Benedikt Morschheuser

THE GAMIFICATION OF CROWDSOURCING SYSTEMS:

EMPIRICAL INVESTIGATIONS AND DESIGN

Karlsruher Institut für Technologie

The Gamification of Crowdsourcing Systems:
Empirical Investigations and Design

Zur Erlangung des akademischen Grades eines

Doktors der Wirtschaftswissenschaften

Dr. rer. pol.

von der Fakultät für Wirtschaftswissenschaften

des Karlsruher Instituts für Technologie (KIT)

genehmigte

DISSERTATION

von

Dipl. Wirt.-Ing. Benedikt Morschheuser

Tag der mündlichen Prüfung: 22. November 2017

Referent: Prof. Dr. Alexander Mädche

Korreferent: Prof. Dr. Juho Hamari

Karlsruhe, November 2017

Abstract

Recent developments in modern information and communication technologies have spawned two rising phenomena, gamification and crowdsourcing, which are increasingly being combined into gamified crowdsourcing systems. While a growing number of organizations employ crowdsourcing as a way to outsource tasks related to the inventing, producing, funding, or distributing of their products and services to the crowd – a large group of people reachable via the internet – crowdsourcing initiatives become enriched with design features from games to motivate the crowd to participate in these efforts. From a practical perspective, this combination seems intuitively appealing, since using gamification in crowdsourcing systems promises to increase motivations, participation and output quality, as well as to replace traditionally used financial incentives. However, people in large groups all have individual interests and motivations, which makes it complex to design gamification approaches for crowds. Further, crowdsourcing systems exist in various forms and are used for various tasks and problems, thus requiring different incentive mechanisms for different crowdsourcing types. The lack of a coherent understanding of the different facets of gamified crowdsourcing systems and the lack of knowledge about the motivational and behavioral effects of applying various types of gamification features in different crowdsourcing systems inhibit us from designing solutions that harness gamification's full potential. Further, previous research canonically uses competitive gamification, although crowdsourcing systems often strive to produce cooperative outcomes. However, the potentially relevant field of cooperative gamification has to date barely been explored. With a specific focus on these shortcomings, this dissertation presents several studies to advance the understanding of using gamification in crowdsourcing systems. First, this dissertation synthesizes the body of literature on gamified crowdsourcing to provide a comprehensive overview of which gamification efforts are used in different crowdsourcing system types and which combinations have been found to be effective. Second, this dissertation investigates in three empirical studies, how features of cooperative games induce and cultivate cooperation in games, how such design features of cooperative games can be used to influence motivations and behaviors of crowdsourcees, and how motivational and behavioral effects differ when competitive, cooperative, and inter-team competitive gamification features are applied in crowdsourcing systems. Based on the extensive findings gained in these studies, this dissertation provides coherent knowledge on the gamification of crowdsourcing systems. Further, practical guidelines for implementing gamification in crowdsourcing systems are derived to support practitioners in effectively influencing crowdsourcees' motivations and behaviors.

Acknowledgments

This dissertation has been made possible through the support of many persons, whom I sincerely thank. My gratitude to my academic advisors, *Prof. Dr. Alexander Mädche* and *Prof. Dr. Juho Hamari*, for their comprehensive support and competent guidance. I thank *Alexander Mädche* – my *Doktorvater* – for giving me the autonomy I needed in order to be creative in my research, but also for being available when I needed advice and mentorship. Further, I thank *Juho Hamari* for his encouragement and valuable support in conducting my scientific studies. I am proud to have had him as my competent advisor for this dissertation and my research. I will always remember how we met at the BizPlay conference 2014 in Karlsruhe and laid the foundations for our fruitful research cooperation.

I thank the *Robert Bosch GmbH* for funding this dissertation, as well as my former colleagues at Bosch. In particular, *Franz Grzeschniok*, for his comprehensive advice and supervision in the company, for creating my doctoral position, and for his support of my research projects. Also, my deepest thanks to *Dietrich Manstetten*, *Manuel Maier, Birgit Thoben*, and *Dimitri Minich* for their interest in my research, their belief in my ideas, and their great support in realizing projects such as ParKing, Parkineers, and Gamification@CRIS.

I thank my *colleagues* and *students* who have worked with me in the past five years. I hope you have learnt from working with me as much as I have from working with you. My thanks to my former colleagues at the University of Leipzig, in particular *Prof. Dr. Rainer Alt* and my friends *Carina Cundius* and *Stephan Sachse*, who shaped the first years of my doctoral career and taught me a great deal. Further, a special thanks to all my co-authors: *Jonna Koivisto*, *Marc Riar*, *Karl Werder*, *Lobna Hassan*, *Dominic Walter*, *Christian Hrach*, *Christian Henzi*, *Roger Bons*, *Veronica Rivera-Pelayo*, *Athanasios Mazarakis*, *and Valentin Zacharias.* It was a great pleasure to work with you, share ideas, discuss research, and write well-cited papers. Further, I thank my meticulous editor and proofreader *Johan Emerson Grobler* for his reliable and swift correction of my outcomes.

Finally, and most importantly, my deepest and most sincere gratitude to my wife *Eva Morschheuser* – heartfelt appreciation for the endless support during the entire journey of my scientific endeavors. Further, my sincere thanks to my parents *Ulrike* and *Herbert Morschheuser* and the rest of *my family* for their immeasurable support, encouragement, investments in my career and the uncountable board games sessions at our family events, which obviously shaped my career in the long term.

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1 Introduction

During the past decade, advances in modern information and communication technologies have simplified the economic coordination of human capital and have thus enabled a pinnacle form of collective value creation: crowdsourcing. While in the past, organizations created value in small and well-defined circles, the Internet and mobile technologies have made it easy to reach, coordinate, and employ large groups of people, *the crowd* (Howe, 2006), for distributed problem-solving and the collective creation of values (Brabham, 2013; Doan et al., 2011; Estellés-Arolas and González-Ladrón-de-Guevara, 2012; Guazzini et al., 2015; Howe, 2006; Nakatsu et al., 2014; Prpić et al., 2015a; Zhao and Zhu, 2014a). As a result, more and more organizations now apply crowdsourcing as a cost-effective alternative compared to employees or suppliers (Prpić et al., 2015a; Tapscott and Williams, 2011, 2010) for outsourcing various types of work. The fields of application are diverse and include the creation of ideas and innovations (Blohm et al., 2011; Hutter et al., 2011; Leimeister, 2010), the gathering of knowledge, and the creation of user-generated content (Brabham, 2010, 2008a; Nov, 2007), the solving of complex problems (Cooper et al., 2010; Sørensen et al., 2016), the annotation of images, text, or video data (Cao et al., 2015; Pinto and Viana, 2015), the recognition of objects in images (Deng et al., 2016; Law and Von Ahn, 2011; Lintott et al., 2008), translation work (Packham and Suleman, 2015; Silva and Lopes, 2016), or the funding of products (Agrawal et al., 2014). Crowdsourcing has already influenced most industries and has become a key aspect of various business models (Tapscott and Williams, 2011), such as the crowd-based testing of software (Zogaj et al., 2014) or the selling of crowd-designed clothes (Brabham, 2013, 2010). When considering the current continuously growing demand for high-quality datasets that arise along with the advancing digitalization and automation in all parts of society, it is very likely that crowdsourcing will continue to grow – in particular for collecting data that cannot or can hardly be gathered without human support, as well as for evaluating the quality of datasets (Doan et al., 2011; Ganti et al., 2011; Von Ahn, 2009; Zhao and Zhu, 2014a).

While the number of crowdsourcing initiatives is on the rise, there is an increasing demand for cost-effective approaches that motivate people to participate in crowdsourcing (Brabham, 2013; Kaufmann et al., 2011; Prpić et al., 2015a; Zhao and Zhu, 2014a, 2014b). Traditionally, participants in crowdsourcing approaches – *crowdsourcees* – are rewarded via extrinsic incentives, such as financial compensations or monetary prices. However, several studies have shown that crowdsourcees' participation and behaviors are in fact driven by intrinsic aspects of crowdsourcing, such as possibilities for self-development, curiosity, altruism, a sense of competence, satisfaction, and accomplishment when solving crowdsourcing tasks or relatedness with a community of peers (Kaufmann et al., 2011; Lakhani and Wolf, 2005; Nov, 2007; Nov et al., 2010; Soliman and Tuunainen, 2015; Zhao and Zhu, 2014b). Since games are seen as particularly effective in invoking intrinsic motivations (Huotari and Hamari, 2017; Van der Heijden, 2004), designers are increasingly *gamifying* crowdsourcing systems (Hamari et al., 2014; Huotari and Hamari, 2017; Katmada et al., 2016; Seaborn and Fels, 2015), that is, designers enrich crowdsourcing approaches with design features from games to address crowdsourcees' intrinsic needs, invoke intrinsic motivations, and make participation in crowdsourcing as appealing an experience as playing a game.

Literature reviews have revealed that crowdsourcing is one of the most popular application areas of gamification (Hamari et al., 2014), and various empirical studies indicate that gamification is an effective approach to increase crowdsourcees' *motivations* (Runge et al., 2015; Tinati et al., 2016), quantitative *participation* (Eickhoff et al., 2012; T. Y. Lee et al., 2013), *long-term engagement* (T. Y. Lee et al., 2013; Prestopnik and Tang, 2015), and *output quality* (Eickhoff et al., 2012; Prestopnik and Tang, 2015). Thus, the use of gamification in crowdsourcing is drawing increasing attention, in both academia and practice (Hamari et al., 2014; J. J. Lee et al., 2013; Prestopnik and Tang, 2015; Sigala, 2015).

However, although there are various empirical studies on the topic that report positive outcomes of using gamification in crowdsourcing, several research gaps prevent us from gain a holistic understanding of the gamification of crowdsourcing and therefore from designing the most effective gamified crowdsourcing solutions.

First, owing to the two phenomena's novelty (Brabham, 2013; Doan et al., 2011; Hamari et al., 2014; Huotari and Hamari, 2017), most research studies into the topic are singular pieces that are scattered and consider only specific aspects of gamified crowdsourcing, such as the effects of a particular gamification feature in a specific crowdsourcing context. Thus, we lack a coherent understanding of the phenomenon. Further, crowdsourcing activities can differ dramatically, and several studies indicate that people in large groups all have their own motivations (Aitamurto, 2015; Brabham, 2010, 2008a; Kaufmann et al., 2011; Soliman and Tuunainen, 2015; Tapscott and Williams, 2010). Thus, it would be short-sighted to assume that different types of crowdsourcing approaches would not require different gamification approaches. However, only a few studies have investigated whether differences exist between various gamification features (Liu et al., 2017) and what type of gamification is most optimal for various crowdsourcing system types. Owing to the lack of a comprehensive overview of research and a dearth of comparative studies that investigate the effects of different forms of gamification on crowdsourcees' motivations and behaviors, we lack crucial knowledge for designing effective gamification solutions. In particular, we lack a clear overview of which gamification feature types are most effective in different crowdsourcing system types, which inhibits us from harnessing gamification's full potential in crowdsourcing.

Second, while there are various forms of crowdsourcing (Doan et al., 2011; Prpić et al., 2015a; Zhao and Zhu, 2014a), cooperation between crowdsourcees is a key characteristic of many crowdsourcing approaches (Doan et al., 2011; Geiger and Schader, 2014; Nov, 2007; Prpić et al., 2015a; Zhao and Zhu, 2014a). Crowdsourcing approaches where crowdsourcees explicitly work together, also known as *crowdcreating* (Geiger and Schader, 2014), open collaboration (Prpić et al., 2015b) or mass collaboration (Doan et al., 2011; Tapscott and Williams, 2010), have gained considerable interest in recent years, since examples such as Wikipedia, Open Street Map, Waze, Trip Advisor, or Yelp have demonstrated that cooperating crowdsourcees can create comprehensive outcomes, such as extensive databases or knowledge repositories (Budhathoki and Haythornthwaite, 2013; Geiger and Schader, 2014; Haklay and Weber, 2008; Levina and Arriaga, 2014; Nakatsu et al., 2014; Nov, 2007; Prpic and Shukla, 2016). Various studies indicate that crowdsourcing initiatives in which crowdsourcees explicitly work together to achieve shared outcomes (Doan et al., 2011), such as wikis (Shen et al., 2009, 2014), ideation platforms (Blohm et al., 2011; Bullinger et al., 2010; Hutter et al., 2011; Scheiner, 2015), self-organized question, and answer platforms (Bagozzi and Dholakia, 2006) could benefit from gamification approaches that engage individuals to form groups and support collective efforts. However, we lack a coherent understanding of how gamification features can be designed and used to support cooperation (Bui et al., 2015; Liu et al., 2017). Previous gamification research has canonically studied the effects of gamification features such as leaderboards, badges, or levels that cause competitions or engage people at an individual level (for reviews, see Bui et al. (2015), Hamari et al. (2014), and Seaborn and Fels (2015)), but there is a dearth of knowledge about the design of cooperative gamification, cooperative gamification features, and their effects on individuals' motivations and behaviors in social environments, such as crowdsourcing systems (Bui et al., 2015; Liu et al., 2017). This is surprising, considering the source of gamification, games, where cooperation between players is often a key component (El-Nasr et al., 2010; Rocha et al., 2008; Zagal et al., 2006). Further, various studies have demonstrated that game features can induce cooperation between players and that many people enjoy playing together (Chen et al., 2008; Cole and Griffiths, 2007; El-Nasr et al., 2010; Islas Sedano et al., 2013; Nardi and Harris, 2006; Scharkow et al., 2015; Yee, 2006). Thus, while explicit cooperation is a key characteristic of many crowdsourcing initiatives (Doan et al., 2011; Geiger and Schader, 2014), and game features can engage people to cooperate (El-Nasr et al., 2010; Rocha et al., 2008), the application of design features of cooperative games in crowdsourcing seems to be particularly suitable and promising. However, the lack of studies about the design of cooperative gamification features and their effects on individuals' motivations and behaviors in crowdsourcing is a large gap in the current body of knowledge. This gap prevents us from exploiting the possible potentials of cooperative gamification and therefore from gaining a comprehensive understanding of how to effectively gamify crowdsourcing as well as to optimally harness the collective potential of crowds, which – besides the possibility to perform distributed labor – is one of their most prominent qualities (Brabham, 2013; Doan et al., 2011; Guazzini et al., 2015; Leimeister, 2010; Pedersen et al., 2013).

1.1 Objectives and Research Questions

Therefore, the aim of this dissertation is *to advance the understanding of the gamification of crowdsourcing systems* by addressing the abovementioned research gaps.

Specifically, this dissertation first aims to address existing conceptual shortcomings that prevent us from holistically understanding and investigating the phenomenon. Second, this dissertation seeks to meet the need for a coherent overview of the research into the gamification of crowdsourcing systems and a comprehensive comparison of previous research results. Third, this dissertation aims to counteract the lack of knowledge about the design of cooperative gamification approaches and their effects when implemented in crowdsourcing. Thus, this dissertation also seeks to advance the understanding of cooperation in games and how cooperative gamification features (i.e. game features of cooperative games) should be designed to positively influence crowdsourcees' motivations and behaviors. Finally, with a specific focus on the dearth of knowledge on the effects of cooperative gamification features in crowdsourcing, and the lack of research into differences between various gamification feature types, this dissertation examines the differences between using cooperative and competitive gamification features in crowdsourcing and how crowdsourcees' motivations and behaviors differ concerning the use of various gamification feature types.

To achieve these objectives, this dissertation conducts multiple studies that can be structured along four research questions (RQs) that guide this research. Concerning the first objective, this dissertation starts by developing an integrated conceptual framework for gamified crowdsourcing systems, based on the extant literature on crowdsourcing (Doan et al., 2011; Geiger and Schader, 2014; Prpić et al., 2015a) and gamification (Hamari et al., 2014; Huotari and Hamari, 2017). Further, a classification framework for defining and separating differed gamification feature types is introduced. Based on these foundations that conceptualize the key aspects of the investigated phenomenon, this dissertation conducts a systematic literature review of existing scientific studies into the uses of gamification in crowdsourcing systems. According to the second objective of this dissertation, this review seeks to understand the current state of gamified crowdsourcing research from a bottom-up perspective. Thus, the review follows a hermeneutical, interpretivist stance (Crotty, 1998). While it generally seeks to provide a comprehensive understanding of the phenomenon, this study specifically investigates how previous research has studied and implemented gamification in crowdsourcing, to identify possible differences that may exist in the uses of gamification in various forms of crowdsourcing. In this sense, this review addresses the research question:

RQ1: How has gamification been studied and implemented in extant crowdsourcing research?

Second, the abovementioned general dearth of studies on cooperation in games (Hamari and Keronen, 2017a; Liu et al., 2013) and the design of cooperative gamification features (Bui et al., 2015; Liu et al.,

2017) prevent us from exploiting the potentials of using gamification for supporting working together. Thus, this dissertation seeks to advance the understanding of how cooperative games and their design features induce and cultivate cooperation. Similar to previous research into cooperation in online communities and crowdsourcing systems (Bagozzi and Dholakia, 2006; Oliveira and Huertas, 2015; Shen et al., 2009), and according to Tuomela (2000), this dissertation follows the theory that true cooperation appears when people share a collective *we-intention* towards working together (Searle, 1990; Tsai and Bagozzi, 2014; Tuomela, 2000). Thus, an empirical study is conducted that investigates how features of cooperative games affect different forms of group dynamics and how they further translate into collective intentions of working together in a group. This study follows a positivist epistemology (Crotty, 1998; Orlikowski and Baroudi, 1991) by evaluating theory-based, predefined hypotheses in a structural equation model and seeks to answer the research question:

RQ2: How do cooperative games and their design features induce and cultivate we-intentions of working as a group?

Third, based on the hereto obtained knowledge, the dissertation further investigates how game features of cooperative games could be applied when designing cooperative gamification features so as to increase motivations and participation of crowdsourcees in cooperative work. Thus, this dissertation presents a design science study (Hevner, 2007; Hevner et al., 2004) in which, first, a gamification feature is developed based on the gathered knowledge to improve cooperative participation in a corporate innovation community; second, this developed gamification feature is evaluated with two experiments to validate the design decisions. The evaluation follows a positivistic stance (Crotty, 1998; Orlikowski and Baroudi, 1991) by hypnotizing propositions about possible psychological and behavioral effects of the developed gamification feature. Accordingly, the following research question is examined:

RQ3: How to design cooperative gamification features in order to increase motivation and participation in crowdsourcing?

