills and resources within a team, and the processes by which members execute the work together (Wageman, 1995). This is the strongest type of interdependence, because highly interdependent tasks not only result in experiencing significantly more task interdependence, they also influence people's perception on outcome interdependence, independent of the actual outcome condition. Outcome interdependence relates to the way that goals are achieved and how performance is rewarded (Wageman, 1995). The manipulation of outcome interdependence has much less effect on the overall intensity of experienced interdependence. However, outcome conditions do affect the type of interdependence that team members perceive. The structure of goals that people have in a particular situation determines how they interact and this interaction determines the outcomes of the situation. If a furniture maker puts safety above productivity he will work slower to avoid injuries and therefore produce less chairs. However, if he also wants his chairs to be powder coated (which he can't do himself) and the powder coater has a tight schedule, he may speed up and set aside his safety concerns.

Goal structures specify the type of outcome interdependence among individuals (i.e. personal safety against staying on schedule) and this, in turn, determines how individuals must interact to achieve their goals. "If the amount of probability of a person's goal attainment is negatively correlated with the amount of probability of the other's goal attainment" (Deutsch, 2006) people are negatively interdependent and this leads to competitive behavior. The most basic type of a competitive goal structure is where one person's gain is the other's loss (in game theory this is called the zero-sum game). In such situations one is more likely to obstruct or block, rather than promote or facilitate the goal attainment of others (Johnson & Johnson, 2006). In contrast, during cooperative situations the correlation between the players' chances of goal attainment is positive and people will be more likely to promote or facilitate the goal attainment of others. Teams that work under the circumstances of positive outcome interdependence are "more open minded regarding others' arguments and desires, more concerned about each other's outcomes, and more inclined to search for solutions and compromises" (Bossche van den, Gijselaers, Segers, & Kirschner, 2006). So by formalizing the goal structure, the way that people collaborate in teams can be influenced in order to achieve a more optimal collective outcome (Figure 3.3).

By designing the rules for goal attainment teamwork can be structured towards competition or cooperation. Positive outcome interdependence induces cooperative behavior and negative outcome interdependence induces competitive behavior. By defining the task characteristics (e.g. sharing a space, distributing information, or influencing each other's movements), task interdependence can be influenced and thereby the intensity of the teamwork.

Gamification is particularly useful for enhancing teamwork. Firstly, because it can structure the process with explicit goals and guide players with game rules towards competitive or cooperative behavior. Secondly, it addresses other factors for good team performance, such as feedback and meaningful outcomes. Thirdly, the preconditions for positive conflict stimulation (i.e. moderate tension level, task-based conflict, and positive outcome interdependence) are addressed in a game design process by nature, cf. the explanation on games as systems of conflict by Salen and Zimmerman (2004).

3.3 Gamification and the Persuasive Game Design model

3.3.1 Gamification

In the literature there is not much agreement on the definition of games and gamification. Currently, at least two definitions of gamification exist. Deterding et al (2011) define gamification as "the use of game design elements in non-game contexts". This definition assumes a designer's perspective in which game design elements are the building blocks for a 'gameful' experience. The affordance of a 'gameful' experience is mentioned as the factor that distinguishes game design elements from other design elements. Huotari & Hamari (2012), define gamification from a user's perspective and elaborate on this latter aspect by interpreting gamification as "a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation".

The relation between the designer and user perspective can be explained through the MDA framework (Hunicke, LeBlanc, & Zubek, 2004), one of the most used frameworks in game design. In this framework three levels of game design elements are defined: mechanics, dynamics, and aesthetics. From the designer's perspective the game mechanics (like points, controls, and levels) are used to achieve a particular aesthetic (like challenge or fellowship). The user will first experience the aesthetics and then start to unravel the mechanics through the dynamics (like time pressure and sharing information). As a gamification designer, it is not only important to have game mechanics at one's disposal, but also to empathize with the user (Nicholson, 2012) and have a feeling for the gameful experience that one is designing (Winn, 2009).

Gamefulness was first mentioned by McGonical (2011) to relate to rule-based play ("ludus") as opposed to free-form play ("paidia") (Caillois, 1961) and playfulness. Role-playing is an example of free-form play. One adopts a role and the story emerges without any explicit rules defining it. Role-play is often used in business training. Learning goals are often achieved by playfulness since one can

Figure 3.4. The use of gameful experiences.

freely explore the possibilities the training offers. Most sports however, are forms of rule-based play where conditions for winning or losing are defined and these are considered to be gameful. In business contexts 'playful' behavior is often less desirable, as its outcome is unknown. 'Gameful' behavior however, can be directed towards a particular outcome by defining goals and rules, and might therefore be useful for teamwork in business contexts (Figure 3.4).

3.3.2 The persuasive game design model

To better understand gamification and gameful experiences we developed the persuasive game design model (Visch, Vegt, Anderiesen, & van der Kooij, 2013). In this model (see Figure 3.5) we combine the designer's perspective and the user's perspective, by placing the designer as the facilitator of the user experience. In our view, it is the user that makes the game by experiencing and interacting with it.

However, it is the designer that designs the gamification by applying game-elements "on real-world attributes to create a user experienced game-world". Crucially, this game world experience is strongly motivating for the user since it provides enjoyment, engagement by direct feedback and freedom by reduced real-world consequences.

The extent to which a user is drawn into a game world experience depends on the context, behavior and the user characteristics. A holiday can be expected to be more related to a game world experience than a business meeting is. But what if the

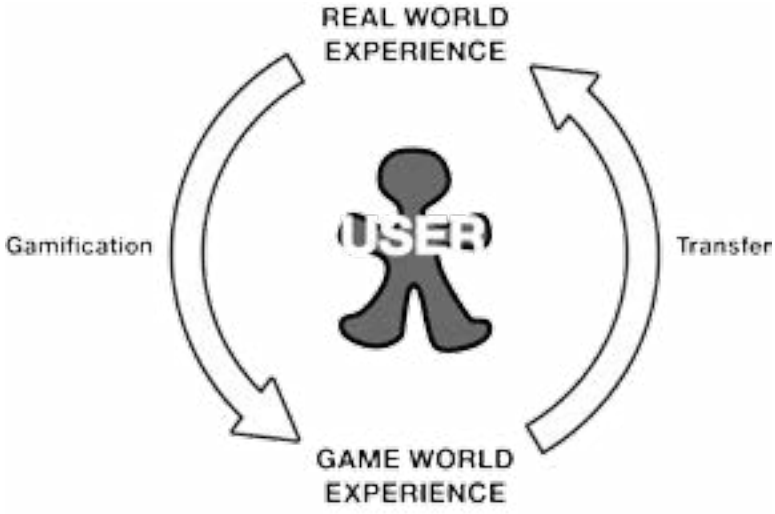


Figure 3.5. Persuasive Game Design Model (Visch, Vegt, Anderiesen, & van der Kooij, 2013).

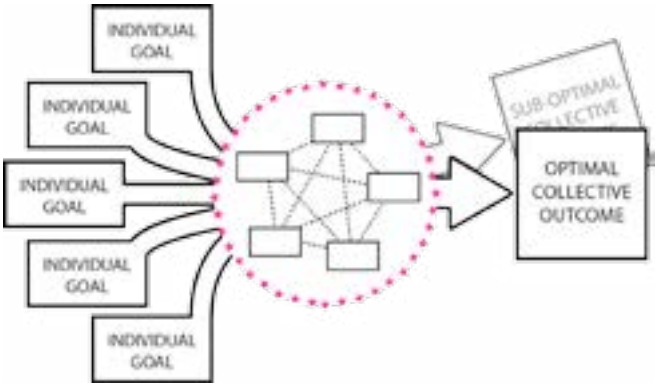


Figure 3.6. Gamified teamwork situations.

business meeting takes place in Hawaii and the holiday consists of voluntary work at a primary school in Bangladesh? Near to completely loosing a game might make people want to retract from the game world, while winning games might people want to stay in the game world. Moreover, parents playing games with their children will try to maintain their child in the game world by not letting him/her loose directly at the expense of not being fully engaged in the game world as a parent.

In persuasive game design, gamification is not only aimed to solely transport the user to a game world experience but also to realize real world outcomes or transfer effects: the effect of a user experienced game world on forming, altering, or reinforcing user-compliance, -behavior, or –attitude, in the real world (Visch *et al*, 2013).

In teamwork situations the real world goal is to improve collaboration. By implementing game design elements the participants are directed towards a more 'gameful' experience, which leads to a game world experience with increased enjoyment, freedom, and engagement. When drawn into the game world users can be directed towards cooperative or competitive behavior by defining game goals and game rules (Figure 3.6). In the Red team meetings, explicitly stating good advice as a game goal may enhance the motivation and commitment of the participants and thereby improve the collaboration towards a good project proposal.

3.4 Game design elements: rules & goals

Game elements are the motivational building blocks for a game world experience. They may consist of rewards, challenges, phantasy world, etc. However, the game rules and goals might be the most basic and prominent elements to design a game. Rules and goals structure the player's behavior in the game and are therefore at the hearth of the "procedural rhetoric" (Bogost, 2007) of games. The behaviors

Figure 3.7. The game mechanics of multiplayer Breakout.

of players define a game, not textual instruction or visual representation. Within a game the rules define this behavior, even if they are implicit.

To investigate the effect of rules on player behavior we conducted an experiment for which we designed two types of a multiplayer Breakout (or Arcanoid) game. The aim was to find out whether competitive or cooperative behavior could be evoked in participants by having different game rules in the two versions of the game. Participants were not informed about the rules or about them being different. To empirically test the effect of implicit rules all other game elements were kept the same. This resulted in a competition and collaboration game where the task, controls, and visuals were identical. Only the rule for goal attainment (i.e. scoring points) was different. In the cooperative game the players had to hit the ball alternately in order to score points. In the competitive game the player that hit the ball would score points (Figure 3.7). No instructions on these rules were given so this was only made explicit through the mechanics in the game.

Figure 3.8 shows a graph of a three-minute gameplay session where two players (top line, bottom line) initially play the game in a competitive way (indicated by the fact that the lines are close to each other: paddles try to obstruct each other). The rules of this version of the game, however, were meant to induce cooperative behavior. After approximately one minute the players understand the rules and start to play the game cooperatively (i.e., they wait for their turn in hitting the ball). The initial competitive behavior is explained by the fact that they have played a game with competitive rules before this session. In Figure 3.9 the reverse is happening.

We found that changing the implicit rules of the game had a significant effect on the players' experiences (measured by asking them about experiences such as the extent to which they felt helped or obstructed) and behavioral patterns (see Figure 3.8 & 3.9). Interestingly the players' skills, knowledge, and attitudes did not seem to affect the results. The fact that they were engaged in a game made them search for

Figure 3.8. Player behavior in multiplayer Breakout shifting from competition to cooperation.

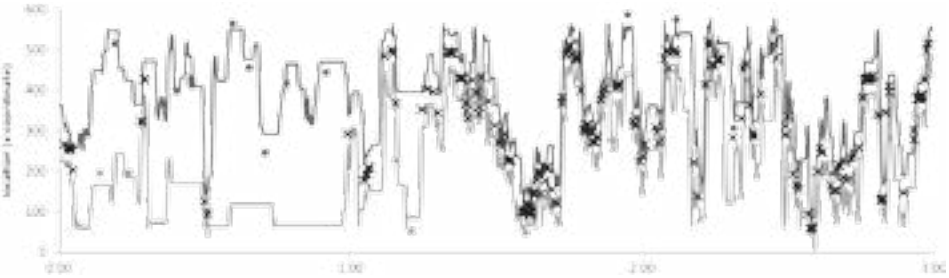


Figure 3.9. Player behavior in multiplayer Breakout shifting from cooperation to competition.

the rules behind the game and eventually behave in compliance with these rules.

Our data showed that players can be expected to search for the goals and rules of a game by just playing it and may be able to infer the correct goals and rules from that. We presume that this knowledge on the use of implicit rules is directly transferable to the gamification of teamwork situations in organizations. Instruction is one way to convey goals and rules, but when people are engaged in a gameful experience they will expect goals and rules and will go searching for them. The experiment showed the powerful effect of game rules on player behavior since even by hiding them in game mechanics they are strong enough to direct the user's behavior to either competition of cooperation. Moreover, the experiment showed us which player behavior might be typical for competition and cooperation.

3.5 A framework for teamwork gamification

In this section we present a framework, to assist in the analysis and gamification design of teamwork situations (Figure 3.11). The framework is based on making a rough distinction between four types of experiences in teamwork situations (Figure 3.10): cooperation (dependent & independent) and competition (dependent & independent).

The acrobats in Figure 3.10 illustrate dependent cooperation. They heavily rely

Figure 3.10. Examples of the four types of user experience in teamwork situations.

on each other (i.e. dependent) in building a human tower and the only way to achieve their collective goal is by working together (i.e. positive outcome interdependence leading to cooperation). The rugby players illustrate dependent competition. In this team competition game the outcome interdependence between the teams is negative. Moreover, players of each team can directly promote or obstruct each other in possessing the ball by passing it through or stealing it. In the example of darts (i.e. independent competition), the players interact independently since they compete for the highest score independently of the other player. The competition is in the point system rather than in the activity itself. This is also the case in the Olympic medal table. Individual athletes contribute to the overall amount of medals won by their country, but they cannot directly help each other in achieving this medal. So this is an example of independent cooperation.

For analyzing teamwork the framework (Figure 3.11) can be read from left to right, first focusing on an analysis of the interdependency of goals as well as of interactions and gradually deducing from that an expectation about the user experience outcome. In case the framework is used as a starting point for gamification design the first step is to set a user experience to aim for (represented by the slider on the left). E.g., should it be a dependent competitive experience, like the rugby players in Figure 3.10? Or should it rather be an independent cooperative experience, like athletes contributing to the medal ranking of their country? Having decided on the

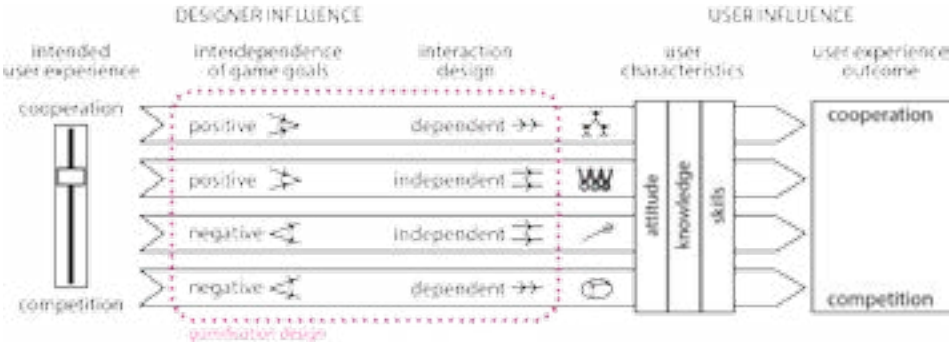


Figure 3.11. Framework for the gamification of teamwork situations.

intended user experience, the framework explains how to deal with interdependency of goals and interactions for achieving that user experience. The characteristics of the user influence the eventual user experience outcome by the way they choose to behave. In the next section the framework and how this can be used is explained in more detail.

3.5.1 Game goals

As explained earlier, it is the correlation between user's goal attainment that directs users towards competitive or cooperative behavior. In most ball games, for example, this correlation is negative as there is just one ball available. If one team possesses the ball the other doesn't. This results in negative correlation of attaining the goal of ball possession and therefore in a competitive game. Whether players want to posses the ball themselves or keep ball possession in the team doesn't make a difference in the overall competitive nature of the game. However, in team sports it is in general not beneficial when the goal of ball possession is not only a team goal but also an individual goal, since such individual concerns might weaken the collective goal attainment of the team.

Cooperation within teams is therefore important: teammates should focus on positively correlated goals, like keeping the ball within the team, or in the case of the acrobats by behaving according to team rules. If several acrobats would be determined to be on top of the human tower, they will never achieve building a proper tower and the individual acrobats will probably also not achieve their individual competitive goal. In certain specific situations, however, the collective goal of the team might actually benefit from competing goals of individuals within the team. This could, for example, be the case when one player is much more skilled or knowledgeable than the other.

The motivational strength of games is that players can determine their own goals in a restricted but complex game system (Salen & Zimmerman, 2004). In order to keep the game motivating it is important to preserve this feature within the design of gamification. This means that a gamified situation should always provide a choice between different goals for each player. Our framework can provide the guidelines for a proper set of game goals, resulting in the intended type of competition or cooperation. The drawback is that users might choose to focus on goals that are not most beneficial for team performance. A team leader or game manager could control this on the fly.

3.5.2 Interaction design

When the goal is set; the player can decide to obstruct or promote the other's goal attainment. However, this decision is not only influenced by the structure of the goal but also by the provided interaction possibilities. The gamification designer can steer and guide the user experience by defining the interaction possibilities, for example by the distribution of resources or by specifying rules that structure and define the degrees of freedom that users have. This determines the boundaries within which the players can achieve their individual or collective goals and to what extent they depend on the actions of other players.

Research on the effect of certain interaction possibilities within computer games shows a significant effect in the game experience. One study showed that playing against a human-controlled opponent intensified the game experience as opposed to playing against a computer-controlled opponent (Weibel, Wissmath, Habegger, Steiner, & Groner, 2007). However, for certain types of social interaction, playing against a human- or computer-controlled opponent doesn't matter for the intensity of the game experience. In a study on social exclusion in computer games, players had a negative experience while playing with a human as well as computer opponent (Zadro, Williams, & Richardson, 2004). A study on the distribution of players over different locations showed that players that are in the same room experience more fun and challenge (Kort de, Ijsselsteijn, & Poels, 2007). And the effect appeared to be even stronger when players are more familiar with each other (Gajadhar, de Kort, & Ijselsteijn, 2008). The distribution of interaction possibilities doesn't seem to have such a linear effect. Increasing the distribution of controls on moving, shooting, and switching color resulted in an increase of the level of experienced sociality and a reduction of the level of experienced control. Partly distributing the controls (e.g. just distributing the color switching) resulted in the most intense game experience (Rozendaal, Braat, & Wensveen, 2010).

Often games do not limit themselves to one type of user experience or interaction design. For instance, TeamUp is a good example of a computer game where task interdependence gradually increases and thereby the intensity of the cooperative experience (Mayer, van Dierendonck, van Ruijven, & Wenzler, 2014). TeamUp is a teamwork training game, originally developed by the Delft University of Technology in cooperation with Accenture, and now further developed by The Barn (2009). In this game, teams get gradually introduced with the interaction possibilities that increase the interdependence among the players.

The game starts with sharing the same (virtual) space. With each level a new game mechanic is introduced that makes players more dependent to each other's performance. Buttons that are scattered over the area generate a distribution of resources and force team members to coordinate their actions and assign roles. Leadership is enforced by unequal distribution of information such as providing one player with more overview than the other. Combinations of a particular distribution of tasks and resources result in complex and challenging puzzles for the players. Within each puzzle players are always positively interdependent in relation to the outcome, so the core of the game has a purely cooperative character. But team performance is eventually ranked in relation to the performance of other teams. This independent competitive experience may motivate teams to perform even better.

Figure 3.12. TeamUp (The Barn, 2009).

3.5.3 User characteristics and user experience

Designing for a particular user experience always ends up with a fuzzy result, as you never know exactly how particular users react to the game elements that you have designed. Designers can only afford a certain experience, which means that it is more likely that users will feel how they are intended to feel. So by defining the rules for goal attainment in such a way that players are negatively interdependent, it is more likely that they will get in a competitive mood and consider other players to be opponents.

For game designers it is important to take into account the players' previous knowledge, skills, and attitude (Winn, 2009). Specific game design elements affect each player differently since the players possess different knowledge and skills. Such differences can be leveled through handicapping or providing practice before actually starting the game. The attitude of players is hard to influence, some players are just more competitive or cooperative then others.

3.5.4 Applying the framework

Our gamification framework can be used to analyze or design for teamwork situations. The goal of the framework is to predict whether the user experience is (or will be) competitive or cooperative, and to what extent. One should analyze each possible goal that a player can focus on separately and determine its resulting user experience. This kind of approach is also mentioned in literature on games (Schell, 2008), such as "skill atoms as a design lens", where games are segmented in small steps of a goal, an activity, and feedback, resulting in learning a new skill (Deterding, 2013). We propose to segment gamified teamwork situations into goal atoms, where the correlation between the players' goal attainment is dichotomous; being either positive or negative. Moreover, one should be either dependent or independent from others in attaining the goal. In this way the framework can be used to analyze and understand existing business games aiming at teamwork collaboration such as the leadership game of RANJ.

3.6 Illustrative design cases

3.6.1 Leadership game RANJ

In the Leadership game, developed by RANJ serious games, a variety of goals can be identified. The game is a one-week simulation to train leadership. Teams compete

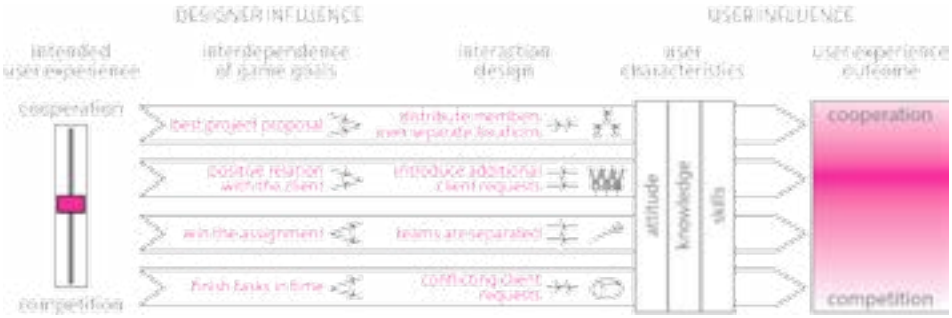


Figure 3.13. Goals and interaction design elements from the leadership game.

to come up with the best project proposal. Only one team can win this challenge in the end while during the week the teams are not depending on each other. So the teams are negatively interdependent between each other in terms of winning the assignment that may lead to an independent competitive experience. The interaction within the teams is more diverse though, since each team is divided over two locations, making the team members more dependent on each other's actions. They are positively interdependent in relation to achieving the best project proposal.

The overall game structure provides independent competition, independent cooperation, and dependent cooperation, resulting in an overall game experience that inclines towards cooperation (Figure 3.13). During the week the teams also receive several sub-tasks. Puppet masters can regulate the challenges for a team by introducing additional tasks, distributing information, introducing conflicting interests, or rescheduling deadlines. Increasing time pressure and creating a task- or information-overload increases the stress level and therefore the need to cooperate, by distributing tasks among team members. The distribution of information and introduction of conflicting interests can direct and enhance outcome interdependence. Teammates might actually become negatively interdependent and therefore be put in a competitive situation within the teamwork. So these sub-tasks can direct the overall teamwork experience towards the competitive or cooperative side.

In general it can be seen that distribution of resources, time constraints and distribution over space are important factors that influence the user experience outcome. It affects the level of challenge and also the way that people play and experience the game (i.e. competitive or cooperative).

3.6.2 Red team game

Returning to our initial case of the Red Team, our framework can be used to analyze the current situation and design gamification interventions to direct the teamwork process. For instance, by designing a Red team game in which all types of competition and cooperation are included, from which a facilitator may employ the appropriate game design elements for a specific situation. Or the whole team may negotiate on the use of particular game elements. Another way to gamify Red team meetings would be to analyze the meetings as how they are now and add the proper game design elements that direct the overall experience towards cooperation or competition. If for example a team needs to brainstorm in order to generate ideas, an independent competitive experience may be introduced. Each individual participant would get the goal to come up with more ideas than the other participants without interacting with them during the process. This most likely improves the quantity of ideas, however not necessarily the variation. In order to achieve a good variety of ideas the participants should become more dependent, by for example coming up with ideas in rounds where authenticity is a criterion for getting it counted to your personal score.

3.7 Future research on transfer effects

3.7.1 Direct effects

Although game design and gamification literature increased over the past decade, to our knowledge there is only scarce and recent literature on the effectiveness of game design elements in a work environment. Hamari (2013) studied the effect of badges on usage activity and Mollick (2013) studied the effect of leaderboards on positive affect and performance at work. Interestingly both studies come to a similar conclusion: gamification doesn't automatically lead to more engagement and enjoyment, and consequently not to increased performance. In the study with badges it was shown that "interest" in the game elements mediates their effect on engagement. And in the leaderboard study it was found that "consent to the game" plays an important role in increasing or decreasing positive affect and performance at work. In our framework this is covered by the user characteristics, and it is worth investigating to what extent these different characteristics influence the user experience and its effect on real world outcomes, like team performance.

Aside from investigating transfer effects of gamification, the knowledge on the contextual real-world preconditions influencing the game world experience

and behavior could be investigated. Such knowledge would improve the reliability of the aimed transfer effects. For instance, it seems that equality is an important precondition for competition to motivate for better performance. It is said that Usain Bolt would have achieved a better 100m world record (estimated at 9s55) at the Olympics of 2008, had he not started to celebrate his win after 60 meters. In other words, the competitive aspect reduced his performance because there were no equal competitors. The eventual world record (9s58) did originate from competition with opponents that kept up during the race. Are there more preconditions for competitive and cooperative experience to have an effect on performance? And can designers influence them? Equality for example can be accounted for by selection procedures, or handicapping. We do, however, need to know possible drawbacks of handicapping. It might level the goal attainment between the players but it might also demotivate the players socially and individually to play the game.

3.7.2 Transfer effects

Games, just as any other type of media, are found to have a transfer effect in the real world. But how specific elements contribute to emotional, cognitive, or behavioral transfer is not well known. For instance, violent game content has been said to cause for violent behavior in the real world, but recent investigations indicate that other game elements have a greater impact on real world behavior. It seems that competition, not violence, is the video game characteristic that has the greatest influence on aggressive behavior. There is at least a short-term effect, most likely due to the increased physiological arousal that was measured in competitive games (Adachi & Willoughby, 2011).

Following this study, the effect of playing violent video games cooperatively or competitively on subsequent cooperative behavior was investigated. The conclusion of this study was that cooperative gameplay (as opposed to competitive gameplay) induced significantly more cooperative behavior in a non-game situation (Edwoldsen, Eno, Okdie, Velez, Guadagno, & DeCoster, 2012). A study about the connection between competitive game play and aggressive cognition showed that cooperative play modes prompt less aggressive cognition (Schmierbach, 2010). Moreover, in a study on altruistic behavior, test subjects were given Superman-like flight in a virtual reality simulator. This increased participant's helping behavior, which suggests that "heroic behavior in a virtual environment can transfer to altruistic behavior in the real world" (Carey, 2013).

So behavior in experienced game worlds affects behavior in the real world and this is as well likely to be the case within the context of team meetings. If

we implement a competitive game design element in the Red team meetings, for example, employees might become more competitive within the organization in general. Investigation of such long-term transfer effects is not only interesting but also needed from an ethical perspective.

3.8 Conclusion

By designing gamification for teamwork we can structure how teams work together and improve collaboration within the team. Game design elements are used to transport users towards a game world experience, and within this game world we steer them towards competitive or cooperative behavior. By addressing factors that affect team performance in non-game contexts we can actually improve the real world collaboration and thereby achieve more optimal team outcomes.

Our study on the use of implicit rules in a multiplayer Breakout game showed that implicit rules influence users in behaving cooperatively or competitively. Based on these results and on insights from organizational psychology, we developed a gamification framework for teamwork in order to analyze and design gamified teamwork situations. We are confident that this is a fruitful starting point for further research and design projects, as illustrated by the leadership game from RANJ and the Red team case at Berenschot that is in fact closer to gamification.

4

Designing game rules to change interdependent behavior in a multiplayer game

In the previous chapter, we explained how goal-driven and interaction rules can steer experienced interdependence and teamwork strategies in theory. This chapter presents the results of a game design experiment aimed at generating knowledge on designing game goals and rules for interdependent behavior. We developed two versions of multiplayer Breakout, varying in rule-sets, designed to elicit player strategies of either dependent competition or dependent cooperation. The results demonstrate that the two rule-sets could generate distinct reported player experiences and observable distinct player behaviors that could be further discriminated into four social behavioral patterns: helping, ignoring, agreeing, and obstructing. Classic game theory was applied to understand the four behavior patterns and made us conclude that goal-driven rules steered players towards competition and cooperation. Interaction rules, in contrast, mainly stimulated dependent competitive behavior, e.g. obstructing each other. Since different types of rules thus led to different player behavior, discriminating between goal-driven and interaction rules in game design seems relevant. Moreover, the study shows that game theory proved to be useful for understanding goal-driven rules.

This chapter is a slightly adapted version of: Vegt, N.; Visch, V.; Vermeeren, A.; de Ridder, H. (2016) Player experiences and behaviors in a multiplayer game: Designing game rules to change interdependent behavior. *International Journal of Serious Games*, *3*(4), pp 69-85.

4.1 Introduction

Teamwork in business organizations (such as a meeting) benefits from individually motivated members and flexible collaborative strategies. Teamwork strategies need to be flexible because teams can change over time in type of task, composition, hierarchy, etc. (Salas, Cooke, & Rosen, 2008). Yet teams often tend to choose for one approach and not adapt their strategy to the situation or task at hand (Hackman, 1987).

In the last two decades various serious games have been developed to improve teamwork and to align individual and collective goals, c.f. (Stoppelenburg, de Caluwe, & Geurts, 2012). Examples of serious games for organizational teamwork range from serious gamification of bricks (e.g. Serious Play by Lego (Kristiansen & Rasmussen, 2014)) to collective play in 3D environments (Bozanta, Kutlu, Nowlan, & Shirmohammadi, 2012; Wendel, Gutjahr, Göbel, & Steinmetz, 2013). However, although various serious games are developed for this organizational application domain and they seem to be valuable for the market, very little is known about the effects of separate game elements constituting the serious games (Deterding, Dixon, Khaled, & Nacke, 2011; Hamari, Koivisto, & Sarsa, 2014). For instance we do know that serious games can enhance collaboration but do not know why (Mayer, Bueren, van, Bots, & Voort, van der, 2005; Apostolakis, et al., 2016). Nor do we know which game-element within a serious game is responsible for targeted player behavior and player experience - most serious games are still developed as black boxes. In the present work, we aim to provide fundamental ground to the player effect of distinct game elements. This knowledge can in our view be applied to understand found effects of existing games. The knowledge might as well be of value in developing precisely targeted serious games.

To start with, in chapter 3 we explored theories in organizational psychology that overlap with game design theory. Like in organizational psychology, game design theorists agree that goals and rules steer the behavior of players. Rules are seen as fundamental building blocks of games (Avedon, 1971; Bogost, 2007; Juul, 2005; McGonigal, 2011). According to Caillois (1961), play in games is governed by rules and simultaneously serves the need for relaxation and purposeful use of one's knowledge and skills. Game designers can direct the behavior of players by defining the purpose of a game and the procedures and rules that govern the activities to reach it. However, still there is little empirical knowledge on what rules affect what player behavior.

For the present research, the aimed-for effect of serious games (i.e. transfer

effect) is team performance. More specifically, the present experiment investigates how player behavior that relates to team performance can be affected by game rules. According to organizational psychology, conflict is one of its main drivers. Most games involve conflict by nature, either among players or between players and the system (Salen & Zimmerman, 2004). Hence conflict management theory could provide a useful perspective for the analysis and design of multiplayer games. Under specific conditions (Dreu de, 2006), conflict can be used to force teams to rethink their approach and switch towards more favorable strategies. The conflict management model describes possible strategies for dealing with conflict. Depending on the situation, teams can adopt bargaining or problem solving strategies, such as competing, collaborating, or compromising (Rahim, 2002). Such strategies are also frequently seen in games. According to social interdependence theory, competition or cooperation arises when people experience interdependence in relation to their goals or tasks (Wageman, 1995). People experience interdependence when a change in the state of one causes a change in the state of other(s) (Johnson & Johnson, 2006). Thus, to design strong teamwork experiences in games, we need to look for game elements that increase the feeling of interdependence and direct teams towards bargaining or problem solving strategies.

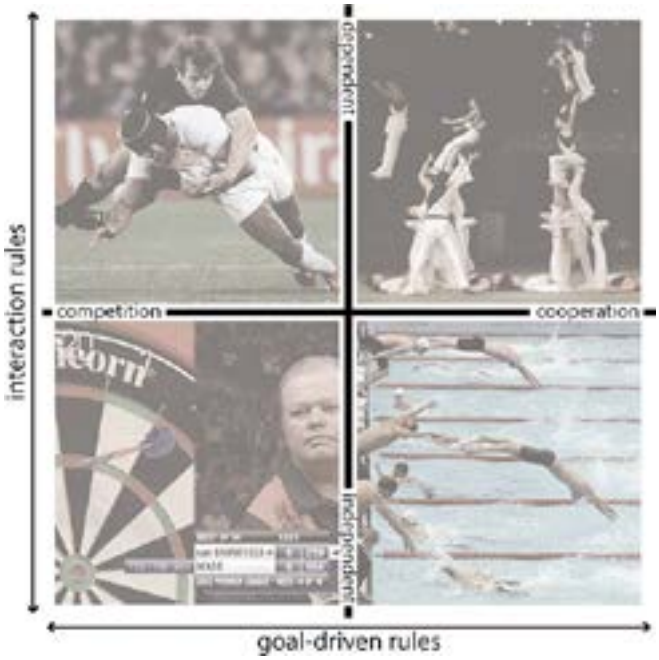


Figure 4.1. Evoking interdependent behaviors/experiences with goal-driven- and interaction rules (improved version of figure 3.10).

Our framework for the gamification of teamwork situations describes how goals and rules can steer interdependent behaviors and experiences of users, depending on their skills, knowledge, and attitude (Vegt, Visch, de Ridder, & Vermeeren, 2014). It defines four types of interdependent game behaviors: dependent competition, independent competition, dependent cooperation, and independent cooperation (see Figure 4.1). Interaction rules define the interdependence between players. For example, in relay swimming or a darts game, the players take turns. They independently cooperate to swim fastest or independently compete for the highest amount of points. In other cases players directly interact with each other, such as in a rugby game or a group of acrobats. Goal-driven rules govern the actions to reach a goal. They can persuade players to compete or cooperate (Deutsch, 2006). For example, in tennis, players gain a point if the other player hits the ball outside the court. The opposite would be to assign points to both players for keeping the ball in the court. The game may become rather boring, but the players will probably cooperate and play the ball such that the other player can hit it back. Think of 'camping badminton'.

Rules in games often relate to objects like coins or an hourglass. Thus embodying rules into game objects is what game design is often about. For example, by drawing lines game designers define the rules for the space of a rugby game. Yet players experience game rules differently. They generally perceive embodied rules, such as the lines of a rugby pitch or the placement of the goals, as game objects rather than rules. From a player perspective, rules are negotiable, "was the tackle allowed or not?" However, from the designer perspective, we are mostly interested in embodied rules, as they can be designed to steer the player behavior and experience. In computer games in particular, most rules are embedded into objects (Järvinen, 2008). Negotiable rules may exist or arise, but generally a computer game consists of a fixed set of elements that players can play with. The rules are defined as algorithms or procedures in the game. Hence when we play computer games "we explore the possibility space its rules afford by manipulating the game's controls" (Bogost, 2007). Based on the given procedures in a computer game, players can decide on their strategy for reaching their goal (e.g. scoring more points than the opponent or reaching an end condition).

This paper investigates in a multiplayer computer game if and to what extent two fundamental types of game rules, i.e. goal-driven- and interaction rules, lead to specific interdependent player behavior and experiences.