Fourth, as noted, this dissertation seeks to understand the differences between and the effectiveness of implementing various gamification types in crowdsourcing. Therefore, this dissertation presents a large field experiment to empirically investigate the psychological and behavioral effects of cooperative, competitive, and inter-team competitive gamification in crowdsourcing. Together with study I, which also investigates differences between individualistic and cooperative gamification features, this study advances the understanding of how different gamification features affect crowdsourcees' motivations and behaviors, following a positivistic stance (Crotty, 1998; Orlikowski and Baroudi, 1991). This study investigates the research question:

RQ4: How do crowdsourcees' motivation and behaviors differ when implementing various types of gamification in crowdsourcing, such as cooperative or competitive gamification?

A detailed overview of the complete research project covered by this dissertation is summarized in Figure 1, which visualizes the individual components of this dissertation in its overall structure, their interrelationships, expected contributions, and how these components relate to the abovementioned research questions.

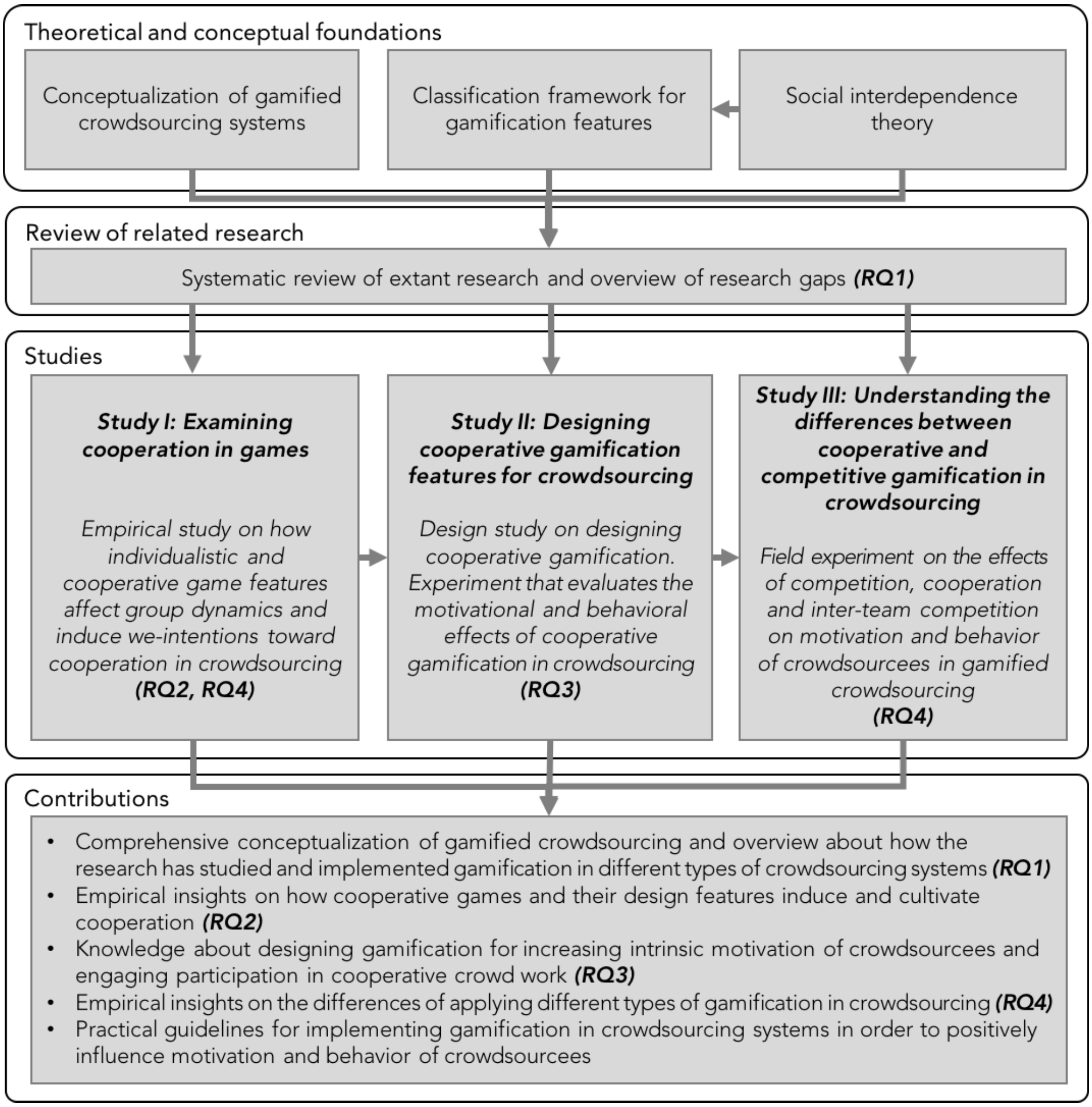


Figure 1. Research Approach, Methods, and Contributions

1.2 Thesis Structure

The dissertation structure follows the presented research approach (Figure 1). The theoretical and conceptual foundations are presented in chapter 2, while chapter 3 contains a comprehensive review of previous research. Chapter 4 provides three empirical studies conducted as part of this dissertation. Finally, chapter 5 concludes the dissertation by discussing the theoretical contributions, providing an outlook for future work, and proposing practical guidelines for gamifying crowdsourcing systems.

1.3 Publications

This dissertation is the result of extensive research conducted by the author in recent years. Parts of this dissertation's content have already been published in peer-reviewed journals or have been presented at several peer-reviewed conferences. It provides an overall framework for these studies and extends previously published content. In the following an overview of the author's publications is presented that relate directly to this dissertation's contributions:

- Morschheuser, B., Hamari, J., Maedche, A. (under review). Cooperation or competition – when do people contribute more? A field experiment on gamification of crowdsourcing.
- 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. Comput. Human Behav., 77, 169-183. doi:10.1016/j.chb.2017.08.026
- Morschheuser, B., Hamari, J., Koivisto, J., Maedche, A., 2017. Gamified crowdsourcing: Conceptualization, literature review, and future agenda. Int. J. Hum. Comput. Stud., 106, 26-43. doi:10.1016/j.ijhcs.2017.04.005
- Morschheuser, B., Maedche, A., Walter, D., 2017. Designing cooperative gamification: Conceptualization and prototypical implementation, in: Proceedings of the 20th ACM Conference on Computer-Supported Cooperative Work and Social Computing (CSCW'17), ACM, Portland, Oregon, USA, pp. 2410–2421. doi:10.1145/2998181.2998272
- Morschheuser, B., Hamari, J., Koivisto, J., 2016. Gamification in crowdsourcing: A review, in Proceedings of the 49th Annual Hawaii International Conference on System Sciences (HICSS), Hawaii, USA, pp. 4375–4384. (Best paper nomination). doi:10.1109/HICSS.2016.543

A full list of the author's publications beyond the core scope of this thesis can be found in the appendix.

2 Theoretical and Conceptual Foundations[1]

2.1 Crowdsourcing

Generally, crowdsourcing is defined as an online, distributed problem-solving approach that transforms *problems and tasks* into *solutions* by harnessing the potential of *the crowd* – a large group of people reachable via the Internet – rather than by using traditional employees or suppliers (Brabham, 2013; Doan et al., 2011; Estellés-Arolas and González-Ladrón-de-Guevara, 2012; Howe, 2006; Nakatsu et al., 2014; Pedersen et al., 2013; Prpić et al., 2015a; Zuchowski et al., 2016). The increasing interconnectedness and new technological developments, such as the Internet and smartphones, have made it fairly easy to reach large groups of people and to include them into various forms of crowdsourcing initiatives (Brabham, 2008b; Doan et al., 2011; Pedersen et al., 2013). Thus, crowdsourcing has become increasingly popular in recent years (Doan et al., 2011; Gatautis and Vitkauskaite, 2014; Geiger and Schader, 2014; Rouse, 2010; Zuchowski et al., 2016) and has strongly influenced the ways in which products and services are invented, produced, funded, marketed, distributed, and used – with strong economic impacts (Tapscott and Williams, 2011, 2010). As a result, an increasing number of startups have crowdsourcing-based business models (Brabham, 2010, 2008a; Tapscott and Williams, 2010), and many companies have begun to invest in external and internal (i.e. in large organizations) (Zuchowski et al., 2016) crowdsourcing (Hutter et al., 2011; Leimeister et al., 2009; Schlagwein and Bjørn-Andersen, 2014; Sigala et al., 2012; Zuchowski et al., 2016). From science and education (Brossard et al., 2005), to government (Hassan, 2017), journalism (Aitamurto, 2015), tourism (Sigala, 2015), software development (LaToza and Van der Hoek, 2016), the manufacturing industry (Hutter et al., 2011), and even banking (Haas et al., 2014), the rise of crowdsourcing has already influenced most industries and has revolutionized their value-creation processes, from closed and monolithic to open and crowdsourcing-based creation of values (Tapscott and Williams, 2011, 2010). In particular, crowdsourcing is considered useful for processing and coordinating work that benefits from collective intelligence, such as the creation of ideas (Leimeister, 2010), or that is hard to process by computers and is therefore outsourced to a mass of people (Von Ahn, 2009).

Various manifestations of crowdsourcing have appeared under different names, including peer production, user-generated content, open collaboration, collective intelligence, wikinomics, crowd wisdom, mass collaboration, human computation, crowdfunding, crowdsharing, and crowdvoting (Doan et al., 2011; Geiger and Schader, 2014; Nakatsu et al., 2014; Prpić et al., 2015b; Tapscott and Williams, 2010). Thus, various efforts have been made to structure the great variety of crowdsourcing systems (Doan et al., 2011; Geiger and Schader, 2014; Nakatsu et al., 2014; Prpić et al., 2015a, 2015b). By

[1] This chapter is based on Morschheuser et al. (2017a, 2017b, 2016, under review)

considering the characteristics of the crowdsourced *work* and the *value creation* of a crowdsourcing system, Geiger and Schader (2014) separated crowdsourcing systems into four categories: *crowdprocessing*, *crowdsolving*, *crowdrating*, and *crowdcreating* approaches, whether they seek homogeneous vs. heterogeneous contributions and produce non-emergent vs. emergent values from their contributions (Figure 2).

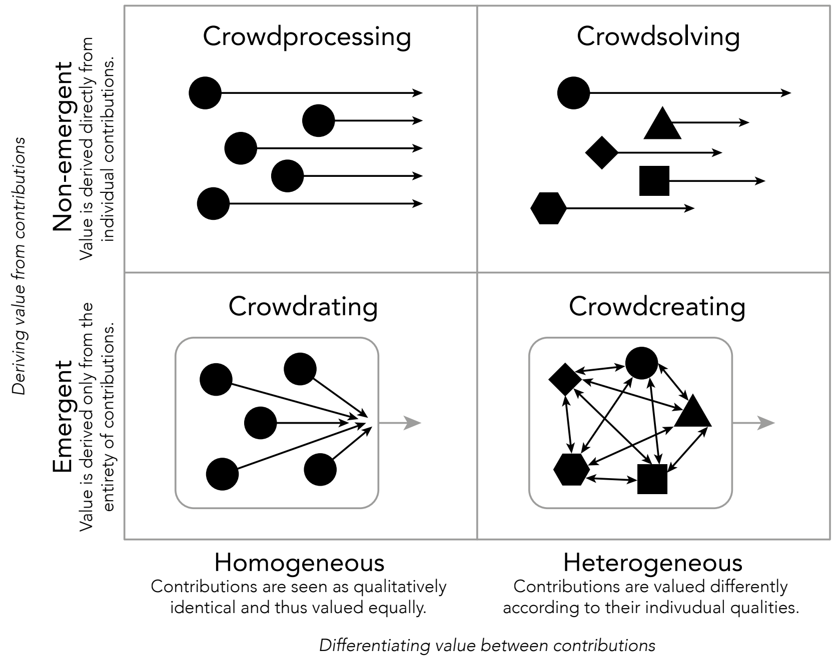


Figure 2. Four Archetypes of Crowdsourcing Systems (based on Geiger and Schader (2014))

First, *crowdprocessing* approaches rely on the crowd to perform large quantities of homogeneous tasks. Identical contributions are a quality attribute of the work's validity. Value is derived directly from all or some of the individual contributions (non-emergent) (e.g. Mechanical Turk or Galaxy Zoo) (Kaufmann et al., 2011; Lintott et al., 2008). Second, *crowdsolving* approaches use the diversity of the crowd to find a huge number of heterogeneous solutions to a problem. The value of this approach results directly from all or some of the contributions (non-emergent). Crowdsolving is often used for very complex problems (e.g. Foldit, a game-based approach to optimize protein folding) (Cooper et al., 2010) or if no pre-definable solution exists (e.g. ideation contests). Third, *crowdrating* systems commonly seek to harness the so-called *wisdom of crowds* (Surowiecki, 2005) to perform collective assessments or predictions. In this case, the emergent value arises from a huge number of homogeneous 'votes' (e.g. NASA Clickworkers, in which the clicks/votes of a crowd were used to identify craters on asteroids) (Kanefsky et al., 2001). Fourth, *crowdcreating* solutions seek to create comprehensive (emergent) artifacts based on a variety of heterogeneous contributions. Typical examples include all kinds of user-generated content (e.g. YouTube) or knowledge derived from collaborative aggregation (e.g. Wikipedia).

Any crowdsourcing initiative's success strongly depends on an active crowd of participants (Brabham, 2013; Doan et al., 2011; Law and Von Ahn, 2011; Leimeister, 2010). Thus, understanding the motivation of *crowdsourcees* is crucial (Zhao and Zhu, 2014a). However, people in large groups all have their own interests and motivations, which makes it difficult for organizations to engage and coordinate crowds for particular tasks or behaviors (Tapscott and Williams, 2010). Several studies indicate that motivating crowds is complex and requires suitable incentive mechanisms (Aitamurto, 2015; Brabham, 2010, 2008a; Kaufmann et al., 2011; Soliman and Tuunainen, 2015). Although much research has been done into crowdsourcing, only a few studies have comprehensively investigated crowdsourcees' motivations (e.g. Brabham, 2010, 2008a; Budhathoki and Haythornthwaite, 2013; Kaufmann et al., 2011; Soliman and Tuunainen, 2015; Zhao and Zhu, 2014b; Zheng et al., 2011) and the design of appropriate incentives for different crowdsourcing systems (e.g. Harris, 2015; Leimeister, 2010; Straub et al., 2015). Studies have shown that a wide variety of reasons and motivations, ranging from intrinsic to extrinsic, lead people to participate in crowdsourcing (Budhathoki and Haythornthwaite, 2013; Kaufmann et al., 2011; Straub et al., 2015; Zhao and Zhu, 2014b; Zheng et al., 2011). For instance, intrinsic motivation – caused by tasks that allow a participant to be creative and experience autonomy, to develop own skills and feel competent, to enjoy a pastime, and/or to achieve social recognition – can in some cases be dominated by extrinsic motivation, evoked by financial payoffs or external social reasons (Kaufmann et al., 2011). Further, task characteristics (Kaufmann et al., 2011; Zheng et al., 2011), task granularity (Nakatsu and Iacovou, 2014; Zhao and Zhu, 2014b), or perceived motivational affordances (Zhao and Zhu, 2014b) can influence an individual's motivation.

Thus, a major challenge in motivating people to participate is to design a crowdsourcing system that promotes and enables the formation of motivations towards crowdsourcing work and fits the activity type. For instance, while some crowdsourcing approaches aim for systematically derived isolated contributions, others may call for incentive structures that promote cooperation. In other words, since crowdsourcing activities can differ dramatically, so can the means to motivate crowdsourcees in a crowdsourcing initiative.

2.2 Gamification

One of the most popular developments in recent years in incentive design is *gamification* (Hamari et al., 2015a, 2014; Morschheuser et al., 2017d). Gamification is defined as "the use of game elements in non-game contexts" (Deterding et al., 2011, p. 9) and with a focus on service design as a "process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation" (Huotari and Hamari, 2017, p. 25) (Hamari, 2015a). While the first definition focuses on the source of gamification, games, and the use of their design features outside of traditional video game environments, the second adds additional details on the effects and outcomes expected by practitioners that apply gamification (Hamari, 2015a). This dissertation primarily follows the second, more detailed definition (Huotari and Hamari, 2017), which – according to Hamari (2015a) – needs not be limited to the domain of services, but can also be applied to the area of information systems and crowdsourcing (Hamari, 2015a; Hamari et al., 2014).

Gamification's popularity stems from the notion that games are particularly effective in invoking intrinsic motivations such as a sense of accomplishment, relatedness, autonomy, flow, and overall enjoyment (Huotari and Hamari, 2017; Ryan et al., 2006), and is therefore believed to afford benefits for multiple behavioral outcomes across different domains. Many studies have shown that applying game design features outside traditional game environments can increase the motivation and influence the behavior of individuals positively (Hamari et al., 2014), such as the use of information systems (Hamari, 2013; Morschheuser et al., 2015a; Thom et al., 2012), learning behavior and outcomes (Bonde et al., 2014; Denny, 2013; Hamari et al., 2016a; Morschheuser et al., 2014), participation in online communities or government services (Hamari, 2017; Tolmie et al., 2013; Vasilescu et al., 2014), public engagement (Tolmie et al., 2013), exercise and physical activity (Chen and Pu, 2014; Hamari and Koivisto, 2015a), healthy living (Jones et al., 2014), creativity and innovation (Barata et al., 2013; Roth et al., 2015), environmental behavior (J. J. Lee et al., 2013), or consumer behaviors (Bittner and Schipper, 2014; Harwood and Garry, 2015), to name a few.

To explain the effects of gamification features, researchers have commonly drawn on the concept of *motivational affordances* (Zhang, 2008a, 2008b) and have conceptualized gamification as enriching a system with *motivational affordances* for invoking intrinsic motivation (Deterding, 2011; Hamari, 2015a; Hamari et al., 2015a; Huotari and Hamari, 2017; Jung et al., 2010). In human-computer interaction research, *affordance* has become established and refers to the actionable properties between an object and an actor (Gibson, 1977), (see also Norman, 1999; Zhang, 2008a, 2008b). *Motivational affordances* comprise properties of an object that can stimulate certain motivational needs of an actor (Zhang, 2008a, 2008b). The conceptualization of gamification features as motivational affordances highlights several key characteristics of gamification: 1) gamification features offer stimuli designed with the intent to address motivational needs, such as competence satisfaction, autonomy, or relatedness, and to invoke mental states, such as flow experience; 2) gamification features can induce psychological experiences, influenced by subjective perceptions and personal characteristics; 3) gamification features can influence behaviors; 4) the adoption of gamification is always voluntary (Huotari and Hamari, 2017; Koivisto and Hamari, 2014; Ryan et al., 2006; Zhang, 2008a, 2008b). Figure 3 provides a schematic overview of how the adding of gamification features into a system can offer motivational affordances and influence behaviors: Designers can enrich information systems with design features known from games. These *gamification features* of a system can act as motivational affordances for gameful experiences by offering "stimuli designed with the intent to provoking the users' motivational needs and affecting the user's psychological states" (Huotari and Hamari, 2017, p. 26). The experiences users expected from interacting with a system and its affordances can further act as mediators for the users' interactions with a gamified system, leading to specific behavioral outcomes (Huotari and Hamari, 2017; Jung et al., 2010; Zhang, 2008a, 2008b).

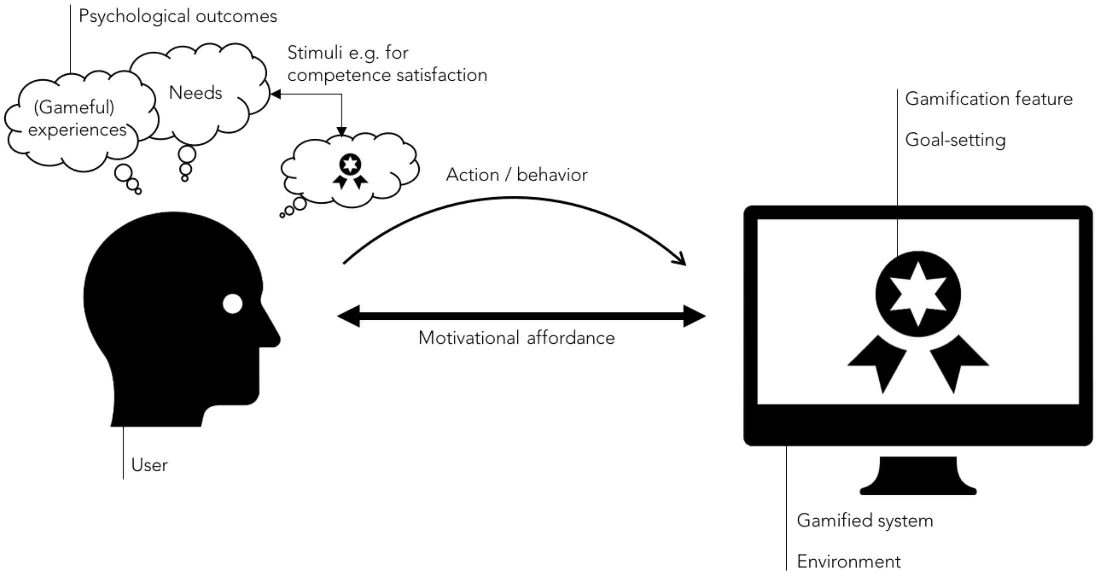


Figure 3. Schematic Overview of How Gamification Acts as Motivational Affordances

On an overarching level, gamification can thus be considered to have three aspects: 1) the *design features* that are implemented in a system and act as motivational affordances, 2) the *psychological outcomes* of gamification, and 3) gamification's *behavioral outcomes* (Hamari et al., 2014; Huotari and Hamari, 2017) (Figure 4). Points, badges, leaderboards, avatars, and stories are often used gamification features (Hamari et al., 2014). Many empirical studies have investigated the effects of different gamification features in various contexts and have demonstrated mostly positive effects on psychological outcomes (e.g. enjoyment and engagement) and behavioral outcomes (e.g. participation, continued use, physical activity, or learning) (for reviews, see Bui et al., 2015; Hamari et al., 2014; Seaborn and Fels, 2015).

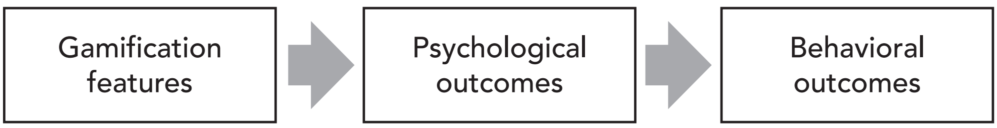


Figure 4. Abstract Conceptualization of Gamification (according to Hamari et al. (2014); Huotari and Hamari (2017))

2.3 Gamified Crowdsourcing Systems

When one considers gamification in the context of crowdsourcing, one can see it as an attempt to redirect crowdsourcees' motivations from purely rational gain-seeking to self-purposeful, intrinsically motivated activity: "Transforming Homo Economicus into Homo Ludens" (Hamari, 2013). Through this redirection of motivations, the goal of designers who use gamification in crowdsourcing is to influence crowdsourcees' behaviors (e.g. participation, concentration, work duration, engagement, or work quality) in the execution of the crowdsourced *work*.

As in classical, non-gamified crowdsourcing systems, gamification can be combined with *additional incentives*, typically monetary rewards, for instance, piece rate payments or a tournament prize that may have additional effects on crowdsourcees' motivations (Straub et al., 2015; Zhao and Zhu, 2014b). Existing empirical works also suggest that contextual factors, such as the *domain* (Hamari, 2013; Hamari et al., 2014), and aspects relating to the user, have effects (Koivisto and Hamari, 2014).

A review of empirical studies into gamification (Hamari et al., 2014) indicated that crowdsourcing systems are among the most popular application areas of gamification. However, the literature is currently fragmented, and there is no comprehensive conceptualization of gamified crowdsourcing systems. Thus, by building on the abovementioned work on crowdsourcing (Geiger and Schader, 2014; Pedersen et al., 2013; Zuchowski et al., 2016) and gamification (Hamari et al., 2014), an integrated conceptual framework has been developed (as depicted in Figure 5). The framework represents all core aspects of gamified crowdsourcing systems outlined above and provides structure to holistically investigate the phenomenon, along its key components: 1) the crowd *work*, characterized by the types of crowdsourced *tasks* and desired *solutions*; 2), the *crowdsourcees* who are responsible for the value creation by transforming tasks into solutions; and 3) the applied *gamification features* and *additional incentives* (i.e. monetary rewards), whose design characterizes a system's *psychological* and *behavioral outcomes*, such as crowdsourcees' motivations and participation (Figure 5).

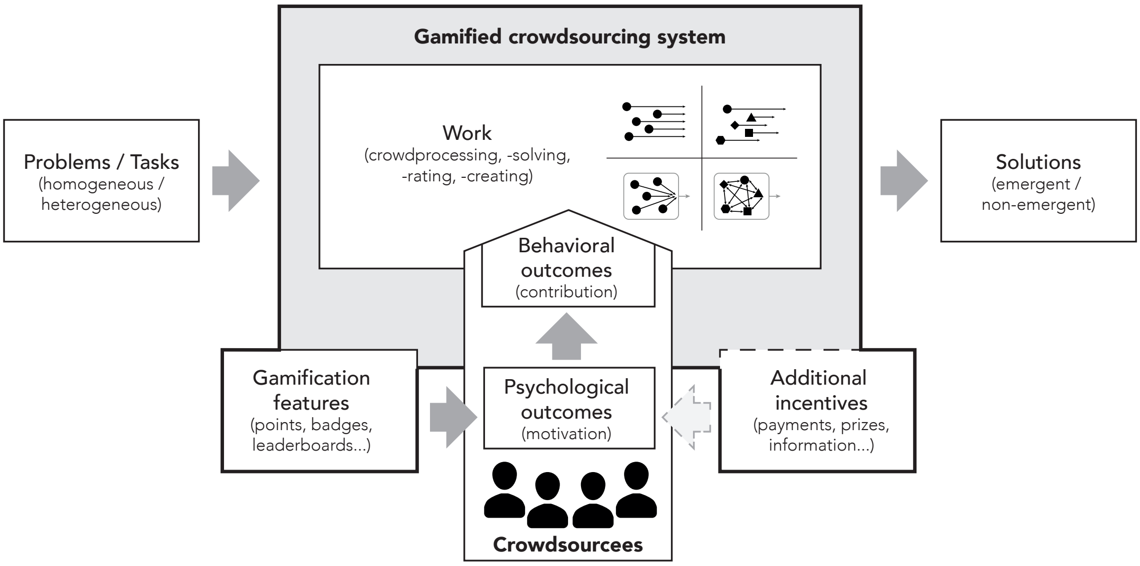


Figure 5. Conceptual Framework of Gamified Crowdsourcing Systems

The framework allows for the identification of the core aspects of gamified crowdsourcing systems and for the classification of different system types. According to Geiger and Schader (2014), the framework distinguishes between homogeneous and heterogeneous *problems/tasks* as well as between emergent (e.g. knowledge repositories or ground truths) and non-emergent *solutions* (e.g. crowd-created ideas, different algorithms for a given problem, or sets of annotations). Further, the framework can be used to differentiate gamified crowdsourcing systems along the implemented *gamification feature types*, as well as their effects on *psychological* and *behavioral outcomes*.

2.4 Cooperative, Competitive, and Individualistic Gamification

The source of gamification, games, is multifaceted and provides designers with a rich variety of possibilities for designing gamification features (Morschheuser et al., 2017d). In order to be able to distinguish between various types of gamified crowdsourcing and to compare the effects of various gamification features in crowdsourcing systems, this dissertation proposes a framework for classifying gamification features that has been missing in current gamification research.

Scholars in various domains have found that in social situations, where groups of individuals interact with one another such as in crowdsourcing, individuals' behaviors can be cooperative, competitive, or individualistic (Deutsch, 1949; Johnson and Johnson, 1989; Stanne et al., 1999; Tuomela, 2000). Gamification is often applied in such situations with the intent to induce and affect specific behaviors (Bui et al., 2015; Hamari et al., 2014; Huotari and Hamari, 2017; Seaborn and Fels, 2015). However, very few studies have investigated whether differences exist between various gamification features (Liu et al., 2017). In particular, differences between gamification features that promote competition or cooperation in social situations have largely been ignored (Bui et al., 2015; Liu et al., 2017). Previous research has commonly referred to *goals* and in particular the *interdependence between goals* of players as a key design aspect that determines whether a game is cooperative or competitive (Chen and Pu, 2014; Goh and Lee, 2011; T. Y. Lee et al., 2013; Massung et al., 2013; Mekler et al., 2013; Peng and Hsieh, 2012; Plass et al., 2013). The social interdependence theory (Deutsch, 1949; Johnson and Johnson, 1989) is widely used to explain and study how the goal structure of a cooperative or competitive environment influences an individual's behavior (Johnson, 2003; Stanne et al., 1999; Tauer and Harackiewicz, 2004). This theory, with an external validity and generalizability rarely found in the social sciences (Johnson, 2003), has also been adapted to the context of video games to differentiate between individualistic, cooperative, competitive, and cooperative-competitive game designs (Liu et al., 2013; Peng and Hsieh, 2012). Following the theory, game designs can be seen as *individualistic* when individual actions have no effect on others (*no interdependence*), *cooperative* when individual actions promote the goals and actions of others (*positive interdependence*), or *competitive* when individual actions obstruct the goals and actions of others (*negative interdependence*) (Liu et al., 2013). In individualistic games, the players commonly compete against given or self-defined goals and constraints (e.g. unlock a badge, reach the next level, achieve a better result than in the last round, solve a puzzle in the least number of moves, beat the time); while in cooperative, competitive, or cooperative-competitive game designs, players interact with other players and try to achieve goals that relate to the multiplayer environment (e.g. surpass another player's result or achieve a shared goal) (Liu et al., 2013; Peng and Hsieh, 2012; Tauer and Harackiewicz, 2004). Since gamification approaches apply the same goal and reward structures as games commonly do (Deterding, 2015), social interdependence theory is very compatible with conceptualizations of gamification and can contribute to the classification of gamification features.

Accordingly, this dissertation propose classifying gamification features into: (1) *individualistic gamification features*, which provide motivational affordances for gameful experiences without causing interdependencies between individuals; (2) *cooperative gamification features*, which provide motivational affordances for gameful experiences by using goal structures that invoke positive interdependencies; and (3) *competitive gamification features*, which provide motivational affordances for gameful experiences by using goal structures that invoke negative interdependencies. In accordance with Liu et al. (2013), this dissertation also adopts the concept of (4) *cooperative-competitive gamification features* that provide motivational affordances for gameful experience based on groups, with positive goal interdependencies within and negative goal interdependencies between the groups, i.e. *inter-team competitive gamification* (Liu et al., 2013; Tauer and Harackiewicz, 2004) (Figure 6).

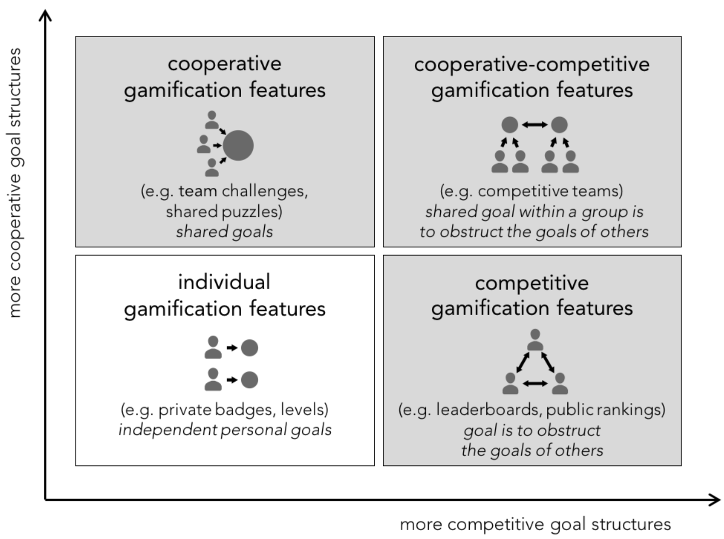


Figure 6. A Classification Framework for Different Types of Social and Individual Gamification Features

A typical gamification feature applied in numerous gamification studies is a leaderboard. Previous research typically considered leaderboards as design features that induce competitions (Eickhoff et al., 2012; Landers et al., 2017; Landers and Landers, 2014; Vasilescu et al., 2014). Generally, leaderboards rank aggregated results of groups or individuals based on a predefined rating object (e.g. a score such as number of points) (Morschheuser et al., 2015b). In this way, leaderboards enable the direct comparison of individuals or groups. Landers et al. (2017) argue that such a social comparability allows users to identify and set personal goals. For instance, overcoming someone with a higher ranking or to achieve the highest overall position in the ranking. Since leaderboards usually allow only one player to achieve the top position and several users could have the goal of achieving the top position, most leaderboards can be considered as competitive gamification features that induce negative interdependencies between individuals. Although at first glance this argumentation seems reasonable, the results of different leaderboard implementations in gamified crowdsourcing applications indicate that the specific design of a leaderboard and its underlying rules influence how users react on the competitive goal structure a leaderboard affords (e.g. Ipeirotis and Gabrilovich, 2014; Massung et al., 2013; Preist et al., 2014). Leaderboards can also have demotivating effects if poorly designed (Liu et al., 2013).

Besides leaderboards, badges are applied in numerous gamification approaches (Hamari et al., 2014; Morschheuser et al., 2016). Previous research into badges noted that "a badge consists of a signifying element (the visual and textual cues of the badge), rewards (the earned badge) and the fulfillment conditions which determine how the badge can be earned" (Hamari, 2017, p. 470). The ways badges are applied can influence whether a badge acts more as individualistic or a competitive gamification feature (Hamari, 2017, 2013). Commonly, badges are designed with the intent to engage individuals on an individual level by defining personal goals (Hamari et al., 2015a). However, studies have shown that badges on a public user profile could lead to comparisons between users and thus are also able to induce friendly competition (Montola et al., 2009).

Considering these examples, it becomes clear that it is not enough to classify and investigate gamification approaches based on the used feature types, such as badges or leaderboards (cf. Bui et al., 2015; Hamari et al., 2014; Seaborn and Fels, 2015). The specific implementation and, in particular, the goal structures a gamification feature induce must also be considered. Thus, the framework proposed in Figure 6 can support the classification of gamification features and the investigation of possible differences between various instantiations of gamification features of one type.

In the context of crowdsourcing systems, various forms of incentive designs can be found, ranging from competitive (Hutter et al., 2011; Prpić et al., 2015a; Straub et al., 2015; Zhao and Zhu, 2014b) to cooperative approaches (Blohm et al., 2011; Goh and Lee, 2011; Hutter et al., 2011; Siu et al., 2014). However, while the body of knowledge on crowdsourcing has been growing in the past few years, the literature is scattered. We lack a comprehensive overview and a comparison of how different gamification feature types are used in different crowdsourcing system types. Thus, a comprehensive review is presented in the following that provides a coherent overview of the phenomenon of gamified crowdsourcing systems and that can act as summary of related work.

3 Review of the Current State of Gamified Crowdsourcing Research[2]

During recent years, the body of literature on both crowdsourcing and gamification has been rapidly growing. Moreover, these concepts appear together frequently. Recent reviews of current crowdsourcing research revealed that crowdsourcing systems are one of the major application areas for gamification (Hamari et al., 2014; Morschheuser et al., 2017a, 2016). The rapid diffusion of these concepts can be seen both in practice and in academia (Estellés-Arolas and González-Ladrón-de-Guevara, 2012; Hamari et al., 2014; IEEE, 2014; Seaborn and Fels, 2015). As of December 2015, almost 3,000 crowdsourcing-related examples are listed at crowdsourcing.org, a leading crowdsourcing industry portal. In parallel, business analysts have estimated that at least 50% of all organizations that manage innovation processes have gamified some of their processes by 2015 (Gartner, 2011). The primary general goals of crowdsourcing are either cost savings or the possibility to handle tasks that would be difficult to perform without human support. However, crowdsourcing relies on the existence of a reserve of people willing to take on tasks for free or for little monetary compensation. Along this reasoning, crowdsourcing systems are increasingly *gamified* (Hamari et al., 2014; Seaborn and Fels, 2015), that is, organizations seek to make the crowdsourced work activity more like playing a game in order to provide other motives for working than just monetary compensation.

However, while the new phenomenon seems intuitively appealing and the body of literature on both crowdsourcing and gamification has been rapidly growing (Figure 7), there is a need to collate and synthesize this growing body of knowledge. Both crowdsourcing and gamification can take a variety of forms, and it would be myopic to assume that differing gamification implementations would function similarly across different crowdsourcing approaches. This lack of comprehensive understanding of the phenomenon inhibits us from designing effective incentive systems for crowdsourcing and therefore to optimally harness the potential of the crowd and to derive the most successful solutions and innovations. Thus, a systematic literature review of 110 papers is conducted that investigates how gamification is being studied and implemented in crowdsourcing research. Following the framework conceptualized above (Figure 5), the review focuses the use of different forms of gamification in different types of crowdsourcing, as well as the interplay of gamification and monetary rewards, the types of work being crowdsourced, the types of crowdsourcees, the domains where gamification in crowdsourcing has been applied, and empirical results of studies on the effectiveness of gamification in crowdsourcing. This meticulous mapping enables us to 1) infer what kinds of gamification efforts are effective in different

[2] This section is based on Morschheuser et al. (2017a, 2016)

kinds of crowdsourcing approaches, and 2) outline a research agenda for this dissertation and future research.