4.2 Designing embodied rules for a multiplayer game

To investigate the effect of interaction and goal-driven rules, we developed multiplayer Breakout (see Figure 4.2). The above-described framework was used to design two variants. The interaction and goal-driven rules were defined such that one variant would stimulate dependent competition and the other variant dependent cooperation. More precisely, interaction rules were kept the same to generate a strong feeling of interdependence in both games, and goal-driven rules had to direct the players towards competition or cooperation.

Multiplayer Breakout is a simple computer game, in which two players move paddles within a confined space and cannot pass each other (nr. 1 in Figure 4.2). The players score points by breaking bricks (2) with a bouncing ball (3). The goal of the game is to achieve an as high as possible individual score (4) within a certain amount of time (5). A study on the motivational effect of the game elements of single player Breakout (Malone, 1981) demonstrated that, compared to the score and the bouncing ball, players mostly enjoyed to see the bricks break. Even though, compared to the game elements used in that study a paddle is added in multiplayer Breakout, we assumed that breaking bricks is still engaging and that the game motivates players to score as many points as possible.

The game starts with a white ball in the middle of the area and 22 bricks at the top. After a countdown, the ball starts moving and bouncing on the objects in a straight angle. Meanwhile, the players can steer their paddles on the bottom of the screen using the arrow keys on a keyboard. By catching the ball on a particular location of the paddle, players can steer the bouncing angle of the ball and thereby

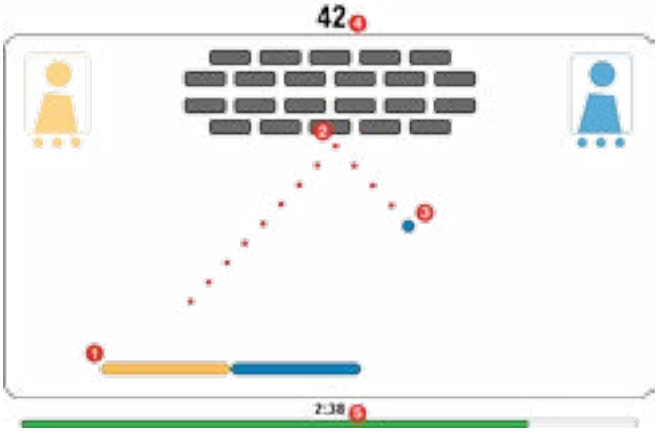


Figure 4.2. Game elements in multiplayer Breakout: 1) paddles, 2) bricks, 3) ball, 4) score, 5) time.

hit the ball into a certain direction. When the ball is not white (i.e. has the color of one of the paddles), it will break the bricks when it hits them. For each broken brick one or both players receive points, depending on the goal-driven rule. Many bricks can be broken in one go when the ball bounces back and forth from one brick to the other. When all bricks are broken, a new level will start in which the speed of the ball increases and a new set of bricks is laid out. The ball can get lost at the bottom of the game area if the paddles do not catch it. Consequently, one or both players will loose a point, unless their score is zero. Every time a ball gets lost, a new white ball will pop up in the middle of the screen. In the original game, players are 'game over' when they have lost 3 balls. Yet in this case, each session takes 3 minutes.

The players only get to see their own score. In order to strengthen the players' focus on their individual score, a high-score list is displayed after each round. It shows one's own scores of all previous rounds and the score from the last round is highlighted. To evoke a strong feeling of interdependence, the paddles cannot cross each other. In a draft version of the game, the paddles were placed on opposite sides of the screen. Yet this resulted in a more independent type of interaction. Moreover, opposition induced a competitive experience, rather than a cooperative experience. In the final version, the interaction rules are defined such that the strength of bouncing each other away depends on the speed of the paddles. Players can take a leap in order to increase speed and thereby make a stronger impact on the other paddle.

The way in which the color of the ball changes embodies the goal-driven rules that should evoke competitive and cooperative behavior. To achieve dependent competition, the players are meant to battle for hitting the ball. The ball therefore adopts the color of the paddle that has hit it. Correspondingly, the player that has hit the ball will score points when bricks are broken and loose points if the ball gets lost. In the cooperative variant, the players are meant to alternately hit the ball. In order to achieve this, the color of the ball indicates the paddle that should hit it. If the yellow paddle hits the ball, it will turn blue (as shown in Figure 4.2) and vice versa. If the color of the ball matches the color of the paddle that hits it, the ball will switch color. Otherwise the ball turns white and cannot break bricks. When bricks are broken, both players receive points. If the ball gets lost, both players loose a point.

Consequently, if players are motivated by achieving an as high as possible individual score, the embodied goal-driven rules should direct them towards battling for the ball in the competitive game, and alternating in hitting the ball in the cooperative game. The players should experience competitive behavior as dependent competition and cooperative behavior as dependent cooperation.

4.3 Experimental design

We set up a within-subject experimental study to test to what extent the two game variants would actually lead to dependent competition and dependent cooperation. As explained above, the only difference between the variants were the goal-driven rules, embodied in the way the color of the ball changes. The interaction rules were kept the same. We wanted to measure how the goal-driven rules affected the behavior of players and the way they experienced the game in terms of interdependence, competition, and cooperation.

To capture experiential as well as behavioral effects, a mixed-methods approach was used in which quantitative and qualitative data are integrated (Tashakkori & Teddlie, 2010). In game analytic research, it is common to use an explanatory design, in which quantitative analysis is followed by qualitative analysis (El-Nasr, Drachen, & Canossa, Game Analytics: Maximizing the Value of Player Data, 2013). Yet from a designer perspective, player experiences generally serve as the starting point. Hence, we adopted an exploratory design (Creswell & Plano Clark, 2007), in which we first analyzed qualitative user experiences building to a quantitative behavioral data analysis.

4.3.1 Measures

In order to measure experienced dependent competition and experienced dependent cooperation, the players reported their experiences on interdependence, competition and cooperation by filling in a questionnaire after each game round. The questionnaire was partly derived from the Social Presence in Gaming Questionnaire (Kort de, Ijsselsteijn, & Poels, 2007). In order to not influence the behavior of the players in successive game rounds, competition and cooperation were phrased as obstructing and helping, based on (Deutsch, 2006). Players rated statements about interdependence, obstructing, and helping in two directions (e.g. "I depended on the other" and "the other depended on me"; scale 1-5). Moreover, players had to rate their own and the other's performance, own satisfaction with the performance, and enjoyment during gameplay. At the end of the session, the players had to rate the games on competition and cooperation, on a scale from purely competitive (1) to purely cooperative (10). In a short structured interview, they were asked about the goals and rules they had focused on. We wanted to know if they had understood the game and what elements motivated them most, to determine what elements had mainly driven their behavior and experience.

For measuring behavioral dependent competition and dependent cooperation,

Figure 4.3. Pairs of players behind a PC in separate rooms.

Figure 4.4. Screenshot of the actual game.

real-time gameplay data and screen capturing captured the player behavior. Initially, it was unknown what behavioral data in the game would be most relevant for measuring interdependence and distinguishing competition from cooperation. Therefore, all gameplay data was stored that could possibly distinguish behavior patterns: location of the paddles, score progression, paddle collisions, and ball hits with coordinates. All game rounds were screen captured to determine behavioral variables that could distinguish interdependence, competition, and cooperation through observation afterwards.

4.3.2 Participants

Game sessions were conducted involving one pair of players at a time. The participants (N = 30, 15 pairs, 19 female, age ranging from 19 to 34 with an average age of 25) were students and employees of the faculty of Industrial Design at Delft University of Technology. The composition of the pairs was random in terms of age

and sex. As a result, we had 2 pairs of men, 6 pairs of women, and 7 mixed pairs. Most players were familiar with the original single player game of Breakout (22 out of 30), 18 participants had also played it before.

4.3.3 Procedure

Each session (30 minutes) started by welcoming two participants in separate, neutral rooms so they would not meet before and during game play. Playing the game in separate rooms ensured that players could not communicate in other ways than through the game. They were seated behind a PC screen with a keyboard and mouse (Figure 4.3). The game was programmed in Flash Actionscript 3.0 and played full screen on a Windows PC with a 17" screen. First, the participants had to sign a consent form. Next, on-screen textual instructions were shown about the goal of the game and the use of the arrow keys. The instructions did announce two types of the game, yet the embodied rules in the game were deliberately not explained.

The participants continued by filling in a nickname. To show them which paddle they would control, the nickname was visible on their paddle. The first two rounds were single player Breakout as a way of practicing the game and measuring the skills of each individual player. Next, they would play the competitive or cooperative version twice, after which they would play the other version twice. To avoid potential order effects, the order of presentation of game conditions varied. In sum, each participant played 6 rounds. Each round took 3 minutes because pilot tests showed that nearly all players had grasped the embodied interaction and goal-driven rules within that time. So the effect of learning the rules was expected to be significantly smaller during each second round. After each round they had to fill in questionnaire questions that would pop-up on the screen. In the final questionnaire, the players were also asked to rate the games on competition and cooperation, and pick the game they liked most. At the end of the session the players were introduced to each other and shortly interviewed together (10 minutes).

4.4 Results

4.4.1 Player experience

First, we looked at the effect of the two game variants on the players' experiences. Each variable from the player reports was analyzed, using a 4-way mixed ANOVA, with the game variants and rounds as within-subject variables, and sex and order as between-subject variables. Before performing these analyses, overall interdependence,

obstructing and helping were calculated by averaging ratings of self and other. As a result, we found that players felt a strong sense of interdependence in both game variants. In the cooperative game, players felt significantly more interdependent than in the competitive game $F(1,21) = 9.29$, $p = .01$, $\eta p^2 = .31$; $M^{coop} = 3.99$, $M^{comp} = 3.45$. Moreover, there was an order effect $F(1,21) = 7.07$, $p = .02$, $\eta p^2 = .26$, in which playing the competitive game first led to a stronger overall feeling of interdependence. As expected, obstruction was reported to be significantly stronger in the competitive game ($M = 4.02$) than in the cooperative game ($M = 2.79$) $F(1,21) = 30.23$, $p = .00$, $\eta p^2 = .59$. The reverse holds for helping with a mean score of 3.58 for the cooperative game and 2.25 for the competitive game. In addition, a first order interaction effect between rounds and game variant was found for helping: in the second competitive round, players reported to help each other more. This effect was strongest when players had not yet played the cooperative game $F(1,21) = 10.80$, $p = .00$, $\eta p^2 = .34$.

Players reported no significant difference in perceived performance and satisfaction between the game variants. We did find a weak first order interaction between order and variant for enjoyment $F(1,21) = 7.72$, $p = .01$, $\eta p^2 = .27$. Players enjoyed the competitive game less when they first played the cooperative game ($M = 3.21$) compared to playing the competitive game first ($M = 4.30$), whereas the

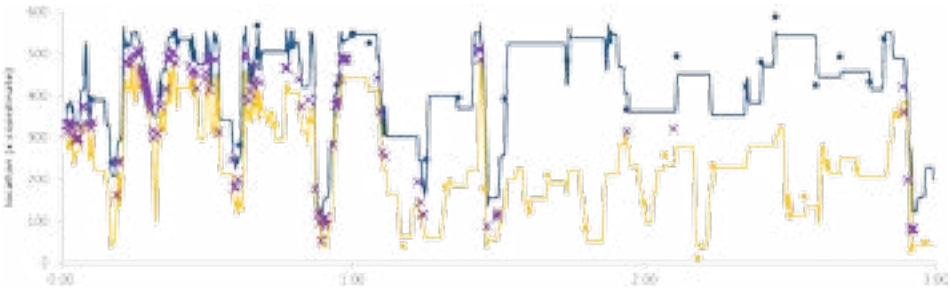


Figure 4.5. Gameplay data of a cooperative game round; example of players switching from competitive to cooperative behavior.

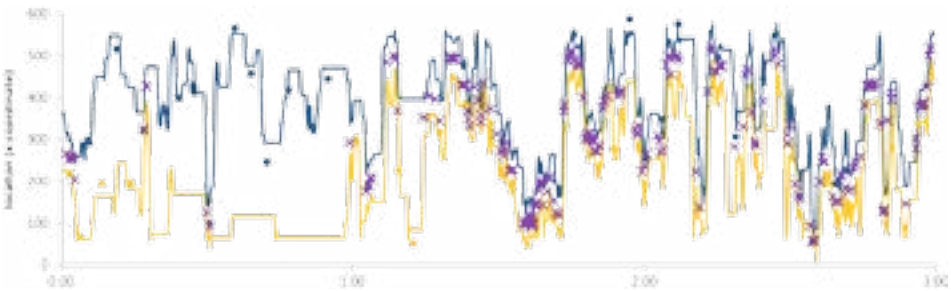


Figure 4.6. Gameplay data of a competitive game round; example of players switch from cooperative to competitive behavior.

cooperative game was always rated approximately the same ($M = 3.84$). At the end of the session, half of the players reported to prefer single-player most. The competitive game was preferred by 37% of the participants, and 13% liked the cooperative game most.

By clustering the competition-cooperation rating (1-5 = competition; 6-10 = cooperation) that players filled in after the final round, analysis shows that 78% of the game rounds were correctly identified which according to a Fisher's exact test is significant at $p < 0.0001$. From the interviews, we know that most players understood the rules of the game immediately (64%), for others it took a few minutes (31%), and 3 players (5%) did not grasp the rules of the cooperative game at all. Fortunately, these players played the game with a peer that did understand the rules.

4.4.2 Player behavior

Next to subjective player reports, we wanted to investigate the behavioral effect of the different goal-driven rules. In order to find the most differentiating behavioral variables, the screen captures of all game rounds were observed to determine patterns in gameplay. The observed patterns served as guidance for selecting behavioral variables that could distinguish dependent competition and dependent cooperation. Next, the self-reports were used to check if the chosen behavioral variables correlated with the experiences of the players.

Figure 4.5 & 4.6 show graphs of game data of two different game rounds of 3 minutes. The blue line depicts the location of the blue paddle and the yellow line the yellow paddle. Ball hits are visualized as dots; purple crosses depict collisions between the paddles. Figure 4.5 shows a game round with the cooperative rule. Before this round, the players played the competitive game. The opposite can be seen in Figure 4.6. These figures suggest that the game variants evoke distinctive behaviors. Initially, paddles move in a way similar to the previous round. In these extreme examples, after approximately a minute (average was 10s) they seem to discover that the rules have changed and adapt their behavior to it. Observations of the screen captures enabled us to describe the different behaviors in more detail.

Screen captures observations

In line with the intention behind the design, we mainly observed paddle movements that related to alternating between hitting and not hitting the ball in the screen captures of cooperative game rounds. If a paddle hit the ball, it would typically go to the side and the other paddle would move to hit it. In some cases the ball was hit in such a way that the ball would go towards the other paddle. We also frequently observed occasions in which both paddles stayed on different halves of the game area. They would hit the ball if it landed on their side. When the ball did

not resemble the color of the paddle on that side, or when the ball would land in the center of the game area, it was not always clear which paddle went for the ball. If one paddle appeared passive, the other would generally try to catch the ball, irrespective if it was their ball color or not.

In the competitive game, we mainly observed paddle movements that did not seem to relate directly to the trajectory of the ball. The paddles mainly seemed to follow each other, rather than following the ball. For example, the players performed timed collisions by taking a leap to increase the speed for a powerful push. In other occasions, collisions were more constant. The paddles would continuously follow each other from one side of the game area to the other. As a result, collisions were observed frequently. We also observed movements in which both paddles tried to follow the trajectory of the ball. In order to do so, they sometimes needed to push away the other. If the ball landed in a corner that the paddle could not get to, it stayed passive, waiting for the moment to follow the trajectory of the ball again. In this behavior, collisions were observed frequently as well, because both paddles would typically try to follow the ball.

By clustering these observations, we derived four behavior patterns that were observed in both game variants and comprised nearly all gameplay: help, agree, ignore, and obstruct. When players were making room for the other to hit the ball, we refer to this as helping each other. On occasions when paddles stayed on one half, they seemed to agree on dividing the game area. When the paddles followed the trajectory of the ball, the other paddle was merely an annoying obstacle, rather than an opponent. The other seemed to be ignored. The pattern of obstructing was the opposite. Players seemed to ignore the ball and were mainly focused on colliding with the other paddle, rather than scoring points or catching the ball. We observed all four patterns in both game variants. Yet players mostly seemed to obstruct each other in the competitive game, and help each other in the cooperative game.

Patterns of behavior in the game data

In order to objectively measure the behavior patterns in the game data, we looked for behavioral variables that could distinguish them. When players helped each other (Figure 4.7), they made room for the other, which would lead to few collisions. When players agreed to divide halves (Figure 4.8), they generally stayed on different sides of the game area, leading to few collisions as well. When players obstructed each other (Figure 4.9), paddles obviously collided frequently. We also expected a large number of collisions when players ignored each other (Figure 4.10), because they would both follow the trajectory of the ball. Thus by counting number of collisions

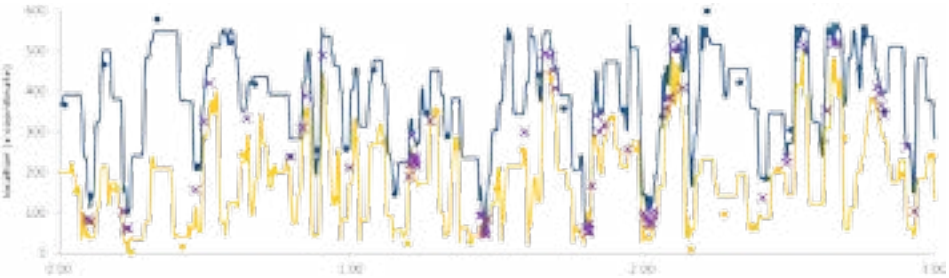


Figure 4.7. Game round where players predominantly **help** each other.

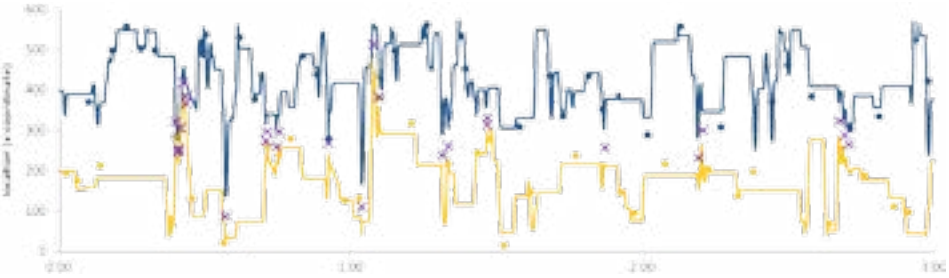


Figure 4.8. Game round where players predominantly **agree** to divide the space.

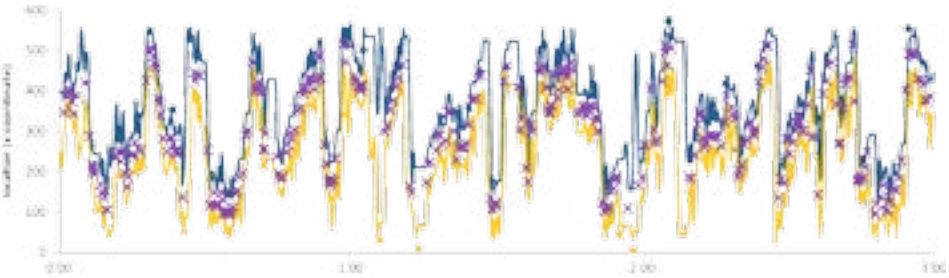


Figure 4.9. Game round were players predominantly **obstruct** each other.

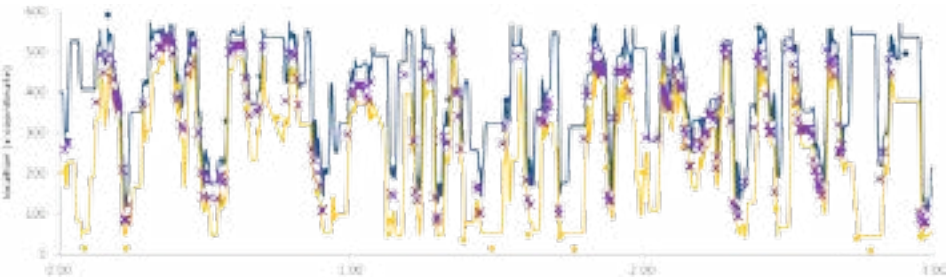


Figure 4.10. Game round where players predominantly **ignore** each other.

within a certain timeframe we expected to distinguish competitive patterns from cooperative patterns.

In the cooperative patterns (help and agree), players seemed to be focused on hitting the ball, and if possible, hit it alternately. As Figure 4.7 shows, while helping each other, they took turns in covering the full game area, whereas while agreeing (Figure 4.8), they divided the game area. These patterns seemed distinguishable by the distribution of the paddles over the game area: helping should lead to larger spatial distribution than agreeing. Unfortunately, ignoring and obstructing could not be distinguished by location distribution, as in both cases they cover the full area, either by following the ball or by following each other. When players followed each other, the paddles stayed close together continuously. When they followed the ball, paddles sometimes became passive when they realized it was not possible to hit the ball or take a leap to push the other paddle away. Hence distance between paddles could distinguish ignoring from obstructing, in which, on average, ignoring was expected to lead to a larger average distance than obstructing.

Next, the chosen behavioral variables were used to determine to what extent each pattern occurred in the game data of the competitive and cooperative game. They were measured in blocks of 10 seconds, which was the granularity necessary to measure a distinguishable number of collisions. Thresholds were determined such that measured patterns in the game data correlated with the patterns observed through screen capture observations. To distinguish competition from cooperation, 8 collisions per 10sec was found to be the threshold, nearly resembling the median of 7. For measuring the mutual location distribution of the two paddles we took the standard deviation of the average location of both paddles over 10sec (max: 49.7px, min: 0.4px). A deviation of 16px (32% of the maximum deviation) was found to distinguish helping (>16px) from agreeing (<=16px). For average distance in 10sec, 140px (27% of the game area, median: 127px) was found to be the threshold, 140 pixels or less was labeled as obstruct, otherwise it would be ignore.

As a result (Table 4.1), we found that in competitive rounds, players ignored each other 16% of the time, they agreed on dividing the space in 21%, and helped each other in 8% of the time. Yet they mostly obstructed each other (55%). In the cooperative rounds, we mostly measured helping behavior (38% of the time) and agreeing behavior (36% of the time). Ignoring and obstructing were measured 18% and 8% of the time respectively. A chi-squared test finds that frequencies of behavior patterns in the competitive game differ significantly from the cooperative game, $\chi^2(3, N = 954) = 281.60$, $p = .000$. Help and agree are associated with the cooperative game and obstruct with the competitive game. Moreover, we found

Table 4.1. Measured behavior patterns per game variant (dark grey: competitive behavior, light grey: cooperative behavior)

	Competitive game	Cooperative game	χ2 sig.
Help	35 [8%]	**193 [38%]**	.000
Agree	95 [21%]	**180 [36%]**	.000
Ignore	74 [16%]	90 [18%]	n.s.
Obstruct	**246 [55%]**	41 [8%]	.000

an order effect for agree, in which the frequency that players agree doubled in the second game variant, irrespective which type.

4.4.3 Player behavior and experience

Lastly, we investigated to what extent these behavior patterns relate to experienced interdependence, competition and cooperation by comparing the measured patterns with player reports. For each round we defined the dominant behavior pattern by determining the pattern that occurred most. Help only dominated in cooperative rounds and obstruct was only dominant in competitive rounds. Figure 4.11 shows the average player reports on interdependence, obstructing and helping, clustered by dominant measured behavior pattern per game round. After playing a round in which ignore or obstruct occurred most, players reported high obstruction (i.e. competition), whereas agree and help led to more reported helping (i.e. cooperation). Moreover, players reported to feel more interdependent when obstructing or helping each other, compared to ignoring and agreeing. Ignore led to the lowest feeling of interdependence.

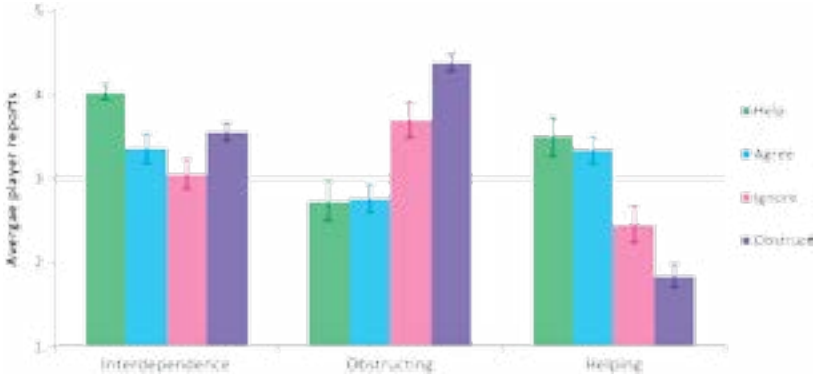


Figure 4.11. Average player reports per dominant behavior pattern.

The relation between dominant behavior patterns and player reports was analyzed by a one-way ANOVA with the dominant patterns as independent variable and reported interdependence, obstructing and helping as dependent variables. We found a main effect for all player reports (interdependence, $F(3,52) = 6.45$, $p = .001$ $\eta p^2 = .28$; obstructing, $F(3,52) = 22.52$, $p = .000$, $\eta p^2 = .58$; helping, $F(3,52) = 19.20$, $p = .000$, $\eta p^2 = .54$). Post-hoc analysis revealed that agree and help significantly differ from ignore and obstruct with respect to reported obstructing and helping. Moreover, rounds in which help dominated led to significantly different reported interdependence compared to agree and ignore.

Effect of goal-driven rules on player behaviors and experiences

The measurements suggest that within the two goal-driven rule types, the competitive rule makes players exhibit behavior that is felt as dependent competition approximately half of the time (i.e. 55% obstruct) and the cooperative rule leads to 74% of dependent cooperative behavior (i.e. help and agree). Thus, the players adapted their behavior considerably to the goal-driven rules. Helping in the competitive game and obstructing in the cooperative game might be explained by not understanding the rules, but still a large part of unexplained behavioral variance remained.

In the cooperative game, players generally behaved as was intended. Helping was clearly aimed at alternating to hit the ball and when players agreed to divide the space they frequently alternated in hitting the ball as well. However, in the competitive game, the intended behavior was not frequently observed. Behavior that is aimed at maximizing individual ball hits corresponds with following the trajectory of the ball. This happens when players ignore each other. Yet players exhibited this behavior only 16% of the time. Instead, players mostly obstructed each other, which led to the intended dependent competitive experience. However, when players had behaved as intended, they might have experienced the competitive game as independent competition, because the player reports suggest that ignoring led to moderately interdependent competition.

This may partly be caused by the selection of behavioral variables, which we will get back to in the discussion. Still, we could conclude that the intended behavior did not correspond with the intended experience in the competitive game. Thus, in order to avoid this incoherence in future game designs, we need to better understand how the goal-driven rules led to player behaviors. Game theory provides methods to describe the rules of a game and make predictions on the resulting behavior of players (Binmore, 2007). Therefore, the following section describes an

analysis of the goal-driven rules using game theoretical principles. First we describe the goal-driven rules using payoff matrices and deduce what would be logical player behavior. Next, a comparison between the predicted behavior and the measured behavior patterns could indicate in what way and to what extent the goal-driven rules have led to the measured player behavior.

4.5 Understanding the effect of goal-driven rules through game theory

Camerer (2003) explains how game theory could be used to predict player behavior. In non-cooperative strategy games (i.e. players cannot negotiate), like multiplayer Breakout, payoff matrices are used to show the outcome (or payoff) of all possible strategy combinations. These matrices allow deducing what would be consistent behavior. To make predictions, the basic assumption is that people play games rationally. They are expected to behave as though maximizing the outcome. In this way, the payoff matrices enable us to describe strategies that players may adopt in relation to achieving an as high as possible score. If predicted strategies correspond with measured behavior patterns we may assume they are affected by the goal-driven rules.

4.5.1 Predicting strategies

In multiplayer Breakout, the color of the ball defines the payoff for each player with respect to the actions: hit ball and not hit ball. The payoff matrices in Table 4.2 & 4.3 show the payoff for each action. Two numbers, separated by a comma, represent the payoff: the left payoff is for the 'row' player (with the paddle that matches ball color, referred to as player 1) and the right payoff is for the 'column' player (that does

Table 4.2. Payoff (i.e. maximum points in 10 seconds) matrix of the competitive game.

Competitive game		Player(2) that does not match ball color	
		Not hit ball	Hit ball
Player(1) that does match ball color	Not hit ball	-4,0	0,6
	Hit ball	6,0	3,3

Table 4.3. Payoff (i.e. maximum points in 10 seconds) matrix of the cooperative game.

Cooperative game		Player(2) that does not match ball color	
		Not hit ball	Hit ball
Player(1) that does match ball color	Not hit ball	-4,-4	0,0
	Hit ball	6,6	3,3

not match ball color, i.e. player 2). The payoffs represent the maximum amount of points that players can win or loose within 10s, reflecting score progression instead of the score for each separate ball hit. Moreover, this allows for comparison with the measured payoffs in relation to the 10s interval of the behavioral measures, as explained in the next section. The highest score that was scored in the single player game (115) was taken as reference for the maximum possible score. A game round takes 3 minutes, so one could win approximately 6 points in 10s. When none of the players hits the ball in 10s, the speed of the ball dictates that it can get lost 4 times. Hence the minimum possible payoff is -4.

Table 4.2 displays the payoffs for the competitive game. If both the players do not hit the ball in 10s, player 1 will loose 4 points and player 2 does not win or loose any points (payoff: -4,0). If one of the players always hits the ball, he or she wins 6 points and the other 0. The players cannot hit the ball simultaneously, so if both players aim to hit it, they have 50% chance of doing so, resulting in a payoff of 3,3 after 10s. In the cooperative game, both players loose points for not hitting the ball. If player 1 hits it, both players win points, and if player 2 hits the ball, no points are scored. Moreover, if both players aim to hit the ball the average payoff would be 3,3.

With the payoff matrices of both games we can derive the strategies that players could adopt to reach the optimal score. In game theory, typically the first thing to consider is dominance. A strategy is dominant if it is the strict best response to any strategy that the other might play. In the competitive game, hitting the ball is the dominant strategy for both players. For player 1, not hitting the ball leads to a payoff of -4 or 0, whereas hitting the ball makes 6 or 3 points. For player 2, hitting the ball leads to 6 or 3 as well, instead of scoring 0 points when not hitting it. In the cooperative game, hitting the ball is dominant for player 1 as well. Player 2 needs to

assume that player 1 will respond with the dominant strategy. Then not hitting the ball dominates for player 2.

Other possible strategies would be to maximize one's minimum possible payoff (i.e. maximin) or minimize the other player's maximum possible payoff (i.e. minimax). In the competitive game, only the minimax strategy for player 2 differs from the dominant strategy to always hit the ball. If player 2 wants to minimize the maximum possible payoff of player 1, he or she should not hit the ball; thereby maximizing the chance that player 1 looses points. In the cooperative game a minimax strategy makes no sense. However, player 2 could adopt a maximin strategy by deciding to hit the ball in order to avoid losing any points.

4.5.2 Comparing predicted strategies with behavior patterns

If the four measured behavior patterns correspond with dominant, minimax, or maximin strategies we may assume that they are driven by the goal-driven rules. Thus, similar to the above-described prediction of game theoretical strategies, we made a hypothetical mapping of the behavior patterns to the payoff matrix (see Table 4.4). Help seems to relate to the dominant strategy in the cooperative game, in which players hit the ball when matching ball color and the other player makes room to allow it. Agree corresponds with the maximin strategy in the cooperative game, i.e. players make sure that one of them always hits the ball, irrespective of its color. Ignore relates to the dominant strategy in the competitive game, in which both players aim to hit the ball irrespective of the other player's actions. Obstruct seems to partly relate to a minimax strategy in the competitive game, in which player 2 tries to block player 1 from hitting the ball. However, observations suggest

Table 4.4. Mapping patterns of mutual player behavior to the payoff matrix.

		Player(2) that does not match ball color	
		Not hit ball	**Hit ball**
Player(1) that does match ball color	**Not hit ball**	Obstruct	Agree
	Hit ball	Agree	Obstruct
		Help	Ignore

that obstruct alternately leads to both hitting and not hitting the ball, which does not correspond with any of the predicted game theoretical strategies.

The mapping was verified by comparing measured scores per pattern with predicted scores per pattern (see Table 4.5). The predicted score per pattern was determined using the mapping in Table 4.4 and the payoffs in Table 4.2 & 4.3. As a result, help leads to a predicted payoff of 6,6 in the cooperative game and 6,0 in the competitive game, because player 1 will always hit the ball. If players agree and the ball lands as frequent on one side of the game area as the other, the players alternately hit the ball. In the cooperative game this would either lead to 6,6 or 0,0 and in the competitive game to 6,0 or 0,6. Hence on average, we expect 3,3 in both variants. Moreover, we expect that ignore leads to 3,3 in both variants. If players obstruct each other, we expect a payoff of 0,1½, assuming that both players will not hit the ball half of the time (-2,0) and alternately score points the other half (1½,1½). In the cooperative game, obstructing leads to 0,0 because the players loose more points than they win.

To determine the measured score per pattern, the average score of all 10 sec instances of a pattern was calculated. In order to avoid analyzing the effect of variation in skills, the scores were corrected in relation to the average single player game score. In order to compare the payoff differences between the paddle matching ball color and the paddle not matching ball color in the competitive game we used number of ball hits. The player with the most ball hits in a 10 sec block resembled the paddle matching ball color. Hence the measured payoff left of the comma in Table 4.5 represents points scored by the player with the most ball hits and the payoff of the player with the least ball hits is given on the right of the comma.

When comparing predicted and measured scores, we see that players tend not to score as many points as expected. Only when they agree in the cooperative game, they reach a larger payoff than predicted. In the competitive game, the actual scores

Table 4.5. Average predicted and measured scores within 10 sec per behavior pattern.

	Competitive game		**Cooperative game**	
	Predicted	Measured	Predicted	Measured
Help	6,0	4,1	6,6	3,3
Agree	3,3	3,2	3,3	3½,3½
Ignore	3,3	3,1	3,3	1½,1½
Obstruct	0,1½	2,1	0,0	1½,1½

correlate quite well with the predicted scores. Help leads to the highest score for the player that matches ball color. Agree leads to a more or less equal distribution of points, and obstructing results in the lowest scores. The score of player 2 for ignore does not correspond with the prediction. Moreover, player 1 scored more points than predicted when players obstruct each other.

4.5.3 Understanding behavior patterns through game theory

In general, we conclude that the predicted scores correlate to a large extent with the measured scores. This suggests that the mapping as shown in Table 4.4 may indeed be used to determine to what extent maximum score drove players to exhibit behavior patterns. In the cooperative game, help and agree were mostly observed (38%, 36%) and this is most likely caused by goal-driven rules, because players do indeed score most points when agreeing or helping. In theory, helping leads to the maximum score. In practice however, cooperating optimally seems to be difficult, as the measured scores demonstrate. In fact, it seems more efficient to divide the space, thereby minimizing maximal loss. Nonetheless, players adopt helping behavior as much as agreeing, even when it does not pay off. Hence goal-driven rules could largely account for the measured behavior in the cooperative game.

However, in the competitive game, players seem less driven by the score. When players obstruct each other (observed 54% of the time), this does not result in a high payoff. Moreover, the measured score possibly rejects the assumption that obstruct could partly be explained by a minimax strategy, because the score of player 1 is not lower than the score of player 2. On the other hand, one could argue that player 1's score is lowest compared to the other patterns. Interestingly, agree approximates the predicted score more than ignore. Thus, if players wanted to play safe, they could cooperate to score an optimal amount of points. This might explain why players adopt agree more than ignore, although ignore corresponds with the dominant strategy as explained in the previous section.