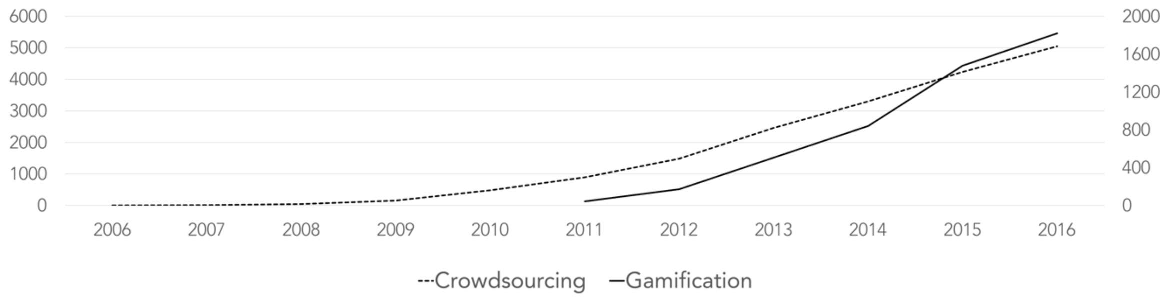


Figure 7. Search Hits on Gamification and Crowdsourcing (Scopus, all fields, crowdsourcing left axis, gamification right axis)

3.1 Methodology

Following the guidelines of Webster and Watson (2002), Boell and Cecez-Kecmanovic (2015), and Ellis (2010), we began the literature review with a literature search. We used the Scopus database as our source of data, since it indexes all other potentially relevant databases, for instance, ACM, IEEE, Springer, and the DBLP Computer Science Bibliography. Since all these individual databases differ in their search functions and algorithms, focusing the search on only one database has ensured that the procedure is replicable, rigorous, and transparent (Boell and Cecez-Kecmanovic, 2015).

The literature search in the Scopus database was conducted in October 2016 using the search query TITLE-ABS-KEY(GAMIF* AND CROWD*). The results included any permutation of the terms *gamification* and *crowdsourcing* in the entry metadata (title, abstract, or keywords). We intentionally limited the search to the metadata, since searching for the terms in all the text would result in a relatively large number of false positives, since many papers refer to gamification and/or crowdsourcing in passing. We did not restrict the search to specific outlets or disciplines, for two reasons. First, crowdsourcing is a socio-technical approach and is therefore applied in various contexts. Second, due to the novelty of the gamification phenomena, most of the studies have not yet found their way into high-quality journals and are published in peer-reviewed conferences instead.

The Scopus search query resulted in 145 hits. These hits contained 16 conference reviews and summaries, which have been excluded since they provide no self-contained research contribution. Further, a preliminary conference paper version of the present study was ignored resulting in a repertoire of 128 hits (for a full list, see the Appendix A). We then screened these papers for inclusion and relevance, using the following criteria: 1) the full paper can be acquired; 2) the paper is in English (and has been published by an international venue); 3) gamification and crowdsourcing must have a significant/relevant role in the paper instead of just being mentioned in the metadata; 4) the paper is not a duplicate that reports the same study in several papers. This screening process was performed by a team of four researchers. As a result of this screening, one paper was excluded due to the full paper not being available, and another for not being in English. Further, we excluded 14 papers from the review, since gamified crowdsourcing was not actually relevant in these papers' content. Moreover, in two cases, duplicates were found. For instance, Liu et al. (2011a) and Liu et al. (2011b) describe the same experiment and report similar results. Thus, we merged the information of the two papers and handled them in the analyses as one entity. Finally, 110 papers were chosen for inclusion in the literature review.

In the next step of the literature analysis, we coded the included papers (Webster and Watson, 2002). First, we gathered information of all the papers pertaining to 1) bibliometric information (authors, years, publication venues, publications types, disciplines), 2) the type of study (conceptual, empirical, research-in-progress), and 3) domain. Using our framework presented in Figure 5, we collected 4) the different characteristics of gamified crowdsourcing systems, including the work type, the crowdsourcing type, gamification features and mechanisms used, the incentive orchestration, and the type of crowdsourcees. Finally, 5) we accumulated the results of empirical studies on the psychological and behavioral outcomes of gamified crowdsourcing systems and gamification's overall effectiveness in crowdsourcing. Based on the coded literature data, we analyzed the results in accordance with Webster and Watson (2002) and compounded the data into frequency tables.

3.2 Results

3.2.1 Bibliometric Information

As a first step in the analysis, we examined the bibliometric data of the 110 included papers. The first study to combine both gamification and crowdsourcing was already published in 2011. While three papers were published in 2012, research on the concepts began to increase in 2013 (15 papers). Up to October 2016, when the search was conducted, the number of papers has been constantly growing (2014: 29 papers; 2015: 41 papers; first half of 2016: 21 papers). The vast majority of these publications are conference papers and workshop papers (Table 1), which is in line with the novelty of the perspective; the reviewed studies were largely exploratory and preliminary works on the topic. However, an increasing number of high-quality journal publications and book chapters can be recognized (2014: 1 paper; 2015: 21 papers; first half of 2016: 11 papers).

Publication type	Frequency	%
Full conference paper	59	53.6
Workshop paper / poster	22	20.0
Journal article / article in press	21	19.1
Short conference paper	5	4.5
Book chapter	3	2.7
Total	**110**	**100**

Table 1. Publication Types of the Reviewed Papers

Concerning the disciplines under which research on the topic was conducted, 84 of the studies had been published in venues and journals related to HCI and computer science. In addition, 9 papers were published on information retrieval-related forums. The rest were published in venues relating to economics (2), engineering (2), cartography (2), IT education (2), communication (1), innovation management (1), electronics (1), librarianship (1), musicology (1), physics (1), media production (1), bioinformatics (1), and social science (1).

3.2.2 DESCRIPTIVE INFORMATION

Beyond bibliometric information, we analyzed the frequency of types of the studies in the body of literature. As reported in Table 2, of the 110 reviewed studies, 63 were empirical. Of these, 37 papers studied the effects of gamification in crowdsourcing, while 25 studies empirically investigated other aspects relating to crowdsourcing and gamification. Beyond the empirical studies, 29 papers merely included preliminary descriptions of a future study or a description of a gamified crowdsourcing system. The body of literature contained 18 conceptual papers.

Type of study	Papers	Frequency	%
Empirical studies with results on how gamification works in crowdsourcing	Altmeyer et al., 2016; Bowser et al., 2013; Carlier et al., 2016; De Franga et al., 2015; Dergousoff and Mandryk, 2015; Choi et al., 2014; Dumitrache et al., 2013; Eickhoff et al., 2012; Feyisetan et al., 2015; Goncalves et al., 2014; Ipeirotis and Gabrilovich, 2014; Itoko et al., 2014; Kacorri et al., 2015; Kawajiri et al., 2014; Kobayashi et al., 2015; J. J. Lee et al., 2013; T. Y. Lee et al., 2013; Liu et al., 2011a, 2011b; Machnik et al., 2015; Martella et al., 2015; Massung et al., 2013; Melenhorst et al., 2015; Nose and Hishiyama, 2013; Packham and Suleman, 2015; Pothineni et al., 2014; Prandi et al., 2016; Preist et al., 2014; Prestopnik and Tang, 2015; Roengsamut et al., 2015; Runge et al., 2015; Saito et al., 2014; Simões and De Amicis, 2016; Snijders et al., 2015; Sørensen et al., 2016; Talasila et al., 2016; Tinati et al., 2016; Vasilescu et al., 2014	37	33.6
Empirical studies with no results on how gamification works in crowdsourcing	Bentzien et al., 2013; Brenner et al., 2014; Brito et al., 2015; Cao et al., 2015; Chamberlain, 2014; Cucari et al., 2016; Deng et al., 2016; Dos Santos et al., 2015; Harris, 2014; He et al., 2014; Inaba et al., 2015; Kacorri et al., 2014; Kurita et al., 2016; Lauto and Valentin, 2016; Lessel et al., 2015; Mason et al., 2012; Nagai et al., 2014; Nunzio et al., 2016; Riegler et al., 2015; Rosani et al., 2015; Sakamoto and Nakajima, 2014; Sheng, 2013; Ustalov, 2015; Uzun et al., 2013; Yakushin and Lee, 2014; ; Yu et al., 2015	26	23.6
(Preliminary) description of a study or a system; no empirical results	Ahmed and Mueller, 2014; AlRouqi and Al-Khalifa, 2014; Ansari et al., 2013; Bainbridge, 2015; Benjamin, 2016; Biegel et al., 2014; Bockes et al., 2015; Burnett et al., 2012; Fava et al., 2015; Fedorov et al., 2016; Hammais et al., 2014; Hantke et al., 2015; Marasco et al., 2015; McCartney et al., 2015; Mizuyama and Miyashita, 2016; Moreno et al., 2015; Netek and Panek, 2016; Panchariya et al., 2015; Pinto and Viana, 2015; Prandi et al., 2015; Roa-Valverde, 2014; Silva and Lopes, 2016; Smith and Kilty, 2014; Stannett et al., 2013; Supendi and Prihatmanto, 2015; Supriadi and Prihatmanto, 2015; Susumpow et al. 2014; Wu and Luo, 2014; Xie et al., 2015	29	26.4
Conceptual, frameworks	Armisen and Majchrzak, 2015; Brandtner et al., 2014; Cherinka et al., 2013; Dai et al., 2016; Greenhill et al., 2016; Katmada et al., 2016; LaToza et al., 2013; Mahnič, 2014; Nakatsu and Iacovou, 2014; Reid, 2013; Reinsch et al., 2013; Roth et al., 2015; Sakamoto et al., 2016; Sigala, 2015; Simões et al., 2015; Simperl, 2015; Snijders et al., 2014; Wang et al., 2015	18	16.4
Total		**110**	**100**

Table 2. Study Types

Domain	Papers	Frequency
General crowdsourcing (no specific domain)	Ahmed and Mueller, 2014; Brenner et al., 2014; Carlier et al., 2016; Choi et al., 2014; Dai et al., 2016; Dergousoff and Mandryk, 2015; Eickhoff et al., 2012; Feyisetan et al., 2015; Hantke et al., 2015; Harris, 2014; He et al., 2014; Ipeirotis and Gabrilovich, 2014; Kacorri et al., 2014; Kacorri et al., 2015; Katmada et al., 2016; Kurita et al., 2016; T. Y. Lee et al., 2013; Panchariya et al., 2015; Nakatsu and Iacovou, 2014; Nose and Hishiyama, 2013; Roengsamut et al., 2015; Runge et al., 2015; Saito et al., 2014; Sakamoto et al., 2016; Simperl, 2015; Stannett et al., 2013; Vasilescu et al., 2014; Yu et al., 2015	28
Environment, nature, ecological behavior	Ansari et al., 2013; Bowser et al., 2013; Fedorov et al., 2016; J. J. Lee et al., 2013; Lessel et al., 2015; Mason et al., 2012; Massung et al., 2013; Netek and Panek, 2016; Preist et al., 2014; Prestopnik and Tang, 2015; Supendi and Prihatmanto, 2015; Supriadi and Prihatmanto, 2015	12
Cartography, navigation	Bockes et al., 2015; Goncalves et al., 2014; Kawajiri et al., 2014; Martella et al., 2015; McCartney et al., 2015; Moreno et al., 2015; Reinsch et al., 2013; Simões and De Amicis, 2016; Talasila et al., 2016; Uzun et al., 2013; Wang et al., 2015; Wu and Luo, 2014	12
Language	AlRouqi and Al-Khalifa, 2014; Benjamin, 2016; Chamberlain, 2014; Itoko et al., 2014; Kobayashi et al., 2015; Packham and Suleman, 2015; Ustalov, 2015	7
Machine learning	Deng et al., 2016; Fava et al., 2015; Inaba et al., 2015; Nunzio et al., 2016; Riegler et al., 2015; Rosani et al., 2015	6
Software development	Biegel et al. 2014; LaToza et al., 2013; Snijders et al., 2014, 2015; Yakushin and Lee, 2014; Xie et al., 2015	6
Innovation	Armisen and Majchrzak, 2015; Brandtner et al., 2014; Cherinka et al., 2013; Lauto and Valentin, 2016; Roth et al., 2015	5
Health, medical, neuro-science	Bentzien et al. 2013; Dumitrache et al., 2013; Silva and Lopes, 2016; Susumpow et al. 2014; Tinati et al., 2016	5
Education	Roa-Valverde, 2014; Marasco et al., 2015; Sheng, 2013	3
Politics	Dos Santos et al., 2015; Mahnič, 2014; Reid, 2013	3
Work	Machnik et al., 2015; Pothineni et al., 2014; Smith and Kilty, 2014	3
Entertainment	Bainbridge, 2015; Burnett et al., 2012; Pinto and Viana, 2015	3
Finance, funding	Altmeyer et al., 2016; Sakamoto and Nakajima, 2014	2
Tourism	Liu et al., 2011a, 2011b; Sigala, 2015; Simões et al., 2015	3
Energy	Cao et al., 2015; Hammais et al., 2014	2
Mobility, transportation	Brito et al., 2015; De Franga et al., 2015	2
Accessibility, disability	Prandi et al., 2016, 2015	2
Fashion	Melenhorst et al., 2015	1
Marketing	Mizuyama and Miyashita, 2016	1
Physics	Sørensen et al., 2016	1
Astronomy	Greenhill et al., 2016	1
Mentoring	Nagai et al., 2014	1
Behavioral research	Cucari et al., 2016	1
Total		**110**

Table 3. Domains

Regardless of the wide spectrum of the domains in which research on crowdsourcing is being conducted, the entire body of literature indicates that crowdsourcing is always information-intensive and relates to some form of information processing or retrieval: solving, creating, processing, and rating. Gamified crowdsourcing is often applied to elicit information about an environment. Such studies commonly contain gathering, recognizing and classifying biological (Ansari et al., 2013; Bowser et al., 2013; Prestopnik and Tang, 2015) and environment-related data (Mason et al., 2012), as well as promoting environmental behavior (J. J. Lee et al., 2013; Massung et al., 2013; Preist et al., 2014). We also identified that gamified crowdsourcing is popular in the context of digital cartography and navigation.

The latter type of studies featured, for instance, the creation of digital maps based on user-reported data, the gathering of location-based sensory data (Kawajiri et al., 2014; Wang et al., 2015), location measurements (Uzun et al., 2013), geospatial information (Goncalves et al., 2014), and (indoor) navigation information (Bockes et al., 2015; Reinsch et al., 2013). Furthermore, as reported in Table 3, the domains of language-related information (e.g. proofreading, translation, etc.), innovation, and software development (e.g. the development of code fragments or requirement elicitation) were also among the most common contexts for gamified crowdsourcing. A rising trend during the past few years in gamified crowdsourcing has been the gathering of datasets for machine learning approaches. Overall, the application of gamified crowdsourcing is far-reaching and involves a variety of contexts, from information retrieval for entertainment purposes (Bainbridge, 2015; Pinto and Viana, 2015), to the solving of physical problems (Sørensen et al., 2016).

3.2.3 Empirical Research Papers

Of the 110 papers included in the review, 63 studies were identified as empirical research papers (Table 2). In the next sections, we report findings from the 63 empirical studies. For clarity on the two empirical results types, in the following tables, we marked the citations to studies with empirical results about the effectiveness of gamification in crowdsourcing in bold, while studies that did not directly investigate effectiveness of gamification are not bolded. Nearly all these papers contained detailed information about the implementation of gamification in a concrete crowdsourcing system. Thus, we were able to investigate both the empirical results that allowed us to draw conclusions about the effectiveness of gamified crowdsourcing, but also the characteristics of the considered systems in the literature along the components described in Figure 5.

3.2.4 Characteristics of Gamified Crowdsourcing Systems in the Literature

The core of every crowdsourcing system is the work that is outsourced to the crowd. A wide variety of activities could be found in the analyzed papers. Therefore, we clustered the crowdsourced work based on the participants' core activities in several categories shown in Table 4. Most of the analyzed approaches with detailed information about the crowdsourced work try to encourage people to do computational work, which otherwise pose challenges for computers without human guidance (Von Ahn, 2009). These include the recognition of objects on images, such as animals, plant species, or waste (Carlier et al., 2016; Deng et al., 2016; Lessel et al., 2015), proofreading of text scanned with OCR technology (Kobayashi et al., 2015), relevance assessment of different images (Harris, 2014), video transcription (Saito et al., 2014), or the annotation of medical texts (Dumitrache et al., 2013). Furthermore, we found that many of the identified approaches sought to encourage people to report different kinds of location-based information. Usually, these cases are mobile apps or distributed stationary installations. Also, work that can easily be virtually disseminated in digital communities – such as the answering of user-generated questions or the provision of feedback – are popular usage cases of gamified crowdsourcing. Only a few studies considered creative creation work, such as ideation or complex optimization tasks that draw on the collective intelligence of a crowd.