4.6 Conclusion

The above-described experiment was aimed at examining to what extent interaction- and goal-driven rules steer interdependent behavior in a multiplayer computer game. Interaction rules were expected to evoke a strong feeling of interdependence. Goal-driven rules were expected to evoke competition in one game variant, and cooperation in the other. The results show that players indeed experienced competition as a result of competitive goal-driven rules and cooperation due to cooperative goal-driven

rules. Unexpectedly, further analysis of the player reports demonstrated that the cooperative game led to a stronger feeling of interdependence than the competitive game. An explanation for this was found in the behavioral measurements. The results suggest that players exhibited significantly more behavior that was experienced as dependent cooperative in the cooperative game (74%) than dependent competitive behavior in the competitive game (55%).

Game theory was used to understand the lack of dependent competitive behavior in the competitive game. Game theoretical strategies predicted that the competitive goal-driven rule would lead to actions that are aimed at a maximum of individual ball hits. This corresponded with behavior patterns agree and ignore, that players perceived as moderately interdependent (see Figure 4.11). Thus the competitive goal-driven rules accidentally induced strategies in which players competed or cooperated relatively independently, even though the intention behind the competitive variant was to evoke dependent competition.

Nonetheless, we mostly observed behavior that evoked a dependent competitive experience in the competitive game (i.e. obstruct each other). Yet the game theoretical analysis predicted that the competitive goal-driven rules would induce agree and ignore, thus we conclude that players either were not driven by scoring points or

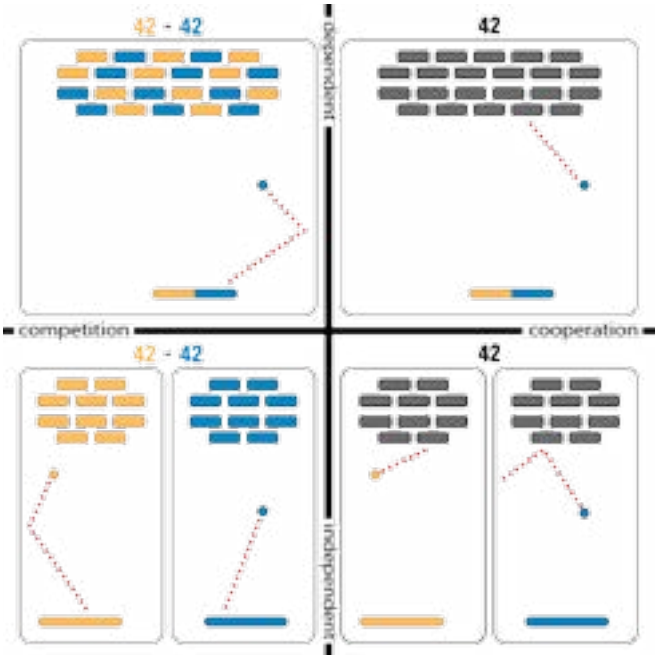


Figure 4.12. Alternative designs of multiplayer Breakout, inspired by the framework.

had other goals in mind. In the interviews, some players indeed expressed they just wanted to obstruct the other player for fun. Others said they wanted to make the other loose the ball or win more points than the other player.

The fact that players mostly exhibited dependent competitive behavior in the competitive game even though it was not the optimal strategy, suggests that the interaction rules may have overruled the effect of goal-driven rules in the competitive game. Players seemed more engaged with interacting with the other paddle than with scoring points. The distracting effect of the interaction rules seemed to diminish over time, as players generally agreed more in the final rounds which is likely to be driven by scoring points.

4.7 Discussion

4.7.1 Limitations

An increase in agreement in the final game rounds could, however, also be explained by passivity of players, because agree was measured by few collisions and a low location distribution. The measured scores do not suggest passivity however. Instead, measured scores suggest that the behavioral variables for ignore (i.e. many collisions and a large distance between the paddles) may have partly captured passivity of one of the players. This could explain why it was observed as much in the competitive game as in the cooperative game and why it was experienced as moderately interdependent. In the present experiment, passivity was not included in the behavioral analysis, because it would probably not significantly impact the relative occurrences of patterns. In more complex contexts, such as a serious game, passivity of players may become a more important factor to take into account.

As explained in chapter 3, the variation between intended and observed behavior patterns could also be explained by user characteristics (i.e. skills, knowledge and attitude). Among other things, learning time seemed to influence player behavior, as some players understood the rules immediately, whereas for others it took a while. Yet a transition phase as shown in Figure 4.5 & 4.6 was rare. On average, players needed 10s to switch to a behavior pattern that related to the game variant. Still, particularly in the cooperative game, not fully understanding the rules or mastering the controls was probably one of the main causes for behavior patterns other than helping.

Next to skills and knowledge, the players' playful attitude may have influenced their behavior, because people that are more playful generally pay less attention to

goal-driven rules (Apter, 1989). Moreover, they would probably react differently on the presence of another player. Some players stayed focused on their individual task, thereby ignoring the other player. Yet most players seemed to be significantly distracted by the presence of the other paddle. And finally, players may have had predetermined preferences for certain strategies. Some prefer to approach conflicts cooperatively, whereas others prefer to compete.

To address effects of player characteristics, the sample size (number of player sets) in this study is too limited. Regarding the effect of the rules on player behavior and experiences the results seem convincing, as effect sizes are relatively high. Moreover behavioral measures, player reports, and player comments in interviews are consistent.

4.7.2 Recommendations for designing game rules

Overall, the findings suggest that by designing interaction- and goal-driven rule-sets, we can persuade players to compete or cooperate in games. Application of these rule types is expected to be of value especially in the design and understanding of serious games aimed at increasing team performance, i.e. interdependent player behavior. Yet defining the rules of a game for particular interdependent behaviors and experiences is proven to be difficult. This paper demonstrated that although we designed a game for a particular type of behavior, players tend to exhibit a broader spectrum of behaviors. Therefore, a framework such as Figure 4.1 or game theoretical principles are useful tools for defining the right set of game elements to stimulate intended behaviors and possibly avoid unwanted ones. For example, game-like workshops often bog down in pure gameplay, where participants loose the serious purpose out of sight. By strengthening goal-driven rules, such as introducing competing groups, this may be avoided.

The game theoretical analysis showed that, when designing multiplayer Breakout, we only had dominant strategies in mind. By predicting strategies from the goal-driven rules, game theory added to a more precise prediction of the resulting player experience. Moreover, game theoretical principles, such as payoff matrices, could be used to design player experiences. For example, by adapting the payoff distribution towards a zero-sum game, in which one player looses points when the other wins them, thereby intensifying competitive experiences.

The framework for the gamification of teamwork situations (Figure 4.1) aided the game design process by identifying behavioral/experiential variations as a result of interaction- and goal-driven rules. Figure 4.12 schematically shows alternatives for the embodiment of interaction- and goal-driven rules in multiplayer Breakout.

For example, by adapting the interaction rules such that both players control one paddle, agreement would not be possible, as shown in the upper variants. Conversely, by giving each paddle its own game area, players are forced to agree or ignore each other. By clearly showing an individual or collective score, competition or cooperation could be stimulated. In this way we could develop games that elicit more distinctive experiences.

In a simple game like Breakout, with simple goals and interactions, developing alternative designs for distinctive experiences seems relatively straightforward. Yet in serious games with its more complex scenarios and decision-making processes, developing such designs is expected to be more difficult. A possible strategy to resolve this gap is to dissect a serious game into its "goal atoms" (Vegt, Visch, de Ridder, & Vermeeren, 2014) for disentangling the effects of individual interaction- and goal-driven rules. For example, in a leadership assessment game, teams compete for winning the challenge, while at the same time teammates cooperate to develop a good product and compete for the best individual assessment. All three goals may be adapted differently using the framework to diversify player experiences or to make them more coherent.

4.7.3 Future work

More distinctive experiences might lead to games that are more engaging over a longer period of time and thus increase gameplay retention. Investigating the effect of varying sets of experiences as a result of interaction- and goal-driven rules on retention rate would be an interesting follow-up question. Next to game design research, our findings could inspire non-game or serious game research, as the findings are based on theory that is not restricted to entertainment games. A direct way of using this paper's outcomes could be to deploy the two variants of multiplayer Breakout as assessment tool in non-game contexts, such as a personality test. As explained above, players seemed to react differently on the game depending on their attitude, knowledge, and skills. Hence, switches in interdependent behavior as shown in Figure 4.5 & 4.6 might say something about a players' characteristics.

Moreover, if game elements can steer players towards particular strategies in entertainment games, we may be able to use the same principles in organizational serious games to influence non-game teamwork situations as explained above. Yet the difficulty of predicting the effects of rules and user characteristics on player behavior possibly complicates the use of interaction- and goal-driven rules in non-game teamwork contexts as they are more complex than multiplayer Breakout. On the other hand, entertainment games generally make players behave more

playful. Thus stepping outside the magic circle (Huizinga, 1950) might positively affect the extent to which people act goal-oriented and consequently the extent to which they can be persuaded by goal-driven rules. Hence investigating the effect of interaction- and goal-driven rules in non-game teamwork contexts remains an interesting direction for future research. Additionally, it would be worthwhile to examine the effect of these rule types in serious games that elicit player behaviors other than the behavior patterns found in the present experiment, such as trading or communication.

Regarding measuring the effect of such interventions, this paper presented a successful account of combining user research with game analytics. Currently, game design research is in need of mixed-methods approaches (El-Nasr, Desurvire, Aghabeigi, & Drachen, 2013), as they seem crucial to address the complexity of serious game design. By thoroughly describing our method and including organizational psychology and game theory, we hope this paper contributes to the methodological discussion as well as to adhere to the still limited knowledge of behavioral effects of rule-sets in games.

5

Balancing game rules for improving team performance in the lab

The previous chapter demonstrated that game rules could significantly steer players towards competitive and cooperative strategies. As explained in chapter 3, both strategies can be beneficial for team performance. In this chapter, we therefore explore to what extent game rules that stimulate competition and cooperation can improve team performance in group-brainstorms in a controlled lab setting. We study effects on brainstorm output and user experience and behavior. A coin-based gamification was developed with rules intended to improve brainstorm output. However, the experienced invasiveness of the gamification can be expected to affect users both positively and negatively. To find an optimum between positive and negative effects of gamification invasiveness, we tested 5 different rule-sets with varying quantity and quality of rules. The results demonstrate that game rules forcing competitive game behavior improve the quantity and quality of brainstorm output. Yet the invasiveness of the gamification also hinders this positive effect, due to discussions about rules and mandatory game behavior. From these results we deduce 3 types of invasiveness: affective, cognitive, and behavioral. We conclude that rule qualities, such as governing, forcing, or embedded rules, largely define gamification invasiveness and the transfer effect.

This chapter is submitted for publication as: Vegt, N. J. H., Vermeeren, A. P. O. S., Visch, V. T., de Ridder, H., & Hayde, Z. M. (2018). *Balancing Game Rules for Improving Creative Output of Group Brainstorms*.

5.1 Introduction

Recent studies suggest that teamwork could benefit from gamification, i.e. the use of game elements in non-game contexts (Deterding, Dixon, Khaled, & Nacke, 2011). For example, game-like incentive mechanisms are introduced that award participants with points for certain activities, which lead to positive effects of increased productivity (Mekler, Brühlmann, Opwis, & Tuch, 2013) and collaborative behavior (Moccozet, Tardy, Opprecht, & Léonard, 2013). These interventions are promising, yet they adopt a rather narrow research approach, only demonstrating the effect of single game elements, like awarding points for particular activities.

Gamification research should broaden its scope to properly understand and optimize its potential effects. Moreover, unintended negative effects should be addressed. Knaving & Björk (2013) suggest that an inappropriate underlying model or mandatory game actions can easily overshadow the non-game goal of a gamification. Yet gamification research generally does not address negative effects (Hamari, Koivisto, & Sarsa, 2014). Most experiments take a systemic perspective in which the introduced game element and its intended effect are leading. This often leads to no or weak results because games are complex systems in which player behavior is hard to predict.

To explore the full potential of gamification, a user-centered perspective (Huotari & Hamari, 2012; Visch, Vegt, Anderiesen, & van der Kooij, 2013) seems more fruitful because the user's behaviors and experiences essentially define its effect. Hence, we take user experience and behavior as the starting point for the development of a gamification. To better understand users in a gamified situation, Visch et al. (2013) suggest that a user's experience lies on a continuum between the extremes of a real world experience and game world experience (see Figure 5.1). By adding game elements to a real world situation, such as winning coins in a brainstorm meeting, the user's experience may be transported (Green, Brock, & Kaufman, 2004) towards a game world experience (i.e. the feeling of playing a game). In gamified contexts, the resulting gameful experience (McGonigal, 2011) could then affect the non-game situation, which is referred to as the transfer effect.

In the present article, we examine the transfer effect of a structured series of gamifications for group brainstorming. Group brainstorming is common practice in many disciplines and generally the process is still based on the four original rules introduced by Osborn (1963): 1) withhold criticism, 2) welcome unusual ideas, 3) combine and improve ideas, and 4) focus on quantity. However, since then, research gained many new insights, suggesting that Osborn's rules are not sufficient for

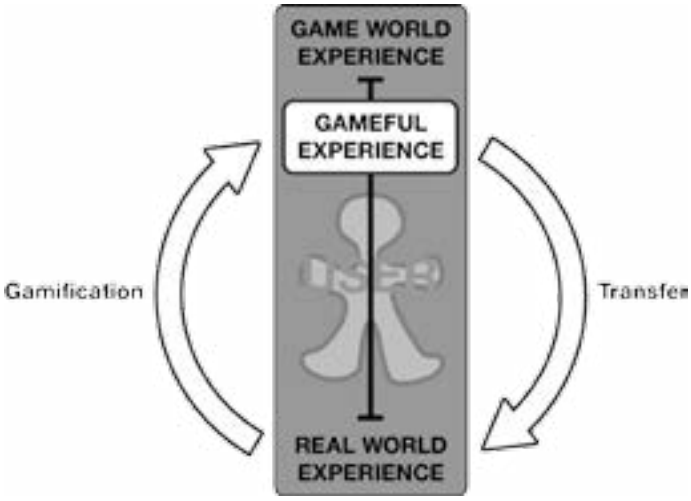


Figure 5.1. Model based on (Visch, Vegt, Anderiesen, & van der Kooij, 2013).

productive brainstorm sessions (Sutton & Hargadon, 1996). Throughout the years, many methods have been developed to improve group brainstorms. For example, gamestorming is a method that generates game worlds in which participants can jointly produce ideas (Gray, Brown, & Macanufo, 2010). Instead of preparing a gamestorm session, just adding game elements to a brainstorm might lead to an equally beneficial game world experience.

To evoke a game world experience, rules are commonly mentioned as an essential element (Caillois, 1961; Juul, 2003; McGonigal, 2011). By adding game rules to a group brainstorm, group members get an increased feeling of playing a game (i.e. gameful experience). This could lead to enhanced creativity since creativity is commonly related to intrinsic motivational states (Amabile, 2012) and game rules generally derive their motivational power by tapping into intrinsic needs, i.e. autonomy, competence and social relatedness (Ryan, Rigby , & Przybylski, 2006). Moreover, rules can stimulate behavior that is beneficial for brainstorm output (see Figure 5.2). However, according to Figure 5.1, if game rules move a user's experience towards the game world, they move it away from the real world. Increased engagement with the gamification could therefore be expected to reduce the user's engagement with the brainstorm (see Figure 5.2). Consequently, an optimum between positive- and negative effects of adding invasive game rules needs to be found, and this will be researched in the present study.

In order to find such an optimal configuration of rules, this article describes an experiment examining the transfer effect of varying rule-sets in a coin-based

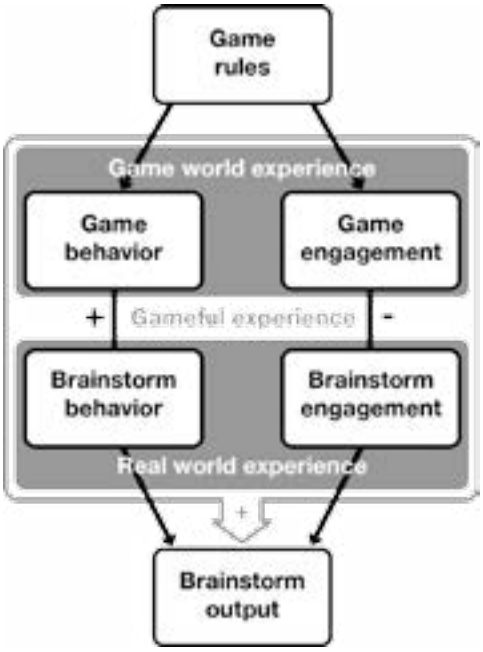


Figure 5.2. Initial model for the gamification of group brainstorming.

gamification for brainstorm sessions. The article is organized as follows. First we look into group brainstorming- and game design literature to further specify the initial model (Figure 5.2) in a research framework that defines possible transfer effects (see Figure 5.3). Based on the framework, an experiment was set up in which rules were clustered into different rule-sets with varying levels of invasiveness. The results of the experiment are used to revise the research framework (Figure 5.14) and to develop a model that addresses positive and negative effects of invasive game rules in brainstorm sessions (Figure 5.15).

5.2 Theoretical background

5.2.1 Game rules

In relation to invasiveness, game design literature commonly distinguishes explicit and implicit rules (Björk & Holopainen, 2003; Salen & Zimmerman, 2004; Sniderman, 2006; Bergström, 2010). Explicit rules are the 'official' rules of a game, whereas implicit rules are referred to as 'unwritten rules'. When distinguishing game rules from a systems perspective, explicit rules are more invasive than implicit rules,

because explicit rules ask for conscious processing and enforcement. However, from a player perspective, implicit rules can define the invasiveness of a game as well. For example in Hagoo, a social game in which two players need to frown while walking towards each other with continuous eye contact (Fluegelman, 1976). In this game, explicit rules define the winning condition and positioning of the players. Yet breaking the implicit social rule of 'staring is impolite' makes Hagoo interesting and engaging. In computer games, the official rules generally are not perceived as rules because they are mostly embedded into virtual objects (Järvinen, 2008). Yet these embedded rules, such as physical obstacles or a withdrawing progress bar, can strongly influence game invasiveness.

Thus rather than distinguishing rules from a systems perspective, adopting a user-centered approach seems more useful for understanding and optimizing the effects of gamification. From a user perspective, a large quantity of rules might already cause stronger invasiveness as to coping with them. Moreover, the quality of rules could influence the invasiveness of a gamification. Knaving & Björk (2013) stress that users should be free to interact with the gamification and mandatory actions should be particularly meaningful. Thus the level of obligation of rules might influence the invasiveness of a gamification as well.

Avedon (1971) describes two categories of rules that vary in obligation: "procedures for action" and "rules governing action". Procedures for action force actions upon players, such as drawing a 'go to jail' card in Monopoly. Conversely, rules governing action just define conditions, such as the rules in chess that prescribe the movements chess pieces can make. These examples demonstrate that governing rules often require a player to make decisions, whereas procedures are just to be followed by the player. As a result, procedures (i.e. forcing rules) are generally less cognitively demanding than governing rules and can be expected to be less invasive in a group-brainstorming task. Moreover, forcing rules may directly stimulate behavior that is beneficial for brainstorm output, so they seem most suitable for the gamification of group brainstorming. On the other hand, unlike forcing rules, governing rules can be flexibly used in favor of attaining a real world goal, such as producing many ideas. Governing rules provide players with playing freedom that is commonly assumed to be crucial for a game experience (Caillois, 1961; Suits, 1978; Juul, 2003; McGonigal, 2011), thereby evoking intrinsic motivation that is beneficial for creativity (Amabile, 2012). In conclusion, obligation encompasses varying beneficial rule qualities. Governing rules could positively influence brainstorm output by evoking a more gameful experience in participants and forcing rules could evoke beneficial behavior.

5.2.2 Group brainstorming

As explained in the introduction, the original group brainstorming method (Osborn, 1963) contained four rules to achieve maximal creativity and creative productivity through interaction between individuals. Recent studies on group brainstorming suggest that these rules are not sufficient. Thus to develop game rules that benefit brainstorm output, we needed to gain a better understanding of the elements that influence the quantity (i.e. productivity) and quality of brainstorm output.

Productivity

As Osborn assumed, exposure to ideas of others indeed positively influences brainstorm productivity (Dugosh & Paulus, 2005). However, many studies on group brainstorming consistently observe that groups are less productive than individuals when generating ideas. Literature suggests several reasons for this group productivity gap (Sutton & Hargadon, 1996; Brown, Tumeo, Larey, & Paulus, 1998). One explanation is that group members avoid expressing ideas because they worry about the opinion of others (i.e. evaluation apprehension). It is also suggested that individuals in groups do not feel accountable for producing ideas and as a result devote less effort to it (i.e. free-riding). Another explanation is that team members tend to match their productivity to members that generate fewer ideas (Brown & Paulus, 1996). Moreover, research suggests that individuals overestimate their productivity in group-brainstorms. They tend to claim more ideas than they actually produce (Paulus, Dzindolet, Poletes, & Mabel Camacho, 1993). The strongest support exists for the fact that, compared to working alone, waiting for your turn to talk as well as listening to others can hamper idea generation (i.e. production blocking). In fact, Nijstad et al. (2006) demonstrate that production blocking partly explains overestimation of one's productivity. Waiting for and listening to others leads to fewer new ideas, yet also to fewer failures, and reduction of failures mostly influences one's satisfaction.

In order to benefit from group brainstorming, attention to each other's ideas and performance feedback are mostly mentioned as crucial factors (Brown, Tumeo, Larey, & Paulus, 1998). Paulus et al. (2002) suggest that the group process needs to maximize exchange of ideas and minimize distracting effects of task-irrelevant discussions. Members should be encouraged to be attentive to ideas of other group members while they are sharing them. Performance feedback can reduce free riding and overestimation (Harkins & Szymanski, 1989). Monitoring each other's tasks was found to improve coordination and feedback processes (Marks & Panzer, 2004).

Yet individual performance feedback could also lead to evaluation apprehension. Jung et al. (2010) suggest that adopting a temporary identity overcomes evaluation apprehension while keeping the benefits from social comparison. Another solution to maximize idea generation could be to provide feedback on behavioral factors, such as individual speaking time or information exchange. Yet such types of feedback generally lead to moderate performance, because group members tend to adapt their effort to underperforming members and high performing teams can get distracted (DiMicco, Pandolfo, & Bender , 2004; Tausczik & Pennebaker, 2013).

In conclusion, to stimulate productivity in a group brainstorm, Osborn's rules of 'combining and improving ideas' and 'focusing on quantity' should be refined. To combine and improve ideas, team members should be encouraged to carefully listen to each other's ideas. To assure a focus on quantity, team members should be allowed to stimulate one another by giving positive as well as negative feedback on each other's productivity.

Quality of ideas

Next to producing many ideas, Osborn's rules (1963) were meant to increase the quality of ideas. Yet rather than 'withholding criticism', conflict is often mentioned as a positive factor for the quality of ideas (Jehn, 1995). Conflicts stimulate team members to think more creatively to resolve the problem that interferes with their goal achievement (Jung & Lee, 2015). Cognitive conflict (i.e. conflict about tasks and goals) is generally found to improve creative team performance, whereas affective conflict (interfering with relationships) is generally detrimental (Wu, Ferris, Kwan, Chiang, Snape, & Liang, 2015). Yet even affective conflict can be beneficial. Yong et al (2014) demonstrate that if one team member experiences affective conflict and the others do not, it positively influences novelty of ideas. However, controlling affective conflict is difficult, thus it is generally recommended to avoid it.

Avoiding affective conflict and encouraging cognitive conflict may be achieved by framing discussions towards learning- instead of performance goals (Huang, 2010) and by emphasizing on collective- instead of individual goal achievement (Deutsch, 2006). The extent to which cognitive conflict is beneficial depends on the way groups deal with it. Generally, when groups adopt a collaborative conflict behavior style (i.e. striving for a win-win solution) they are found to arrive at the most successful outcomes (Weingart & Jehn, 2003). However, in creative group processes, adopting a pure collaborative style seems less effective. Badke-Schaub et al. (2010) demonstrate that design teams that exhibit relatively more competitive conflict behavior produce more new ideas and are more associative, leading to high

innovation and functionality in design concepts.

In conclusion, Osborn's rule of 'withholding criticism' requires refinement to lead to high quality brainstorm output. Indeed, personal or emotional criticism should be avoided, yet criticism in relation to the collective output should be allowed, because competition among group members can stimulate the quality and quantity of brainstorm output.

5.2.3 Research framework

Based on the above-described insights, we developed a framework for the gamification of group brainstorms (see Figure 5.3). Group brainstorming literature provides a variety of ways to improve brainstorm processes and two factors stand out that could be addressed well by gamification: individual performance feedback and competitive behavior. By introducing a game-like feedback mechanism in which participants judge each other on their contribution to the brainstorm, they may become more attentive to each other's ideas. Moreover, games often are competitive systems of conflict (Salen & Zimmerman, 2004) providing many mechanics that could stimulate competitive conflict behavior, such as opponents competing for 'the best idea' or a zero-sum score distribution in which only one idea 'survives'.

As described by the framework (Figure 5.3), forcing rules can be used to

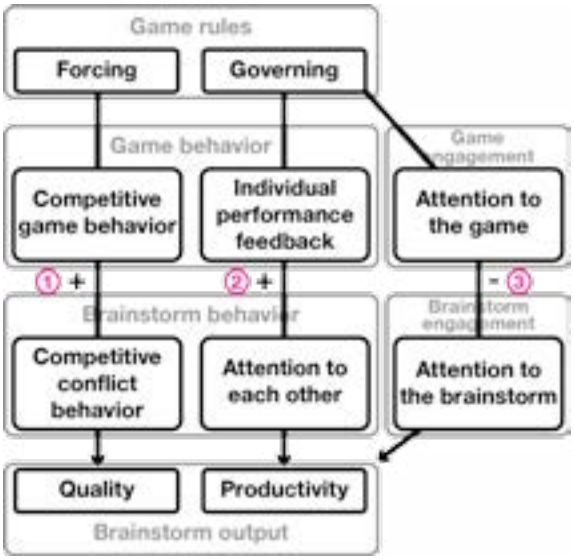


Figure 5.3. Expected transfer effects of game rules on brainstorm output. 1) Positive effect on quality by evoking competition, 2) positive effect on productivity by evoking attention to each other, 3) negative effect on brainstorm output due to distraction by the game.

achieve a positive transfer effect on the quality of brainstorm output by evoking competitive game behavior that stimulates competitive conflict behavior. For a positive transfer effect on productivity, governing rules need to provide a system of individual performance feedback that stimulates attention to each other's ideas. However, as explained in the introduction, we also expect a negative transfer effect of the quantity of rules within a gamification layer. With an increasing number of game rules, participants are expected to pay more attention to the gamification and reduce their attention to the brainstorm, leading to reduced output quality and quantity. In other words, increased engagement in the game world probably weakens the intended positive transfer effect in the real world.

5.3 Study design

To find the optimal invasiveness of a gamification layer, we developed a game with gold-colored coins (see Figure 5.5) in which participants reward and punish each other for their contribution to the brainstorm by giving and taking coins. Based on the research framework, the game rules were designed to stimulate behavior that would improve brainstorm output. After designing the rules of the brainstorm gamification (described below), 5 rule-sets were defined to achieve variance in invasiveness (see Table 5.1). The rule-sets increased in quantity of rules, with rule-set 1 only containing the basic rules and rule-set 5 containing all rules. Moreover, they varied in quality as to the number of governing, forcing, and embodied rules. The increasing quantity of rules across rule-sets was expected to increase the invasiveness of the gamification. In particular rule-set 2 was expected to raise attention to the gamification due to the large number of additional governing rules. Only the additional rule in rule-set 5 was expected to reduce invasiveness.

The rule-sets were randomly assigned to 10 groups, such that each rule-set was played in 2 sessions. As shown in Figure 5.4, we measured invasiveness of the gamification, brainstorm behavior & engagement and brainstorm output. During the brainstorm, video recording and observations captured the participants' behavior. At the end of a session, participants filled in a questionnaire about their behavior and engagement. To measure brainstorm output, two experts assessed: the number of different ideas, the originality of ideas, and the feasibility of ideas (Christiaans, 2002; Amabile & Pillemer, 2012). One researcher conducted the study by observing the brainstorms live on a monitor and assessing brainstorm output afterwards. A second researcher first assessed the output and observed videos afterwards to avoid biased judgment. To increase the participants' commitment, the five best performing groups would be rewarded with prize money.

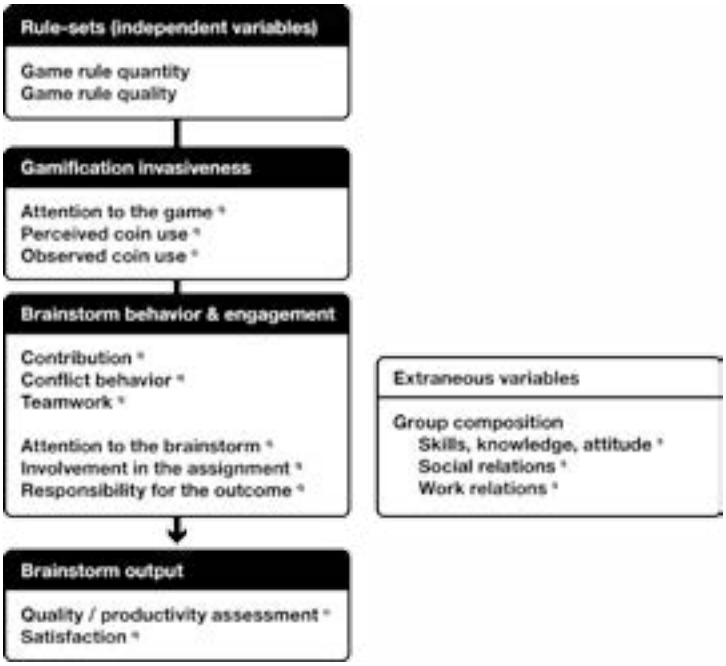


Figure 5.4. Study variables with rule-sets as independent variable and invasiveness, behavior & engagement and output as dependent variables (q: questionnaire, o: observation, s: pre-selection).

5.3.1 Procedure

Ten groups of four design students were asked to participate in a 30-minute brainstorming challenge. One session, including introduction and filling in questionnaires, took approximately 1 hour. Each group was separately welcomed in a neutral room and sat around one table to work on. They received the game material, an instruction sheet and explanation from the researcher about the assessment procedure, distribution of prize money, and the rules of the game. Groups with rule-set 1 received instructions explaining that one could give each other coins for useful contributions to the brainstorm and take coins for criticizing each other's contributions. Groups with subsequent rule-sets received the rules as described in Table 5.1. The rule of taking coins every 5 minutes was announced through an intercom by the researcher sitting in a separate room. In rule-set 5 participants received cups instead of sheets as pools, so they would not see each other's coins.

After the introduction, participants were asked to sign a consent form, stating that they understood the rules and procedure. Next, they would receive several colored pencils, large flip-over sheets, and a description of the assignment. When

Figure 5.5. Design students in a brainstorm session with the coin game (rule-set 4).

participants started to read the assignment, the researcher started a 30-minute timer (not visible for the participants). The assignment consisted of two phases: 1) domain selection, and 2) idea generation. To avoid spending much time on discussing the domain, the groups had to choose a user (elderly, young children, teenagers, professionals), context (hospital, shopping mall, airport, outdoor) and product category (mobility, clothing, tools, entertainment). We assumed that they would choose a domain that would be easy for them, thereby equalizing the influence of prior experiences and interests. After 30 minutes, the participants had to put down their pencils and make final coin transactions if necessary (in rule-sets 4 & 5). Next, they would fill in the questionnaire. When all participants were done, they were debriefed about the purpose of the experiment and again reminded of the procedure for assessing and rewarding their output.

5.3.2 Brainstorm game rules

Participants started with 3 coins (rule 1 in Table 5.1). Pilot tests demonstrated that this number was low enough to make participants carefully consider their transactions and large enough to keep exchange going. The rules explicitly allowed taking and giving (rule 2), and the winning condition was to own the most coins in the end (rule 3). To retain participants from excessively taking coins from each other in order to win, the winning condition was restricted to coins that were given to someone (rule 3a). To clarify this rule, a stock and profit pool was introduced (rule 4). Only received coins go into the profit pool. The start-coins and taken coins had to go into the stock pool (rule 4a). Consequently, the profit pool resembled one's score and the stock pool contained coins that could be used for exchange but would

Table 5.1. Rules of the brainstorm gamification.

Rules	Rule-set 1	Rule-set 2	Rule-set 3	Rule-set 4	Rule-set 5
1. 3 Coins per participant					
2. Give and take coins					
3. Most coins wins					
a. Most coins in profit wins					
4. Stock pool / profit pool					
a. Receive is profit / take is stock					
b. Own stock to profit prohibited					
c. Take from profit, otherwise stock					
5. Take 2 coins every 5 minutes					
6. Stock pool size limit (4 coins)					
7. Stock must be empty at the end					
8. Pools are blinded					

Note. Light grey: embodied rules; medium grey: governing rules; dark grey: forcing rules.

not count as score. Transporting one's own stock coins to one's profit pool was prohibited (rule 4b). Moreover, to keep the exchange going, one had to take coins from the other's profit pool, unless it was empty (rule 4c).

Rule 5 forced the group every 5 minutes to designate 1 participant to take 2 coins. This rule was added because individuals tend to reward good contributions more frequently than they punish bad contributions (Wang, Galinsky, & Murnighan, 2009). As rule 5 would lead to a large increase of coin taking, a size limit was introduced for the stock pool (rule 6) to force participants to give away coins when they had taken many (see Figure 5.6). Moreover, rule 7 obligated participants to give away all stock coins before the end of the meeting. To avoid that participants would become too strategic in exchanging coins (e.g. exchange coins to equalize scores or only take coins from high performing participants), they could not see the state of each other's pools (rule 8). In this way, participants were expected to focus more on rewarding or punishing brainstorm contributions instead of winning the game.

5.3.3 Participants

Eight groups consisted of Master students at the design faculty of the Delft University of Technology. Two groups contained 1 and 2 students with another background.

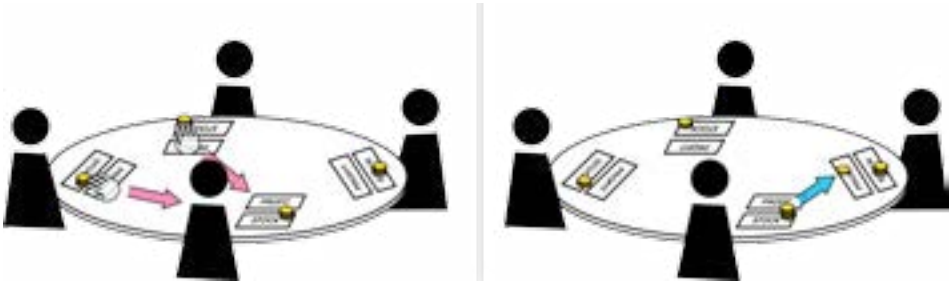


Figure 5.6. Taking 2 coins obliges the 'taker' to give 1 coin because he owns more than 4.

Four groups consisted of only male participants; the other groups were mixed with either predominantly male participants or an equal gender distribution. All participants were familiar with group brainstorming, thus individual experience level and group coherence, important factors for group productivity (Bottger & Yetton, 1987), were expected to be similar. Moreover, all groups consisted of participants that already knew each other in advance, because social factors were expected to play a role. Three groups had worked together before, four groups consisted of friends, and three groups had worked together and were friends.

5.3.4 Measures

Brainstorm output

Brainstorm output measurement reflected the assessment criteria for the challenge. As described above, two researchers performed the assessment. The number of varying ideas assessed productivity. The quality of ideas was assessed by rating the originality and feasibility (scale 1 – 10) of the total set of ideas that were drawn on the paper sheets (see Figure 5.7). For example, brainstorm output containing just 1 highly original idea would be rated higher than 5 moderately original ideas. In this way, quality and productivity were separate measures of brainstorm output.

Observations

As explained earlier, one researcher observed the sessions live on a monitor in a separate room. A second researcher did observations through the recorded videos. The main purpose of the observations was to count coin transactions, marked by direction (giving and taking) and obligation (voluntary and obligatory). While counting coin transactions, the researchers also made qualitative notes on other behavior that stood out, such as long discussions about the rules or the vividness of brainstorm discussions.

Figure 5.7. Brainstorm output. a) Least productive group, b) most productive group.

Questionnaire

After the brainstorm, a questionnaire examined perceived behavior and engagement (see Appendix I). In this questionnaire, first the participants were asked about brainstorm behavior in terms of one's own contribution and contribution of the others. Next, the questionnaire inquired the participants' perception of conflict behavior (criticizing and complementing) and attention to each other (ignoring and noticing). Brainstorm engagement was measured through statements regarding own and others' involvement with the assignment and responsibility for the outcome. Gamification invasiveness was measured through statements about the number of coins used and one's attention to the game. For comparison, the questionnaire also inquired attention to the brainstorm. Next to the main variables, the questionnaire inquired: the coin game's added value, satisfaction with brainstorm output, and quality of the teamwork.

5.4 Results

The data was analyzed in 3 steps (see Figure 5.8). The first step examined the variation in brainstorm output between rule-sets to find effects of the quantity and quality of rules. Secondly, we investigated to what extent the rule-sets led to variation in invasiveness of the gamification and its subsequent effect on brainstorm output. Thirdly, the mediating effect through brainstorm behavior and engagement was analyzed. Before describing the results of each step we describe the data and observations.

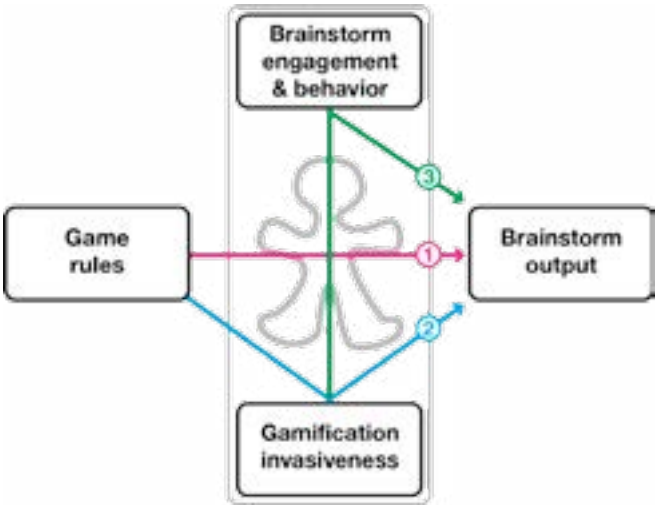


Figure 5.8. Steps of data analysis. 1) The effect of rule-sets on brainstorm output, 2) the mediating effect of gamification invasiveness, 3) the mediating effect through brainstorm engagement & behavior.

5.4.1 Data and observations

Altogether, the groups produced 112 ideas. The most productive group came up with 19 ideas and the least productive group generated 4 ideas (see Figure 5.9). The former group (group 2) quickly started drawing, whereas the latter group (group 7) spent a considerable amount of time on exploring the domain (see mind map in Figure 5.7a). The participants seemed aware of their own approach, as participants of the productive group reported strong engagement with brainstorm output and participants in the unproductive group reported stronger engagement with the process (see Table 10.1 in Appendix II).

The variation in quality of ideas among the groups was relatively small. Groups scored on average 6.0 on originality, with the best performing group scoring 8.0 and the worst performing group 4.0. The average score regarding feasibility was 6.6, ranging between 8.5 and 4.0. The two assessments per group generally matched or just varied by 1 point. Only regarding the originality of ideas of group 4, and the originality and feasibility of group 9, assessments deviated more. In both cases, the drawings were unclear and prone to different interpretations.

Observations suggest that most groups used the coins meaningfully. In the first 5 minutes, half of the groups already exchanged coins voluntarily with comments such as: “good argument, you deserve a coin”. On average, 10 coins were exchanged voluntarily in a session. In sessions with forcing rules, 7 obligatory coin transactions

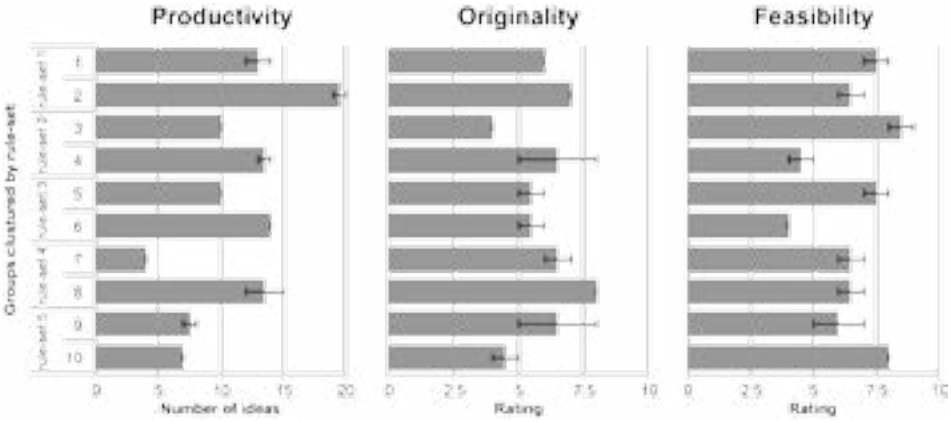


Figure 5.9. Average brainstorm output per group (error bars: SE).

were carried out additional to the voluntary transactions. Figure 5.10 shows the total number of coin transactions during each session, categorized by obligation and direction. Overall, groups with the same rule-set exchanged approximately the same number of coins and thus seem to have followed the given rules. Only the groups with rule-set 5 differ strongly. This could be explained by the fact that group 9 interpreted the obligatory taking moment as the only moment to exchange coins. After a taking round, one participant commented: "this [coin exchange moment] feels like standing in front of a council".

Table 10.1 in Appendix II shows the data of the questionnaire. One questionnaire from group 10 was not filled in properly (all questions were rated equally low) and thus discarded from analysis. To get an initial indication for possible effects we used a MANOVA with all questionnaire elements as dependent variable and the groups as independent variable. The results revealed that groups only varied significantly in perceived coin use $F(9, 39) = 16.94$, $p = .036$, $\eta p^2 = .43$ and attention to the game $F(9, 39) = 13.94$, $p = .004$, $\eta p^2 = .53$. Post hoc comparisons revealed significant differences in attention to the game between groups 3 & 6 ($p = .005$), 3 & 7 ($p = .021$), and 6 & 9 ($p = .021$), which indicate an effect of the rule-sets. For the other items, we found no clear patterns that indicate an effect of the rule-sets. Instead, they reflect common practice in group-brainstorms. Participants were generally positive about one's own ($M = 3.5$, $SD = .82$) and others' contribution ($M = 3.7$, $SD = .75$). They complemented each other more ($M = 3.5$, $SD = .68$) than that they criticized each other ($M = 2.6$, $SD = 1.03$) and the participants reported more noticing ($M = 3.7$, $SD = .83$) than ignoring ($M = 2.4$, $SD = 1.10$).

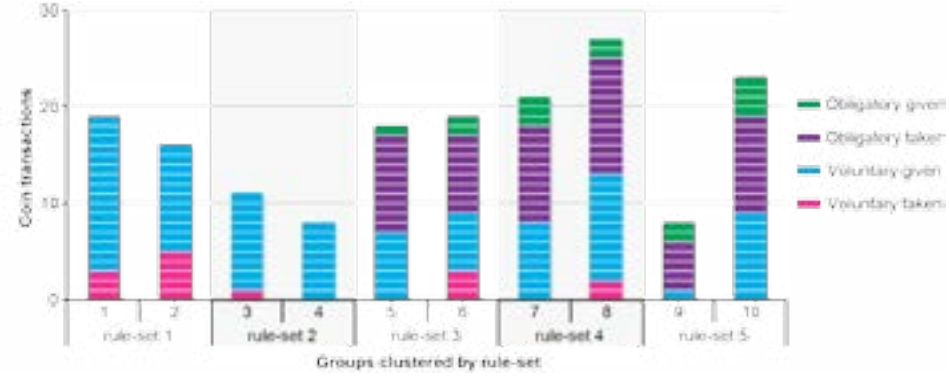


Figure 5.10. Observed coin use per group.

5.4.2 Analysis step 1. Effect of rule-sets on brainstorm output

To examine the effect of the quantity and quality of rules on brainstorm output, we compared output assessments per rule-set (see Figure 5.11). We used a separate one-way ANOVA for each output category with productivity, originality, and feasibility scores as dependent variables and the rule-sets as independent variable. Levene's tests revealed unequal variance in productivity ($p < .001$) and feasibility ($p = .003$), as such Welch's tests were used for productivity and feasibility. Trends in brainstorm output across rule-sets could indicate an effect of quantity of rules and variations between individual rule-sets could indicate effects of rule qualities. We checked for an influence of group composition by analyzing the effect of gender distribution and internal relationships on brainstorm output. The results did not reveal any significant effects of group composition.

The analysis of brainstorm output per rule-set only revealed a significant main effect of rule-sets on productivity Welch $F(4, 6.34) = 9.88$, $p = .007$, est. $\omega^2 = .78$. There was a significant linear trend $F(1, 15) = 15.66$, $p = .001$, indicating that an increasing quantity of rules reduces brainstorm productivity. The productivity graph in Figure 5.11a mainly shows drops between rule-sets 1 & 2 and between rule-sets 4 & 5. This suggests a negative effect of additional governing rules and of blinding the pools. Yet post hoc comparisons, using the Games-Howell post hoc procedure, indicated no significant differences between these individual rule-sets. Thus effects of rule qualities could not be deduced. Consequently, these results only indicate a negative effect of game rule quantity on brainstorm productivity. Brainstorm output quality (i.e. originality and feasibility) was not directly affected.

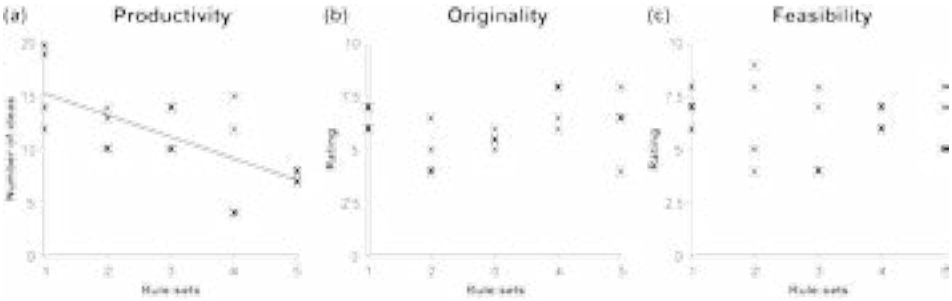


Figure 5.11. Brainstorm output assessment per rule-set (line: significant trend).

5.4.3 Analysis step 2. Gamification invasiveness

Effect of rule-sets on gamification invasiveness

As an increasing number of game rules reduced productivity, we expected that participants experienced increased invasiveness of the gamification across rule-sets. To define and analyze gamification invasiveness; we combined attention to the game, perceived coin use, and observed coin use (α = .91; see Figure 5.12). Observed coin use was transformed to a 1-5 scale (as shown in the y-axis on the right) to resemble the other two items. Moreover, the average rating of attention to the game and perceived coin use was taken because they both seem to have measured perceived invasiveness of using the coins. The variation in gamification invasiveness between rule-sets (see outlined bars in Figure 5.12) was examined using a one-way ANOVA with the rule-sets as independent variable and invasiveness as dependent variable. The results revealed a significant variation in invasiveness as a result of the rule-sets $F(4, 19) = 5.01$, $p = .009$, $\eta^2 = .57$. Post-hoc comparisons, using Tukey's test, revealed significant variation in invasiveness of the gamification between rule-sets 2 & 4 ($p = .004$), indicating that the forcing rules led to a statistically significant increase of gamification invasiveness.

The separate invasiveness items were analyzed to investigate the users' game behavior and experience in more detail. We analyzed the effect of rule-sets on perceived coin use and attention to the game using a MANOVA with the rule-sets as independent variable and all questionnaire elements as dependent variables. The results revealed a significant multivariate effect $F(80,72) = 1.69$, $p = .012$, $\eta p^2 = .65$ with significant variation between rule-sets in perceived coin use $F(4,34) = 5.39$, $p = .002$, $\eta p^2 = .39$ and attention to the game $F(4,34) = 5.04$, $p = .003$, $\eta p^2 = .37$. Post-hoc comparisons revealed significant variation in perceived coin use between rule-

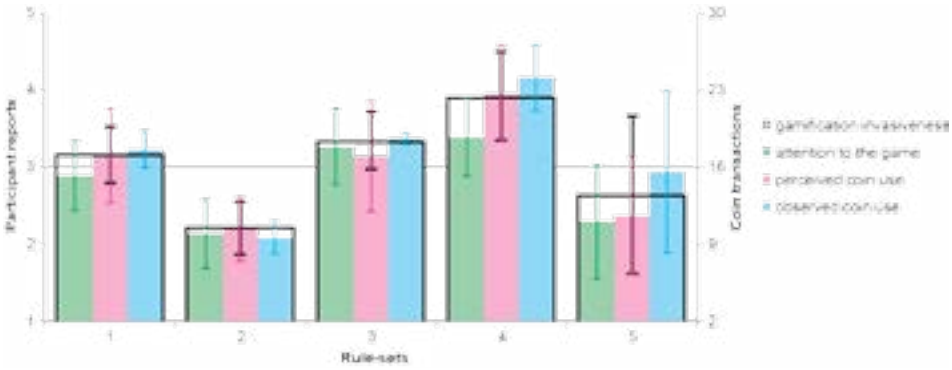


Figure 5.12. Gamification invasiveness per rule-set (error bars black: SD, green/red: 95% CI, blue: SE).

sets 2 & 4 (p = .002) and 4 & 5 (p = .008), and in attention to the game between rule-sets 2 & 3 (p = .022), 2 & 4 (p = .009), and 4 & 5 (p = .036). Hence, next to the positive effect of forcing rules, blinding the pools reduced perceived invasiveness.

The effect of rule-sets on observed coin use was analyzed using a one-way ANOVA with the number of transactions as dependent variable. The analysis revealed no significant variation, probably due to the low number of brainstorm sessions per rule-set. We did find significant variation when separating coin exchange in directions (i.e. giving and taking). The results revealed a significant variation between rule-sets in the number of taken coins Welch $F(4, 2.37) = 28.95$, p = .021, est. ω^2 = .92. Post hoc comparisons, using the Games-Howell post hoc procedure, indicated that rule-set 3 led to significantly more coin taking than rule-set 2 (p = .015), which is explained by the forcing coin taking rule in rule-set 3 (rule 5 in Table 5.1).

Effect of gamification invasiveness on brainstorm output

As the invasiveness of the gamification did not vary strongly, analyses of the effect of invasiveness on output did not reveal significant results. To get an indication of possible transfer effects, we exploratively examined the relationship between invasiveness and brainstorm output by calculating correlations. The results, shown in Table 5.2, indicate that overall invasiveness did not relate to brainstorm output. Yet the separate invasiveness items do reveal significant correlations. We found a strong and significant positive relationship between perceived coin use and originality. Groups that perceived more coin use generally scored higher on the originality of their ideas (see Figure 5.13a). Moreover, the observed number of voluntary taken and obligatory given coins correlated significantly with productivity. Voluntary

Table 5.2. Correlations between gamification invasiveness and brainstorm output (N = 10).

	Productivity		Originality		Feasibility	
	r	*p*	*r*	*p*	*r*	*p*
Gamification invasiveness	-.018	.961	.378	.282	-.133	.714
Attention to the game	.176	.626	.416	.231	-.466	.174
Perceived coin use	.169	.640	**.692*** Fig.5.13	**.027**	-.262	.464
Observed coin use	-.046	.900	.201	.577	.213	.554
Voluntary given	.394	.260	.036	.921	.409	.240
Voluntary taken	**.829****	**.003**	.292	.413	-.139	.702
Obligatory given	**-.646***	**.044**	-.066	.856	.016	.965
Obligatory taken	-.468	.172	.140	.700	-.004	.992

Note. ** p < .01; * p < .05.

taking related positively to productivity, suggesting that competitive game behavior may have stimulated idea generation. Obligatory giving correlated negatively with productivity, which indicates reduced productivity due to obligatory transactions.

5.4.4 Analysis step 3. Brainstorm engagement and behavior

To examine the mediating effect of brainstorm engagement and behavior, correlations were calculated as well (see Table 5.3). The correlations with attention to the game and perceived coin use were calculated using the questionnaire data per participant (*N* = 39). The other correlations used averages per group (*N* = 10). The correlations with perceived brainstorm behavior revealed significant relationships with contribution, criticizing, and collaboration. Self-reported contribution to the

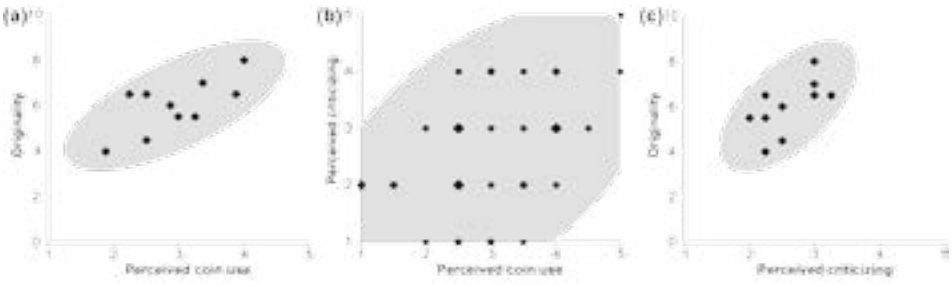


Figure 5.13. Significant correlations signifying a positive transfer effect on brainstorm output quality. a) Perceived coin use and originality (N = 10), b) perceived coin use and perceived criticizing (N = 39), c) perceived criticizing and originality (N = 10).

Table 5.3. Correlations ($p < .20$) of perceived brainstorm behavior & engagement with brainstorm output and gamification invasiveness.

	Brainstorm behavior						**Brainstorm engagement**			
	Contribution	**Complement**	**Criticize**	**Ignore**	**Notice**	**Collaboration**	**Attention to the brainstorm**	**Own engagement with the process**	**Own engagement with the output**	**Satisfaction with brainstorm output**
Productivity				.478						
Originality	-.464		**.633*** Fig.5.13c							
Feasibility	**.797****				-.621					
Gamification invasiveness						-.465				**-.660***
Attention to the game										
Perceived coin use			**.478**** Fig.5.13b					.241	-.212	
Observed coin use		-.451								**-.826****
Voluntary given	.587						**.650***			
Voluntary taken				.603		**-.726***				
Obligatory given		-.498					-.510	-.558		**-.666***
Obligatory taken									-.512	-.619

Note. ** $p < .01$; * $p < .05$; italic = individual-level correlations (N = 39); non-italic = group-level correlations (N = 10)

brainstorm related positively to feasibility, indicating that the participants assessed their contribution mainly on feasible output rather than on original output. Criticizing correlated positively with originality (Figure 5.13a). Thus in sessions where participants perceived more critique, the output was more original. This supports the expected positive effect of competitive conflict behavior on brainstorm output (Badke-Schaub, Goldschmidt, & Meijer, 2010). Interestingly, criticizing also correlated significantly with perceived coin use (Figure 5.13b), indicating that increased coin exchange evoked competitive conflict behavior. Moreover, perceived

collaboration correlated negatively with voluntary taking, suggesting that coin exchange reduced collaborative conflict behavior as well.

The correlations with brainstorm engagement only revealed significant relationships with gamification invasiveness. Attention to the brainstorm correlated positively with voluntary giving, suggesting that groups that were more occupied with the brainstorm gave each other more coins without being forced by the rules. Conversely, obligatory transactions only revealed negative correlations, suggesting that obligatory game behavior distracted participants from brainstorming. Moreover, significant negative correlations with output satisfaction suggest that the gamification made participants feel less satisfied with the output.

5.4.5 Summary of the results

In summary, we found a significant linear negative trend in productivity across rule-sets, indicating a negative effect of rule quantity on brainstorm productivity. The analysis of gamification invasiveness revealed that the forcing rules, in contrast to governing rules, significantly increased the invasiveness of the gamification. Subsequently, significant correlations between separate invasiveness items and brainstorm output suggest that the invasiveness of the gamification did affect brainstorm output. Perceived coin use correlated positively with originality and voluntary coin taking correlated positively with productivity. Conversely, obligatory coin giving correlated negatively with productivity.

The analysis of brainstorm behavior revealed significant positive correlations between perceived criticizing and perceived coin use as well as originality. Moreover, contribution positively related to the feasibility of brainstorm output. Correlations between brainstorm engagement and gamification invasiveness mainly revealed negative relationships between obligatory coin exchange and brainstorm engagement as well as negative relationships between overall gamification invasiveness and satisfaction with brainstorm output.

5.5 Reconsidering the research framework

To better understand the effects of game rules, we used the experimental data to reconsider and revise the initial research framework (Figure 5.3). As explained below, the revised framework (Figure 5.14) describes positive and negative transfer effects based on the above-described experimental results.

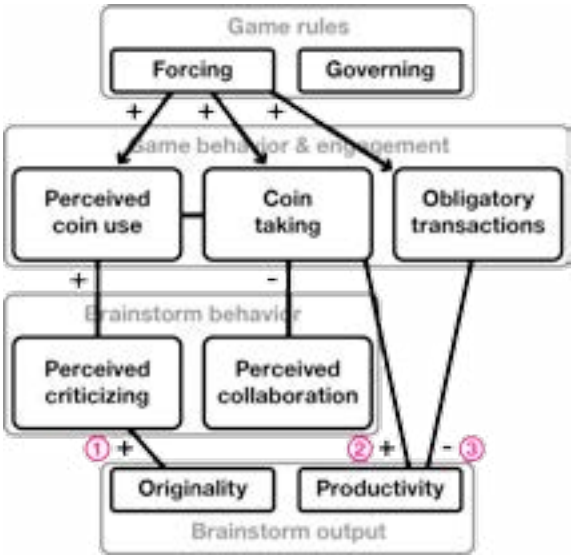


Figure 5.14. Revised framework based on experimental results. 1) Significant positive transfer effect of forcing rules on originality, 2) significant positive transfer effect of voluntary competitive game behavior on productivity, 3) significant negative transfer effect of forcing rules on productivity.

5.5.1 Positive effects of the gamification

The forcing rules seem to have positively influenced the originality of brainstorm output by evoking competitive behavior in the brainstorm (see nr.1 Figure 5.14). Forcing rules significantly increased perceived coin use and perceived coin use was on its turn positively related to originality (Figure 5.13a). The analysis of questionnaire data revealed that this positive effect was mediated by perceived criticizing because it correlated positively with perceived coin use and originality (Figure 5.13b-c).

Additionally, coin taking related to reduced collaboration and improved productivity (nr.2 Figure 5.14). This was, however, not caused by the forcing rules, because only the number of voluntarily taken coins correlated significantly with collaboration (see Table 5.3) and productivity (see Table 5.2). The data does not show a significant relationship between collaboration and productivity, yet literature suggests that intense collaboration can reduce productivity because participants need to wait for their turn to talk (Paulus, Leggett Dugosh, Dzindolet, Coskun, & Putman, 2002). Hence, we assume that coin taking led to increased productivity by reducing collaborative behavior.

5.5.2 Negative effects of the gamification

The negative trend in productivity across rule-sets (Figure 5.11a) could only partly be explained by the research results. The linear reduction indicates a negative effect as a result of the quantity of rules. The correlations between observed coin use and brainstorm output (Table 5.2) suggest that obligatory transactions and thus the forcing rules may have hindered idea generation (nr.3 in Figure 5.14). Yet the data did not fully support this, because only voluntary taking and obligatory giving correlated significantly with productivity (see Table 5.2).

When inspecting the reduction of productivity across rule-sets in Figure 5.11a more closely, we conclude that obligatory transactions were not the only cause for production blocking. The data mainly shows drops in rule-sets 2 & 5, where obligatory transactions had no or reduced influence (see Figure 5.10). Instead, in both rule-sets, gamification invasiveness dropped along with productivity. This suggests that the rules that were introduced in rule-sets 2 & 5 not only hindered participants in producing ideas but also in using the coins.

5.6 Discussion

This article presented an experiment that investigated positive and negative effects of adding game rules to group brainstorms by examining the participants' behavior and engagement during gamified brainstorms. In these gamified brainstorms participants could reward or punish each other by giving or taking golden coins. Game rules were designed to stimulate competitive conflict behavior and attention to each other by forcing and governing game behavior. According to literature, this would be beneficial for the quality and quantity of brainstorm output. Yet we also expected that increased engagement with the gamification would probably weaken brainstorm performance. In a between-group experiment, brainstorm groups received different rule-sets to investigate to what extent the invasiveness of the gamification affected their originality, feasibility, and productivity. Moreover, the behavior and engagement of participants were measured to gain a better understanding of how the rules influenced brainstorm output.

The results of the experiment demonstrate that voluntary competitive game behavior (i.e. coin taking) related to reduced collaboration in the brainstorm and increased productivity. This suggests that rules that simply allow for game-like competition could already be beneficial for brainstorm output quantity. Additionally, the quality of brainstorm output improved as a result of rules that forced competitive game behavior. The forcing rules significantly increased invasiveness of

the gamification and were related to competitive brainstorm behavior and a higher originality of ideas.

The forcing rules also seem to have had a negative effect on brainstorm productivity. In general, the quantity of rules had a negative effect on the number of produced ideas and further analysis suggested that this was caused by mandatory game behavior (i.e. behavior that was forced by the rules). However, we observed the major productivity drops in brainstorm sessions where the forcing rules had no or reduced influence. Instead, the invasiveness of the gamification dropped along with productivity. These drops occurred in sessions where the rule-sets contained governing rules (rule-set 2) and a rule that blinded the participants' score (rule-set 5). The latter rule was indeed intended to reduce invasiveness, yet with the assumption that it would increase engagement with the brainstorm and improve productivity. Oppositely, the governing rules were indeed expected to reduce productivity, yet as a result of an increased invasiveness of the gamification. Instead, in both cases the rules led to discussions that were irrelevant to the brainstorm, thereby hindering idea generation as well as coin exchange.

Regarding the positive effects of the gamification, the results support our initial assumptions. The found negative effects, however, contradict our expectations. Based on Visch et al. (2013), we initially assumed that increased invasiveness of the gamification would reduce engagement with the brainstorm (see Figure 5.1). Yet the experiment suggests that a user's game world and real world experience are not directly linked. Instead, gamification may lead to a game world experience that exists next to- or independent from a user's real world experience and the strongest positive as well as negative effects were found where both types of experience were high.

To achieve a strong game world experience as well as real world experience, we need to gain a better understanding of gamification invasiveness. This was an important secondary aim of the experiment because it is generally overlooked in gamification literature (Hamari, Koivisto, & Sarsa, 2014). Most gamification studies raise the issue of user consent, i.e. the extent to which users accept a gamification layer. The results of our experiment suggest that the invasiveness of a gamification layer could be the underlying mechanism for the consent of users. Users seem to abandon the gamification to reduce its invasiveness if the game rules do not fit their real world goal, such as high quantity and quality of ideas during brainstorm sessions. However, this not only reduces gameplay but also hinders real world performance.

To avoid this dual negative effect, the game rules need to fit the real world context and be as little invasive as possible. In the present experiment we mainly

found evidence for behavioral invasiveness, as described by the revised framework (Figure 5.14). Yet the data suggests that other types than behavioral invasiveness are experienced as well. As described by the model in Figure 5.15, the distracting effect of governing rules and blinding scores indicates cognitive invasiveness (see Figure 5.15). Additional governing rules demand understanding and decision making from the participants and blinding the scores demands memorization. Moreover, the positive effect of forcing rules on brainstorm quality may be explained by affective invasiveness (e.g. a playful attitude). In our experiment, all positive effects were related to competition, which in the collaborative context of a group brainstorm made participants probably more playful, leading to increased creativity (Amabile & Pillemer, 2012).

As to affective invasiveness, framing (Bateson, 1972; Goffman, 1974) a brainstorm as a game may already have an effect on creativity. The game-like nature of giving each other feedback through coins may have reduced evaluation apprehension just like a temporary identity reduced it (Jung, Schneider, & Valacich, 2010). Moreover, coin exchange may have framed personal criticism, thereby reducing the negative impact of affective conflict (Jung & Lee, 2015). In the current setup of our experiment, the effect of framing could not be examined, yet the positive correlations between gamification invasiveness and output originality (see Table 5.2) do hint towards a framing effect.

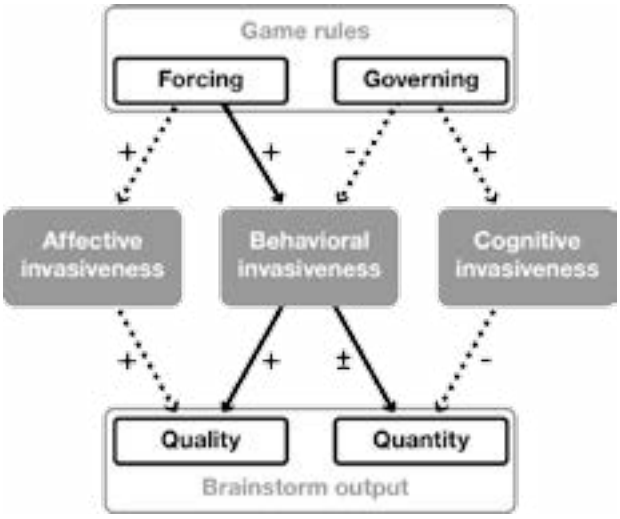


Figure 5.15. The invasiveness of game rules and its effect on brainstorm output (straight lines: supported by data, dashed lines: not supported by data).

5.6.1 Limitations

Due to the low number of groups per rule-set; direct effects of particular rule-sets on brainstorm output remain speculative. Regarding their effect on gamification invasiveness we can be more certain, as the effects were coherent within rule-sets and significantly different between rule-sets. Accordingly, the correlations with gamification invasiveness items (i.e. attention to the game, perceived coin use, observed coin use) can be regarded to reflect true relations. The effect of the rules through specific coin exchange categories should be interpreted more carefully, because the variation between groups and rule-sets was small and generally not significant.

Moreover, the causal effect of coin exchange categories remains questionable. For example, a group might have been more competitive by nature and therefore have taken more coins from each other. Consequently, coin exchange may have reflected a group's brainstorm process, rather than influence it. Thus, again, effects from coin exchange categories should be interpreted carefully and subsequently the assumed influence that the game rules may have had.

The fact that the participants in the present experiment were design students may have weakened the positive effect of the gamification on brainstorm output due to a ceiling effect. The participants probably already adopted a playful attitude because they knew they were going to have a brainstorm. Thus the positive affective invasive effect may have been negligible. A group of participants without a design background, such as managers in a company, might benefit more from the gamification because the affective effect will be stronger.

Moreover, the goal, task, and timeframe of the brainstorm may have influenced the effect of the gamification. In the present experiment, time was short and the brainstorm's goal was relatively ambiguous, i.e. focusing on quantity as well as on quality. The short timeframe might explain the fact that we only found significant effects of the straightforward forcing rules, as opposed to the governing rules that require more learning time. The ambiguous brainstorm goal may have reduced the positive transfer effect of giving each other feedback through coins, because the attribution of the feedback was often not clear. If the brainstorm would have been aimed at only generating feasible ideas, for example, coin exchange may have improved the feasibility of brainstorm output.

5.7 Conclusion

In conclusion, we could deduce two negative and two positive transfer effects from the experimental data: 1) competition in gamification increased the quality of brainstorm output, 2) voluntary competition led to increased brainstorm output quantity, 3) obligatory behavior in the gamification reduced the quantity of brainstorm output, and 4) discussion about the rules reduced quantity as well. Overall, in the present coin game, competitive game behavior improved the quality of brainstorm output at the cost of productivity. Hence, to arrive at an optimum for brainstorm output, a gamification layer should stimulate competition, yet avoid discussable governing rules and limit mandatory game behavior.

To design an effective gamification, the quality of game rules seems more important than the quantity. Forcing rules were found to be beneficial because they were easy to learn. This explains their positive effect in the present experiment, because groups played the gamification for the first time. The governing rules apparently required too much learning for this particular experiment.

5.7.1 Lessons learned for gamification design and research

To reduce the learning curve, the rules should be defined clearly. One way to achieve this is by embedding all rules into objects. For example, the coins could be visually marked as given or taken in order to ease enforcement of the rules related to the stock- and profit pool (rule 4a-c in Table 5.1). Another solution could be to transform these rules into forcing rules (i.e. procedures) by digitalizing the game and automatically place given and taken coins in their respective pool.

The distinction between behavioral, cognitive, and affective invasiveness not only provides a model for anticipating on positive and negative transfer effects of a gamification, they can also be used to define the level on which you want to impact a non-game situation. As explained before, simply putting game-like artifacts on the table can lead to positive affective invasiveness. Adding a game system, such as rules governing coin exchange, makes a gamification cognitively invasive. In brainstorms this is detrimental, yet in other situations cognitive invasiveness might have a positive effect, such as making conscious decisions about your health. Steering users towards, for example, competition increases behavioral invasiveness in a generally collaborative setting such as a brainstorm. Yet a gamification may be much less behaviorally invasive if game and non-game behavior are aligned.

In gamification research, we would recommend to measure the different types of invasiveness separately. Ideally, behavioral invasiveness should than only be

measured through behavioral data. Cognitive and affective invasiveness are more difficult to separate, because both generally rely on self-reporting. Yet cognitive invasiveness may also be measured through transcriptions of communication or by counting speaking time about the rules of a gamification.

5.7.2 Future research

Based on our research framework, we see opportunities for gamification research on three levels: game rules, user experience & behavior, and real world output. Regarding game rules, our findings suggest that rule qualities should receive more attention in gamification research. In this article we distinguished rules in their quality of obligation, yet in other contexts other qualities may be relevant, such as being open-ended or goal-driven.

Regarding brainstorm output, our research demonstrated an improvement in the originality of ideas. Yet within the process of product development originality is mainly beneficial at the beginning. An interesting follow-up question would be: do gamified brainstorms eventually lead to better products? In some cases, the feasibility of ideas may be more important, which was not influenced or even reduced by the gamification in our experiment. To gamify a full design process one should probably design separate gamifications for each part that requires a different attitude from the user.

The main take-away of this article is probably that understanding the dynamics within a gamified situation provides a much broader and deeper understanding of the transfer effects of a gamification. Behavioral, cognitive, and affective invasiveness allowed us to capture all behaviors and experiences of users that are relevant for understanding and optimizing a gamification to achieve its intended real world goal.