Work type	Papers	#
Recognizing, identifying, and tagging work *image recognition, object recognition, feature recognition, character recognition, information recognition*	**Altmeyer et al., 2016**; Brenner et al., 2014; **Carlier et al., 2016**; Deng et al., 2016; **Dergousoff and Mandryk, 2015**; **Feyisetan et al., 2015**; **Itoko et al., 2014**; **Kobayashi et al., 2015**; Kurita et al., 2016; Lessel et al., 2015; Mason et al., 2012; Riegler et al., 2015; **Roengsamut et al., 2015**; Rosani et al., 2015; **Runge et al., 2015**	15
Reporting location-based information *location tagging, reporting of location-based information, on-location experience, taking location-based photos*	**Bowser et al., 2013**; Brito et al., 2015; **De Franga et al., 2015**; **Goncalves et al., 2014**; **Kawajiri et al., 2014**; **Liu et al., 2011a, 2011b***; **Martella et al., 2015**; **Massung et al., 2013**; **Prandi et al., 2016**; **Preist et al., 2014**; Sheng, 2013; **Simões and De Amicis, 2016**; **Talasila et al., 2016**; Uzun et al., 2013	14
Answering questions/sharing knowledge *answering user-generated questions, providing feedback, knowledge-sharing in communities*	**Ipeirotis and Gabrilovich, 2014**; Inaba et al., 2015; **Liu et al., 2011a, 2011b***; **Machnik et al., 2015**; **Pothineni et al., 2014**; **Vasilescu et al., 2014**	6
Creative creation work *idea creation, algorithm development, requirements elicitation*	Bentzien et al., 2013; **Choi et al., 2014**; Dos Santos et al., 2015; Lauto and Valentin, 2016; **Snijders et al., 2015**; Yakushin and Lee, 2014	6
Text annotation work *text annotation, medical text annotation, biological data annotation*	Cao et al., 2015; Chamberlain, 2014; **Dumitrache et al., 2013**; **Nose and Hishiyama, 2013**; Ustalov, 2015	5
Assessment work *relationship building, relevance assessment, classification work, decision-making*	**Eickhoff et al., 2012**; Harris, 2014; **Melenhorst et al., 2015**; **Prestopnik and Tang, 2015**; Yu et al., 2015	5
Searching for and/or optimization of tasks *document searching, searching for digital profiles, finding optimal solutions*	He et al., 2014; **T. Y. Lee et al., 2013**; Nunzio et al., 2016; **Sørensen et al., 2016**; **Tinati et al., 2016**	5
Transcription work *video captioning*	**Kacorri et al.**, 2014, **2015**; **Saito et al., 2014**	3
Translation work *translating sentences*	Packham and Suleman, 2015	1
N/A *no clear work description provided, user-generated tasks, social activities*	Cucari et al., 2016; **J. J. Lee et al., 2013**; Nagai et al., 2014; Sakamoto and Nakajima, 2014	4
References in bold refer to studies in which empirical results about gamification have been reported. * Mentioned twice, because the core task of that crowdsourcing system is the answering of location-based questions.		

Table 4. Types of Crowdsourced Work

By analyzing the value creation (emergent or non-emergent solution) and the contribution type (homogeneous or heterogeneous contribution) according to our framework (Figure 5) and Geiger and Schader (2014), we found that most cases in the reviewed literature can be classified as gamified crowdprocessing systems (homogenous tasks, non-emergent outcome). Cases with gamified crowdsolving and crowdrating were also present. However, very few cases described gamified crowdcreating systems (see Table 5).

We identified 12 categories of gamification features (design elements, known from video games) in the reviewed body of literature (see Table 5). Points (in 53 cases) were clearly the most reported gamification components and usually provided the basis for other features. Commonly, points were combined with leaderboards (in 45 cases) to create competition between participants. Points were also combined with further elements in diverse ways across implementations; they were used in combination with, for instance, time limits (e.g. Harris, 2014; Kacorri et al., 2014), they were used as a basis for calculating the level of crowdsourcees in a level system (e.g. T. Y. Lee et al., 2013; Saito et al., 2014), with the ability to compare them between team members and peers (e.g. T. Y. Lee et al., 2013; Saito et al., 2014), as well as with badges and missions to visualize specific goals (e.g. Bowser et al., 2013; J. J. Lee et al., 2013; Massung et al., 2013; Preist et al., 2014; Vasilescu et al., 2014).

Looking at the relative shares of gamification features reported in all the reviewed papers, we found the largest variety of features in studies that investigated solving-related crowdsourcing work, while papers on crowdprocessing and crowdrating reported simpler forms of gamification such as simple combinations of points and leaderboards. Crowdsourcing types of crowdcreating and crowdsolving differ from crowdrating and crowdprocessing in that the participation at crowdsourcing work depends on a variety of heterogeneous contributions. Our review showed that studies in the areas of crowdcreating and crowdsolving reported the use of more manifold sets of gamification features. These approaches employed not only points and leaderboards, but also, for instance, storytelling, missions, and avatars. Especially crowdsourcing approaches that sought heterogeneous location-based information or sought to solve complex problems based on creative and diverse contributions often applied rich gamification designs. For instance, Tinati et al. (2016) applied points, badges, progress statistics, virtual teams, and leaderboards to engage users to find patterns in 3-D maps of neuro-scans, while Prandi et al. (2016) created an augmented reality with zombies and virtual weapons as a playground for creating a user-generated map of heterogeneous accessibility barriers.

Since most studies provided comprehensive information on the applied game mechanics and rules, we also analyzed and classified the gamification approaches along their applied goal structures into competitive, cooperative, and individualistic gamification designs (Table 6). Crowdsourcing types of creating and rating differ from solving and processing in that the end goal of the crowdsourced work is the emergent value from all the contributions. Therefore, it could be assumed that designers of gamified crowdsourcing systems with emergent outcomes would rather use cooperative gamification designs compared to designs of non-emergent approaches. However, when analyzing the goal structures used in these types, no notable differences could be found. Competition-based designs with points and leaderboards that encourage individual work rather than cooperative work were used very often in all four crowdsourcing types. However, the scoring approaches differed based on how points were awarded and from which actions they could be earned. In crowdprocessing approaches, where the sheer number of contributions is often more important than quality (Geiger and Schader, 2014), users were commonly rewarded for general participation (e.g. number of completed tasks (Itoko et al., 2014), number of correct answers (Ipeirotis and Gabrilovich, 2014), or the number of visited locations (Uzun et al., 2013)). While in crowdrating approaches, where the output is more emergent, users were also rewarded for the quality of their contributions (e.g. the quality of contributions rated by others (Dumitrache et al., 2013), or similarity/agreement with other crowdsourcees' contributions (Eickhoff et al., 2012; Goncalves et al., 2014; Harris, 2014; Saito et al., 2014)). Such scoring mechanisms, which depend on the extent of agreement with other crowdsourcees' contributions, seem to be suitable for motivating users to emulate others and to "think and act like the community". In crowdsolving approaches, both forms occurred equally (e.g. the number of completed tasks (Liu et al., 2011a, 2011b; Yakushin and Lee, 2014), and the quality of contributions rated by others (J. J. Lee et al., 2013; Vasilescu et al., 2014)). Unfortunately, the small amount of studies investigating gamification in the crowdcreating approaches limits the identification of a clear pattern in their gamification implementations.

Crowdsourcing type/feature	Processing (N = 27)	Rating (N = 12)	Solving (N = 17)	Creating (N = 7)	Frequency (total 63)
Points/Scores	Brenner et al., 2014; **Carlier et al., 2016;** Cao et al., 2015; Cucari et al., 2016; Deng et al., 2016; **Dergousoff and Mandryk, 2015; Feyisetan et al., 2015**; **Inaba et al., 2015; Ipeirotis and Gabrilovich, 2014**; **Kawajiri et al., 2014**; **Kobayashi et al., 2015;** Kurita et al., 2016; **T. Y. Lee et al., 2013**; **Melenhorst et al., 2015; Nose and Hishiyama, 2013**; **Packham and Suleman, 2015; Prestopnik and Tang, 2015;** Riegler et al., 2015; **Roengsamut et al., 2015;** Rosani et al. 2015; **Runge et al., 2015; Talasila et al., 2016;** Uzun et al., 2013	**Altmeyer et al., 2016; Dumitrache et al., 2013**; **Eickhoff et al., 2012**; **Goncalves et al., 2014**; Harris, 2014; Kacorri et al., 2014; **Kacorri et al., 2015;** Lessel et al., 2015; Mason et al., 2012; **Massung et al., 2013**; **Preist et al., 2014**; **Saito et al., 2014**	**Choi et al., 2014**; Dos Santos et al., 2015; **De Franga et al., 2015**; He et al., 2014; Lauto and Valentin, 2016; **J. J. Lee et al., 2013**; **Liu et al., 2011a, 2011b**; Nunzio et al., 2016; **Simões and De Amicis, 2016**; **Sørensen et al., 2016; Tinati et al., 2016; Vasilescu et al., 2014**; Yakushin and Lee, 2014	Brito et al., 2015; **Martella et al., 2015; Pothineni et al., 2014**; **Prandi et al., 2016;** Sheng, 2013; **Snijders et al., 2015**	54
Leaderboards/ Rankings	Brenner et al., 2014; Cao et al., 2015; Cucari et al., 2016; **Dergousoff and Mandryk, 2015**; **Feyisetan et al., 2015***; **Inaba et al., 2015; Ipeirotis and Gabrilovich, 2014***; **Itoko et al., 2014**; **Kawajiri et al., 2014**; **Kobayashi et al., 2015; T. Y. Lee et al., 2013***; **Machnik et al., 2015; Melenhorst et al., 2015; Packham and Suleman, 2015;** Riegler et al., 2015; **Roengsamut et al., 2015;** Rosani et al. 2015; **Talasila et al., 2016;** Uzun et al., 2013	**Altmeyer et al., 2016;** Chamberlain, 2014; **Dumitrache et al., 2013**; **Eickhoff et al., 2012**; **Goncalves et al., 2014**; Harris, 2014; **Kacorri et al., 2015;** Lessel et al., 2015; **Massung et al., 2013**; **Preist et al., 2014**; **Saito et al., 2014**	Bentzien et al., 2013; **De Franga et al., 2015;** Dos Santos et al., 2015; He et al., 2014; Lauto and Valentin, 2016; **J. J. Lee et al., 2013**; **Liu et al., 2011a, 2011b**; Nunzio et al., 2016; **Tinati et al., 2016;** Ustalov, 2015; **Vasilescu et al., 2014**; Yakushin and Lee, 2014	**Bowser et al., 2013; Martella et al., 2015; Snijders et al., 2015**	45
Badges/ Achievements	Cao et al., 2015; **Feyisetan et al., 2015***; **Itoko et al., 2014**; **Kobayashi et al., 2015; T. Y. Lee et al., 2013***; **Melenhorst et al., 2015; Talasila et al., 2016;** Uzun et al., 2013	**Altmeyer et al., 2016;** Mason et al., 2012; **Massung et al., 2013**; **Preist et al., 2014**	**De Franga et al., 2015; Liu et al., 2011a, 2011b**; **Tinati et al., 2016; Vasilescu et al., 2014**	**Bowser et al., 2013**; **Martella et al., 2015;** Sheng, 2013	19
Levels	Brenner et al., 2014; **Feyisetan et al., 2015***; **T. Y. Lee et al., 2013*;** Riegler et al., 2015; **Roengsamut et al., 2015; Talasila et al., 2016; Yu et al., 2015**	**Dumitrache et al., 2013**; **Saito et al., 2014**	**De Franga et al., 2015;** Nagai et al., 2014; Nunzio et al., 2016; Yakushin and Lee, 2014	**Martella et al., 2015;** Sheng, 2013	15

Progress	Cao et al., 2015; **Feyisetan et al., 2015***; **Itoko et al., 2014**; **T. Y. Lee et al., 2013***		**J. J. Lee et al., 2013**; Nagai et al., 2014; **Tinati et al., 2016; Vasilescu et al., 2014**	Brito et al., 2015	9
Feedback	Brenner et al., 2014; Deng et al., 2016; **Feyisetan et al., 2015***; **Ipeirotis and Gabrilovich, 2014***; **Melenhorst et al., 2015**	**Kacorri et al., 2015**;	**J. J. Lee et al., 2013**; **Liu et al., 2011a, 2011b**		8
Virtual objects/ resources (e.g. weapons, materials)	**Dergousoff and Mandryk, 2015**; **Prestopnik and Tang, 2015*** ; **Talasila et al., 2016**		Lauto and Valentin, 2016; Nunzio et al., 2016; **Simões and De Amicis, 2016**	**Prandi et al., 2016*; Snijders et al., 2015**	8
Storytelling	**Nose and Hishiyama, 2013**; **Prestopnik and Tang, 2015***		Sakamoto and Nakajima, 2014; **Simões and De Amicis, 2016**	Brito et al., 2015; **Prandi et al., 2016*;** Sheng, 2013	7
Virtual territories	**Talasila et al., 2016**		**Liu et al., 2011a, 2011b; Simões and De Amicis, 2016**	Brito et al., 2015; **Martella et al., 2015; Prandi et al., 2016*;** Sheng, 2013	7
Teams		**Saito et al., 2014;** Kacorri et al., 2014; **Kacorri et al., 2015**	Bentzien et al., 2013; **Tinati et al., 2016;** Ustalov, 2015		6
Missions	Cucari et al., 2016		**J. J. Lee et al., 2013**; Sakamoto and Nakajima, 2014		3
Avatars/Virtual characters	**Dergousoff and Mandryk, 2015**; **Talasila et al., 2016**		**De Franga et al., 2015**; Nagai et al., 2014		4
References in bold refer to studies in which empirical results about gamification have been reported. * In this paper the gamification feature is used as experimental condition in a comparison of different gamification features.					

Table 5. Gamification Features per Crowdsourcing Type

Crowdsourcing type/design approach	Processing	Rating	Solving	Creating	Frequency
Competitive	16 (+2)*	9	10	3	38 (+2)
Cooperative / Cooperative-competition	2	2	5	3	12
Individualistic	4 (+2)*	1	-	1	6 (+2)
Not clear (due to missing details)	3	-	2	-	5
* Two papers compared an individual with a competitive approach and found that competitions seem to be more effective.					

Table 6. Gamification Design Approaches per Crowdsourcing Type

In most of the studies, the incentives were solely based on gamification (Table 7). Some studies additionally employed financial rewards, for instance, a small monetary task-based compensation or a prize for the leaders on a high-score list, to motivate participants.

Incentive	Literature	#
Gamification	**Altmeyer et al., 2016**; Bentzien et al., 2013; **Bowser et al., 2013**; Cao et al., 2015; Chamberlain, 2014; Cucari et al., 2016; **De Franga et al., 2015**; **Dergousoff and Mandryk, 2015**; **Dumitrache et al., 2013**; **Goncalves et al., 2014**; He et al., 2014; **Itoko et al., 2014**; **Kacorri et al.**, 2014, **2015**; **Kobayashi et al., 2015**; Kurita et al., 2016; Lauto and Valentin, 2016; **J. J. Lee et al., 2013**; **T. Y. Lee et al., 2013**; Lessel et al., 2015; **Liu et al., 2011a, 2011b**; Martella et al., 2015; Mason et al., 2012; Nagai et al., 2014; **Nose and Hishiyama, 2013**; Nunzio et al., 2016; **Pothineni et al., 2014**; Prestopnik and Tang, 2015; Roengsamut et al., 2015; Rosani et al., 2015; **Runge et al., 2015**; **Saito et al., 2014**; Sakamoto and Nakajima, 2014; Sheng, 2013; **Simões and De Amicis, 2016**; **Snijders et al., 2015**; **Sørensen et al., 2016**; **Tinati et al., 2016**; Ustalov, 2015; Uzun et al., 2013; **Vasilescu et al., 2014**; Yakushin and Lee, 2014; Yu et al., 2015	43
Gamification + monetary rewards	Brenner et al., 2014; Brito et al., 2015; **Choi et al., 2014**; Deng et al., 2016; Dos Santos et al., 2015; Harris, 2014; Inaba et al., 2015; **Kawajiri et al., 2014; Melenhorst et al., 2015**; Riegler et al., 2015	10
Gamification + other rewards	**Machnik et al., 2015** (reward: access to specific information)	1
Both as an experimental condition	**Carlier et al., 2016**; **Eickhoff et al., 2012**; **Feyisetan et al., 2015**; **Ipeirotis and Gabrilovich, 2014**; **Massung et al., 2013**; **Packham and Suleman, 2015**; **Prandi et al., 2016; Preist et al., 2014**; **Talasila et al., 2016**	9
References in bold refer to studies in which empirical results about gamification have been reported.		

Table 7. Incentive Orchestration

As seen in Table 8, most studies combining crowdsourcing and gamification were not targeted to any specific types of crowds but rather described implementations that are agnostic as to who the crowdsourcees should be. However, interestingly a few implementations were designed with a specific crowdsourcee segment in mind. For instance, Yakushin and Lee (2014) crowdsourced the development of algorithms for humanoid robots to a network of specialists in a competitive way, while for instance, T. Y. Lee et al. (2013) motivated employees to search for and identify Twitter accounts. These examples demonstrate that gamification is usable in a variety of usage cases with different target groups. However, to date, we have seen little research into whether there are differences between user groups or which gamification features should be used to support different motivations of crowdworkers. However, first empirical studies suggest that the effectiveness of gamification may differ according to crowdsourcees' personal characteristics, such as the contributors' ages (Itoko et al., 2014; Kobayashi et al., 2015). Based on Eickhoff et al. (2012) and Itoko et al. (2014), gamification has great potential for young and senior crowdsourcees, although competition-based gamification might be more effective with young participants.

Participants		#
Unspecified crowd	(all other empirical papers)	44
Students	**Bowser et al., 2013**; **Kawajiri et al., 2014**; **J. J. Lee et al., 2013**; Nunzio et al., 2016; **Talasila et al., 2016**	5
Experts	Cao et al., 2015; **Dumitrache et al., 2013**; Mason et al., 2012; **Melenhorst et al., 2015**; Ustalov, 2015	5
Researchers	Yakushin and Lee, 2014	1
Employees	Lauto and Valentin, 2016; **T. Y. Lee et al., 2013**; **Machnik et al., 2015**; **Pothineni et al., 2014**; **Snijders et al., 2015**	5
The elderly	Nagai et al., 2014	1
Citizens	Dos Santos et al., 2015; **Goncalves et al., 2014**	2
References in bold refer to studies in which empirical results about gamification have been reported.		

Table 8. Crowdsourcees

3.2.5 Psychological and Behavioral Outcomes

Finally, we examined the psychological and behavioral outcomes described in the empirical papers and associated with the use of gamification features. The psychological outcomes were not commonly measured using comprehensive measurement instruments; they were mostly examined via simple questionnaires or qualitative observations, or the observations of how participants behaved was used as a proxy for psychological aspects. Currently, only four studies used validated psychometric measurement instruments (Kobayashi et al., 2015; Melenhorst et al., 2015; Prestopnik and Tang, 2015; Runge et al., 2015). Table 9 provides an overview of the literature in which results about psychological outcomes were reported.

Psychological outcome	Literature	#
Motivation	**Altmeyer et al., 2016**; **Bowser et al., 2013**; **Eickhoff et al., 2012**; **Itoko et al., 2014**; **Kawajiri et al., 2014**; **Kobayashi et al., 2015**; **Liu et al., 2011a, 2011b**; **Machnik et al., 2015**; **Massung et al., 2013**; **Nose and Hishiyama, 2013**; **Preist et al., 2014; Prestopnik and Tang, 2015**; **Roengsamut et al., 2015**; **Runge et al., 2015**; **Tinati et al., 2016**	15
Attitudes	**Bowser et al., 2013**; **Dergousoff and Mandryk, 2015**; **Itoko et al., 2014**; **Kobayashi et al., 2015**; **Martella et al., 2015**; **Preist et al., 2014**; **Prestopnik and Tang, 2015**; **Roengsamut et al., 2015**; **Runge et al., 2015**; **Tinati et al., 2016**	10
Fun/Enjoyment	**Altmeyer et al., 2016**; **Bowser et al., 2013**; **Choi et al., 2014**; **Dumitrache et al., 2013**; **Kobayashi et al., 2015**; **J. J. Lee et al., 2013**; **Melenhorst et al., 2015; Prandi et al., 2016**; **Prestopnik and Tang, 2015**; **Roengsamut et al., 2015**; **Runge et al., 2015;** Sheng, 2013; **Tinati et al., 2016**	13
Engagement	**Altmeyer et al., 2016**; **Bowser et al., 2013; Liu et al., 2011a, 2011b; Snijders et al., 2015**	4
Other (e.g. appeal, interest, immersion)	Cucari et al., 2016; **Kobayashi et al., 2015**; **Melenhorst et al., 2015; Prestopnik and Tang, 2015**;	4
References in bold refer to studies in which empirical results about gamification have been reported.		

Table 9. Psychological Outcomes Reported in the Literature

In most studies, the behavioral outcomes of gamification are related to the participation of crowdsourcees in a specific task (Figure 5). Several studies that directly compared a gamified and non-gamified approach (Table 10) report positive outcomes, such as increases in (long-term) participation (e.g. Eickhoff et al., 2012; Kawajiri et al., 2014; T. Y. Lee et al., 2013), output quality (Eickhoff et al., 2012; Goncalves et al., 2014; T. Y. Lee et al., 2013), and reduction in cheating compared to traditional paid crowdsourcing (Eickhoff et al., 2012). However, gamification does not necessarily lead to an increase in participation. Massung et al. (2013) measured very small differences compared to a control group without gamification, while Packham and Suleman (2015) found that simple gamification approaches (points and leaderboards) cannot replace financial incentives in crowdprocessing. Overall, three studies reported more negative effects than positive (Table 10). In addition to the above studies that employed direct comparisons, 10 studies reported positive results based on users' perceptions of the gamified crowdsourcing system (Bowser et al., 2013; Dumitrache et al., 2013; J. J. Lee et al., 2013; Saito et al., 2014) or based on the measured user engagement (Pothineni et al., 2014). These – mostly descriptively reported – results showed no effects of gamification per se, but can be seen as positive indicators for the acceptance of gamification in the context of crowdsourcing (Table 10).

Some studies even compared different gamification designs and provided first empirical results for designing gamified crowdsourcing approaches in order to achieve positive psychological and behavioral outcomes (Table 10). For instance, Choi et al. (2014) showed in an experiment that explicitly expressed gamification rewards before the task phase can increase the quality of crowdsourcing work and crowdsourcees' engagement levels. The empirical findings of T. Y. Lee et al. (2013) indicate that social achievements seem to be a bit more effective than individual ones (see also Feyisetan et al., 2015; Runge et al., 2015). The authors examine this by comparing the effects of public participation rankings that encourage workers to compare their efforts with others and level systems that motivate via the visualization of individual achievements. Ipeirotis and Gabrilovich (2014) showed that the concrete design of a leaderboard or ranking can have significant effects on the participation. Based on their findings, the authors recommend to use 'all-time' leaderboards prudently, since they may demotivate low-ranked participants and newcomers. Massung et al. (2013) and Preist et al. (2014) showed demotivating effects of leaderboards and possible negative effects on the overall outcome; they propose a set of design principles for designers of gamified crowdsourcing systems and suggest mixing several gamification features for different target groups to increase the overall outcome. However, T. Y. Lee et al. (2013) and Dumitrache et al. (2013) indicate that adding more gamification features does not always increase motivation and that to date we have too little knowledge to be able to explain effectiveness of gamification features for a specific user group (Itoko et al., 2014). Prestopnik and Tang (2015) highlighted the effects of storytelling in gamified crowdsourcing. By comparing two gamified crowdprocessing approaches, the researchers identified that storytelling can transform perceptions of a crowdsourcing task from work-related to play-related.

Results	Compared a gamified approach with a non-gamified one	No comparison (interviews, user feedback, perceptions, time series analysis, influence of context factors)	Comparisons between different gamification designs	#
Quantitative -*inferential*	**Eickhoff et al., 2012**; **Nose and Hishiyama, 2013**; **Dergousoff and Mandryk, 2015**	**Melenhorst et al., 2015**	**Choi et al., 2014**; **Ipeirotis and Gabrilovich, 2014**; **T. Y. Lee et al., 2013**; **Runge et al., 2015**	8
Quantitative -*descriptive*	**Carlier et al., 2016***; **De Franga et al., 2015**; **Dumitrache et al., 2013***; **Kobayashi et al., 2015**; **Liu et al., 2011a, 2011b**; **Simões and De Amicis, 2016**; **Sørensen et al., 2016**; **Talasila et al., 2016**	**Pothineni et al., 2014; Roengsamut et al., 2015**	**Feyisetan et al., 2015; Packham and Suleman, 2015***	12
Qualitative	**Kacorri et al., 2015; Martella et al., 2015**	**Machnik et al., 2015; Saito et al., 2014; Tinati et al., 2016**	**Preist et al., 2014; Prestopnik and Tang, 2015**	7
Mixed -*inferential*	**Altmeyer et al., 2016; Vasilescu et al., 2014**	**Bowser et al., 2013; Itoko et al., 2014**	**Kawajiri et al., 2014**; **Massung et al., 2013**; **Prandi et al., 2016**	7
Mixed -*descriptive*	**Goncalves et al., 2014**	**J. J. Lee et al., 2013**; **Snijders et al., 2015**		3
Total	**More positive (14) / negative (2)**	**More positive (10)**	**More positive (10) / negative (1)**	**37**
* Studies that reported negative effects of gamification, for instance compared to paid crowdsourcing or non-gamified approaches				

Table 10. Results on Gamified Crowdsourcing

Outcomes	Literature	#
Positive effects on the quantitative contribution / willingness to contribute	**Altmeyer et al., 2016; Bowser et al., 2013; De Franga et al., 2015; Dergousoff and Mandryk, 2015; Eickhoff et al., 2012; Feyisetan et al., 2015; Ipeirotis and Gabrilovich, 2014; Itoko et al., 2014; Kawajiri et al., 2014; Kobayashi et al., 2015; J. J. Lee et al., 2013; T. Y. Lee et al., 2013; Liu et al., 2011a, 2011b; Martella et al., 2015; Massung et al., 2013; Nose and Hishiyama, 2013; Pothineni et al., 2014; Prandi et al., 2016; Preist et al., 2014; Prestopnik and Tang, 2015; Roengsamut et al., 2015; Simões and De Amicis, 2016; Snijders et al., 2015; Talasila et al., 2016; Tinati et al., 2016; Vasilescu et al., 2014**	26
Positive effects on the qualitative contribution	**Dergousoff and Mandryk, 2015; Eickhoff et al., 2012; Feyisetan et al., 2015; Goncalves et al., 2014; Ipeirotis and Gabrilovich, 2014; Kawajiri et al., 2014; Kobayashi et al., 2015; T. Y. Lee et al., 2013; Massung et al., 2013; Prestopnik and Tang, 2015; Runge et al., 2015; Simões and De Amicis, 2016; Sørensen et al., 2016**	13
Positive effects on continued work / long-term engagement	**Itoko et al., 2014; Kawajiri et al., 2014; Kobayashi et al., 2015; T. Y. Lee et al., 2013; Massung et al., 2013; Prestopnik and Tang, 2015**	6

Table 11. Positive Effects of Gamification in Crowdsourcing Reported in the Literature

Taken together, these three categories of empirical studies on the effectiveness of gamification in crowdsourcing, more than 90% of the analyzed studies reported positive or predominantly positive outcomes of gamification in crowdsourcing (Table 10). Most cases reported positive effects on quantitative contributions (Table 11). However, qualitative and long-term effects could also be achieved, which strongly depends on the context and concrete implementation of gamification features.

3.3 Discussion

In this study, we have provided a comprehensive review and overview of the use of gamification in crowdsourcing in the current body of literature. Following an integrated conceptual framework (Figure 5), we analyzed characteristic features of gamified crowdsourcing systems. Especially, we reviewed the use of different forms of gamification in different types of crowdsourcing (crowdprocessing, crowdsolving, crowdrating, and crowdcreating), as well as the interplay between gamification and additional monetary rewards, the types of work that have been crowdsourced, the types of crowdsourcees, and the domains in which gamification in crowdsourcing has been applied. Furthermore, we investigated the results of empirical studies on the psychological and behavioral outcomes of gamification in crowdsourcing systems. This meticulous mapping enabled us to identify limitations, emerging issues, and future research directions.

3.3.1 Limitations, Emerging Issues, and Future Research Directions

Our results provided a structured overview that helps to identify current issues and gaps for future research. We addressed this by providing a research agenda that covers methodological, theoretical, and thematic directions for future research, as well as by pinpointing empirical and design research gaps.

Methodological Agenda

Although 37 of the reviewed studies contained empirical findings on the effects of gamification in crowdsourcing and our analyses show that while gamification is a viable and beneficial approach for motivating crowdsourcees, our understanding of how different gamification features affect motivational and behavioral outcomes in crowdsourcing is still in its infancy. A common methodological issue in the current body of literature is that very few studies have used properly validated psychometric measurement instruments when gauging changes in crowdsourcees' motivations. Due to this methodological shortcoming, the individual effects of gamification features on psychological and behavioral outcomes are comparable only on an abstract level. Moreover, many empirical studies reported only descriptive statistics (Table 10), while several studies did not isolate and measure separately the effects of different gamification mechanics. Consequently, current research provides scattered, particular insights regarding the complex interaction of all factors that affect crowdsourcees' motivations in gamified crowdsourcing systems. Thus, we call for careful and systematic empirical mapping of the effects of gamification features, psychological outcomes, and behavioral outcomes, as well as the differences between various gamification designs.

Agenda point 1: *Further studies should isolate gamification effects by using isolated experiment groups for different gamification features, to survey psychological outcomes with validated measurements, and to apply statistical methods that go beyond the description of data.*

Most of the reviewed empirical literature only examined the effects of gamification in crowdsourcing in a short timeframe (< 4 weeks). Likewise, many empirical findings relied on a small sample size (N < 40). The reasons might lie in the novelty of the phenomenon and the fact that many studies investigated the effectiveness of prototypes or concepts (e.g. Nagai et al., 2014; Preist et al., 2014; Massung et al., 2013; Saito et al., 2014). Very few researchers applied experimental designs that were able to control the influences of novelty effects (e.g. Kawajiri et al., 2014), which are deemed a characteristic of many gamification approaches (Koivisto and Hamari 2014). While small studies can provide quick insights into the phenomenon, additional large longitudinal studies are needed to ensure the reliability and generalizability of the results. Furthermore, long-term studies could identify and control for the influences of novelty or saturation effects (cf. T. Y. Lee et al., 2013), which have seen little attention in the current literature.

Agenda point 2: *Future research should include larger sample sizes and should conduct longitudinal studies to provide rigorous and generalizable results that extend the current literature.*

Most of the reviewed literature with empirical results reported quantitative results (Table 10). Since gamification is deeply rooted in psychology, we need qualitative research that goes beyond the measurement of simple perceptions if we are to understand mechanisms and triggers that evoke engagement and motivation in gamified crowdsourcing (e.g. Massung et al., 2013; Preist et al., 2014; Prestopnik and Tang, 2015). Qualitative findings may also be able to inform quantitative research into the antecedents of participation intentions. However, currently, most of the interview-based studies were very superficial and provide few deep insights into the manifold ways in which crowdsourcees perceive gamification and its effects on their work. Furthermore, most existing qualitative studies provide mainly findings from people who participated in gamified crowdsourcing and therefore have positive feelings towards the overall topic. However, knowledge of the reasons why people stop participating in gamified crowdsourcing and the perceptions of users who are critical towards participating could help one to design more successful gamified crowdsourcing systems. As the current literature has mainly reported positive results, some publication bias may loom in the body of literature.

Agenda point 3: *Future qualitative research in gamified crowdsourcing should seek to capture all different facets of the phenomenon. Qualitative research should provide in-depth results that cover not only the positive perceptions, but also the reasons why people stop participating.*

Our review identified only very few studies considering the influence of user characteristics (Eickhoff et al., 2012; Itoko et al., 2014). However, previous research suggests that the perceptions towards and effectiveness of a gamification approach strongly depends on users, their characteristics, and their individual goals (Hamari, 2013; Kobayashi et al., 2015; Koivisto and Hamari, 2014). The impacts of personal characteristics and player types (Hamari and Tuunanen, 2014) as moderators of psychological and behavioral effects as well as the differences between various types of crowdsourcees (e.g. students, employees, or citizens) (Table 8) require further scrutiny. In this context, differences between the so-called *power contributors* and *free-riders* could also provide new insights into the design of effective gamified crowdsourcing systems for different target groups (T. Y. Lee et al., 2013; Levina and Arriaga, 2014; Zhao and Zhu, 2014a).

Agenda point 4: *Future research should systematically investigate differences between different types of crowdsourcees, and should consider including the potential influences of user characteristics as a moderator in research models on the effectiveness of gamified crowdsourcing.*

Theoretical Agenda

Most of the reviewed studies with empirical results on gamification in crowdsourcing focused on the effectiveness of gamification. Most of these studies lacked theory to ground the research, were rudimentary, or were disconnected from the applied work. By paying attention to these theoretical limitations, future research could provide valuable contributions to better understand and explain gamification in crowdsourcing. We recommend borrowing theoretical perspectives (Whetten, 1989) from psychology, philosophy, or marketing to serve as a basis for study design and to explain psychological effects and behavioral outcomes. Especially, we recommend drawing on Csíkszentmihályi's (1990) theory of flow and self-determination theory (Ryan and Deci, 2000), when investigating the motivational effects of gamification features. These two theoretical perspectives are frequently used to investigate motivational effects in crowdsourcing (Zhao and Zhu, 2014b; Zheng et al., 2011) and gamification (Hamari et al., 2016b; Hamari and Koivisto, 2014), since they provide insights into inducing and achieving intrinsic motivation. Considering gamification features as motivational affordances (Huotari and Hamari, 2017) that are designed to stimulate motivational needs, goals achievement, and help people to achieve their personal goals, goal-setting theory and the affordance concept provide essential foundations (cf. Huotari and Hamari, 2017; Jung et al., 2010). Finally, to understand the effects of gamification and gamification rewards on attitudes and behavioral outcomes, we recommend that researchers draw on the theory of planned behavior (Ajzen, 1991) and self-efficacy theory (Bandura, 1977), which are often applied in general gamification research (Hamari and Koivisto, 2015a, 2015b).

Agenda point 5: *Future research should increasingly employ theory from (motivational) psychology to justify research activities, operationalize research, and interpret results.*

Thematic Agenda

Previous research on the motivation of crowdsourcees has primarily analyzed motivations in non-gamified crowdsourcing platforms with financial incentives. Commonly, the findings have indicated that users are driven by a mixture of intrinsic motivation and monetary rewards (Brabham, 2010, 2008b; Kaufmann et al., 2011; Leimeister et al., 2009; Zhao and Zhu, 2014a; Zheng et al., 2011). Our overview demonstrated that 68% of the analyzed gamified crowdsourcing cases used only gamification to incentivize crowdworkers (Table 7). This indicated that gamification could not only be used in addition to financial rewards to increase positive experiences (e.g. engagement or enjoyment); rather, it provides a cost-effective opportunity to entirely replace financial incentives. Some studies demonstrated the complex interplays between financial and gamified incentive structures (Massung et al., 2013; Preist et al., 2014). To date, it is unclear for which crowdsourcing system type, crowdsourcee type, and task type the use of gamification is more beneficial compared to financial incentives, or when the combination of the two is the best approach. Future research should compare different incentive mechanisms (see Straub et al., 2015; Harris et al., 2015) and should consider contextual factors and user characteristics. Furthermore, the economic value of gamification also requires further research. Future research could examine the development costs in relation to the effects of gamification, to evaluate the value and to provide insights into gamification-based business models.

Agenda point 6: *Research into gamified crowdsourcing should explore optimal incentive orchestrations for different crowdsourcing contexts and should provide insights into the overall cost efficiency of gamified crowdsourcing.*

The findings summarized in Table 6 demonstrate that cooperative approaches, such as gamified crowdcreating systems, are currently receiving less attention from scholars compared to the other system types. This is surprising, since several popular crowdcreating examples, such as Google Ingress, Dell's Ideastorm, or Threadless (Kavaliova et al., 2016) have implemented various gamification approaches. Further, notably, all reviewed empirical studies that have measured the effects of gamification on participation have analyzed the effects on the intention of an individual to participate, but have neglected that crowdsourcees can form groups with collective intentions (Tsai and Bagozzi, 2014). Studies have shown that collective intentions play a key role in cooperative crowdsourcing (Shen et al., 2009; Shen et al., 2014). Finally, we identified that social factors, which have been identified as an essential aspect of gamification (Hamari and Koivisto, 2015b) and could gauge cooperation (such as trust, reciprocity, and sense of community), have been neglected in the literature.

Future research that continues ideas from previous studies about virtual teams (Jarvenpaa and Leidner, 1998; Powell et al., 2004), collective intentions in virtual communities (Tsai and Bagozzi, 2014), cooperative games design (El-Nasr et al., 2010; Liu et al., 2013), and social factors of gamification (Hamari and Koivisto, 2015a) could provide new insights into the effects of gamification on collective intentions, relationships between crowdworkers, social identities, or collaborative behavior. Future research could utilize established social psychological theories that have evaluated the effects of competition, cooperation, and the combination of the two on enjoyment or performance as a basis for examining the motivational effects of different goal structures in gamification approaches (Tauer and Harackiewicz, 2004). In this context, the use of cooperative gamification approaches such as virtual teams, cooperative missions, or shared goals that empower the formation of groups and collective intentions could be analyzed to expand the mainly competition-focused gamification conceptions and that help to design effective gamified crowdsourcing communities.