6

Game design for team meetings: discovering implications from implementation in the field

In the previous chapter, we explored the use of game rules and objects for team performance in a controlled lab setting. This chapter investigates the use of game elements at real-life team meetings to discover implications from implementation in the field. We executed a pilot intervention study at meetings of occasional teams (Red Teams) at a management consultancy firm. In this chapter, the main focus is on the gamification design process and the pilot study setup. The pilot study results suggest that the tested gamification was successful in evoking a positive gameful experience, yet participants doubted to what extent they would be motivated by the coin game in the long-term. The design process taught us that reviewing teamwork processes as if they are a game provides valuable insights for gamification as well as for possible improvements in the teamwork process itself. Moreover, gamification design could be applied in the study design by integrating the effect evaluation in the gamification concept.

6.1 Introduction

The previous chapters taught us many lessons for the application of game elements in non-game teamwork contexts. This chapter describes a pilot test of gamifying so-called 'Red Team meetings' at a business consultancy firm to discover implications of applying these lessons in the field. Red Teams originate from the American army to independently challenge plans, operations, concepts and capabilities in the context of the operational environment (Mulvaney, 2012). The original aim of a Red Team is to view a problem from the adversary or competitor's perspective, thereby enhancing decision-making processes (Matesk, 2013). Nowadays, red teaming is more widely used in organizations, for example by contracting hackers to challenge software development.

In the studied consultancy organization, Red Teams are aimed at boosting creativity in writing project proposals to raise the chance of winning tenders. Procedurally, in this organization, it is compulsory to schedule a Red Team meeting for tenders with large budgets. This is supposed to be done within several hours after the tender has come in. Yet in practice employees are hesitant to schedule them, because the individual as well as collective benefits are unclear. Moreover, within this short timeframe it is hard to develop a common ground and define an appropriate way of working.

To promote Red Teams and improve their effectiveness, the management considered gamification a promising method. They expected that additional game-like motivational elements could increase participation and as a result enhance the Red Teams' positive impact on the quality of project proposals. To develop an effective gamification of Red Team meetings, we applied the lessons learned from the previous chapters of this dissertation.

In chapter 2 we explored the application of game elements at a steel production factory. After implementing a game-like performance dashboard for operators, the results of the effect study suggested that gamification is mainly a matter of transforming implicit work elements into explicit game elements. The work-related elements that were directly addressed by the gamification (i.e. key performance indicators and personal information) received increased attention from the workers, while the attention for other elements did not change, such as interdependence and work-related communication. Hence, gamification could improve work processes by amplifying elements that benefit the outcome. Consequently, to achieve improved outcomes, thorough analysis of the work process and the workers' motivations is crucial.

Chapter 3 combined organizational teamwork and game design literature, concluding that teams could benefit from competitive and cooperative rules that increase the feeling of interdependence. It showed that, according to conflict management theory, cooperative as well as competitive strategies could benefit teamwork depending on the situation. In chapter 4 we demonstrated that a single goal-driven game rule can steer players towards cooperative or competitive behavioral strategies. The interaction rules within a game seemed mainly related to the intensity of feeling interdependent, whereas goal-driven rules directed players towards competition or cooperation. Hence, applying goal-driven game rules in a business teamwork context was expected to be an effective intervention for steering teams towards strategies that are beneficial for their performance.

Following this assumption, chapter 5 described a lab experiment in which we explored the use of game rules to steer the strategies of brainstorming groups in order to improve their output. Literature suggested that increased competition would improve creativity, thus we developed game rules that evoked competitive behavior. The results demonstrated that game rules that stimulated competition indeed improved the quality of ideas, yet the rules' invasiveness reduced output quantity. To better understand the negative invasive effect, we distinguished behavioral, cognitive, and affective invasiveness. We found that additional game behavior reduced the time spent on idea generation. Yet the strongest negative effect appeared to originate from trying to understand the game rules, i.e. cognitive invasiveness. This negative cognitive invasive effect was mainly caused by rules that require decision making, i.e. governing rules. Forcing rules just led to behavioral invasiveness.

In conclusion, to develop an effective gamification strategy for Red Team meetings, we had to analyze the employees' motivations and work processes to find the right work elements to be gamified. To develop meaningful game elements, we needed to focus our analysis on the interdependence among team members and their competitive and/or cooperative strategies. Next, we had to design and balance the game rules such that negative invasiveness would be minimized, based on the rule qualities described by chapter 4 and 5.

In the following sections, we describe four cycles in developing the gamification of Red Team meetings in more detail: analysis, design, implementation, and evaluation (see Figure 6.1). The analysis cycle revolved around finding implicit work elements in the meetings and working procedure that could be gamified, leading to a model for gamification (see Figure 6.3). During the design cycle, we first proposed game elements for different levels of interdependence within a Red Team

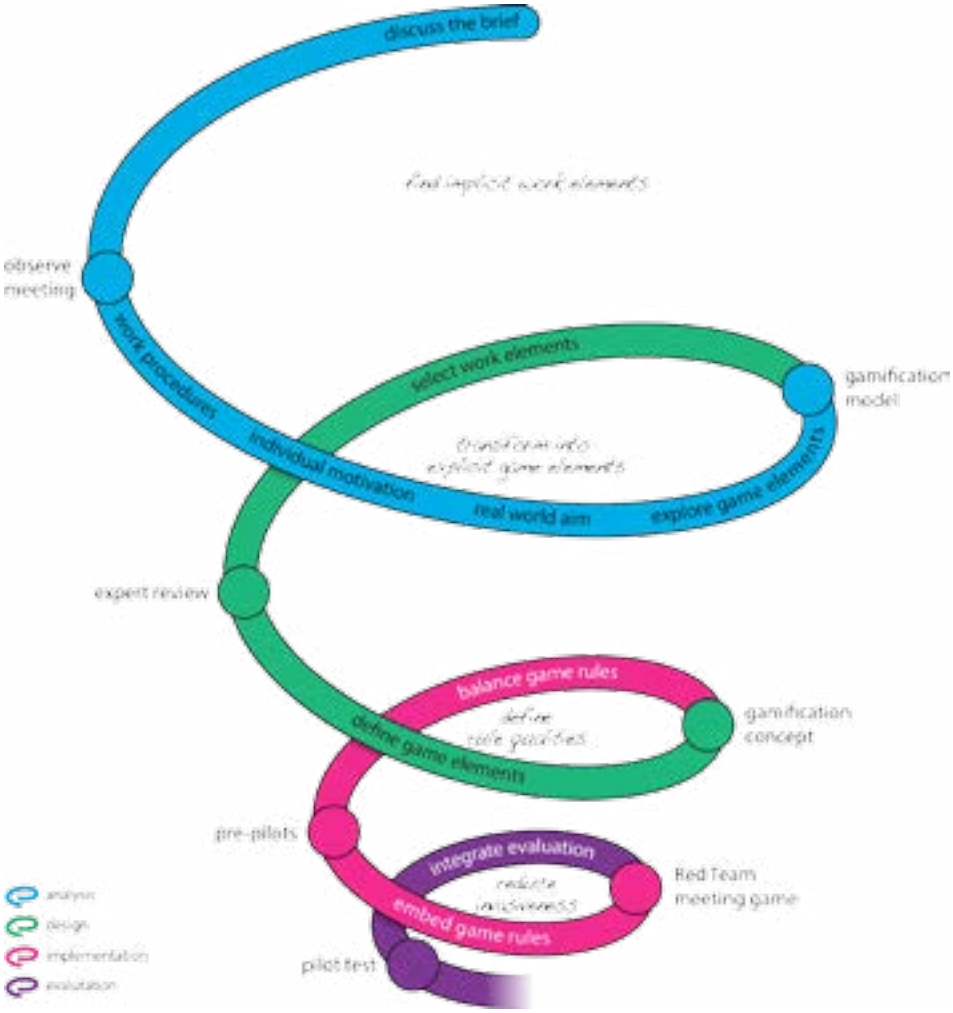


Figure 6.1. Cycles in the process of designing a gamification for Red Team meetings revolving around lessons learned in previous chapters.

and reviewed them with experts to select work elements that would be feasible to gamify. Next, the selected elements were transformed into game elements, resulting in a gamification concept. In the implementation cycle, pre-pilot tests were done to balance the rules and design the game objects that embodied the rules. The evaluation cycle mainly revolved around reducing the invasiveness of the test setup by integrating the evaluation method in the gamification.

6.2 Analysis cycle: find implicit work elements

The gamification design process started by discussing the assignment with the consultancy firm's management. They assumed that gamification would be an interesting method to improve the impact of their Red Team meetings to increase the employees' motivation to attend them. Yet it was not exactly clear why employees were initially hesitant in attending them. Thus we first needed to find the participants' (lack of) motivation regarding Red Team meetings. After observing several Red Team meetings, it became clear that the employees' motivations could not be understood without knowing the overarching procedure of writing and submitting a proposal (see Figure 6.2). We therefore first describe the overall proposal writing process based on observations and interviews.

6.2.1 The proposal writing process

When a tender has reached the company, a project leader is assigned to send out an invitation for a Red Team meeting to discuss the tender (see Figure 6.2). Generally, 10 employees are invited to join the Red Team and the meeting is held shortly after the tender has come in, ideally within several hours. The invitees can accept or resign the meeting invitation, so the composition of the team strongly varies. Ideally, the team consists of employees from different divisions, covering a variety of expertise and experience. This should ensure that alternative perspectives are discussed. Moreover, conflicting perspectives may lead to active reflection within the team, which is known to enhance creativity (Shin, 2014) and reduce team-level biases and errors in decision-making (Schippers, Edmondson, & West, 2014). In many cases, however, not all invitees show up, resulting in gaps in the expertise of the team. For example, in one meeting all invitees with a legal background rejected the invitation, so the legal aspect of the tender could not be discussed.

Participants get to read the tender beforehand. During the meeting the team reviews all aspects of the tender. In the beginning the agenda is introduced and someone is assigned to take minutes. Next, they discuss the aims and feasibility of the tender and brainstorm about approaches that could achieve the aims. Additionally, the members exchange ideas, opinions, anecdotes, and interpretations.

At the end of the meeting each member's individual contribution to writing the proposal is discussed, including possible contributors that could not attend the Red Team meeting. A selection of the Red Team continues as the writing team (white puppets in Figure 6.2). The writing team members divide tasks to separately fill in parts of the document, guided by a structure that is generally provided by the project

Figure 6.2. Phases in the ideal proposal writing process at the management consultancy firm.

leader. Halfway the deadline of submitting the proposal, the writing team meets again to discuss the draft proposal and schedule the remaining tasks. Then the final proposal is submitted and the team waits for the outcome. When the tender is won, the project leader assigns an acquisition percentage to the employees that were in the writing team. This acquisition percentage partly defines the individual performance of the company's employees. They are assessed on the amount of budget they bring in (i.e. acquisition) and the amount of budget they spend (in terms of working hours).

6.2.2 Individual motivations

By reviewing observations from the perspective of the overall writing process, we deduced several motivations for attending a Red Team meeting: the Red Team's social atmosphere, pressure from colleagues, interest in the topic, and the benefit of Red Teams for the company. New employees, for example, sometimes use Red Team meetings as a networking opportunity to get to know colleagues from other departments. Some members just participate because they were told to or because they work as a team. There were also participants that attended a meeting because they were interested in the topic and some were explicitly asked to bring in their expertise for the benefit of the quality of the proposal.

Yet employees mostly attend a Red Team meeting to fulfill acquisition hours and increase the possibility of taking part in a project. In the observed Red Team meetings, 5 of 10 invitees accepted the meeting request and all of them were going to participate in the writing process. In interviews after the meeting, they explained

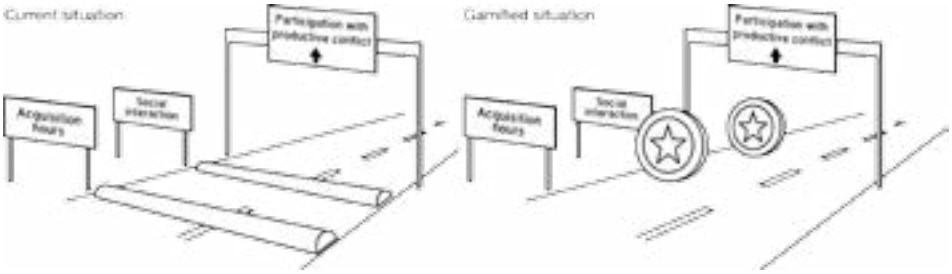


Figure 6.3. In the current situation motivations from employees are barriers for participation and conflict in Red Team meetings. In the gamified situation these barriers are transformed into game elements.

that each employee is responsible for his or her own acquisition and project hours. As a result, they basically compete for the available project and acquisition hours. According to the participants, this plays a role in their decision to attend a Red Team meeting. According to literature, such personal goals generally reduce motivation to contribute to meetings (Barron, 2003).

As a result, accepting a Red Team invitation implicitly implies participation in the writing team, because without partaking in the writing team they cannot earn acquisition hours. Yet committing to writing involves a risk, because one might invest much time without receiving any acquisition hours if the tender is not won. On the other hand, the members of a Red Team just risk investing time in a 1½-hour meeting. In practice however, the implicit implications of accepting a Red Team request seem to lead to invitation rejections, because employees seem to decide if they want to partake in the proposal writing process before accepting the Red Team invitation.

The employees that do attend a Red Team meeting want to get along well, because they assume they will work together on the proposal. As a result, the atmosphere is amicable and conflicts are avoided. In the observed meetings, the tender was reviewed in a relatively unstructured fashion. Moreover, team members speak mostly independently from each other. They mainly share their thoughts rather than actually debate a topic. In the interviews after the meeting, members acknowledged the independent and unstructured process of the meeting by calling it “organic”.

In conclusion, acquisition hours appear to be the dominant motivator, leading to small Red Teams and conflict avoidance. Employees decide if the tender is worth the effort before accepting a Red Team invitation and the resulting Red Team generally consists of members that want to get along well.

6.2.3 Real world aim of the gamification

From the analysis we concluded that the employees' motivations for attending a Red Team meeting are not well aligned with the conditions for an effective Red Team (see Figure 6.3). To achieve more effective Red Team meetings, the gamification should transform the individual motivators into game elements that: 1) stimulate participation of employees that will not partake in writing the proposal, and 2) stimulate and regulate conflict during the meetings.

Firstly, stimulating participation should ensure that more perspectives than the proposal writing team can address are reviewed at a Red Team meeting. Moreover, if the Red Teams are considerably larger, an active selection process from Red Team members could improve the composition of the writing teams. This might as well evoke a competitive atmosphere, which is known to improve creativity (Badke-Schaub, Goldschmidt, & Meijer, 2010).

Secondly, the gamification should stimulate conflict that is beneficial for teamwork (Jehn, 1995). If conflicts become personal and emotional they can be detrimental (Wu, Ferris, Kwan, Chiang, Snape, & Liang, 2015), yet task-related conflict improves creative group processes (Jung & Lee, 2015). Moreover, social interaction often absorbs the individuals, thereby reducing engagement with the collective outcome (Argyle, 1991) and leaving the approach during the meeting unclear (Hackman, 2002). This generally reduces the individual motivation to contribute to meetings (Hackman & Morris, 1975). Thus the gamification should stimulate task-related conflict and regulate conflict strategies to reduce distracting social interaction.

6.2.4 Exploring gamification opportunities

After defining the aim of the gamification, we reviewed game elements that could possibly achieve increased participation and productive conflict. In general, meetings can be structured by intervening in the content or in the process. To influence the content, topics can be introduced, such as "Oblique Strategies" (Eno & Schmidt, 1975), or participants can be stimulated to adopt a particular perspective, as in "Innovation Games" (Hohmann, 2007). On the other hand, game elements can influence the process of a meeting by providing real-time feedback (DiMicco, Pandolfo, & Bender , 2004; Tausczik & Pennebaker, 2013) or enforcing phases and procedures (Gray, Brown, & Macanufo, 2010). In "Design Games" (Brandt & Messeter, 2004), both the content and process are structured: participants perform brainstorms according to a particular procedure and are stimulated to adopt a user

perspective. In Red Team meetings, the content is very specific and defined by the tender, so we only explored game elements that influence the process.

Each phase of the proposal writing process was addressed to not miss any opportunities that could stimulate participation in Red Team meetings. For example, employee profiles (i.e. avatars) could be introduced to facilitate the invitation process. The profiles should portray each employee's expertise and skill, as well as one's acquisition and project hours. In this way a project leader could easily select suitable candidates for a particular tender and estimate each candidate's willingness. Another idea was to portray the tender as an opponent to emphasize on the challenge of writing a winning proposal. The benefits of a Red Team could than be explained in the light of this challenge. Other game elements we considered were: reward systems, rule sets, quests, direct feedback mechanisms, time pressure, roles, and simulation.

To stimulate and regulate conflict during the meetings, similar game elements were reviewed. For example, explicitly introducing the challenge of coming up with a task division in a game-like manner was expected to emphasize on the selection of the writing team and stimulate competition. Another idea was to assign each participant to a specific role and assess and reward each other's performance in the light of the given (or chosen) role. The roles could be designed to stimulate and regulate conflict.

Eventually, most game elements were considered to be too obtrusive or not feasible to implement. For example, introducing roles would probably interfere with the roles that employees already have and implementing a system with personal profiles would be a major operation given the size of the company (±350 employees). According to Hron et al (2000), simply adding some rules for discussion leads to more coherence in discussions with regard to the completion of topics. Hence, a simple reward system or direct feedback mechanism with some additional rules seemed the most appropriate and feasible game element within the context of Red Team meetings. These elements were considered in the development of a Red Team gamification concept, as described below.

6.3 Design cycle: game elements for Red Team meetings

In the design cycle, we selected the work elements that were going to be gamified and transformed them into game elements. By presenting several gamification concepts to experts within the company, the eventual work elements were selected as well as the game elements that would be added.

As explained before, the main driver for participation in Red Team meetings is the

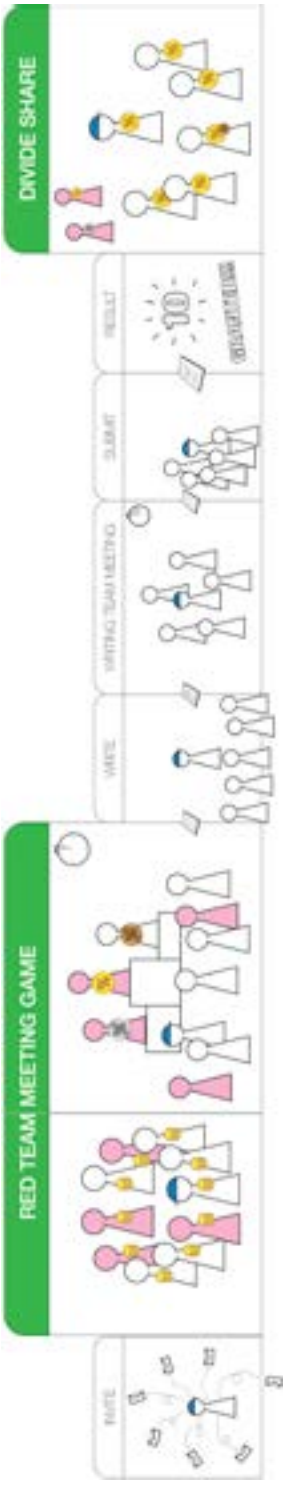


Figure 6.4. Gamifying Red Team meetings in context of the proposal writing process: assess each other by giving coins, awarding acquisition percentage to the best performing Red Team members, dividing acquisition hours among writing team members and Red Team members.

employees' individual performance in spending acquisition and project hours. Thus, we started the design cycle by developing a gamification concept using acquisition percentage. In order to gamify the acquisition percentage, we had to develop a gamification concept that covered the whole proposal writing process, because only when the tender is won, each contributor receives a percentage of acquisition as turnover to his or her individual performance statistic.

We reviewed the proposal writing process as if it were a game. Within this 'proposal writing game' the acquisition percentage seemed to be the object that the participants play with. When employees contribute to a proposal they invest a certain amount of time in acquisition. By accepting a Red Team invitation they agree to spend 1½ acquisition-hours and by partaking in the writing team they spend much more in order to receive an acquisition percentage in the end.

In the original situation, participating in a Red Team meeting would not lead to individual profit. So in the initial gamification concept (see Figure 6.4), participants of a Red Team meeting could win acquisition percentages based on their contribution during the meeting. The participants would assess each other's contribution and the best performing Red Team members would receive a small share of the acquisition percentage. In this way, employees were expected to be more motivated to spend time in a Red Team meeting. Additionally, the competition for acquisition percentages could stimulate conflict and the interdependent assessment on contribution was expected to regulate it.

However, when developing the game rules in more detail, we ran into trouble. Acquisition percentage appeared to be an inappropriate currency in relation to the effort that employees invest in a Red Team meeting. If the acquisition percentage were in proportion with the hours, it would be too low to serve as an incentive to participate. Yet to achieve a percentage that would be worthwhile, it would be out of proportion in relation to actual hours. Thus acquisition percentage could not be used as a reward system for a single meeting. Moreover, relating game elements to such a serious consequence would probably stimulate participants to adopt strategies that serve their individual rather than the collective interest. Hence, relating the gamification to the acquisition percentage was dropped.

Consequently, the assessment of each other's contribution during the Red Team meeting, thereby regulating conflict, remained in the final gamification concept. Teams benefit from being flexible in adopting strategies depending on the situation (Hackman, 1987). Thus the gamification allowed team members to play with different types of meeting contributions, based on conflict management strategies (Thomas, 1992). We defined three types of contribution that members could reward each other for: competitive, cooperative, and supportive contributions. Cooperative and competitive contributions covered assertive strategies. Activities that did not fit these contribution categories were considered to relate to non-assertive strategies and were generally supportive, such as writing minutes or keeping track of time.

Due to dropping the acquisition percentage as a game element, the intended increase in participation was not directly addressed anymore. To still achieve increased participation to some extent, we added a 'Red Team reward' for the participant that had the best assessment of his or her contribution to the meeting. The teams themselves could further specify its value. In this way, the Red Team reward was meant to be a weak incentive to attend more Red Team meetings.

6.4 Implementation cycle: defining the rules

During the implementation cycle, the above-described game elements were designed and two pre-pilot tests were performed in order to balance the game rules and test the participants' understanding and acceptance of the designed game objects.

For the first pre-pilot test, we designed golden coins to facilitate the assessment of each other's contribution. The pre-pilot test was done to see to what extent Red Team members would accept the use of coins during the meeting. In this test, participants were just told to use coins in relation to each other's contribution to the meeting, without any additional rules. This test revealed two issues that could

Figure 6.5. The coins: (red) Red Team, (purple) Good critique, (yellow) Good support, (green) Good idea.

reduce the impact of the gamification. First of all, the participants gave coins to each other regularly, yet they hardly took any coins from each other. Hence, relating critical contributions to coin taking seemed inappropriate. Secondly, the participants distributed the coins equally at the end of the meeting, so no winner could be appointed.

The hesitance to take coins was further examined in the second pre-pilot test at a research consortium meeting. In this test, the game's interaction rules explicitly allowed giving as well as taking to resemble cooperative and competitive contributions. Moreover, the rules forced coin taking each five minutes. As a result, the coin game became a side activity that was totally detached from the meeting. It obstructed the meeting rather than supporting it. Hence, for the final version of the game, we designed different types of coins (see Figure 6.5) and only allowed giving in the game's rules. Based on the three types of contributions, we designed coins with which participants could reward good critique, good ideas, and good support.

The eventual procedure of the gamification was as follows: the participants start the meeting with three coins of each type. They can reward their colleagues at any time during the meeting for good critique, good ideas, or good support. Each participant has a cup in which received coins should be deposited to avoid the groups' tendency to end the game with an equal coin distribution. At the end, the participant with the most coins wins and receives a 'Red Team coin'. After collecting a certain number of Red Team coins they can be exchanged for a reward, such as a bottle of wine or dining voucher.

Figure 6.6. Screenshot of the mobile website for capturing coin exchange. Translation: GOOD IDEA – GOOD CRITIQUE – GOOD SUPPORT. Click the coin at the moment it is being played. Click the Stop button when the meeting is over.

6.5 Evaluation cycle: reducing invasiveness

We evaluated the eventual gamification in a pilot study during actual Red Team meetings at the management consultancy firm. The pilot study had three aims: 1) evaluate to what extent the gamification would be accepted by Red Team members, 2) gain insights in the measurement and meaning of play strategies, and 3) find indications for the effect of the gamification on stimulating participation and regulating conflict.

6.5.1 Integrating evaluation

As the game would be played in a real setting at the company, we had to guarantee it would not negatively influence the meeting. Hence, the study design had to be as little invasive as possible. To achieve this, we developed a measurement method that was integrated in the gamification, instead of having an observer at the meeting or recording the meeting through video or audio. Confidentiality was an important requirement, as Red Team meetings are concerned with winning tenders. Hence,

recording the meeting was not allowed. Moreover, arranging an objective observer for each meeting would be too invasive, because the meetings are scheduled on an ad hoc and irregular basis. So to capture coin exchange, we chose to develop an app on a mobile website at which one of the participants could record coin exchange by tapping the coins that were played (see Figure 6.6).

The recording procedure was as follows: after opening the given URL on a phone, tablet, or laptop, the user had to press Start to mark the beginning of the meeting. With each press on one of the three coins, coin type and timestamp were sent to an online database. The end of the meeting was recorded by pressing Stop, after which the number of participants had to be filled in.

Finally, the website would show a chart depicting all exchanged coins relative to all available coins (see Figure 6.8). This direct visualization of the game behavior was meant for debriefing the pilot test as well as serve as a tool for reflection on the meeting process. Participants could, for example, compare coin exchange graphs from different meetings and thus be motivated to participate at more Red Team meetings.

6.5.2 Pilot study design

The gamification pilot consisted of a box containing: 30 coins of each type, 10 cups, 10 coin explanation cards, several Red Team coins, 1 instruction sheet, 1 dice, and 1 tablet (see Figure 6.7). The Red Team Meeting Game box was available at the secretary of the company. When a Red Team meeting was initiated, the initiator of

Figure 6.7. Red Team Meeting Game box.

the meeting (generally the project leader) could pick it up. Potential project leaders were informed they could use the game for Red Team meetings. In order to induce a game experience the intervention was specifically communicated as a game.

The instruction sheet contained the rules of the game as well as a consent text that the project leader could communicate to all participants. At the beginning of the meeting, each participant received a small card that explained the meaning of the coins (Appendix I). During the meeting the initiator, secretary, or any other participant had to log the use of the coins with a tablet computer, which was included in the game box. At the end, the participant with the most coins would receive a Red Team coin. Furthermore, participants were asked to fill in an online questionnaire. Some participants did this immediately after the meeting; others filled it in one or two days later.

In the online questionnaire (see Appendix II), participants were first asked about their own and others contribution to the meeting and how they experienced critiquing, complementing, and supporting behaviors during the meeting (1 – 5 scale: 1 = very negative, 5 = very positive). Next, they were asked to estimate the influence of the coin game on these elements (1 – 5 scale: 1 = very negative, 5 = very positive) to get an indication for the effect of the gamification on conflict regulation. Finally, they were asked about the clarity of the rules (1 – 5 scale: 1 = fully disagree, 5 = fully agree) and if they would encourage implementing the gamification in every Red Team meeting (yes or no) to measure to what extent they accepted the gamification. Regarding the use of the gamification for every Red Team meeting, they were asked to explain their opinion in a text box.

6.5.3 Pilot study results

Within a period of two months, three Red Teams played the game. The teams consisted of 7 (team 1), 4 (team 2), and 5 (team 3) participants of different compositions. Due to the earlier pre-pilot test, approximately half of the participants in every team had played the coin game before. For an unknown reason, we only received responses from participants from team 1 and 2, resulting in 8 responses. Hence, the coin exchange data as well as the participants' acceptance and opinion about the impact of the coins could only be interpreted in general terms.

Acceptance

The participants found the gamification moderately clear (M = 3.6, SD = 0.9). Five participants indicated that the coin exchange was easy to understand (rating it with

Figure 6.8. The graphs that participants from the three teams saw at the end of the meeting.

4 or 5), whereas two participants rated the clarity as moderate (3) and one found the clarity low (2). The participants that found the gamification relatively unclear were all part of team 1, the largest team with the most coin exchange.

The participants generally responded positively to structural implementation of the coin game in the Red Team procedure. Five of the eight respondents were in favor of truly implementing it. One participant explained that he or she would be in favor of implementation if the gamification would only "*clarify and value different types of contributions*", yet voted against because it also "*stimulates raising your reputation at the expense of others*". One of the participants that disfavored implementation found the gamification of "*too little added value*".

Play strategies

As shown in Figure 6.8, team 1 clearly used the most coins. Of the 63 available coins (i.e. 7 participants with 9 coins each) they used 48 (76%), with an equal distribution across coin types (i.e. 16 critique coins, 16 idea coins, and 16 support coins). Consequently, we suspected strategic coin use that was not related to the meeting's content. Yet the use of coins over time did not support this (see Figure 6.9). Over time, the order of used coin types was mixed, with a peak in coin use halfway the meeting. Hence, the coins seemed to have been used as intended. The distribution of coin use over time at team 2 and 3 suggested serious use of the coins as well. Yet they did use significantly less coins (39% and 44% respectively). At each meeting, single coin transactions were done, indicating that the coin transaction was triggered by a meeting event instead of a game event, such as giving a coin as a response to receiving one.

Even though no more than 3 teams played the game, several patterns in the coin exchange data could be observed (see Figure 6.9). First of all we see that for 2 out of the three teams good critique coins are less used than the other two

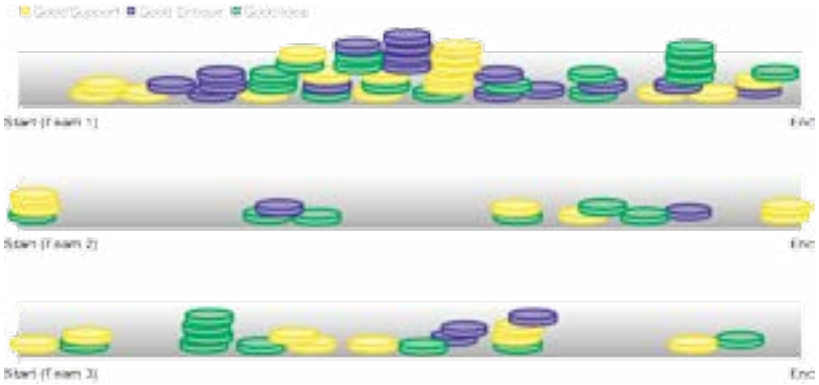


Figure 6.9. Logged coin use over time in the studied meetings (±1½ hours).

coin types, in team 1 coin distribution is equal across the three types of coins. Moreover, it seemed that good critique coins were mainly used in the middle of the meeting. Teams tended to start with good support coins whilst good idea coins were used throughout the whole meeting. These patterns resemble the process that Red Team meetings generally go through, as explained in the analysis cycle. At the beginning mainly supportive contributions are made, such as presenting the agenda and appointing a minutes secretary. When the meeting progresses, discussions arise where ideas and critiques are expressed. At the end of the meeting the amount of critique diminishes because follow-up actions are discussed.

Moreover, the logged number of coin transactions seemed to correspond with the participants' assessment of critique, ideas, and support during the meeting. Team 1 used a large number of coins of each type and accordingly was positive about their critical (M = 3.8, SD = 0.5), complementary (M = 4.0, SD = 0.0), and supportive contributions (M = 4.2, SD = 0.5). Team 2 used the same number of support and idea coins (6), yet less critique coins (2). This was reflected in their opinion about their contribution, as they were less positive about their critical contributions (M = 2.7, SD = 0.6) compared to their complementary (M = 3.7, SD = 0.0) and supportive contributions (M = 4.0, SD = 0.0).

Effect on the meeting

Overall, participants believed that the gamification had a neutral to moderately positive effect on meeting contributions (M = 3.4, SD = 0.7). Team 1 was more positive about the coin game's impact on meeting contributions (M = 3.6, SD = 0.7) than team 2 (M = 3.1, SD = 0.5). The participants from team 2 mainly believed that the gamification would positively influence support (M = 3.7, SD = 0.6), whereas

participants from team 1 were moderately positive about the impact on every type of contribution.

Several participants acknowledged that the coins clarified the value of different types of contribution. They stated that the gamification: "*stimulates a positive critical attitude*", "*forces to focus more on my contribution*", "*challenges to make my contribution better than the others*", and "*helps making feedback explicit*". These reactions suggest that the gamification does stimulate conflict.

The participants seemed generally negative about the long-term impact of the coin game. One participant stated that the gamification "*generates a positive atmosphere, but will not work for ever*". Hence, it might shortly increase participation, yet this effect was not expected to last.

6.6 Conclusion / Discussion

The main aim of the gamification pilot at Red Team meetings was to discover implications of designing and applying game elements in a real-life teamwork context. We discuss the found implications in relation to the design process and in relation to the assumed effects based on the pilot results.

6.6.1 Design process summary

The design process consisted of four cycles: analysis, design, implementation, and evaluation. In the analysis cycle, we searched for implicit work elements that could be used as game elements. After analyzing the writing procedure and observing Red Team meetings we concluded that the main motivators for attending them were acquisition hours and social interaction. Yet these motivators were found to be barriers for participation and productive conflict. By transforming acquisition percentage and conflict into game elements (see Figure 6.3) the aim was to stimulate participation and productive conflict to increase the quality of Red Team meetings.

The design cycle revolved around transforming the work elements into game elements. Conflict was made explicit by direct assessment of each other's contributions during the meeting in three categories and by proclaiming a winner in the end. By transforming the acquisition percentage into a game element, we discovered that it was unsuitable as a direct motivator for participating in Red Team meetings. Hence, acquisition percentage was dropped and an additional reward for the winner was added (the "Red Team coin") to stimulate participation.

In the implementation cycle, we designed coins to resemble contribution categories and defined the goal-driven and interaction rules. Pre-pilot tests

demonstrated that a rule that forced competitive behavior (i.e. coin taking) detached the coin game from the meeting, thereby hindering the meeting progress. Hence, the game rules had to avoid competitive interaction. As a result, competitive and cooperative conflict was made explicit through different types of coins (i.e. "good critique", "good idea", "good support") instead of through the interaction. The interaction rules only allowed giving and the goal was to receive the most coins.

The evaluation cycle revolved around reducing the invasiveness of the pilot study, resulting in an integrated measurement method that could also serve as an additional motivator to participate (i.e. logging coin exchange on a tablet and showing the graph directly after the meeting). The results of the pilot test suggest that the gamification pilot did not hinder the meetings, as participants were generally positive about the game's impact on the meeting.

6.6.2 Transform implicit work elements into explicit game elements

In conclusion, the development of the gamification was mainly based on transforming implicit work elements into explicit game elements. This transformation taught us which work elements we could and could not use. By explicitly using the acquisition hours as a game element, we found out that it could not be used to reward participation in a Red Team meeting. In fact, there was no existing explicit reward available for such short-term activities.

Moreover, transforming the same work element (contribution types) into different game elements (rules allowing giving and taking vs. coin types) taught us what game elements would be effective. As explained above, the pre-pilot tests helped us select game elements that suited the Red Team meeting context. The fact that coin taking totally changed the impact of the gamification complements our findings in chapter 4. A single competitive or cooperative game rule can not only strongly influence interdependent behavior in a game but also in non-game contexts.

In the evaluation cycle, transforming the measurement method into game elements was found to be beneficial for the real world aim as well. The coin exchange data was not only used to trace play strategies, but also to make the evaluation transparent and useful for the participants in the form of a graph. In the long-term, this could be a reason to keep on using the gamification. In the present pilot tests, none of the participants mentioned the graph and thus may not have seen it. In future experiments, the long-term quality of the game elements should be tested and emphasized more.

6.6.3 Balancing game rules

After transforming work elements into game elements, the rule qualities described in chapter 4 and 5 were used to balance the game's rules. Chapter 5 suggested three types of rule invasiveness: behavioral, cognitive, and affective. The above-described negative effect of competitive interaction in the pre-pilot tests may be explained by affective invasiveness in which the competitive game experience did not resemble the cooperative meeting experience. To overcome this negative affective invasive effect, we aligned the game experience with the meeting experience in the eventual pilot test by only allowing cooperative interaction (i.e. coin giving). To regulate conflict, competition was evoked by the goal-driven rules (i.e. collecting critique coins and receiving the most coins in the end).

Next to the goal-driven and interaction qualities of game rules, their embodiment in game objects (Järvinen, 2008) was an important quality. In the case of assessing each other's contribution, exchanging coins is a natural activity and thus was expected to be less invasive. Still, only the largest team in the pilot test used a large part of the available coins. Yet the participants of this team also gave low ratings regarding the clarity of coin transactions. This suggests that a large number of exchanges reduces the clarity of the gamification and possibly, as a result, reduces the meaning of the game behavior in relation to the meeting.

In order to optimize clarity, additional pilots should indicate the ideal number of transactions, which might vary depending on the Red Team's size. The current pilot results suggest that participants should receive one or two coins per contribution type at the start instead of three, because the large number of transactions at team

Figure 6.10. The assumed positive effect of the coins on meeting productivity based on literature.

1 seemed to reduce clarity and for the smaller teams (team 2 and 3) more than 50% of the available coins remained unused.

6.6.4 Effect of the gamification

Due to the low number of meetings in which the gamification was tested, the pilot results only provide rough indications for the extent to which the aims of the gamification (i.e. participation and productive conflict) were achieved. We found the strongest support for conflict stimulation and regulation. The fact that the logged coin transaction data resembled the process that a Red Team meeting generally goes through suggests that members used the coins meaningfully in relation to meeting contributions. Moreover, this is supported by the correlation between the used coins and the participants' opinion about meeting contributions.

Hence, the coins seemed successful in explicating different types of contributions, based on conflict management strategies (see Figure 6.10). As a result, we assume that this stimulated task-related conflict (as opposed to emotional conflict), which according to literature improves meeting productivity (Jung & Lee, 2015). Next to explicating contribution types and raising awareness about them, the coins may have directly influenced meeting contributions as well. For example, by explicitly providing the possibility of rewarding good criticism, participants may feel more comfortable to criticize each other more, which supports the original aim of a Red Team (Matesk, 2013).

To what extent the tested gamification could improve participation in Red Teams remains uncertain. By dropping the use of acquisition percentage as a game element, the expected effect on stimulating participation was significantly weakened. Yet the fact that most participants were moderately positive about the gamification suggests that it could increase interest in Red Team meetings. However, some participants stated that the game is not interesting enough to increase participation in the long term. As explained above, emphasizing on the coin transaction graph might increase long-term motivation. Additionally, the Red Team coins could be better integrated in the overall reward system at the company. Yet, as we found out during the design cycle, this would require an adaptation or expansion of the reward system, which currently does not reward short-term activities.

6.6.5 Implications for the coin game

Besides some small balancing issues, the coin game seemed successful in providing a fun short-term experience for Red Team members. The fact that the gamification

of Red Team meetings was positively accepted may also be attributed to the type of organization in which it was implemented. A playful organizational structure leads to a creative, spontaneous and inspiring organization (Warmelink, 2013, p. 47). Hence, a management consultancy firm seems the right type of organization for playful interventions, because they value such qualities.

Yet in order to achieve a coin game that is more broadly applicable, the game should not rely on the existing company culture. To achieve a generalizable coin game concept, long-term motivations are the major concern. The long-term game elements used in the tested coin game (i.e. the Red Team coin and coin transaction graph) did not directly appeal to the employees' motivations and the company's working procedures. This was caused by the fact that long-term game elements were generally considered to invade too much in existing work processes.

To address long-term motivations, unrelated long-term game elements could be aligned with long-term work elements. In the present coin game, the Red Team coins could, for example, resemble acquisition percentage and the graphs may become part of assessments of the overall proposal writing process. In this way, long-term game elements could serve as 'hooks' to cling on existing motivations and procedures, thereby allowing implementation in many other types of meetings. Yet to optimally address motivations and procedures, game elements should directly explicate existing long-term work elements, such as acquisition percentage or an employee's performance in several Red Team meetings. In conclusion, the short-term game elements (i.e. the coins) may be reused in the gamification of other types of meetings; long-term game elements should be tailor-made and may even require adaptations in the organization's reward system.

7
General discussion

When we started this research project, McGonigal (2011) had just published her inspiring book about using game elements for non-game purposes and definitions of the term 'gamification' were in the making (Deterding, Dixon, Khaled, & Nacke, 2011; Huotari & Hamari, 2012). Since then, the research field grew with elaborate theories in order to understand gamification (Knaving & Björk, 2013; Hamari & Koivisto, 2013; Kappen & Nacke, 2013; Koivisto & Hamari, 2014; Fuchs, Fizek, Ruffino, & Schrape, 2014). Yet research on gamification practice (Hamari, Koivisto, & Sarsa, 2014; Walz & Deterding, 2014; Reiners & Wood, 2015) stayed behind. Theory provides a broad spectrum of game elements that could be used for non-game purposes and is generally optimistic about their effect. Yet there are little applied cases to fully appreciate gamification in practice and most of the existing applied studies only address the effect of one particular game element without examining the methods and processes that can explain effective gamification.

Our research aimed to bridge the gap between theory and practice. In this dissertation we have structurally explored the application of game elements in varying teamwork contexts in the lab as well as in the field, with emphasis on user behaviors and experiences. Next to evaluable gamification designs, this led to practice-driven theories on how to effectively apply game elements in real-life teamwork contexts. We addressed teams as an application area, because many companies rely on teamwork and the application of social gaming in business contexts is not much explored (Mollick & Werbach, 2014; Reiners & Wood, 2015; Morschheuser, Riar, Hamari, & Maedche, 2017). Moreover, using game elements to improve the performance of teams seemed promising because in motivation psychology as well as game design theory, social elements are often mentioned as a strong motivator (Przybylski, Rigby, & Ryan, 2010; Bateman & Nacke, 2010; Marlow, Salas, Landon, & Presnell, 2016).

Our main research aims were to explore the effects that game elements could have on the performance of teams and to discover conditions for effective

gamification design for teamwork. While mainly focusing on designing and applying game elements in non-game teamwork contexts, we also devised theories about teamwork to support our gamification designs. In section 7.1, we discuss our findings by answering the research questions that were posed in the introduction (see below), followed by recommendations for the design and research of teamwork gamification in section 7.2 & 7.3, and suggestions for future research in section 7.4.

Research questions

To what extent can game elements improve the performance of teams?

a. What game elements can be identified that may improve team performance?
b. How can the identified game elements be used to improve team performance?
c. What is the effect of the identified game elements on team performance?

7.1 To what extent can game elements improve the performance of teams?

Due to the complexity of teamwork (McGrath, Arrow, & Berdahl, 2000), the implementation of game elements cannot be directly related to improvements in performance outcomes. Instead, they seem effective in influencing team processes and other mediators for team performance. As explained by Ilgen *et al* (2005), recent research suggests a large variety of factors that influence team effectiveness, often broken down into input, process, and output. The relationships are often not linear and feedback loops influence teamwork as well. Figure 7.1 gives an overview of factors that influence team effectiveness based on four literature reviews. Hackman (1987) and Kozlowski & Bell (2013) focus their review on the teamwork process. Hackman described conditions for effective teamwork and Kozlowski & Bell (2013) reviewed cognitive, affective/motivational, and behavioral constructs and mechanisms that influence team processes. Sundstrom, De Meuse & Futrell (1990) and Cohen & Bailey (1997) reviewed team effectiveness from a broader organizational perspective.

As Figure 7.1 shows, attributing performance enhancement of teams in organizations just to the implementation of game elements is nearly impossible, because many extraneous variables influence the effectiveness of a team. Moreover, we need to be careful in assuming causal relationships due to interrelated factors and feedback loops. For example, increased team cohesion might improve team performance, yet better team performance might on its turn increase the team members' commitment. The effect of game elements on team performance largely depends on the team members' behaviors and experiences. Hence, our studies

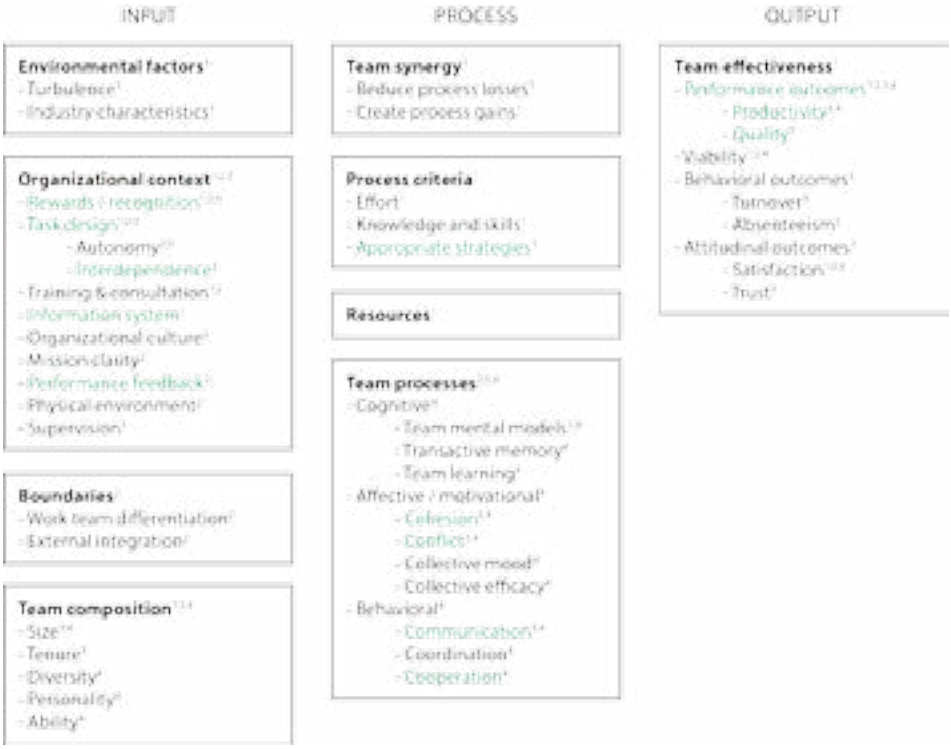


Figure 7.1. Overview of factors that influence team effectiveness based on: 1) Hackman (1987), 2) Sundstrom, De Meuse, & Futrell (1990), 3) Cohen & Bailey (1997), 4) Kozlowski & Bell (2013). Elements addressed in our experiments are highlighted in green.

were mainly focused on measuring effects on behaviors and experiences, such as performance feedback and team cohesion.

As outlined by the sub-questions in the introduction, to investigate to what extent game elements could improve team performance; we first had to identify game elements that were expected to improve team performance. Next, methods for applying the identified game elements had to be defined, followed by investigating their effect on collaboration and team performance. The introduction chapter explored game design literature (Huizinga, 1950; Caillois, 1961; Suits, 1978; Salen & Zimmerman, 2004; Juul, 2005; McGonigal, 2011) to identify the fundamental components of a game experience. We concluded that a game(ful) experience is evoked by goals, rules, objects, and freedom. These elements can be used to steer team member behaviors and experiences towards better team performance, as was demonstrated in the experiment with multiplayer Breakout (Chapter 4).

The gamification experiments described in Chapters 2, 5, and 6 basically show two methods by which goals, rules, objects, and freedom can be applied. The

first method is to use them to explicate elements in the teamwork. By identifying teamwork elements that are implicit or neglected and transforming them into game elements, team members focus more on these elements and may adapt their behavior to them. At the steel-processing factory, for example, animated graphical elements on an interactive screen explicated performance indicators and personal information (Chapter 2). This increased the attention for- and discussion about team performance and social interaction: a shift leader questioned certain performance indicators and operators had more non-work-related conversations. At the group-brainstorms (Chapter 5) and Red Team meetings (Chapter 6), coin transactions explicated feedback on each other's contribution, which seemed to improve team performance. For example, in the Red Team meetings, members indicated that the coins made them more aware of their contributions to the meeting and stimulated them to perform better.

The second gamification method is to regulate the interaction between team members. In the factory, pop-up statements on the screen regulated informal interaction between operators by allowing them to fill in hobbies and interests on the profile of colleagues, leading to 'funny' profile information. The interaction between the members of the brainstorming groups and Red Teams was regulated through the goals and rules in relation to coin transactions. The effects of regulation varied strongly. In a game context (e.g. multiplayer Breakout), embedded goal-driven and interaction rules were effective in evoking strategies and experiences that would benefit teamwork (Chapter 4). Yet in non-game contexts, the effect varied significantly depending on the situation.

We explained these differences by the cognitive, affective, and behavioral invasiveness of game elements. The intensity and level on which game elements intervene in teamwork seems to largely define their effect. In the factory, for example, the operators did generally not appreciate the 'funny' profile information because it was considered to be too playful. This undermined the credibility of the gameful intervention and thus probably its impact on the teamwork. Conversely, rules that forced competition at the brainstorming groups probably led to positive invasiveness because a more playful atmosphere could explain the increase in creativity (Amabile & Pillemer, 2012). On the other hand, in the context of a consortium meeting (described in Chapter 6), forcing competitive rules led to negative behavioral invasiveness because they hindered the meeting's progress by forcing transactions that did not fit in the meeting process.

In summary, game elements can draw the attention of team members by making teamwork elements (more) explicit, which can raise awareness and lead to

discussion. By directing discussions towards teamwork elements that benefit the performance, teams might adapt their processes and as a result perform better. Next to drawing attention, game elements evoke gameful strategies and experiences that could, directly or indirectly, lead to performance enhancing adaptations in teamwork processes. For example, a common problem that we came across in our studies was the implicit avoidance of conflict and competitive strategies. The introduced game elements seemed to evoke a gameful experience that made team members feel freer to assertively deal with conflicts and adopt competitive strategies when they are beneficial. Yet in order to actually improve the performance of a team, team members themselves need to adapt their way of working. Thus game elements only have an effect if users comply and if the evoked gameful strategies and experiences are aligned with the teamwork processes on a cognitive, affective, and behavioral level.

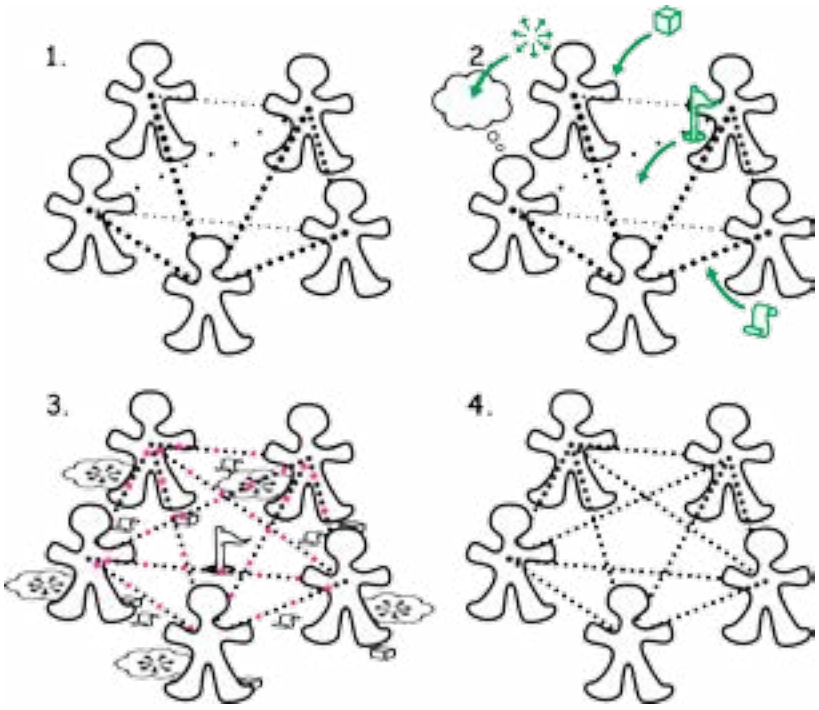


Figure 7.2. Stages of teamwork gamification: 1) unbalanced teamwork, 2) explicating, adapting, and/or adding objects, goals, rules, and freedom, 3) the gamification layer sometimes triggers gameful moments during teamwork, 4) balanced teamwork.

7.2 A toolbox for gameful teamwork

In order to align game elements with teamwork processes, we used and discussed a variety of tools and theories in the preceding chapters. Most of these tools and theories can be used for the analysis of teamwork as well as provide inspiration and structure for designing effective teamwork gamification. The game elements that we applied in our experiments can be related to the fundamental components of a game experience and led to a particular type of invasiveness (see Table 7.2). The game experience components and types of invasiveness encompass the gamification design space (see Table 7.1). Within this space we can decide how to intervene and what kind of elements we are going to use. Often an intervention in one area, such as cognitive invasiveness through rules, influences the other types of invasiveness as well as other components. For example, a goal may evoke positive cognitive invasiveness but have a negative behavioral effect. To avoid the negative behavioral effect, rules may be applied which on their turn might lead to other invasive effects. To describe this gamification design space in more detail, we will first elaborate on the different types of invasiveness, followed by a description of the areas per component.

7.2.1 Invasiveness

The invasiveness of game elements can be defined as the extent to which users are transported towards a game world experience. As shown by the adapted persuasive game design model in the introduction (Figure 1.5), a user's gameful experience can be close to a real world experience (i.e. weak invasiveness) or close to a game world experience (i.e. strong invasiveness). In our field experiments (chapter 2 & 6) we were mainly concerned with achieving positive invasiveness and avoiding negative invasiveness to achieve a positive transfer effect. As a result, we explicated, added, and adapted objects, goals, rules and freedom to devise a gamification layer that once in a while would trigger a gameful moment, rather than generating a continuous feeling of playing a game (see Figure 7.2). These gameful moments, such as throwing a coin or filling in a colleague's hobby, are less invasive and good timing can help in achieving a positive transfer effect. Thus, in general, deciding where and when to be invasive is a core activity when designing game elements for teamwork. The different types of invasiveness: behavioral, cognitive, and affective (introduced in Chapter 5), could serve as a tool for consciously defining the level of invasiveness of game elements as well as the level on which transfer effects may occur.

We used affective invasiveness (i.e. the emotional impact of game elements) in our

Table 7.1. The gamification design space consists of the game experience components and their invasiveness.

Components of a game experience	Invasiveness: Affective (emotional impact)	Cognitive (impact on attention)	Behavioral (impact of gameplay)
Objects			
Goals		GAMIFICATION DESIGN SPACE	
Rules			
Freedom			

experiments to evoke experiences that stimulate performance, such as a competitive experience that stimulates idea generation. Negative affective invasiveness can occur if the evoked experiences do not correspond with experiences in the real world, such as a competitive attitude in a factory where each mistake could cost thousands of euros. In general, the affective invasiveness of game elements can be described as an increase in playfulness, or paratelic state (Apter, 1989), and results in a reduced sense of consequences, which is often described as the magic circle (Huizinga, 1950; Salen & Zimmerman, 2004). If increased playfulness is appropriate and directed towards the right non-game elements, the magic circle may serve as a safe zone for exploration. This can raise creativity or the determination to break certain work patterns for the benefit of team performance. In other cases, affective invasiveness might become a barrier to impact the non-game situation. A danger could be that game elements isolate particular behaviors and experiences by reducing their consequences. The challenge is to find a balance between providing a safe zone without blocking the transfer effect.

The cognitive invasiveness of game elements can be used to clarify or simplify complex systems or situations. It signifies the power of game elements to attract the user's attention and increase their engagement with particular factors that could improve collaboration within a team, such as a visualization of interdependencies between team member skills or direct feedback on productivity. However, if the to-be-gamified context is not complex, game elements may add complexity that hinders the effect of the gamification by, for example, requiring additional decision-making processes. Moreover, if game elements attract the team members' attention to irrelevant factors, they may distract from achieving high team performance.

Behavioral invasiveness signifies the impact of behavior that is evoked by game

elements. To achieve positive transfer effects, game elements should evoke behavior that benefits the non-game aim, such as competitive conflict behavior in group-brainstorms or eating less meat for CO2 reduction. Gameful behavior is generally strategic, i.e. driven by the goals and rules of the gamification. Hence, positive behavioral invasiveness is achieved by aligning game goals and rules with non-game goals and rules, such as collecting 'good critique' coins. Next to user behavior as a result of goals and rules, gameful behavior could also be the result of seduction or persuasion, among other types of influence (Tromp, Hekkert, & Verbeek, 2011). For example, a brainstorm facilitator could reward good contributions with a compliment or beautiful sound. Yet similar to cognitive invasiveness, the evoked behavior can be irrelevant or distracting. One way to avoid negative behavioral invasiveness is by offering a variety of strategies, rather than forcing certain behavior upon users. In this way users can choose what behavior is appropriate at a particular occasion.

7.2.2 Objects

The process of developing a gamification concept generally starts with defining the object that users will be playing with. To achieve a positive transfer effect, style, meaning, and affordance are important qualities of the objects within a gamification (see Table 7.2). The selection of the objects that users will be playing with is crucial in achieving the real world aim of a gamification. For example, playing with information about hobbies and interests had to lead to more informal interaction in Chapter 2 and playing with feedback had to lead to increased productivity in Chapter 5. It is nearly impossible to generalize the design of objects in a gamification because they strongly depend on: the real world object it resembles, the context in which it is implemented, and the type of goals and rules that are embedded. In general, a game-like style can add to evoking a gameful experience, such as the racing cars that depicted the performance of the operating teams. At the Red Team meetings, we mainly used secondary instead of primary colors for the coins to avoid a childish playful style.

In our experiments, the objects were made tangible, either digitally through e.g. pop-up statements or physically through e.g. coins. Yet they can also just exist in agreements among team members, such as allowing each member three times to praise someone during a meeting. However, tangible objects generally reduce the cognitive invasiveness by embodying the current state of a gamification. As depicted in Figure 7.2, the studied gamification layers trigger gameful moments once in a while. In order to achieve continuity, objects contain the meaning of a gamification layer and facilitate the connection between each gameful moment. For example,

Table 7.2. Factors that influence the invasiveness of objects, goals, rules, and freedom in gamified teamwork and examples from our experiments.

	Affective invasiveness	**Cognitive invasiveness**	**Behavioral invasiveness**
Objects	Style *e.g. race cars, secondary colors*	Meaning *e.g. bottom car is target, coins represent contribution types*	Affordance *e.g. click on details, throw coins across the table*
Goals	Goal attribution *e.g. compare team productivity, individually collect coins*	Direct feedback *e.g. number of coils produced, number of coins collected*	Conflict behavior *e.g. neglect cleaning, equalize coin distribution*
Rules	Interdependence *e.g. colleague responses in personal profile, only allow praise through coin giving*	Learning *e.g. policy for training, limitation in owning coins*	Strategic behavior *e.g. negotiate target calculations, take a coin to increase own profit*
Freedom	Credibility *e.g. control over own profile content, forced coin transactions*	Decision-making *e.g. provide incorrect profile options, give a coin for a good idea*	Playful behavior *e.g. filling in an offensive hobby or interest, exchange coins for coffee*

differently colored coins reduce the cognitive load of remembering the number of praises one has left for each contribution type. Properties of affordance (Norman, 2001) probably play an important role in keeping continuity and relating to the real world aim as well, such as coins that by nature are meant as a reward and afford transactions.

7.2.3 Goals

After defining the objects that a team will be playing with, we generally started building a goal and rule structure to steer the behaviors and experiences of team members. In our experiments, we based the gamification goals on the behaviors and experiences they had to evoke to achieve a positive transfer effect, e.g. benefit team performance. Goal attribution, direct feedback, and conflict behavior were important factors for the gamification of teamwork goals.

In teams, goal achievement is either attributed to collective or individual effort. In order to evoke a teamwork experience that benefits team performance, the game goal needs to be aligned with the non-game collective goal of a team. Depending on the process of achieving a non-game collective goal, the collective goal can be gamified directly or the gamification can contain aligned individual goals. If collective non-game goals are gamified, the alignment comes naturally. For example, at the steel-processing factory, comparing the productivity of the different teams increased the operators' attention for the collective productivity within the team. Yet when a gamification contains individual goals, they should either correspond to the non-game collective goal, such as rewarding 'good critique' that is beneficial for the quality of brainstorm output, or be explained in context of the collective goal, such as collecting coins for acquisition percentage.

In the field studies (Chapter 2 and 6) we used direct feedback to draw the team members' attention to certain goals. The operators became more attentive to their productivity and Red Team members became increasingly concerned with their contribution to the meeting. Yet direct feedback is a highly engaging intervention, thus in both cases, the cognitive invasiveness had to be balanced by reducing the visibility of the feedback. Operators had to walk to the canteen in order to see their current productivity and the coins were kept in cups to diminish the team members' engagement with collecting coins.

Explicitly showing collective and/or individual goals also explicates conflicts. Some operating teams, for example, neglected cleaning activities in order to produce more coils and in the group brainstorms, members equalized the coin distribution to avoid conflict. Hence, conflict management theory (Thomas, 1992; Rahim, 2002; Dreu de, 2006) served as a useful tool to analyze and predict behaviors of team members as a result of their goals. In order to achieve positive behavioral invasiveness, the intensity of possible conflicts within a gamification needs to be balanced and, depending on the situation, goals can steer conflict behavior towards competitive or cooperative strategies.

7.2.4 Rules

Next to steering behaviors and experiences through a gamified goal, we generally also introduced rules to steer behaviors and experiences that benefit the teamwork. Interdependence, learning, and strategic behavior were important factors regarding the invasiveness of rules. Based on the framework of interdependent experiences (see Figure 3.11 & 4.1), we distinguished goal-driven and interaction rules. Interaction rules directly regulate the interaction between team members, thereby defining the

intensity of their interdependence. For example, the popup-statements on the screens at the steel-processing factory allowed to directly fill in hobbies and interests on a colleague's profile page, thereby evoking interdependence on a social level. Goal-driven rules regulate how the goal of a gamification is achieved. For example, in the brainstorm case (Chapter 5), only the coins that were given by teammates counted as score, which was meant to lead to a more cooperative experience. Rules can thus strongly influence the affective invasiveness of game elements within teamwork.

Rules are cognitively invasive, mainly because they have to be learned. If learning is the aim of the gamification, explicitly playing with the rules can be positively invasive. In other cases, learning the rules is often a necessary evil to achieve a positive effect on other levels. In the group brainstorm experiment, for example, the larger rule-sets were clearly more distracting because team members had to enforce certain rules themselves, such as the size limit of the pools. On the other hand, in the steel factory, learning the rules seemed positively invasive. One operator wondered why he had less puppets on the production line compared to colleagues that started much later than him. In other words, the visualization of his skills explicated the fact that he had received less training than others and may have raised his interest in the company's training policy.

Eventually, rules in a game regulate player behavior. Behavior that is evoked by rules is often strategic behavior, i.e. the best possible behavior towards achieving a goal within the boundaries of the rules. In Chapter 4, we explained how goal-driven rules could steer the players' strategies through classical game theory (Camerer, 2003). In the field experiments, strategic behavior could be found as well. The calculation of the operating teams' targets, for example, was strategically questioned by a shift leader, and at the group brainstorms, members started arguing about the appropriateness of particular coin transaction strategies. In multiplayer Breakout, the strategies could be predicted based on the payoff of each strategy, yet in gamified contexts the users' strategies are often more complex. Moreover, the payoff may situate in the real world or in the game world. Due to the complexity of the behavioral effect of rules, the only way to achieve positive behavioral invasiveness is generally by testing rule-sets as we did in Chapter 5.

7.2.5 Freedom

Freedom can be seen as the opposite component of goals and rules in a game experience, like silence in music. Following game design literature, gamification users can feel free in: (the intensity of) participation (Suits, 1978; McGonigal, 2011), playing with rules (Bogost, 2007), optional actions (Burgun, 2013), and the

consequences or outcomes of actions (Juul, 2005). Even if the degrees of freedom are low, and voluntary participation and negotiable outcomes are not always allowed, game elements probably always increase the user's feeling of freedom to some extent. Hence, when developing game elements for teamwork, the invasiveness of increased freedom is important to consider.

In our experiments, the effect of freedom on affective invasiveness mainly came down to the game elements' credibility. For example, the operators at the steel-processing factory were free to interact with the screen, yet the screen's content was not voluntary or negotiable. The operators had no control over their own profile information, whereas colleagues could fill in any kind of hobby or interest. This freedom of filling in pop-up statements seemed to evoke playful behavior that reduced the credibility of the gamification. Moreover, operators did not always agree with the KPI information, yet next to reducing the screen's credibility, this seemed to have a positive effect through constructive discussions about the target calculations.

Decision-making seems to be a core factor in defining the cognitive invasiveness of freedom. In chapter 5, we explored varying degrees of freedom through governing and forcing rules. In the brainstorm case, forcing rules (i.e. less freedom) were less cognitively invasive than governing rules because they required less decision-making. On the other hand, forcing rules did not allow any flexibility in behavior and timing, leading to irrelevant coin transactions and thus negative behavioral invasiveness. As a result, the credibility of the coin game reduced and participants started to exchange coins for unrelated activities, such as getting coffee. For idea generation, such behavioral invasiveness is negative, yet it might as well lead to a more positive atmosphere in the group, which could benefit productivity. Hence, to achieve a positive transfer effect, balancing the degrees of freedom can be a delicate matter and generally requires several iterations.

In general, the invasiveness of freedom depends on the work that it is attributed to. For example, consulting and operating teams differ significantly in the consequences of their work, operators seem to accept much less playfulness than consultants. Moreover, decisions within a gamification should clearly relate to the teamwork, otherwise the game elements loose their credibility and as a result become negatively invasive.

7.3 General lessons for teamwork gamification

7.3.1 Game design thinking

The analysis phase of a gamification design process seems to come down to one basic question: what do we (i.e. all stakeholders) want the users to play with? This not only concerns the selection of the to-be-gamified teamwork elements, but generally also refines the real world aim of a gamification. By already applying game design in the analysis phase, we could quickly deduce work elements that are suitable for gamification.

In the two field studies described in chapters 2 and 6, the gamification design process started with defining the transfer effect with the stakeholders (e.g. users, game designers, context experts, researchers). Next, the context was analyzed in which the game elements were going to be applied. In parallel with the analysis, we generated gamification ideas to directly probe our findings. For example, at the steel factory, most operators did not mention the end product (i.e. galvanized steel coils) as a motivator. Hence, we proposed to put up banners in the production hall, displaying how the factory's clients use the coils and how this contributes to people's daily lives. This was, however, rejected by the management as it was considered to be too invasive, so we had to drop the societal impact as a motivator. In retrospect, you could say that this element was too large to play with.

Next to aiding the design process, applying game design thinking in the analysis of work processes led to reflections regarding their effectiveness. The motivations of workers may be better aligned with organizational procedures if we design business processes as if they are games. For example, at the consultancy firm described in chapter 6, we reviewed the proposal writing process as if it were a game and learned that participants mainly seemed to play with their acquisition and project hours. These motivators were, however, not suitable as game elements for achieving the aims of the Red Team gamification (i.e. stimulating participation and regulating conflict). Hence, we questioned to what extent the overall reward system within the company supports the daily work processes.

7.3.2 Transparency through gameplay

The gamification method of making implicit real world elements explicit through game elements implies that the gamified situation should become more transparent for its users. Moreover, the regulation of interaction between team members could increase transparency by, for example, exposing the goals of team members and

the rules that managers pose upon the teamwork. In the case of the operating teams (Chapter 2), performance targets indeed became more transparent. Among the brainstorming groups, opinions about each other's contribution became more transparent (Chapter 5) and at the Red Team meetings (Chapter 6) the initial concept aimed to make the participants' motivations for attending the meeting more transparent.

To define what teamwork elements could or should become more transparent to achieve better team performance, we devised a custom underlying model of the teamwork situation within each gamification project (Figure 2.2, 5.2 , & 6.1). In the cases described in this dissertation, the underlying models mostly consisted of implicit elements, such as pride and praise, because they were based on social psychological constructs. Yet, to achieve better team performance, making implicit elements explicit is generally not enough. Users need to understand and accept the value of playing with the introduced game elements.

A transparent underlying model could achieve such understanding and acceptance. One way of making a model transparent is by designing game elements for all variables that the underlying model consists off. For example, the cohesion model in Chapter 2 would than require game elements for: task commitment, pride, interpersonal interaction, cohesion, interdependence, and performance. As the example shows, this is often a complex and costly process. Instead, users might be able to discover the underlying model themselves by playing with some of its elements. To achieve this, game elements need to address real world motivations of the users and serve as a vehicle for discovering the underlying model. For example, Red Team members could discover the value of contribution types by playing the coin game several times and compare the resulting coin exchange graphs. However, as explained in Chapter 6, Red Team members were not explicitly encouraged to play the game several times. Hence, the value of the coins was only considered to be short-term and the gamification just raised awareness about the underlying model rather than making it transparent through gameplay.

7.3.3 Integrate evaluation

The integration of evaluation in the gamification layer could assist in making an underlying model transparent, because the evaluation of the transfer effect of a gamification is often based on the underlying model. Hence, by integrating the evaluation, users may better understand what the gamification is meant for and thus accept and value it more easily. For example, at the steel-processing factory we evaluated the effect of the gamification on cohesion and interdependence through

questionnaires. This evaluation could have been part of the gamification by, for example, implementing quiz-like questions about each other's role within the team. In this way, the transfer effect of the gamification could have been measured in a more unobtrusive way as well as become a game element that draws attention to the measured variable.

If team members use such evaluative game elements with the aim of improving their performance, the measurement becomes the intervention. As a result, acceptance and continued use become the critical factors for the effectiveness of a gamification. The results of evaluation then only serve as a feedback or control mechanism. As such, evaluative elements become game elements and the gameplay data indicates to what extent a real world aim is achieved.

7.3.4 User-centered gamification

The motivations of users are often mentioned as a critical factor in this dissertation and seem to be the central concern in the development of a gamification layer in general. If game elements do not address elements that employees are motivated by, it will be hard to design an effective gamification concept. Therefore, a bottom-up process in which the needs and wishes of users are central is recommended (Woodcock & Johnson, 2017). Stakeholder- and contextual requirements, such as representations of team performance or placement at the workplace, should be considered secondarily.

Assuming voluntary participation, which is a common precondition in games (McGonigal, 2011), can assist in developing game elements that address the users' motivations. By assuming that users cannot be forced to participate in a gamified situation, gamification developers are forced to consider how they can persuade users to start playing. Currently, many gamification concepts just rely on transforming existing real world elements into game elements or on adding additional motivational elements. Often managers see an opportunity for gamification and a game design agency then transforms the elements that were brought up by the management into game elements. As a result, users are often not motivated to start using the game elements and prolonged use is often a problem as well.

Also in the evaluation of the effect of game elements the users' motivations should be central. In our studies we measured user behaviors, experiences, and game and/or non-game outcomes. We did this to not only gain an understanding of the transfer effect of game elements, but also to understand what happens during gameplay and improve the gamification designs based on the reactions of users.