Agenda point 7: *Future research should seek to investigate the design and effects of cooperative gamification and consider social factors in crowd communities.*

Crowdsourcing as a problem-solving concept is a multifaceted phenomenon and can be applied in various contexts. Marginal differences can be found in the reviewed studies regarding the domain in which the systems are applied (Table 3), the crowd characteristics (Table 4, Table 8), and the media (e.g. mobile apps (Bowser et al., 2013; Uzun et al., 2013), website (Choi et al., 2014; T. Y. Lee et al., 2013; Liu et al., 2011a, 2011b), or local installations (Goncalves et al., 2014)). Future research is needed to understand how contextual factors affect gamified crowdsourcing systems. Optimally, studies could apply one gamified crowdsourcing system in a variety of contexts. Since this would be a rather sizeable undertaking, we might have to wait for the accumulating literature to cover more ground.

Agenda point 8: *Research is needed to understand how contextual factors, such as the domain, the media, and crowd characteristics affect gamified crowdsourcing systems.*

Our overview indicated that gamification implementations differ in the context of crowdsolving, crowdrating, and crowdprocessing approaches (Table 5). Finally, we identified different recommendations for designers of gamified crowdsourcing systems. Further work is needed to evaluate and extend these recommendations and to study the potentials of different design approaches. Especially manifold designs with for instance avatars, storytelling, or virtual teams provide opportunities for future research.

Furthermore, advanced gamification approaches that automatically consider user characteristics and context characteristics should be examined. Building on the results of Itoko et al. (2014) and Koivisto and Hamari (2014), individual adaptive incentive orchestrations might increase effectiveness, acceptance, and long-term motivations. Such adaptive gamification design that goes beyond the current rewards mechanisms used in gamification could utilize recent developments of individualization in crowdsourcing (Geiger and Schader, 2014) and games design (Prakash et al., 2009). Finally, recent technology trends such as virtual realities (Prandi et al., 2016), connected everything, artificial intelligence, and sharing economies are influencing current developments in game design and crowdsourcing. These trends also provide new spaces for gamified crowdsourcing systems that should be studied.

Agenda point 9: *Future research should expand the design space used in current gamified crowdsourcing systems and should consider novel trends in games design and crowdsourcing.*

Future Research
In this review of applied research and theoretical papers, we were particularly interested in the use of gamification in crowdsourcing systems. However, it is possible that related research has been conducted, also under other conceptual developments such as serious games, games-with-a-purpose, pervasive games, human-based computation, or persuasive technology. Some of these related research areas might be investigating similar phenomena, but were not included in this study. Therefore, future efforts could compare these approaches and their contributions to gamified crowdsourcing. Relatedly, we conducted the literature searches intentionally with a set of keywords to find particularly studies on gamification and crowdsourcing. In our view, our selection of search keywords and data sources was successful for the review’s intended breadth. The choice of a systematic literature study is the reason for some of these limitations (Boell and Cecez-Kecmanovic, 2015). However, in our view, the benefits of a structured summary and a clear aggregation of previous findings outweighed the disadvantages in our case. Future efforts could go beyond these limitations and could extend our findings.

3.4 Conclusions

Along with the emergence of the interwoven phenomena of gamification and crowdsourcing, gamified crowdsourcing systems have drawn scientific attention and have led to a continuously rising number of research publications. In this review, we sought to provide a structured overview that compared the different characteristics of gamified crowdsourcing systems, examined the results on the effectiveness of gamification in crowdsourcing, and highlighted starting points for future research. We found a wide array of different gamification implementations in different types of crowdsourcing in the literature.

However, the literature seems to be unanimous; gamification does seem to work with a majority of configurations and can positively affect the motivations of crowdsourcees, their participation, and output quality. Depending on the type of crowdsourcing (crowdcreating, crowdsolving, crowdprocessing, and crowdrating), we identified patterns in the use of gamification features. In the context of crowdsourcing initiatives that provide homogenous and often more monotonous tasks such as crowdprocessing and crowdrating, authors commonly report the use of simple forms of gamification such as points and leaderboards (Table 5). Conversely, crowdsourcing studies with crowdcreating and crowdsolving work that seek diverse and creative contributions employ gamification in more manifold ways with a richer set of mechanics. Generally, gamification is used to promote a kind of competition between the participants rather than a cooperative experience. Monetary rewards could be used as an addition in gamified crowdsourcing systems, but most of the analyzed cases did not apply supplementary financial incentives. However, at this early stage, the literature is still fairly fragmented, and too little research has been conducted to draw clear conclusions on which specific implementations would work better or worse in certain situations. It is clear that contextual factors and factors related to crowdsourcees play a role, but to what extents and how are still unclear. These and further aspects that would help us to understand and design successful gamified crowdsourcing systems provide much room for future research.

4 Examining and Designing the Gamification of Crowdsourcing

The review of literature on the use of gamification in crowdsourcing systems confirms the abovementioned research gaps. In particular, the review showed that further rigorous empirical research is needed, which isolates and compares the effects of different gamification features in crowdsourcing systems (research agenda point 1). Further, the review revealed that the gamification of cooperative crowdcreating approaches has been studied little and we lack a comprehensive understanding of how gamification features can motivate crowdsourcees to participate in cooperative efforts (research agenda point 7).

Thus, in the following sections, this dissertation presents three studies to address these shortcomings. The first study examines how games and their design features induce and cultivate collective intentions toward cooperation. The second study investigates the design of cooperative gamification features for increasing motivation and participation in crowdsourcing. The third study compares the effects of applying competitive, cooperative and cooperative-competitive gamification features on motivation and behavior of crowdsourcees in crowdsourcing systems.

4.1 Study I: Examining Cooperation in Games[3]

4.1.1 INTRODUCTION

Concerning video games, it can be observed that, in many games, cooperation emerges effortlessly; people start to pool individual efforts, cooperate seamlessly even against the most unimaginable odds, and express strong enthusiasm while acting together (Chen et al., 2008; Cole and Griffiths, 2007; Ducheneaut et al., 2006; Scharkow et al., 2015; Teng and Chen, 2014; Yee, 2006). Thus, today, practitioners turn to games for inspiration on how to design information systems, services, and organizational structures more cooperatively (Bui et al., 2015; Ribeiro et al., 2014; Schacht and Maedche, 2015; Thom et al., 2012). This trend can be understood as part of the *gamification* movement, which represents the use of game elements and mechanics outside traditional video game environments (Hamari et al., 2014; Huotari and Hamari, 2017). Initial empirical studies indicate that applying game mechanics and features of cooperative games, such as point systems that reward cooperation (Blohm et al., 2011; Chen and Pu, 2014; Siu et al., 2014; Thom et al., 2012), team competitions (Chen and Pu, 2014; Peng and Hsieh, 2012), or virtual worlds with avatars (Rico et al., 2011) can positively influence cooperation in various contexts. However, we still lack a comprehensive understanding of how games

[3] This section is based on Morschheuser et al. (2017c)

cultivate cooperation (Hamari and Keronen, 2017a; Liu et al., 2013), which keeps us from successful wielding the potential of cooperative games in gamification (Bui et al., 2015; Liu et al., 2017).

Recently, the concept of *we-intentions* has gained attention in information system research concerning understanding cooperation with collaborative technologies. Compared to typically studied individual intentions, the concept of we-intention relies on the idea that true cooperation requires collective intentions and therefore cannot be analyzed only as the sum of individual intentions (Searle, 1990; Tuomela, 2000). The concept is increasingly gaining attention in information system research, in order to study cooperation and cooperative behaviors in online communities (Bagozzi and Dholakia, 2002; Cheung and Lee, 2010; Dholakia et al., 2004; Shen et al., 2013, 2011; Tsai and Bagozzi, 2014) and crowdsourcing systems (Bagozzi and Dholakia, 2006; Shen et al., 2009, 2014). Owing to the strong similarities between such virtual communities and online games, this theoretical framework provides excellent support for investigating cooperation in games.

Therefore, in this study, we empirically investigate how games cultivate we-intentions of working as a group by drawing on cooperation theory (Tuomela, 2000) and particularly the concept of we-intentions (Bagozzi and Dholakia, 2002; Tsai and Bagozzi, 2014; Tuomela, 2000). On the basis of survey data, gathered in the context of the augmented reality game Ingress that engages people in generating an interactive map with cultural points of interest, we seek to enhance current understandings of how engagement with cooperative game features induce we-intentions via *group dynamics*, such as group norms, positive and negative anticipated emotions, social identity, joint commitment, and attitudes toward cooperation. Further, we investigate whether engagement with individualistic game features – such as private badges, points or levels – that are currently often used in the context of collaborative technologies (Hamari et al., 2014; Morschheuser et al., 2016) influence these effects.

4.1.2 Theoretical Background and Research Model

We-Intentions and their Antecedents

Researchers have put much effort into theoretically conceptualizing and studying the phenomenon of *cooperation* from different perspectives, including philosophy (Gilbert, 1989; Tuomela, 2000), game theory (Nash, 1953), and social psychology (Johnson, 2003). Commonly, pure or *full-blown* cooperation is typically considered to consist of collective social actions, in which more than one person act jointly toward a common goal (e.g. carrying a table jointly) (Gilbert 1989; Tuomela 2000).

According to Tuomela (2011, 2000), such cooperation is characterized and determined by a collective *we-intention* of group members towards a shared goal. Thus, recently, studies have commonly drawn on the concept of *we-intention* (Searle, 1990; Tuomela, 2011, 2000) to operationalize cooperation in groups. In contrast to typically investigated personal intentions, which capture individual commitment to an action, we-intentions involve a 'we-perspective', expressing a collective commitment to participate in a cooperative action (Bratman, 1997; Searle, 1990; Tuomela, 2011, 2000). Therefore, we-intentions are explicitly formulated with reference to a collective entity of *we* or *us*, which expresses the intention to jointly perform an activity together with others: “We intend to do X jointly” (Bratman, 1997; Searle, 1990; Tuomela, 2011, 2000).

Since the inception of these conceptualizations, the *we-intentions* operationalization has been applied in the study of cooperation in several technology-mediated contexts, such as wikis, crowdsourcing platforms, instant messaging services, and other social communities (Bagozzi and Dholakia, 2006, 2002; Shen et al., 2014; Tsai and Bagozzi, 2014). These studies have shown that we-intention is a strong proximal determinant of cooperation and provides a more comprehensive explanation of user participation in group efforts than traditionally investigated personal intentions.

Although the adoption and use of collaborative technologies have been frequently investigated in information system research (Lin and Bhattacherjee, 2008; Lin and Lu, 2011; Majchrzak et al., 2000), studies have mostly investigated individual intentions (*i-intentions*). The we-intention concept has been largely overlooked by the repetitive application of theories such as the technology acceptance model (Davis, 1989), the theory of reasoned action (Fishbein and Ajzen, 1975), and the theory of planned behavior (Ajzen, 1991), all of which solely investigate intentions from an individual perspective. However, it is obvious that participation and cooperation in online communities and other collaborative technologies are commonly a group activity. Typically, users adopt and use such technologies for a common reason or to achieve a shared goal. Thus, cooperation in such collaborative technologies is increasingly investigated through the concept of we-intention in recent information system research (Oliveira and Huertas, 2015; Shen et al., 2013; Tsai and Bagozzi, 2014). Guided by Bagozzi and Dholakia (Bagozzi and Dholakia, 2006, 2002; Dholakia et al., 2004; Tsai and Bagozzi, 2014), a variety of efforts have been made to empirically investigate the cooperation of users in social communities, crowdsourcing approaches, or instant messaging services (Table 12). A synthesis of extant research indicates that individual factors, such as attitudes (Tsai and Bagozzi, 2014) and anticipated emotions (Bagozzi and Dholakia, 2002; Tsai and Bagozzi, 2014) as well as social antecedents, such as joint commitment (Shen et al., 2009, 2014; Tuomela, 2000), social identity (Bagozzi and Dholakia, 2002; Tsai and Bagozzi, 2014), and group norms (Bagozzi and Dholakia, 2002; Oliveira and Huertas, 2015; Tsai and Bagozzi, 2014) influence we-intentions to work together with collaborative technologies.

More importantly, it has remained unclear which features in these technologies are responsible for invoking we-intentions and how specific features can, in the end, engage more cooperation. Moreover, the particular context of cooperation in games and gamified approaches has been largely ignored in prior we-intention research.

Work	Context	Significant antecedents of we-intention
De Oliveira and Huertas, 2015	Participation in the social network Facebook	Group norms, social identity, subjective norms, social enhancement, maintaining interpersonal interconnectivity
Tsai and Bagozzi, 2014	Participation in a Chinese social network	Group norms, subjective norms, social identity, anticipated emotions, attitudes toward contributing, desire
Shen et al., 2014	Crowdsourcing participation in wikis	Commitment to the community, team trust
Shen et al., 2013	Collaboration via instant messaging	Group norms, social identity, perceived critical mass
Cheung et al., 2011	Participation in the social network Facebook	Group norms, social enhancement, entertainment value, maintaining interpersonal interconnectivity, social presence
Shen et al., 2011	Collaboration via instant messaging	Group norms, social identity, desire
Cheung and Lee, 2010	Participation in the social network Facebook	Social identity, subjective norms
Shen et al., 2009	Crowdsourcing participation in wikis	Joint commitment, mutual agreement, personal outcome expectations, community-related outcome expectations
Bagozzi and Dholakia, 2006	Participation in Linux user groups	Social identity, attitudes toward contributing, negative anticipated emotions, perceived behavioral control
Dholakia et al., 2004	Participation in virtual communities	Group norms, social identity, mutual agreement, desire
Bagozzi and Dholakia, 2002	Participation (chatting) in different virtual communities	Social identity, positive anticipated emotions, desire

Table 12. We-intention and its Antecedents in Collaborative Technologies

Cooperation and Games

Games are a pinnacle form of hedonic systems that invoke rich motivational experiences and excite masses of people (Hamari, 2015a; Ryan et al., 2006; Vesa et al., 2017; Yee, 2006). Since the first video games, researchers were fascinated by the psychological and behavioral outcomes of games and made efforts to understand the design characteristics, which are responsible for the rich motivational experiences and the different behavioral effects of games (Choi and Kim, 2004; Hamari and Keronen, 2017a; Hamari and Tuunanen, 2014; Malone, 1981; Ryan et al., 2006; Yee, 2006). One particular behavior that can be observed in many games is cooperation. Especially in the context of *online games* that utilize the internet to bring people together, cooperation seems to effortlessly spring up between people who might not even have had previous connections (Cole and Griffiths, 2007; Velez and Ewoldsen, 2013; Yee, 2006).

Several studies have revealed that popular *online games*, such as World of Warcraft, Star Wars Galaxies, or Ultima Online attract masses of people by providing them with rich social experiences while playing together (Przybylski et al., 2010; Rigby and Ryan, 2011; Yee, 2006; Zhong, 2011). Research has showed that players greatly enjoy the social interaction and cooperation in such games games (Przybylski et al., 2010; Velez and Ewoldsen, 2013; Yee, 2006). In all these games, people help each other voluntarily to accomplish common missions and goals, strongly interact with one another to discuss in-game strategies and opportunities, share comprehensive knowledge about game contents in forums and wikis, and form groups (known as guilds, clans or factions) that persist over time. Further, several empirical studies in the context of video games and gamified systems highlight the positive effects of cooperation in games compared to competition. For instance, Y. Chen and Pu (2014), Marker and Staiano (2015), Peng and Hsieh (2012), and Plass et al. (2013) found that cooperative approaches can lead to higher engagement with games or gamified systems compared to competitive approaches. Positive effects on goal commitment (Peng and Hsieh, 2012), motivation (Marker and Staiano, 2015), and intentions to recommend a game (Plass et al., 2013) have also been found to be effects of games that are designed to support cooperation. However, little research has analyzed the design features and dynamics in games and gamified systems that enable and promote cooperation (Bui et al., 2015; Liu et al., 2013; Morschheuser et al., 2017b).

Drawing on social interdependence theory (Johnson, 2003), games (Liu et al., 2013) and their game features have been classified as *cooperative*, *competitive*, or *individualistic* based on the applied goal structures. Individualistic game features refer thereby to game features such as private badges or levels that provide gameful experiences based on individual goals, without invoking interdependencies to goals of other players. In contrast, cooperative game features provide gameful experiences by using *cooperative goal structures* such as shared goals for a group of players. Similar to this deductive approach, several empirical studies have highlighted the roles of shared goals and have provided further details on key characteristics of cooperative games. By investigating popular online and video games, Rocha et al. (2008) observed that *shared goals* and *specific game mechanics* can be found in games in which players cooperate. They report that games invoke shared goals for a group of players or positive correlations between individual goals, in order to provide clear reasons for playing together (El-Nasr et al., 2010; Rocha et al., 2008). Examples include the implementation of a team challenge or a shared puzzle (El-Nasr et al., 2010; Liu et al., 2013; Morschheuser et al., 2017b; Plass et al., 2013). Furthermore, the application of game mechanics that equip players with different abilities and action possibilities have been found to be typical design patterns of cooperative games. Examples include the implementation of complementary abilities (e.g. characters with different skills), abilities that can only be used on other players, limited resources, or special rules that support all players of a team (El-Nasr et al., 2010; Rocha et al., 2008). Finally, communication features that can be used to discuss common goals and strategies have been highlighted as important aspects of cooperative games (Beznosyk et al., 2012; Ducheneaut et al., 2006; Velez and Ewoldsen, 2013). Similar patterns were identified by Zagal et al. (2006), who have explored cooperative design patterns in board games.

Based to the synthesis of this research, and inspired by Choi and Kim (2004), who have investigated design features of online games, three key design features of cooperative games can be summarized: 1) cooperative games apply goal structures that give one reasons to cooperate, 2) cooperative games provide special rules and mechanics that enable and support cooperative behavior, and 3) cooperative games provide communication features to allow social interaction (Beznosyk et al., 2012; Choi and Kim, 2004; Ducheneaut et al., 2006; Velez and Ewoldsen, 2013). In the following, we build on these categories to specify what we consider as *cooperative game features* (Figure 8).

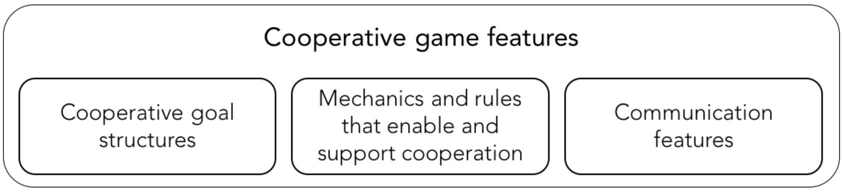


Figure 8. Key Design Features of Cooperative Games

Several studies on cooperative video games and gamified systems support the assumption that there is a correlation between the engagement with such *cooperative game features* and *cooperation* in games. Based on observations of player behaviors, El-Nasr et al. (2010) identified that shared goals and several game mechanics that enable and support cooperation, especially complementary abilities, influence enjoyment, excitement, and cooperative behaviors in popular cooperative video games. Further, research that investigated cooperative games and their game features' effects, indicates that applying design features of cooperative games (e.g. shared goals) can induce cooperative behaviors (Chen and Pu, 2014; Goh and Lee, 2011; Hsu and Lu, 2004; Plass et al., 2013) and can positively influence social interaction (Hamari and Koivisto, 2015a; Scheiner, 2015). Inspired by these findings, we seek to better understand this possible correlation between cooperative game features and cooperation by investigating how *engagement* (cf. use and interest) *with cooperative game features* induce *we-intentions*.