7.4 Future research

7.4.1 Designing and studying game elements for teamwork

As explained before, the effects described in this dissertation cannot provide absolute predictions about the effect of game elements on the performance of teams. The scope of our studies just allowed for measuring relatively short-term effects (max. ¾ year), whereas studies on interventions in organizations often require longer periods to measure effects (Stoppelenburg, de Caluwe, & Geurts, 2012). Moreover, as shown by Figure 7.1, each study touches upon the tip of an iceberg concerning the conditions for effective teamwork. For each experiment we addressed another factor (e.g. cohesion, conflict management strategies, and interdependence) and quick literature scans led to superficial theoretical models (Figure 2.2, 5.2 & 6.1).

Investigating the gamification of each separate factor that influences teamwork is probably impossible, because the dynamics and relationships are complex and strongly context dependent. Instead, we would recommend investigating the design process of gamifying teamwork to discover the general methods in which game elements can influence team effectiveness. This should not only involve the performance outcomes of teamwork, but also satisfaction and viability. The methods discussed in this dissertation (i.e. explication and regulation) suggest that game elements can unlock possibilities for interventions in teamwork that are often regarded as being too complex, e.g. wicked problems. Teamwork research often addresses input and output factors whereas the process causes the actual problem (Ilgen, Hollenbeck, Johnson, & Jundt, 2005), such as withholding criticism or one-sided decision-making. Addressing team processes in the form of game dynamics (Hunicke, LeBlanc, & Zubek, 2004) elicits play with the factors of effective teamwork, thereby increasing understanding of complex processes and possibly unraveling wicked connections through repetition and exploration (Coovert, Winner, Bennett, & Howard, 2017).

As we have been investigating the effect of game elements in two completely different teamwork contexts, the problems that both teams faced may be transferable to teamwork in general. First of all, the lack of perceived interdependence often seems to be a problem for collaboration in organizations (Wageman, 1995). Employees may not perceive to what extent they depend on each other's skills or they have a reduced perception of the collective goal (i.e. outcome interdependence). Game elements seem effective in making interdependencies explicit. Hence, further research on explicating interdependencies within teams and organizations or between teams and

employees could be valuable. Yet, measuring perceived interdependence was found to be difficult in our experiments. Our questionnaires could generally not capture any changes in perceived interdependence. Behavioral measures might lead to better results, possibly by measuring the communication and coordination between team members (Mayer *et al*, 2014).

A second common problem in teams appears to be the avoidance of conflict and selecting the appropriate conflict management strategy. As games are generally 'systems of conflict' (Salen & Zimmerman, 2004), game elements are particularly useful for conflict stimulation and regulation. In our experiments we mainly tried to stimulate competitive conflict management strategies, because the aim was to improve creativity (Badke-Schaub, Goldschmidt, & Meijer, 2010). Future research could explore other types of strategies. Moreover, the differentiation between task and emotional conflict (Jehn, 1995) and conflict intensity (Dreu de, 2006) seem important factors to address. For example, game elements could facilitate emotional conflict resolution, such as dealing with hierarchy differences in healthcare teams.

Games or game elements could as well aid teamwork research. The current trend in teamwork research is to address teams as an entity rather than its individual members (Dillenbourg, Baker, Blaye, & O'Malley, 1996). Also in our research, we found that the influence of, for example, individual character traits did not significantly influence the effect of game elements on team performance. It would thus be valuable to define the character of a team as a whole. Teams often tend towards certain approaches and strategies by nature. Understanding a team's tendency towards a certain way of working could define its character. Games or game elements could quickly detect a team's natural tendency, by posing a short challenge and measuring gameplay. In the collaboration game TeamUp (The Barn, 2009), for example, teams perform challenges to practice communication. Such a game could be used to measure a team's natural approach (Mayer, van Dierendonck, van Ruijven, & Wenzler, 2014).

As teamwork is so complex and dynamic, it may sometimes be easier to redesign the teamwork itself, rather than intervening in existing teamwork with game elements. We could use the gamification design space (Table 7.1) to design teamwork processes from scratch. In general, organizational design could probably benefit from the motivation-driven approach that is common in game design. As suggested by van Bree (2013), it would be interesting to apply game design thinking in developing business processes. Moreover, by allowing gameplay in organizational processes, employees may feel the freedom to reorganize their way of working or suggest new ways of organizing things in favor of the organization. By delivering

tools and information in the form of game elements, teams may be motivated to work more autonomously, thereby improving their collaboration.

7.4.2 Broadening our understanding of gamification in practice

We need more studies that investigate the full complexity of gamification, in which behaviors and experiences are central. As explained before, gamification research has mainly examined the effect of points, badges, and leaderboards (Hamari, Koivisto, & Sarsa, 2014). Yet, when understanding gamification as a game-inspired intervention, there are many more opportunities. Game elements can trigger all types of motivation, ranging from enforced actions to seductive visuals. By considering how a situation would be if it were a game, many more types of game elements come into mind than just points, badges, and leaderboards. If the aim would be to create an increased feeling of playing a game, just adding a little more playfulness through, for example, primary colors, might do the trick as well.

Regarding the explication and regulation of interaction between team members the main challenge seems to be dealing with the dynamics within a team and balancing invasiveness so that a gamification positively influences the collaboration. A straightforward solution is to keep a gamification layer simple by reducing the number of rules. Moreover, providing voluntary options for gameplay allows users to define the invasiveness themselves. Yet these solutions all assume a static presence of game elements, whereas most computer games are dynamic these days. They are updated on a regular basis and rule systems automatically adapt to the behavior of players. Investigating such dynamic systems could be particularly useful for the gamification of teamwork, because teams benefit from being flexible and reflexive (Widmer, Schippers, & West, 2009). However, balancing the invasiveness of a gamification becomes increasingly difficult when game elements become dynamic. As a result, the alignment of a complex real world with a complex game world becomes increasingly important.

Dynamic game elements could be a solution for achieving long-term use of a gamification. Long-term use is an important problem that we could not address in our experiments. The suggested integration of evaluative elements could feed adaptations in a gamification layer's goals, rules, objects, and freedom, thereby maintaining the interest of the users. In many computer games, the goals and rules adapt in order to keep the player playing; in a gamification the rules could also adapt to achieve a certain transfer effect. For example, if the coins for Red Teams would be virtual or have a display, their availability could adapt based on how much they are used. This can be done virtually, yet a puppet-master or game leader could make

such adaptations as well.

Most of the above-described topics not only apply to the gamification of teamwork, but to gamification design in general. The fundamental components of a game experience (i.e. goals, rules, objects, and freedom) are present in any type of gamification. The same holds for our findings regarding invasiveness. Hence, most factors that are mentioned in Table 7.1 could be used for investigating the effect of gamification, either directly or by translating them to factors that concern individuals.

To further broaden our understanding of gamification, 'end' may actually be a better term than 'goal', because sometimes a gamified activity may just end without achieving a particular goal. Assuming that a gameful experience does not have a goal but just an end could lead to new types of gamification. For example, in the case of collecting as many as possible coins within a certain timeframe, the time limit may be a more dominant element for the gameful experience than the number of coins one has gained at the end.

7.5 The value of gaming in teams

We started this dissertation with 'the promise of gaming'. Games can be highly motivating and its fundamental elements could as well be used in non-game contexts (McGonigal, 2011). For example, I introduced rules to my daily walk to the university, leading to strong engagement with the street tiles. However, fundamental knowledge about how and where to implement game elements for positive transfer effects is scarce and expectations seem generally too positive. Many applied cases of gamification are accused of exploiting people's motivations for the profit of large organizations and lacking the fun that 'gamification' implies (Bogost, 2014; Woodcock & Johnson, 2017). Also the gamification of performance indicators at the steel factory, described in chapter 2, received criticism of not making the work truly more fun for the operators (Bouma, 2014; Berg van den, 2015).

On one hand, the resistance against gamification actually demonstrates its core quality of exposing implicit real world elements. Many management models rely on performance figures and in many gamification projects these performance figures have been transformed into game elements (Mollick & Werbach, 2014). Gamification exposes real world goals, rules, objects, and freedom by turning them into elements that one can play with. As a result, people get directly confronted with them, which might lead to negative, yet useful, experiences. On the other hand, a gameful experience is expected to be fun and highly motivating. Hence, simply

transforming elements of existing management models into game elements does not automatically lead to a gameful experience.

There are basically two experiential levels on which we can review the value of gaming. The overall gameful experience is a meta-level experience of feeling as if playing a game, which we refer to as the magic circle and leads to strong motivation and a reduced sense of consequences. The second level of experiences lies within the overall gameful experience, in which game elements can steer the user's emotions, attention, and behaviors to achieve a transfer effect. The power of gaming seems to lie in eliciting play with gamified components within a gameful experience and the meta-level emotions one expects to feel when playing. If the evoked meta-level experience matches the expected experience, intended transfer effects are likely to occur, if the game elements are well designed and balanced. If the meta-level experience does not match one's expectation of a gameful experience, users may abandon the gamification, but also become more aware of the fact that the gamified real world activity is not motivating.

Thus besides judging a gamification on the amount of fun that it evokes, it should also be judged on its representation of the underlying real world elements and the amount of transformative discussion it evokes. Such social activation is not only confined to teamwork. Game elements might as well stir discussions about societal problems. Ultimately, the optimal result of gamification is to improve its underlying real world mechanisms and eventually to become obsolete.

References

Abt, C. (1970). *Serious games*. New York: Viking Press.

Adachi, P. J., & Willoughby, T. (2011). The effect of video game competition and violence on aggressive behavior: which characteristic has the greatest influence? *Psychology of violence*.

Amabile, T. M. (2012). *Componential theory of creativity*. Harvard Business School.

Amabile, T. M., & Pillemer, J. (2012). Perspectives on the social psychology of creativity. *The journal of creative behavior*, *46*(1), 3-15.

Anderiesen, H. (2015). *Tovertafel games*. Retrieved February 2, 2016, from Active Cues: http://activecues.com/en/games/

Apostolakis, K. C., Psaltis, A., Stefanidis, K., Kaza, K., Thermos, S., Dimitropoulos, K., et al. (2016). Exploring the prosociality domains of trust and cooperation, through single and cooperative digital gameplay in Path of Trust. *International journal of serious games*, *3*(3), 39-57.

Apter, M. J. (1989). Reversal theory: a new approach to motivation, emotion and personality. *Anuario de psicología/The UB journal of psychology*, *42*, 17-30.

Argyle, M. (1991). *Cooperation (psychology revivals): The basis of sociability*. New York: Routledge.

Avedon, E. M. (1971). The structural elements of games. In E. M. Avedon, & B. Sutton-Smith (Eds.), *The study of games* (pp. 419-426). New York: Wiley.

Avedon, E. M., & Sutton-Smith, B. (1981). *The study of games*. New York: John Wiley & Sons, Inc.

Badke-Schaub, P., Goldschmidt, G., & Meijer, M. (2010). How does cognitive conflict in design teams support the development of creative ideas? *Creativity and innovation management*, *19*(2), 119-133.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational psychologist*, *28*(2), 117-148.

Barron, B. (2003). When smart groups fail. *The journal of the learning sciences*, *12*(3), 307–359.

Bateman, C., & Nacke, L. E. (2010). The neurobiology of play. In *Proceedings of the international academic conference on the future of game design and technology* (pp. 1-8). Vancouver: ACM.

Bateson, G. (1972). *Steps to an ecology of mind (1987 ed.)*. Northvale, New Jersey: Jason Aronson Inc.

Beal, D. J., Burke, M. J., McLendon, C. L., & Cohen, R. R. (2003). Cohesion and performance in groups: A meta-analytic clarification of construct relations. *Journal of applied psychology, 88*(6), 989–1004.

Berendsen, A. M. (2014). *Analysis & design for self-managing teams in organizations using a gamification approach*. http://repository.tudelft.nl/assets/uuid:010ab703-0d79-4f8b-91af-da61392046ad/2014-03-24_Scientific_Article_-_A.M._Aniek_Berendsen_1515861_.pdf .

Berg van den, C. (2015, Februari 3). *Gamification: 8 voorbeelden van hoe het vooral níet moet*. Retrieved September 15, 2017, from Frankwatching: https://www.frankwatching.com/archive/2015/02/03/gamification-8-voorbeelden-van-hoe-het-vooral-niet-moet/

Bergström, K. (2010). The implicit rules of board games – on the particulars of the lusory agreement. In *proceedings of the 14th international academic mindtrek conference: envisioning future media environments* (pp. 86-93). New York: ACM.

Binmore, K. (2007). *Game theory: A very short introduction*. Oxford: Oxford University Press.

Björk, S., & Holopainen, J. (2003). Describing games: An interaction-centric structural framework. In *Proceedings of digital games research conference 2003*. Utrecht: DiGRA.

Bogost, I. (2007). *Persuasive games: the expressive power of videogames*. Cambridge: MIT Press.

Bogost, I. (2014). Why gamification is bullshit. In S. P. Walz, & S. Deterding (Eds.), *The gamefull world: Approaches, issues, applications* (pp. 65-80). Cambridge, Massachusetts: MIT Press.

Bossche van den, P., Gijselaers, W. H., Segers, M., & Kirschner, P. A. (2006). Social and cognitive factors driving teamwork in collaborative learning environments. *Small group research*, *37*(5).

Bottger, P. C., & Yetton, P. W. (1987). Improving group performance by training in individual problem solving. *Journal of applied psychology*, *72*(4), 651-657.

Bouma, K. (2014, October 18). *Spelenderwijs werken*. De Volkskrant , Retrieved from: http://www.volkskrant.nl.

Bozanta, A., Kutlu, B., Nowlan, N., & Shirmohammadi, S. (2012). Multi user virtual environments and serious games for team building. *Procedia computer science*, *15*, 301-302.

Brandt, E., & Messeter, J. (2004). Facilitating Collaboration through Design Games. In *Proceedings participatory design conference 2004* (pp. 121-130). Toronto: ACM.

Bree van, J. (2013). *Exploring the rules by playing the game: An investigation of the potential of video game design to enrich organizations*. Nyenrode Business Universiteit.

Brounstein, M. (2002). *Managing teams for dummies*. New York: Wiley Publishing, inc.

Brown, V., & Paulus, P. B. (1996). A simple dynamic model of social factors in group brainstorming. *Small group research*, *27*(1), 91-114.

Brown, V., Tumeo, M., Larey, T. S., & Paulus, P. B. (1998). Modeling cognitive interactions during group brainstorming. *Small group research*, *29*(4), 495-526.

Burawoy, M. (1979). *Manufacturing consent: Changes in the labor process under monopoly capitalism*. Chicago: University of Chicago Press.

Burgun, K. (2013). *Game design theory: A new philosophy for understanding games*. Boca Raton, FL: A K Peters/CRC Press.

Caillois, R. (1961). *Man, play, and games*. University of Illinois Press.

Camerer, C. F. (2003). *Behavioral game theory: Experiments in strategic interaction*. Princeton University Press.

Carey, B. (2013, January 31). *Stanford experiment shows that virtual superpowers encourage real-world empathy*. Standford report.

Carless, S. A., & De Paola, C. (2000). The measurement of cohesion in work teams. *Small group research*, *31*(1), 71-88.

Castka, P., Bamber, C. J., Sharp, J. M., & Belohoubek, P. (2001). Factors affecting successful implementation of high performance teams. *Team performance management*, *7*(7/8), 123-134.

Chang, A., & Bordia, P. (2001). A multidimensional approach to the group cohesion–group performance relationship. *Small group research*, *32*(4), 379-405.

Christiaans, H. H. (2002). Creativity as a design criterion. *Creativity research journal*, *14*(1), 41-54.

Cohen, S. G., & Bailey, D. E. (1997). What makes teams work: Group effectiveness research from the shop floor to the executive suite. *Journal of management*, *23*(3), 239-290.

Cook, D. (2007, July 19). *The chemistry of game design*. Retrieved January 14, 2016, from Gamasutra: http://www.gamasutra.com/view/feature/129948/the_chemistry_of_game_design.php

Coovert, M. D., Winner, J., Bennett Jr, W., & Howard, D. J. (2017). Serious games are a serious tool for team research. *International journal of serious games*, *4*(1), 41-55.

Creswell, J., & Plano Clark, V. (2007). *Designing and conducting mixed methods research*. Thousand Oaks: Sage.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, *11*(4), 227-268.

DeShon, R. P., Kozlowski, S. W., Schmidt, A. M., Milner, K. R., & Wiechmann, D. (2004). A multiple-goal, multilevel model of feedback effects on the regulation of individual and team performance. *Journal of applied psychology*, *89*(6), 1035-1056.

Deterding, S. (2013). Skill atoms as design lenses for user-centered gameful design. In *Workshop papers CHI2013*. Paris: ACM.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining "gamification". In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* (pp. 9-15). ACM.

Deutsch, M. (2006). Cooperation and competition. In M. Deutsch, P. T. Coleman, & E. C. Marcus (Eds.), *The handbook of conflict resolution: Theory and practice* (pp. 23-42). San Francisco: Jossey-Bass.

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1996). The evolution of research on collaborative learning. In E. Spada, & P. Reiman (Eds.), *Learning in humans and machine: Towards an interdisciplinary learning science* (pp. 189-211). Oxford: Elsevier.

DiMicco, J. M., Pandolfo, A., & Bender , W. (2004). Influencing group participation with a shared display. In *Proceedings of the 2004 ACM conference on computer supported cooperative work* (pp. 614-623). ACM.

Dormans, J. (2012). *Engineering emergence: Applied theory for game design*. Amsterdam: Creative Commons.

Dreu de, C. K. (2006). When too little or too much hurts: Evidence for a curvilinear relationship between task conflict and innovation in teams. *Journal of management*, *32*(1), 83-107.

Dugosh, K. L., & Paulus, P. B. (2005). Cognitive and social comparison processes in brainstorming. *Journal of experimental social psychology*, *41*, 313-320.

Edery, D., & Mollick, E. (2009). *Changing the game: How video games are transforming the future of business*. New York: Financial Times Press.

Edwoldsen, D. R., Eno, C. A., Okdie, B. M., Velez, J. A., Guadagno, R. E., & DeCoster, J. (2012). Effect of playing violent video games cooperatively or competitively on subsequent cooperative behavior. *Cyberpsychology, behavior, and social networking*, *15*(5), 277-280.

Egenfeldt-Nielsen, S. (2006). Overview of research on the educational use of video games. *Digital kompetanse*, *1*(3), 184-213.

Eickhoff, C., Harris, C. G., Vries, A. P., & Srinivasan, P. (2012). Quality through flow and immersion: Gamifying crowdsourced relevance assessments. In *Proceedings of the 35th international ACM SIGIR conference on Research and development in information retrieval* (pp. 871-880). Portland: ACM.

Elias, G. S., Garfield, R., & Gutschera, K. R. (2012). Multiplayer games. In *Characteristics of games* (pp. 37-69). Cambridge, Massechusetts: MIT Press.

El-Nasr, M. S., Desurvire, H., Aghabeigi, B., & Drachen, A. (2013). Game analytics for game user research, Part 1: A workshop review and case study. *IEEE computer graphics and applications*, *33*(2), 6-11.

El-Nasr, M. S., Drachen, A., & Canossa, A. (2013). *Game analytics: Maximizing the value of player data*. Springer.

Eno, B., & Schmidt, P. (1975). *Oblique strategies* [Cards]. Winston: Opal Records.

Farzan, R., DiMicco, J. M., Millen, D. R., Brownholtz, B., Geyer, W., & Dugan, C. (2008). Results from deploying a participation incentive mechanism within the enterprise. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 563-572). Florence: ACM.

Fluegelman, A. (1976). *The new games book*. New York: Doubleday.

Frenkel, S. J., & Sanders, K. (2007). Explaining variations in co-worker assistance in organizations. *Organization studies*, *28*(6), 797–823.

Fuchs, M., Fizek, S., Ruffino, P., & Schrape, N. (2014). *Rethinking gamification*. Lüneburg: Meson press.

Gajadhar, B. J., de Kort, Y. A., & Ijselsteijn, W. A. (2008). Shared fun is doubled fun: Player enjoyment as a function of social setting. In *Fun and games* (pp. 106-117). Springer, Berlin, Heidelberg.

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. New York: Harper & Row.

Gray, D., Brown, S., & Macanufo, J. (2010). *Gamestorming: A playbook for innovators, rulebreakers, and changemakers*. Sebastopol, CA, USA: O'Reilly Media Inc.

Green, M. C., Brock, T. C., & Kaufman, G. F. (2004). Understanding media enjoyment: The Role of transportation into narrative worlds. *Communication theory*, *14*(4), 311-327.

Grossman, R. (2014). *How do teams become cohesive? A meta-analysis of cohesion's antecedents*. Florida: Doctoral dissertation, University of Central Florida Orlando.

Gully, S. M., Devine, D. J., & Whitney, D. J. (2012). A meta-analysis of cohesion and performance: Effects of level analysis and task interdependence. *Small group research*, *43*(6), 702-725.

Hackman, J. R. (1969). Toward understanding the role of tasks in behavioral research. *Acta Psychologica*, *31*, 97-128.

Hackman, J. R. (1987). The design of work teams. In J. Lorsch (Ed.), *Handbook of organizational behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Hackman, J. R. (2002). Why teams don't work. In *Theory and research on small groups* (pp. 245-267). Springer, Boston, MA.

Hackman, J. R., & Morris, C. G. (1975). Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. In L. Berkowitz (Eds.), *Advances in experimental social psychology*. New York: Academic Press.

Hackman, J. R., & Oldham, G. R. (1980). *Work redesign*. Reading: Addison-Wesley.

Hamari, J. (2013). Transforming homo economicus into homo ludens: A field experiment on gamification in a utilitarian peer-to-peer trading service. *Electronic commerce research and applications*, *12*(4), 236-245.

Hamari, J., & Koivisto, J. (2013). Social motivations to use gamication: An empirical study of gamifying Exercise. *ECIS 2013 Proceedings*. Paper 112.

Hamari, J., Koivisto, J., & Sarsa, H. (2014, January). Does gamification work?--a literature review of empirical studies on gamification. In *System Sciences (HICSS), 2014 47th Hawaii International Conference* (pp. 3025-3034). IEEE.

Harkins, S. G., & Szymanski, K. (1989). Social loafing and group evaluation. *Journal of personality and social psychology*, *56*(6), 934-941.

Henricks, T. S. (2011). Play as a pathway of behavior. *American journal of play*, *4* (2), 225-253.

Hohmann, L. (2007). *Innovation games: Creating breakthrough products through collaborative play*. Upper Saddle River, NJ: Addison- Wesley.

Hron, A., Hesse, F. W., Cress, U., & Giovis, C. (2000). Implicit and explicit dialogue structuring in virtual learning groups. *Britisch journal of educational psychology*, *70*, 53-64.

Hsieh, T. (2010). *Delivering happiness*. New York: Business Plus.

Huang, J.-C. (2010). Unbundling task conflict and relationship conflict: The moderating role of team goal orientation and conflict management. *International journal of conflict management*, *21*(3), 334-355.

Huizinga, J. (1950). *Homo ludens: Proeve eener bepaling van het spel-element der cultuur (2008 ed.)*. Amsterdam: Amsterdam University Press.

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. In *Proceedings of the AAAI Workshop on Challenges in Game AI* (pp. 1-5). AAAI Press San Jose, CA.

Huotari, K., & Hamari, J. (2012, October). Defining gamification: a service marketing perspective. In *Proceeding of the 16th international academic MindTrek conference* (pp. 17-22). ACM.

Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. *Annual review of psychology*, *56*, 517-543.

Järvinen, A. (2008). *Games without frontiers: Theories and methods for game studies and design*. Tampere: University of Tampere.

Jehn, K. A. (1995). A multimethod examination of the benefits and detriments of intragroup conflict. *Administrative science quarterly*, *40*, 256-282.

Johnson, D. W., & Johnson, R. T. (2006). New developments in social interdependence theory. *Genetic, social, and general psychology monographs*, *131*(4), 285-358.

Jung, E. J., & Lee, S. (2015). The combined effects of relationship conflict and the relational self on creativity. *Organizational behavior and human decision processes*, *130*, 44-57.

Jung, J., Schneider, C., & Valacich, J. (2010). Enhancing the motivational affordance of information systems: The effects of real-time performance feedback and goal setting in group collaboration environments. *Management science*, *56*(4), 724-742.

Juul, J. (2005). *Half-real: Video games between real rules and fictional worlds*. Cambridge: MIT Press.

Juul, J. (2003). The game, the player, the world: Looking for a heart of gameness. In M. Copier, & J. Raessens (Eds.), *Level up: Digital games research conference proceedings* (pp. 30-45). Utrecht: Utrecht University.

Kappen , D. L., & Nacke, L. (2013). The kaleidoscope of effective gamification: Deconstructing gamification in business applications. In *Gamification'13 proceedings of the first international conference on gameful design, research, and applications* (pp. 119-122). ACM.

Kennedy, B. (2002, July 11). *Uncle sam wants you (to play this game)*. The New York Times.

Kidwell, Jr., R. E., Mossholder, K. W., & Bennett, N. (1997). Cohesiveness and organizational citizenship behavior: A multilevel analysis using work groups and individuals. *Journal of management*, *23*(6), 775-793.

Knaving, K., & Björk, S. (2013). Designing for fun and play: Exploring possibilities in design for gamification. In *Gamification 2013 proceedings* (pp. 131-134). Stratford, ON, Canada: ACM.

Koivisto, J., & Hamari, J. (2014). Demographic differences in perceived benefits from gamification. *Computers in human behavior* , *35*, 179–188.

Kooij, van der, K., Hogendoorn, E., Spijkerman, R., & Visch, V. (2014). Changamoto: Design and validation of a therapy adherence game. In B. Schouten, S. Fedtke, M. Schijven, M. Vosmeer, & A. Gekker (Eds.), In *Games for health 2014: Proceedings of the 4th conference on gaming and playful interaction in healthcare* (pp. 144-149). Amsterdam: Springer.

Kort de, Y. A., Ijsselsteijn, W. A., & Poels, K. (2007). Digital games a social presence technology: Development of the social presence in gaming questionnaire (SPGQ). In *PRESENCE 2007 Proceedings* (pp. 195-203). Barcelona.

Koskinen, I., Zimmerman, J., Binder, T., Redström, J., & Wensveen, S. (2011). *Design research through practice: From the lab, field, and showroom*. Waltham: Morgan Kaufmann.

Kozlowski, S. W., & Bell, B. S. (2013). Work groups and teams in organizations: Review update. In N. Schmitt, & S. Highhouse (Eds.), *Handbook of psychology: Vol. 12. Industrial and organizational psychology* (2nd ed., pp. 412-469). Hoboken, NJ: Wiley.

Kozlowski, S. W., Grand, J. A., Baard, S. K., & Pearce, M. (2015). Teams, teamwork, and team effectiveness: Implications for human systems integration. In D. Boehm-Davis, F. Durso, & J. Lee (Eds.), *The handbook of human systems integration* (pp. 555-571). Washington: American Psychological Association.

Kozlowski, W. J., & Ilgen, D. R. (2006). Enhancing the effectiveness of work groups and teams. *Psychological science in the public interest*, *7*(3).

Kristiansen, P., & Rasmussen, R. (2014). *Building a better business using the Lego serious play method*. John Wiley & Sons.

MacBryde, J., & Mendibil, K. (2003). Designing performance measurement systems for teams: theory and practice. *Management decision*, *41*(8), 722-733.

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Coginitive science, 4*, 333-369.

Malone, T. W., & Lepper, M. R. (1987). Making learning fun: A taxonomy of intrinsic motivations for learning. In R. E. Snow, & M. J. Farr (Eds.), *Aptitude, learning , and instruction (Vol. 3: Conative and affective process analyses)*. London: Lawrence Erlbaum Associates, Publishers.

Marks, M. A., & Panzer, F. J. (2004). The influence of team monitoring on team processes and performance. *Human performance*, *17*(1), 25-41.

Marlow, S. L., Salas, E., Landon, L. B., & Presnell, B. (2016). Eliciting teamwork with game attributes: A systematic review and research agenda. *Computers in human behavior*, *55*, 413-423.

Matesk, M. (2013, May 28). *Red teaming and alternative analysis*. Retrieved October 21, 2015, from Red Team Journal: http://redteamjournal.com/about/red-teaming-and-alternative-analysis/

Mayer, I., Bekebrede, G., Harteveld, C., Warmelink, H., Zhou, Q., Ruijven, T., ... & Wenzler, I. (2014). The research and evaluation of serious games: Toward a comprehensive methodology. *British Journal of Educational Technology*, *45*(3), 502-527.

Mayer, I. S., Bueren, van, E. M., Bots, P. W., & Voort, van der, H. (2005). Collaborative decisionmaking for sustainable urban renewal projects: A simulation - gaming approach. *Environment and planning b: Planning and design* , *32*(3), 403-423.

Mayer, I., van Dierendonck, D., van Ruijven, T., & Wenzler, I. (2014). Stealth assessment of teams in a digital game environment. In De Gloria A. (Eds.) *Games and learning alliance. GALA 2013. Lecture notes in computer science, vol 8605*. Springer, Cham.

McGonigal, J. (2011). *Reality is broken*. London: Jonathan Cape.

McGrath, J. E. (1997). Small group research, that once and future field: An interpretation of the past with an eye to the future. *Group dynamics: Theory, research, and practice*, *1*(1), 7-27.

McGrath, J. E., Arrow, H., & Berdahl, J. L. (2000). The study of groups: Past, present, and future. *Personality and social psychology review*, *4*(1), 95-105.

Mekler, E. D., Brühlmann, F., Opwis, K., & Tuch, A. N. (2013). Disassembling gamification: The effects of points and meaning on user motivation and performance. In *CHI'13 extended abstracts on human factors in computing systems* (pp. 1137-1142). ACM.

Mello, A. L., & Delise, L. A. (2015). Cognitive diversity to team outcomes: The roles of cohesion and conflict management. *Small group research*, *46*(2), 204–226.

Mendibil, K., & MacBryde, J. (2006). Factors that affect the design and implementation of team-based performance measurement systems. *International journal of productivity and performance management*, *55*(2), 118-142.

Mitchell, T. R., & Daniels, D. (2003). Motivation. In W. C. Borman, D. R. Ilgen, & R. J. Klimoski (Eds.), *Handbook of psychology: Industrial and organizational psychology* (Vol. 12). New Jersy: John Wiley & Sons Inc.

Moccozet, L., Tardy, C., Opprecht, W., & Léonard, M. (2013). Gamification-based assessment of group work. In *Interactive collaborative learning (ICL), 2013 international conference on* (pp. 171-179). IEEE.

Mollick, E. R., & Rothbard, N. (2013). Mandatory fun: Gamification and the impact of games at work. *The Wharton School Research Paper Series*.

Mollick, E., & Werbach, K. (2014). Gamification and the enterprise. In S. P. Walz, & S. Deterding (Eds.), *The gameful world* (pp. 439-458). Cambridge, Massechusetts: MIT Press.

Montola, M., Stenros, J., & Waern, A. (2009). *Pervasive games: Experiences on the boundary between life and play*. Burlington: Morgan Kaufmann Publishers.

Morschheuser, B., Riar, M., Hamari, J., & Maedche, A. (2017). How games induce cooperation? A study on the relationship between game features and we-intentions in an augmented reality game. *Computers in human behavior*, *77*, 169-183.

Mulvaney, B. S. (2012, July). Red teams: Strengthening through challenge. *Marine Corps Gazette*, 63-66.

Murphy, K. R., & Davidshofer, C. O. (2013). *Psychological testing: Principles and applications* (6th Edition ed.). Pearson Education Limited.

Nakamura, J., & Csikszentmihalyi, M. (2002). The concept of flow. In *Handbook of positive psychology* (pp. 89-105). New York: Oxford University Press.

Nicholson, S. (2012). A user-centered theoretical framework for meaningful gamification. *Games+Learning+Society 8.0*. Madison.

Nijstad, B. A., Stroebe, W., & Lodewijkx, H. F. (2006). The illusion of group productivity: A reduction of failures explanation. *European journal of social psychology*, *36*, 31-48.

Norman, D. (2001). *The design of everyday things* (Fourth printing ed.). London: MIT Press.

Osborn, A. F. (1963). *Applied imagination: Principles and procedures of creative problem solving*. New York, NY: Charles Scribner's Sons.

Paulus, P. B., Dzindolet, M. T., Poletes, G., & Mabel Camacho, L. (1993). Perception of Performance in Group Brainstorming: The Illusion of Group Productivity. Personality and Social Psychology Bulletin , 19 (1), 78-89.

Paulus, P. B., Leggett Dugosh, K., Dzindolet, M. T., Coskun, H., & Putman, V. L. (2002). Social and cognitive influences in group brainstorming: Predicting production gains and losses. In W. Stroebe, & M. Hewstone (Eds.), *European review of social psycholgy* (pp. 299-325). John Viley & Sons Ltd.

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A motivational model of video game engagement. *Review of general psychology*, *14*(2), 154–166.

Rahim, M. A. (2002). Toward a theory of managing organizational conflict. *The international journal of conflict management*, *13*(3), 206-235.

RANJ Serious Games. (2011). *About juf-in-a-box*. Retrieved February 2, 2016, from Juf-in-a-Box: http://www.jufinabox.com/about-juf-in-a-box/

Reeves, B., & Read, J. L. (2009). *Total engagement: Using games and virtual worlds to change the way people work and businesses compete*. Cambridge, MA: Harvard Business Press.

Reiners, T., & Wood, L. (2015). *Gamification in education and business*. Springer.

Rovio, E., Eskola, J., Kozub, S. A., Duda, J. L., & Lintunen, T. (2009). Can high group cohesion be harmful? A case study of a junior ice-hockey team. *Small group research*, *40*(4), 421-435.

Roy, D. F. (1959). "Banana time" Job satisfaction and informal interaction. *Human organization*, *18*, 158-168.

Rozendaal, M. C., Braat, B. A., & Wensveen, S. A. (2010). Exploring sociality and engagement in play through game-control distribution. *AI & Society*, *25*(2), 193-201.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, *25*(1), 54-67.

Ryan, R. M., Rigby , C. S., & Przybylski, A. (2006). The motivational pull of video games: a self-determination theory approach. *Motivation and emotion*, *30*(4), 344-360.

Salas, E., Cooke, N. J., & Rosen, M. A. (2008). On teams, teamwork, and team performance: discoveries and developments. *Human factors*, *50*(3), 540-547.

Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Massachusetts: MIT Press.

Salen, K., & Zimmerman, E. (2005). *The game design reader: A rules of play anthology*. Cambridge, Massachusetts: Massachusetts Institute of Technology.

Sanders, K., & Nauta, A. (2004). Social cohesiveness and absenteeism: The relationship between characteristics of employees and short-term absenteeism within an organization. *Small group research*, *35*(6), 724-741.

Schell, J. (2008). *The arf of game design: A book of lenses*. Boca Raton, FL: CRC Press Taylor & Francis Group.

Schippers, M. C., Edmondson, A. C., & West, M. A. (2014). Team reflexivity as an antidote to team information-processing failures. *Small group research*, *45*(6), 731-769.

Schmierbach, M. (2010). "Killing spree": Exploring the connection between competitive game play and aggressive cognition. *Communication research*, *37*(2), 256-274.

Shin, Y. (2014). Positive group affect and team creativity: Mediation of team reflexivity and promotion focus. *Small group research*, *45*(3), 337–364.

Silverman, R. E. (2011, October 10). *Latest game theory: Mixing work and play.* Retrieved January 7, 2016, from The Wall Street Journal: http://www.wsj.com/articles/SB10001424052970204294504576615371783795248

Sniderman, S. (2006). Unwritten rules. In K. Salen, & E. Zimmerman (Eds.), *The game design reader: a rules of play anthology* (pp. 476-502). Cambridge, Massachusetts: MIT Press.

Spataro, S. E., Pettit, N. C., Sauer, S. J., & Lount Jr., R. B. (2014). Interactions among same-status peers: Effects of behavioral style and status level. *Small group research*, *45*(3), 314–336.

Stoppelenburg, A., de Caluwe, L., & Geurts, J. (2012). *Gaming: Organisatieverandering met spelsimulaties*. Deventer: Kluwer.

Suits, B. (1978). *The grasshopper: Games, life and utopia*. Godine Press.

Sundstrom, E., De Meuse, K. E., & Futrell, D. (1990). Work teams: Applications and effectiveness. *American psychologist*, *45*(2), 120-133.

Sutton, R. I., & Hargadon, A. (1996, Dec.). Brainstorming groups in context: Effectiveness in a product design firm. *Administrative science quarterly*, *41*(4), pp. 685-718.

Tan, E. S., & Jansz, J. (2008). The game experience. In H. N. Schifferstein, & P. Hekkert (Eds.), *Product experience* (pp. 531-556). San Diego: Elsevier Ltd.

Tashakkori, A., & Teddlie, C. (2010). *Sage handbook of mixed methods in social & behavioral research*. Thousand Oaks: Sage.

Tausczik, Y. R., & Pennebaker, J. W. (2013). Improving teamwork using real-time language feedback. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 459-468). ACM.

The Barn. (2009). *TeamUp* [video game]. Delft: The Barn. http://www.thebarngames.nl/teamup/teamup/

Thom, J., Millen, D., & DiMicco, J. (2012). Removing gamification from an enterprise SNS. In *Proceedings of the ACM 2012 conference on Computer supported cooperative work* (pp. 1067-1070). ACM.

Thomas, K. W. (1992). Conflict and conflict management: Reflections and update. *Journal of organizational behavior, special issue: conflict and negotiation in organizations: Historical and contemporary perspectives*, *13*(3), 265-274.

Tromp, N., Hekkert, P., & Verbeek, P.-P. (2011). Design for socially responsible behavior: A classification of influence based on intended user experience. *Design issues*, *27*(3).

Verhaeghe, P. (2015). *Autoriteit*. Antwerpen: De Bezige Bij.

Visch, V., Vegt, N. J., Anderiesen, H., & van der Kooij, K. (2013). Persuasive game design: A model and it definitions. In *Workshop papers CHI2013*. Paris: ACM.

Vliert van de, E., & Dreu de, C. K. (1994). Optimizing performance by conflict stimulation. *The international journal of conflict management*, *5*(3), 211-222.

Voulgari, I., & Komis, V. (2015). Exploring group cohesion in massively multiplayer online games. *Age*, *18*(7), 18-24.

Wageman, R. (1995). Interdependence and group effectiveness. *Administrative science quarterly*, *40*, 145-180.

Walz, S. P., & Deterding, S. (2014). *The gameful world: Approaches, issues, applications*. London: MIT Press.

Wang, C. S., Galinsky, A. D., & Murnighan, J. K. (2009). Bad drives psychological reactions, but good propels behavior: Responses to honesty and deception. *Psychological science*, *20*(5), 634-644.

Warmelink, H. (2013). *Towards playful organizations: How online gamers organize themselves (and what other organizations can learn from them)*. Delft: Next Generation Infrastructures Foundation.

Warmelink, H., Mayer, I., Weber, J., Heijligers, B., Haggis, M., Peters, E., & Louwerse, M. (2017, October). AMELIO: Evaluating the team-building potential of a mixed reality escape room game. In *Extended Abstracts Publication of the Annual Symposium on Computer-Human Interaction in Play* (pp. 111-123). ACM.

Weibel, D., Wissmath, B., Habegger, S., Steiner, Y., & Groner, R. (2007). Playing online games against computer- vs. human-controlled opponents: effects on presence, flow, and enjoyment. *Computers in human behavior*, *24*(5), 2274-2291.

Weingart, L., & Jehn, K. A. (2003). Manage intra-team conflict through collaboration. In *handbook of principles of organizational behavior: Indispensable knowledge for evidence-based management, Second,* 327-346.

Wendel, V., Gutjahr, M., Göbel, S., & Steinmetz, R. (2013). Designing collaborative multiplayer serious games. *Education and information technologies*, *18*(2), 287-308.

Widmer, P. S., Schippers, M. C., & West, M. A. (2009). Recent developments in reflexivity research: A review. *Psychology of everyday activity*, *2*(2), 2-11.

Winn, B. M. (2009). The design, play, and experience framework. In R. Ferdig (Eds.), *Handbook of research on effective electronic gaming in education* (pp. 1010-1024). IGI Global.

Winters, D., & Latham, G. (1996). The effects of learning versus outcome goals on a simple versus a complex task. *Group and organization management*, *21*, 236-250.

Wittgenstein, L. (1953). *Philosophical investigations*. New York: Macmillan.

Woodcock, J., & Johnson, M. R. (2017). Gamification: What it is, and how to fight it. *Sociological review*, online first: http://journals.sagepub.com/doi/full/10.1177/0038026117728620.

Wu, L.-Z., Ferris, L. D., Kwan, H. K., Chiang, F., Snape, E., & Liang, L. H. (2015). Breaking (or making) the silence: How goal interdependence and social skill predict being ostracized. *Organizational behavior and human decision processes*, *131*, 51-66.

Yong, K., Sauer, S. J., & Mannix, E. A. (2014). Conflict and creativity in interdisciplinary teams. *Small group research*, *45*(3), 266–289.

Zadro, L., Williams, K. D., & Richardson, R. (2004). How low can you go? Ostracism by a computer is sufficient to lower self-reported levels of belonging, control, self-esteem, and meaningful existence. *Journal of experimental social psychology*, *40*, 560-567.

Zigon, J. (1997). Team performance measurement: A process for creating team performance standards. *Compensation & benefits review*, *29*(1), 38-47.

Summary

Game designers seem masters in motivating people to start playing, continue playing, and return to playing games. The possibilities of applying game elements for positive behavior change in non-game contexts (gamification) seem limitless, ranging from politics to treatment of mental illness. However, the number of applied gamification studies is still limited. Thus to what extent the promises can be fulfilled remains uncertain. The gamification research field came to life 7 years ago and since then the theoretical knowledge base grew steadily, yet research on gamification in practice stayed behind.

This doctorate work aims to contribute to the knowledge about the real-life application of game elements and bridge the gap between theory and practice. We examined to what extent game elements could improve team performance. Our research focuses on teamwork in organizations as the application area, first of all, because many companies start applying gamification and largely rely on teamwork within their organizations. Secondly, social elements are strong motivators, yet underexplored in gamification studies. The studies that were done to answer this question were executed with a consortium of academics, game developers, and organizational experts, to achieve directly applicable outcomes.

As gamification and game design theory do not provide a commonly accepted definition of games and gamification design, the dissertation starts with a treatise on the fundamental components of a game experience. We take an experiential perspective because a game cannot be distinguished from other categories based on its building blocks. Consequently, gamification is defined as the transportation of a user's experience from a real world experience towards a game world experience, resulting in a gameful experience that is aimed at achieving an effect in the real world, i.e. a transfer effect. The gameful experience, i.e. an increased feeling of playing a game, lies between the two extremes of a real world and game world experience, and originates from four components: objects, goals, rules, and freedom. These components are assumed to be crucial to generate a gameful experience and thus inevitable for investigating the transfer effect of a gamification.

With this initial theory, chapter 2 explores the application of game elements in a real-life teamwork context, to better understand designing game elements for non-game teamwork and evaluating transfer effects. Two intervention studies at a steel-processing factory investigate the effect of a gamified dashboard displaying the performance of the operating teams and the effect of adding game-like social elements

to the dashboard. The results indicate that displaying game-like performance information increased the operators' commitment to their tasks and their perception of the team's performance. The added social elements led to increased non-work-related conversation. Both interventions demonstrate that gamification increased attention for the elements in the work that were gamified (i.e. key performance indicators and non-work-related conversation topics); yet the intended transfer effect of increasing team cohesion was not found. This may be explained by the relatively small interventions in relation to the complexity of factory work. We conclude that game design interventions are mainly valuable for raising the user's attention to pre-chosen parts of the work. As a result, gamification design was defined as: transforming real world elements into game world elements.

Chapter 3 describes a literature exploration to find the theoretical overlap between real world teamwork elements and game world teamwork elements, leading to more specific theory about the gamification of teamwork. The resulting framework describes how game goals and game rules could influence two fundamental principles in organizational psychology: interdependence and conflict management strategies. Users can be directed towards competitive or cooperative conflict management strategies by defining the rules for achieving a certain goal (i.e. goal-driven rules). Interaction rules define to what extent users interact with each other and thereby influence the feeling of interdependence. As a result, goal-driven and interaction rules could lead to four types of interdependent experiences: dependent competition, independent competition, dependent cooperation, and independent cooperation.

In chapter 4, the above-described framework is applied in a simple multiplayer computer game (Breakout). In order to investigate the experiential and behavioral effect of goal-driven and interaction rules, two game variants were designed. Without explaining the rules, one variant intended to evoke dependent competition and the other was intended to evoke dependent cooperation. The measured player experiences demonstrated that the games evoked significantly different experiences and were indeed experienced as dependent competition and dependent cooperation. Yet the behavior of the players was more divers. We found four distinctive behavioral patterns that were not all experienced as interdependent. In fact, an analysis using classical game theoretical principles indicated that the competitive goal-driven rule unintentionally elicited independent competitive behavior. Hence, we concluded that goal-driven and interaction rules were effective in intentionally evoking particular teamwork experiences, yet we have to be careful in predicting their behavioral effect. Experienced interdependence does not correspond one-to-one with interdependent behavior.

Before implementing game rules in a real-life teamwork setting, chapter 5 describes an experiment investigating the effect of different types of gamification on team collaboration in the lab. Students participated in a group-brainstorming challenge with coins to reward or punish each other's contributions. We measured the effect of 5 different rule-sets, varying in the number of governing and forcing rules, on brainstorm output and the users' behaviors and experiences. The rules that forced competitive game behavior improved the quantity and quality of brainstorm output significantly, yet the invasiveness of this forced behavior hindered the positive effect. Governing rules evoked distracting discussions, leading to a negative effect. In order to better understand and predict the transfer effect of gamification in the future, we propose a distinction between affective, cognitive and behavioral invasiveness. For the tested gamification, just adding coins without any additional game rules seemed the safest option, because it probably increases the participants' playful attitude, stimulates competition and avoids the found negative invasive effects of rules.

Chapter 6 describes a gamification pilot study at team meetings in a management consultancy firm. This experiment in a real-life teamwork setting taught us implications of implementing game elements for teamwork in the field. Based on the conclusions from chapter 5, we redesigned the coin game to fit the requirements of the company's team meetings. The rules were kept as unintrusive as possible by embedding goals and rules into objects: coins resembling contribution types. Next to reducing the invasiveness of the gamification, the measurement method had to be noninvasive as well. It was integrated in the gamification procedure, giving one of the participants the task to record coin transactions during the meeting on a mobile website. The pilot study results suggest that the tested gamification was successful in evoking a positive gameful experience, yet participants doubted whether the coin game would be motivating enough to achieve a positive transfer effect in the long-term. The design process taught us that reviewing teamwork processes as if they are a game provides valuable insights for the design of a gamification as well as for possible improvements in the teamwork process itself. Moreover, we discovered that gamification design could be applied in the study design by integrating the effect evaluation in the gamification concept.

From the gamification studies described in this thesis we conclude that there are basically two methods for designing teamwork gamification: 1) explicating implicit non-game (teamwork) elements and 2) adding or changing regulation. The resulting transfer effects are: 1) increased attention for the gamified elements and 2) changes in behavior. When designing gamified objects, goals, rules, and freedom, balancing

the invasiveness of the gamification is crucial to achieve a positive transfer effect. Hence, we conclude that the four proposed components of a gameful experience and the three types of invasiveness (affective, cognitive, behavioral) constitute the Gamification Design Space (GDS). Based on our research, we found the following factors in the GDS that need to be balanced to achieve effective teamwork gamification: style, meaning, affordance, goal attribution, direct feedback, conflict behavior, interdependence, learning, strategic behavior, credibility, decision-making, and playful behavior.

The GDS broadens our understanding of gamification design, compared to the common notion of gamification design as points, badges, and leaderboards. The found factors can serve as guidelines for designing teamwork gamification as well as serve as factors on which a gamification design can intervene. In order to fully exploit the value of gaming, future research should further explore the GDS and examine the above-mentioned factors that influence the transfer effect of a gamification.

Samenvatting

Spelontwerpers lijken meesters in het motiveren van mensen om te beginnen met spelen, het spelen voort te zetten, en een spel opnieuw te spelen. De mogelijkheden om spel elementen toe te passen voor positieve gedragsverandering in niet-spel omgevingen (gamificatie) lijken eindeloos, variërend van politiek tot behandelingen in de geestelijke gezondheidszorg. Het aantal toegepaste gamificatie studies is echter beperkt. In hoeverre de beloftes kunnen worden waargemaakt is daarom nog onzeker. Het gamificatie onderzoeksveld is 7 jaar geleden ontstaan en sindsdien is het theoretische kennisveld gestaag gegroeid, maar onderzoek naar gamificatie in de praktijk blijft achter.

Het doel van het onderzoek in dit proefschrift is een bijdrage leveren aan de kennis over de daadwerkelijk toepassing van spel elementen en het overbruggen van het gat tussen theorie en praktijk. In dit proefschrift onderzoeken we in hoeverre spel elementen team prestaties kunnen verbeteren. Ons onderzoek richt zich specifiek op groepswerk in organisaties als toepassingsgebied. Ten eerste, omdat veel bedrijven al begonnen zijn met het gebruik van gamificatie en zij over het algemeen grotendeels van samenwerking in teams afhankelijk zijn. Ten tweede, zijn sociale elementen sterk motiverende factoren, maar nog onderbelicht in gamificatie studies. Om dit in de praktijk te kunnen onderzoeken zijn de studies uitgevoerd in een samenwerkingsverband tussen academici, spel ontwerpers, en organisatie deskundigen.

Aangezien gamificatie en spel ontwerp theorieën geen algemeen gangbare definitie van spellen en gamificatie ontwerp bevatten, beginnen we het proefschrift met een verhandeling over de fundamentele componenten van een spel ervaring. We nemen de spelerservaring als basis omdat een spel niet te onderscheiden is van andere categorieën op basis van zijn bouwstenen. Daarom definiëren we gamificatie als 'de transportatie van de ervaringen van een gebruiker van de echte wereld naar de spel wereld'. Dit resulteert in een meer spelachtige (gameful) ervaring met als doel een effect te hebben in de echte wereld, d.w.z. een transfer effect. De gameful ervaring, oftewel een verhoogd gevoel een spel te spelen, ligt tussen de twee extremen van een echte wereld ervaring en een spel wereld ervaring en ontstaat uit vier componenten: objecten, doelen, regels en vrijheid. We gaan er vanuit dat deze componenten cruciaal zijn om een gameful ervaring op te wekken en daarom ook voor onderzoek naar de transfer effecten van gamificatie.

Met deze initiële theorie verkennen we in hoofdstuk 2 het ontwerp, de

toepassing, en effecten van spel elementen in een echte wereld teamwork context. In twee interventie studies in een staalverwerking fabriek onderzoeken we het effect van een gamified prestatie dashboard en het effect van spelachtige sociale elementen op het dashboard. De resultaten laten zien dat gamified prestatie informatie leidt tot meer commitment met de taken van het team en een verbetering in de ervaren team prestatie. De sociale elementen leiden tot meer niet-werk gerelateerde conversaties. Beide interventies tonen aan dat gamificatie de aandacht vergroot voor de gamified elementen in het werk. Echter, het bredere doel om de cohesie binnen het team te versterken is niet behaald. Een verklaring zou kunnen zijn dat de interventies te klein waren in de complexe context van een fabriek. We concluderen dat spelachtige interventies voornamelijk waardevol zijn voor het vergroten van de aandacht voor gegamificeerde elementen in het werk. Dit resulteert in de volgende definitie van gamificatie ontwerp: echte-wereld elementen transformeren naar spelelementen.

Hoofdstuk 3 beschrijft de resultaten van een verkenning van literatuur om de theoretische overlap te vinden tussen elementen in echte wereld teamwork en elementen in spel wereld teamwork. Het resulterende model beschrijft hoe speldoelen en spelregels twee fundamentele principes in de organisatiepsychologie kunnen beïnvloeden: onderlinge afhankelijkheid en conflicthantering strategieën. De regels m.b.t. het behalen van het doel (ofwel doel-gedreven regels) kunnen gebruikers sturen naar competitieve of coöperatieve conflicthantering strategieën. Interactie regels bepalen in hoeverre gebruikers interactie met elkaar hebben en daarmee in hoeverre ze zich onderling afhankelijk voelen. Doel-gedreven regels en interactie regels kunnen derhalve leiden tot vier types ervaringen van onderlinge afhankelijkheid: afhankelijke competitie, onafhankelijk competitie, afhankelijke coöperatie, en onafhankelijke coöperatie.

In hoofdstuk 4 gebruiken we het hierboven beschreven model in een simpel multiplayer computer spel (Breakout). Om de ervarings- en gedragseffecten van doel-gedreven en interactie regels te onderzoeken hebben we twee spelvarianten ontworpen. Zonder uitleg over de regels zou de ene variant afhankelijke competitie moeten opwekken en de andere variant afhankelijke coöperatie. De gemeten ervaringen van de spelers tonen significant verschillende ervaringen aan, waarbij de ene variant inderdaad werd ervaren als afhankelijke competitie en de andere variant als afhankelijke coöperatie. Het gedrag van spelers was echter meer divers. We vonden vier onderscheidende gedragspatronen die niet allemaal als onderling afhankelijk werden ervaren. Sterker nog, een analyse van de competitieve doel-gedreven spelregels, d.m.v. principes uit de klassieke spel theorie, toonde aan dat deze regels onbedoeld onafhankelijke competitie ontlokte. Uit deze resultaten

concluderen we dat doel-gedreven en interactie regels effectief zijn in het intentioneel opwekken van een bepaalde teamwork ervaring, maar dat het gedrag van spelers moeilijker te voorspellen en beïnvloeden is. De ervaren afhankelijkheid in een spel hangt dus niet direct samen met het bijbehorende gedrag.

Om beter grip te krijgen op het effect van spelregels op team gedrag beschrijven we in hoofdstuk 5 een lab experiment waarin we het effect van verschillende gamificatie varianten op de samenwerking binnen teams onderzoeken. Groepjes studenten werden gevraagd deel te nemen aan een brainstorm opdracht waarbij ze elkaars bijdrage met munten konden belonen of bestraffen. We hebben het effect van vijf verschillende regel-sets gemeten, variërend in het aantal controlerende en verplichtende regels, op de brainstorm output en de ervaringen en het gedrag van de deelnemers. Regels die competitief spelgedrag verplichtten verbeterden de kwantiteit en kwaliteit van brainstorm output significant, maar de indringendheid (invasiviteit) van het verplichtte spelgedrag verstoorde dit positieve effect. Controlerende regels wekten afleidende discussies op en hadden daarmee een negatief effect. Om het transfer effect van gamificatie in de toekomst beter te begrijpen en voorspellen stellen we in dit hoofdstuk een onderscheid voor tussen affectief, cognitief, en gedragsmatige indringendheid. Ten aanzien van de geteste gamificatie concluderen we dat het toevoegen van munten zonder regels de meest veilige optie lijkt. Dat roept waarschijnlijk de meest speelse houding op bij de deelnemers en kan competitie stimuleren zonder de negatieve effecten van indringende spelregels.

Met de kennis uit de hierboven beschreven hoofdstukken hebben we een pilot studie uitgevoerd bij team overleggen in een management consultancy bedrijf, beschreven in hoofdstuk 6. Dit experiment leverde kennis op over de implicaties van de implementatie van spel elementen voor teamwork in het veld. Gebaseerd op de conclusies van hoofdstuk 5, hebben we het muntenspel aangepast aan de eisen die de team meetings bij het bedrijf stelden. We hebben de regels zo min mogelijk indringend gemaakt door het doel en de regels van het spel in objecten vast te leggen: munten die verschillende types van bijdragen vertegenwoordigen. Naast het reduceren van de indringendheid van de gamificatie, moest ook de meting van het effect zo min mogelijk indringend zijn. Daarom hebben we de meetmethode in het gamificatie concept geïntegreerd, waarbij een van de deelnemers de taak kreeg om op een mobiele website de transacties met de munten te registreren. De resultaten van de pilot tests suggereren dat het muntenspel positieve gameful ervaringen heeft opgewekt, maar de deelnemers gaven ook aan dat ze verwachten dat het spel op de lange termijn niet motiverend genoeg is om een langdurig positief transfer effect op te leveren. Daarnaast heeft het ontwerpproces ons geleerd dat ‘een teamwork

proces benaderen alsof het een spel is' inzichten oplevert voor het ontwerp van de gamificatie en voor verbeteringen van het teamwork proces zelf. Daarnaast hebben we ontdekt dat gamificatie ook kan worden toegepast in de studie opzet door de evaluatie van het beoogde effect te integreren in het gamificatie concept.

Uit de omschreven gamificatie studies kunnen we concluderen dat er in feite twee methodes zijn om een teamwork gamificatie te ontwerpen: 1) het expliciet maken van impliciete niet-spel elementen (in teamwork) en 2) het toevoegen of aanpassen van regels. Hieruit volgen ook twee mogelijke transfer effecten: 1) verhoogde aandacht voor het gegamificeerde element en 2) veranderingen in gebruikersgedrag. Bij het ontwerpen van spel-achtige objecten, doelen, regels en vrijheid is het balanceren van de indringendheid cruciaal om een positief transfer effect te bewerkstelligen. Daarom concluderen we dat de vier voorgestelde componenten van een gameful ervaring en de drie typen van indringendheid (affectief, cognitief, en gedrag) tezamen de Gamificatie Design Space (GDS) vormen. Aan de hand van onze onderzoeken hebben we binnen de GDS de volgende factoren gevonden die moeten worden gebalanceerd om een effectieve teamwork gamificatie op te leveren: stijl, betekenis, handelingsmogelijkheden, attributie van doelen, directe feedback, conflict gedrag, onderlinge afhankelijkheid, leren, strategisch gedrag, geloofwaardigheid, besluitvorming, en speels gedrag.

De GDS verbreed ons begrip over gamificatie ontwerp, vergeleken met het gangbare idee dat gamificatie ontwerp bestaat uit punten, buttons, en scoreborden. De gevonden factoren kunnen fungeren als richtlijnen voor het ontwerpen van teamwork gamificatie en ook als punten waarop een gamificatie kan ingrijpen. Om de waarde van gaming volledig te kunnen benutten is er meer onderzoek nodig binnen de GDS in het algemeen en naar de transfer effecten van iedere factor afzonderlijk.

Appendix

I. Questionnaire operating teams (translated)

Could you indicate to what extent you agree or disagree with the statements below regarding your work within the team in the past weeks.

	Strongly disagree	Disagree	Neither agree, nor disagree	Agree	Strongly agree
In the past weeks, the team felt as if it was divided into separate **islands**.	○	○	○	○	○
In the past weeks, reaching the **goals** of the team was important to me.	○	○	○	○	○
In the past weeks, executing **all tasks** of the team was important to me.	○	○	○	○	○
In the past weeks, the team **performed well**.	○	○	○	○	○
In the past weeks, I felt **proud** of the team.	○	○	○	○	○

Could you describe some of the **team performances**?

	Never	Rarely	Once in a while	Regularly	Often
In the past weeks, I […] talked to my colleagues about **non-work related topics**.	○	○	○	○	○

(If applicable) Could you describe some **non-work related topics** that you talked about with your colleagues?

(encircle one of the options below)

In the past weeks, I worked at **section**…

INTAKE RELEASE

CHEMISTRY CONTROL ROOM

Could you indicate to what extent you agree or disagree with the statements below regarding the collaboration with your colleagues per section in the past weeks. The statements are the same for each section.

INTAKE	Strongly disagree	Disagree	Neither agree, nor disagree	Agree	Strongly agree
The activities of my colleagues at the intake section were **hindering my work** in the past weeks.	○	○	○	○	○
My activities were **hindering the work of my colleagues** at the intake section in the past weeks.	○	○	○	○	○
My colleagues at the intake section have **done something in favor of my work** in the past weeks.	○	○	○	○	○
I have **done something for the work of my colleagues** at the intake section in the past weeks.	○	○	○	○	○
My activities **depended on activities of my colleagues** at the intake section in the past weeks.	○	○	○	○	○
Activities of my colleagues at the intake section **depended on my activities** in the past weeks.	○	○	○	○	○
RELEASE					
The activities of my colleagues at the release section were **hindering my work** in the past weeks.	○	○	○	○	○
My activities were **hindering the work of my colleagues** at the release section in the past weeks.	○	○	○	○	○
My colleagues at the release section have **done something in favor of my work** in the past weeks.	○	○	○	○	○
I have **done something for the work of my colleagues** at the release section in the past weeks.	○	○	○	○	○
My activities **depended on activities of my colleagues** at the release section in the past weeks.	○	○	○	○	○
Activities of my colleagues at the release section **depended on my activities** in the past weeks.	○	○	○	○	○

CHEMISTRY	Strongly disagree	Disagree	Neither agree, nor disagree	Agree	Strongly agree
The activities of my colleagues at the chemistry section were **hindering my work** in the past weeks.	○	○	○	○	○
My activities were **hindering the work of my colleagues** at the chemistry section in the past weeks.	○	○	○	○	○
My colleagues at the chemistry section have **done something in favor of my work** in the past weeks.	○	○	○	○	○
I have **done something for the work of my colleagues** at the chemistry section in the past weeks.	○	○	○	○	○
My activities **depended on activities of my colleagues** at the chemistry section in the past weeks.	○	○	○	○	○
Activities of my colleagues at the chemistry section **depended on my activities** in the past weeks.	○	○	○	○	○
CONTROL ROOM					
The activities of my colleagues at the control room were **hindering my work** in the past weeks.	○	○	○	○	○
My activities were **hindering the work of my colleagues** at the control room in the past weeks.	○	○	○	○	○
My colleagues at the control room have **done something in favor of my work** in the past weeks.	○	○	○	○	○
I have **done something for the work of my colleagues** at the control room in the past weeks.	○	○	○	○	○
My activities **depended on activities of my colleagues** at the control room in the past weeks.	○	○	○	○	○
Activities of my colleagues at the control room **depended on my activities** in the past weeks.	○	○	○	○	○

Below, several statements are presented regarding the **RANJ screen** and your work in general.

	Strongly disagree	Disagree	Neither agree, nor disagree	Agree	Strongly agree
I find it **important** to have a RANJ screen.	○	○	○	○	○

	Never	Once a month	Once a week	Once a day	Nearly every hour
I **look** […] at the RANJ screen.	○	○	○	○	○

I am …..…..…. years employed at Wuppermann Steel Netherlands.

I am …..…..…. years employed in general.

II. Questionnaire coin game group-brainstorm

To what extent were the following aspects present during the design assignment?

	Not much	Little	Somewhat	Much	A great deal
1. **Your contribution** to the end result.	○	○	○	○	○
2. The contribution to the end result of your **fellow designers**.	○	○	○	○	○
3. **Criticize** each other's contribution.	○	○	○	○	○
4. **Complement** each other's contribution.	○	○	○	○	○
5. **Ignore** each other's contribution.	○	○	○	○	○
6. Taking **notice** of each other's contribution.	○	○	○	○	○
7. **Your involvement** in the assignment.	○	○	○	○	○
8. The involvement of your **fellow designers** in the assignment.	○	○	○	○	○
9. Your feeling of **responsibility** for the outcome of the design assignment.	○	○	○	○	○
10. The feeling of **responsibility** of your fellow designers for the outcome of the design assignment.	○	○	○	○	○
11. The use of **coins during** the assignment.	○	○	○	○	○
12. The use of **coins at the end** of the assignment.	○	○	○	○	○
13. The **added value** of the coin game to the **progress** of the assignment.	○	○	○	○	○
14. The **added value** of the coin game to the **outcome** of the assignment.	○	○	○	○	○
15. A **proportional contribution** of all participants to the assignment.	○	○	○	○	○
16. Your **attention** to the design challenge.	○	○	○	○	○
17. Your **attention** to the coin game.	○	○	○	○	○

Could you indicate the quality of the following aspects of the design assignment?

	Very low	Low	Average	High	Very high
18. The **collaboration** during the assignment.	○	○	○	○	○
19. The **end result** of the assignment.	○	○	○	○	○
20. Your **chance of winning** the challenge.	○	○	○	○	○
21. The **solidarity** within the group.	○	○	○	○	○

III. Questionnaire data coin game

Table 10.1. Average self-reported behavior and engagement per group with ranking in brackets.

	Engagement					Brainstorm behavior					
Group	Brainstorm process	Brainstorm output	Brainstorm attention	Game attention*	Perceived coin use*	Own contribution	Other's contribution	Criticize	Complement	Ignore	Notice
1	[3]4.1	[4]3.5	[2]3.8	[5]2.8	[6]2.9	[1]4.0	[2]4.0	[5]2.5	[3]3.5	[5]2.5	[4] 3.8
2	[5]3.9	[1]4.0	[1]4.0	[4]3.0	[3]3.4	[6]3.3	[6]3.5	[2]3.0	[3]3.5	[1]3.3	[7] 3.5
3	[7]3.8	[8]2.8	[6]3.5	**[10]1.8**	[10]1.9	[5]3.5	[6]3.5	[7]2.3	[7]3.3	[3]2.8	[10] 2.8
4	[2]4.3	[1]4.0	[2]3.8	[8]2.5	[7]2.5	[4]3.8	[2]4.0	[7]2.3	[1]4.3	[8]2.0	[1] 4.3
5	[1]4.4	[4]3.5	[2]3.8	[5]2.8	[5]3.0	[1]4.0	[2]4.0	[7]2.3	[2]3.8	[10]1.0	[1] 4.3
6	[5]3.9	[10]2.5	[10]2.8	**[1]3.8**	[4]3.3	[6]3.3	[5]3.8	[10]2.0	[7]3.3	[6]2.3	[3] 4.0
7	[3]4.1	[7]3.0	[6]3.5	**[2]3.5**	[2]3.9	[6]3.3	[10]3.3	[2]3.0	[7]3.3	[9]1.8	[8] 3.3
8	[8]3.6	[9]2.6	[2]3.8	[3]3.3	[1]4.0	[1]4.0	[1]4.3	[2]3.0	[3]3.5	[2]3.0	[4] 3.8
9	[8]3.6	[6]3.1	[9]3.0	**[9]2.0**	[9]2.3	[10]3.0	[6]3.5	[1]3.3	[3]3.5	[3]2.8	[4] 3.8
10	[10]3.3	[3]3.7	[8]3.3	[7]2.7	[7]2.5	[6]3.3	[6]3.5	[5]2.5	[7]3.3	[6]2.3	[8] 3.3

Note. * Significant variation between groups ($p < .05$); grey highlights: groups that vary significantly ($p < .05$).

IV. Coin explanation card (translated)

V. Questionnaire red team meeting (translated)

	Yes	No
Have you participated before in a Red Team meeting with the coin game?	○	○

Can you give **your opinion** about the following aspects in relation to the meeting?

	Very negative	Negative	Neutral	Positive	Very positive
Your **own contribution** to the meeting.	○	○	○	○	○
Your **colleagues' contribution** to the meeting.	○	○	○	○	○
The **critique** towards each others' contribution.	○	○	○	○	○
The **reinforcements** to each others' contribution.	○	○	○	○	○
Your and your colleagues' **supportive contribution** to the meeting.	○	○	○	○	○
The **outcome** of the meeting.	○	○	○	○	○
The **collaboration** during the meeting.	○	○	○	○	○

How would you assess the **influence of the coin game** to these aspects?

	Very negative	Negative	Neutral	Positive	Very positive
Your **own contribution** to the meeting.	○	○	○	○	○
Your **colleagues' contribution** to the meeting.	○	○	○	○	○
The **critique** towards each others' contribution.	○	○	○	○	○
The **reinforcements** toe ach others' contribution.	○	○	○	○	○
Your and your colleagues' **supportive contribution** to the meeting.	○	○	○	○	○
The **outcome** of the meeting.	○	○	○	○	○
The **collaboration** during the meeting.	○	○	○	○	○
The number of **compliments** for each other's contribution.	○	○	○	○	○

To what extent do you agree or disagree with the statements below?

	Fully disagree	Disagree	Neither agree, nor disagree	Agree	Fully agree
We held the meeting as a **team**.	◯	◯	◯	◯	◯
It was **clear** when to expect or give away coins.	◯	◯	◯	◯	◯

	Yes	No
The coin game should be a **standard procedure** for Red Team meetings.	◯	◯

Could you describe in your own words **why** the coin game should be or not be a standard procedure for Red Team meetings?

About the author

Niko Vegt was born in 1984 in Tilburg, the Netherlands. After finishing his secondary school at the Newman College in Breda (2003), he obtained a Bachelor's (2008) and Master's (2011) degree in Industrial Design at the Eindhoven University of Technology. During this time he also worked as a research assistant, coached rowing teams and spent six months at Technical University of Denmark as an Erasmus exchange student. For his Master graduation, Niko investigated the developments in nanotechnology and designed the 'Nano World Map' to support designers to develop designs for debate for the Rathenau Institute and Next Nature Institute.

Niko started his PhD research at the Department of Industrial Design at the Delft University of Technology in 2011. His research focused on the design and application of game elements in teamwork contexts. As part of this research, Niko developed gamification designs for management consultancy firm Berenschot and galvanizing factory Wuppermann Steel Netherlands. Moreover, he developed and facilitated gamified workshops at companies and conferences, among which The Footwearists, CHI Sparks 2014, and DEAF Biennale. Next to the research, Niko also worked as an educator and coach in a variety of design courses at the faculty of Industrial Design Engineering at Delft University of Technology.

Author's publications related to this dissertation

Vegt, N., Vermeeren, A., Visch, V., de Ridder, H., & Hayde, Z. (2018). *Balancing game rules for improving creative output of group brainstorms*. Manuscript submitted for publication.

Vegt, N., Visch, V., Vermeeren, A., & de Ridder, H. (in press). A case study on gamified interventions for team cohesion in factory work. *Human Technology*.

Vegt, N., Visch, V., Vermeeren, A., & de Ridder, H. (2016). Player experiences and behaviors in a multiplayer game: designing game rules to change interdependent behavior. *International journal of serious games*, *3*(4), 69-85.

Vegt, N., Visch, V., de Ridder, H., & Vermeeren, A. (2014). Designing gamification to guide competitive and cooperative behavior in teamwork. In T. Reiners, & L. C. Wood (Eds.), *Gamification in education and business* (pp. 513-533). Cham: Springer International Publishing AG.

Vegt, N., & Visch, V. (2013). Social gaming rules: Changing people's behavior through games. In *Workshop papers CHI2013*. Paris: ACM.

Visch, V., Vegt, N., Anderiesen, H., & van der Kooij, K. (2013). Persuasive game design: A model and its definitions. In *Workshop papers CHI2013*. Paris: ACM.