Since cooperative games address similar social needs as other online communities (Rigby, 2015; Scharkow et al., 2015; Tsai and Pai, 2014; Yee, 2006), we expect that the dynamics invoked by cooperative game features are comparable to the socio-psychological processes identified in previous research on we-intention in virtual communities. Therefore, we focus our research on typical antecedents of we-intentions in virtual communities (Table 12) and empirically investigate whether and how game design features induce we-intentions to play with others in a group. Figure 9 summarizes our proposed model. The underlying hypotheses are explained in the following.

The Roles of Shared Goals

Since the beginning of video game research, challenging goals have been highlighted as a core feature of games (Malone, 1981). By setting challenging goals and providing instant positive feedback concerning goal achievement (Deterding, 2015; Malone, 1982, 1981), games provide motivational affordances for the experience of competence satisfaction, mastery, or achievement (Huotari and Hamari, 2017). According to the goal-setting theory (Locke and Latham, 1990), the setting of challenging goals such as those applied in games and gamification approaches (Bui et al., 2015; Deterding, 2015; Hamari, 2017, 2013; Huotari and Hamari, 2017; Jung et al., 2010; Rigby, 2015) can influence motivation and behavior. Several studies that have investigated the influences of particular game features in the context of gamification research underpin this theoretical assumption. For instance, Jung et al. (2010) have shown that the integration of goal-setting and performance feedback in the form of a leaderboard in an innovation community can increase the performance of participants, while Hamari

(2017) has indicated that goal-setting with badges can positively influence social interaction in communities.

Cooperative games typically provide challenges based on goals that are shared with other players (El-Nasr et al., 2010; Rocha et al., 2008). Empirical studies indicate that such shared goals can have strong effects on enjoyment, excitement, and cooperative behaviors in popular cooperative video games (El-Nasr et al., 2010). This outcome is in line with Tuomela's (2000, p. 26) cooperation theory, which claims that "cooperation in the fullest sense involves acting towards a collective goal".

Previous research that has drawn on we-intention has operationalized the influence of shared goals by investigating a group member's perceived *group norms* (e.g. Dholakia et al., 2004; Oliveira and Huertas, 2015; Tsai and Bagozzi, 2014). Group norms capture the perceived overlap between individual goals and the goals of other members in a group (Tsai and Bagozzi, 2014), and has been found to be a good indicator of internalization processes that occur when people act together (Bagozzi and Dholakia, 2002; Dholakia et al., 2004; Tsai and Bagozzi, 2014). From a theoretical perspective, strong group norms that reflect the values and goals a user shares with a group implicitly generate consensus among members of a group. Thus, strong group norms promise to positively impact participation of group members in a joint group activity (Dholakia et al., 2004). Several studies have shown that strong group norms lead to mutual agreement among group members (Dholakia et al., 2004) and a higher level of we-intention (Cheung et al., 2011; Dholakia et al., 2004; Shen et al., 2013). In this respect, we expect that cooperative game features that explicitly specify shared goals or intertwine individual goals will create correlation between players' goals and will invoke group norms. Grounded in previous research about we-intentions in virtual communities, we further expect that strong group norms directly influence the we-intentions of players in a group to act together (cf. Cheung et al., 2011; Dholakia et al., 2004; Oliveira and Huertas, 2015; Shen et al., 2013). Therefore, we posit:

H1a: *Engagement with cooperative game features positively relates to group norms.*

H1b: *Stronger group norms lead to higher levels of we-intention.*

Players of cooperative games that engage individuals to cooperate towards a shared goal might evaluate the motivational consequences of contributing or not contributing toward a collective goal. A player might imagine the pleasant aspects of cooperating with other players and possible negative emotional consequences of not playing together to achieve a shared goal. The positive and negative emotional reactions that arise from evaluating the consequences of achieving or not achieving a shared goal (Perugini and Bagozzi, 2001) has been identified as a predictor of cooperative behavior in similar scenarios (Bagozzi and Dholakia, 2006, 2002; Tsai and Bagozzi, 2014). The theoretical underpinning of these anticipated emotions can be found in the model of goal-directed behavior (MGB) (Perugini and Bagozzi, 2001). Perugini and Bagozzi (2001) suggest that the prospects of (not) achieving a goal-directed action influence desires and the intentions to act, and thereby the de facto behaviors. Based on studies that have shown positive relationships between personal anticipated emotions and we-intentions in several virtual communities (Table 12), we assume that cooperative game features that engage players to cooperate in order to achieve shared goals will induce anticipated emotions, which mediate the influence of game features on we-intentions. Accordingly, we hypothesize:

H2a: *Engagement with cooperative game features positively relates to positive anticipated emotions.*

H2b: *Greater levels of positive anticipated emotions are associated with higher levels of we-intention.*

H2c: *Engagement with cooperative game features positively relates to negative anticipated emotions.*

H2d: *Greater levels of negative anticipated emotions are associated with higher levels of we-intention.*

The Roles of Social Identification Processes

People that are part of a social group, such as players in a team of cooperative games, reflect their personal positions in the group. This socio-psychological process that is characterized by the personal self-awareness of his or her membership in a group is defined as a user's social identity (Bagozzi and Lee, 2002; Ellemers et al., 1999; Tajfel, 1982). Social identity has cognitive, affective, and evaluative components: the cognitive awareness of one's membership in a group (cognitive), a sense of emotional involvement in the group (affective), and the group-based self-esteem (evaluative) (Ellemers et al., 1999). From social identity theory, we learn that identities can be activated in situations (salience) in which the situational conditions allow access to achieving group goals (Stets and Burke, 2000). Cooperative game features can be viewed as such situational conditions that provide access to achieving group goals and may therefore activate individuals' social identities. Further, cooperative game features that allow one to interact with other group members may increase one's emotional tie to the group and may influence one's affective commitment. Previous literature implies that expressing mutual welfare and by believing in the virtue of a relationship forms a foundation for trust (McAllister, 1995; Rempel et al., 1985). Ultimately, it can be assumed that a trust relationship can be established by reciprocatively displaying cooperative behavior, since such behavior demonstrates aspirations for mutual welfare and a belief in the virtue of a relationship. This may intensify the emotional tie to membership of a group. Cooperative games typically provide direct feedback to individual behavior and allow one to reflect on the own performance in relation to others (Zagal et al., 2006). Such performance feedback may influence individuals to act as others in the group want them to act, which can increase an individual's self-esteem in the group (Bagozzi and Dholakia, 2002; Zagal et al., 2006). Consequently, the use of cooperative game features and the personal success that may be attached to using such features may lead to a positive evaluation of an individual's own value in the group and thus may affect his or her group-based self-esteem. Previous research on we-intention showed that a social identity positively influences we-intentions (Table 12). Therefore, we hypothesize:

H3a: Engagement with cooperative game features positively relates to social identity.

H3b: Greater levels of social identity are associated with higher levels of we-intention.

The Roles of Joint Commitment

Cooperative games typically apply features that allow players to communicate and interact with other players (Choi and Kim, 2004; Ducheneaut et al., 2006; El-Nasr et al., 2010; Yee, 2006). This involves features for verbal and written communication, such as virtual chat (Ducheneaut et al., 2006), but also functions that can be used for non-verbal interactions. Examples of the latter are in-game abilities that can be used to interact with other players in a virtual world (e.g. virtual objects and virtual gifts) or abilities that can be used to positively influence other players (e.g. healing abilities) (El-Nasr et al., 2010; Rocha et al., 2008). Some cooperative games, such as Portal2 or LittleBigPlanet, also give players opportunities to use the body of an avatar in order to express feelings and communicate with other players via virtual body language (cf. Hsu et al., 2014). A key aspect of these features is that players can use them as a medium to express willingness and commitment to participate in a joint action. For instance, a player who buys a virtual item that increases the attack value of all the players in his area shows his willingness to go into battle together with others. Also, avatar-based body language, which encourages other players to stick together, can serve as an instrument to express commitment to a joint action (Hsu et al., 2014).

Theory on cooperation (Gilbert, 1989; Tuomela, 2000, 1995) emphasizes that participants' joint commitment to a collective action is crucial to the cultivation of cooperation. Thus, joint commitment has been identified as an antecedent of we-intentions (Shen et al., 2014): "We-intention involves a joint commitment to contribute to the realization of the content of the we-intention" (Tuomela, 2000, p. 63). Compared to personal commitments, joint commitment involves a mutual agreement by every member to participate in a joint activity ("we do X jointly"). In other words, joint commitment can be defined as the common knowledge that all participants jointly express their readiness to be under the obligation to participate in a joint action and are jointly committed to do their part of "X" (Gilbert, 1999; Shen et al., 2009; Tuomela, 2000, 1995). We assume that communication features in cooperative games may support the joint commitments, similar to other virtual communities (Bagozzi and Dholakia, 2002; Shen et al., 2009, 2014), since they enable players to communicate and express personal beliefs and obligations. Further, we expect that cooperative game features that enable and support cooperative interaction as described above, can be an important instrument to express joint commitment. Based on this discussion, we assume that:

H4a: *Engagement with cooperative game features positively relates to joint commitment.*

H4b*: Joint commitment positively relates to we-intention.*

The Roles of Attitudes

In the context of games and gamification approaches, many studies have investigated the relationships between individual attitudes and the behavioral intention to use a game or a gamified system (Hamari and Koivisto, 2015a, 2015b; Hsu and Lu, 2004; for a review, see Hamari and Keronen, 2017b). An individual's attitude toward a behavior represents the psychological evaluation of a planned behavior along a positive-to-negative dimension (Ajzen, 1991). Attitudes are cognitive variables that influence decision-making and lead to behavioral intentions (Armitage and Conner, 2001). Research has revealed that hedonic aspects of games (Hamari et al., 2015b; Wu and Liu, 2007) and social features that increase social recognition (Hamari and Koivisto, 2015a, 2015b) influence attitudes to use gamified systems and games. However, very few studies have investigated attitudes and intentions to play together with others.

According to research on we-intentions, attitudes toward a cooperative act has been identified as a key psychological predictor of we-intention intention (Bagozzi and Dholakia, 2006; Tsai and Bagozzi, 2014). In the context of games, this relationship between attitude and we-intention is expected to be similar. Thus, we posit:

H5a: *Engagement with cooperative game features positively relates to attitudes toward playing together with others.*

H5b: *Greater levels of attitudes toward playing together with others are associated with higher levels of we-intention.*

The Mediating Roles of Group Dynamics

Extensive research that has been conducted in order to investigate the antecedents of we-intention (Table 12) revealed that group norms, positive and negative anticipated emotions, social identity, joint commitment, and attitudes toward cooperating together with a group explain we-intentions very well (Bagozzi and Dholakia, 2006, 2002; Dholakia et al., 2004; Shen et al., 2009; Tsai and Bagozzi, 2014). Especially concerning collaborative technologies – such as online communities, crowdsourcing platforms and messaging services – these group dynamics seem to predict we-intention and cooperation (Table 12). We extend this research by investigating whether and how cooperative game features induce we-intentions. As hypothesized, we suspect that cooperative features in games influence all these group dynamics in order to invoke and cultivate we-intentions. Consequently, there is no obvious reason to suspect that these variables do not fully mediate the relationships between cooperative game features and we-intentions. Accordingly, we posit:

H6: *The effect between engagement with cooperative game features and we-intention is fully mediated by group norms, positive and negative anticipated emotions, social identity, joint commitment, and attitudes toward cooperating with others.*

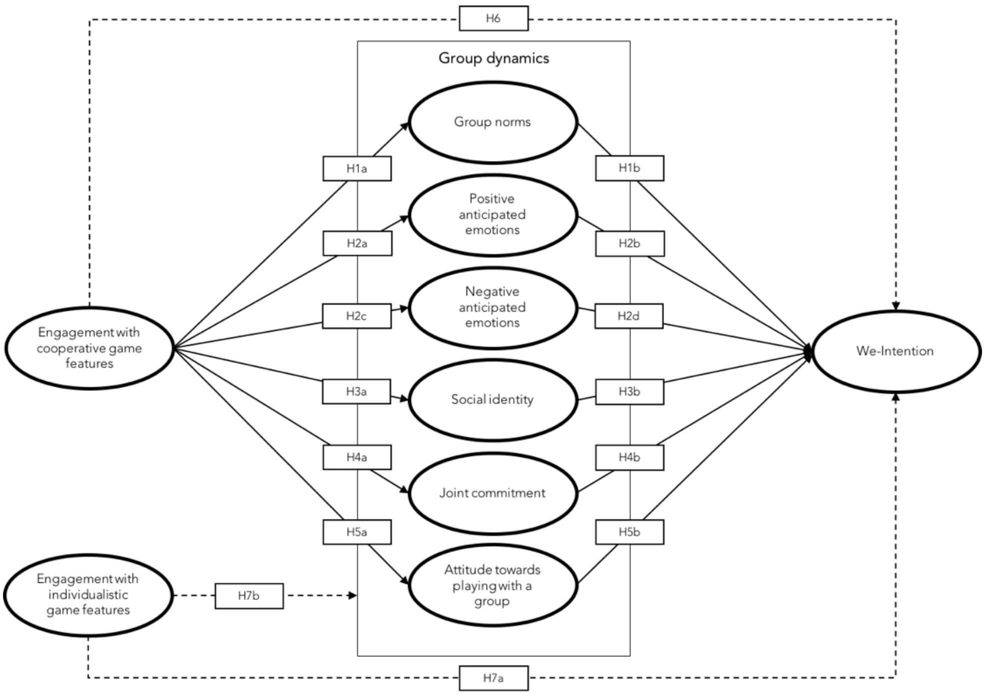


Figure 9. The Research Model

The Roles of Other, Non-Cooperative Game Features

Popular discussion pertaining to online games such as World of Warcraft or Pokémon Go highlight that people easily and organically form highly cohesive teams in games (Brown and Thomas, 2006; Ducheneaut et al., 2007), indicating that games seem to uniquely cater for the development of we-intentions between individuals. However, games are often complex and characterized by the uses of various game features (Björk and Holopainen, 2005; Vesa et al., 2017) that allow a user to play them alone or together with others (Marker and Staiano, 2015; Peng and Hsieh, 2012). Currently, most game companies develop games in a way that allows the player to play both in single-player and/or cooperative multiplayer modes by integrating various game features. While we mainly hypothesize that games' positive effects on group dynamics and we-intention stem from a game's cooperative features, it is possible that the single-player features also have a role in the formation of cooperation in games. According to Liu et al. (2013), only cooperative game features are designed to invoke cooperative goal structures that have been defined as a key antecedent of 'full-blown' cooperation (Tuomela, 2000). In contrast, non-cooperative (cf. single-player/individualistic) game features are detached from cooperative goals and characterize individual goal structures, invoking personal intentions that lead to individual play rather than we-intentions and cooperation. Several studies have indicated clear differences in behavioral outcomes between cooperative, individualistic, and competitive designs in games and gamified systems (Chen and Pu, 2014; Goh and Lee, 2011; Marker and Staiano, 2015; Peng and Hsieh, 2012; Plass et al., 2013; Siu et al., 2014). Based on these considerations and empirical results, we hypothesize that cooperative game features induce we-intentions and positively affect group dynamics, hypothesizing that individualistic game features have no effects on group dynamics that invoke we-intentions. Accordingly:

H7a: *Engagement with individualistic game features is not associated with we-intentions.*

H7b: *Engagement with individualistic game features is not associated with group dynamics.*

4.1.3 Empirical Study

We gathered the data from players of Ingress, a popular game with over 11 million downloads in more than 200 countries (Smith, 2015; Takahashi, 2014). Ingress is an augmented reality game that relies on a map of the real world and extends reality with location-based virtual objects, the so-called portals, at places of public art (Hulsey and Reeves, 2014). Ingress players can use an app on their mobile phones, the so-called scanner, to find the location of such portals and create new virtual portals, which are connected by their location to landmarks in the real world. The game rules define that these portals should be created at places of public art, for instance, at statues, graffiti, or buildings with outstanding architecture. Main goal in the game is to collect points by creating and conquering these virtual portals and linking them together in order to create triangular fields in virtual space. The scoring system is based on these fields (the more space is covered by a field, the more points one can get). Two factions (Enlightened vs. Resistance) compete against each other for the portals and fields. The winning team with the most points (Mind Units) in a predefined period is determined at regular intervals. Since the portals and other game content are created by the community of players, Ingress can be also specified as a gamified crowdsourcing approach that creates an interactive map with cultural points of interest (Hulsey and Reeves, 2014). The user-generated database has been used as source for other services, such as the Pokémon Go app.

Ingress seems apt for this study, because participants display strong cooperative behavior in their faction. Research has identified that, besides factors such as fun and exploration, the community in a faction and their shared progress is of great importance to Ingress players (Sheng, 2013). Further, there are many regional associations of Ingress players on the internet that organize regional meetups, teach one another, and discuss strategies to achieve regional supremacy[4].

All of the above mentioned cooperative design features are implemented in Ingress. First, the game defines clear goals for all members of a faction. The common goal is to obtain more Mind Units (MU) than the other team in predefined time intervals (Checkpoints and cycles). Second, different mechanics and rules are implemented that allow players to cooperatively support each other, such as applying Mods, upgrading portals, and recharging Resonators of other players or the possibility to share items among faction members with Capsules. Third, players can interact with each other in Ingress using an

[4] https://www.ingress.com/community/directory.

integrated chat feature (COMM). In addition to these technical features, the Ingress community regularly hosts events where people can meet to socialize, exchange strategies, and play Ingress together (e.g. Mission Days, XM Anomalies and First Saturday events). Ingress also uses several more individualistic features, such as a level system, badges, and personal (agent) statistics, which are designed to invoke individualistic goal structures and allow to play the game as a single player.

Participants and Procedure

We tested our proposed model with data from Ingress players gathered via an online questionnaire. We invited the participants in different open Ingress communities on Google+ by posting a short description of the survey and a link to it. In addition, we asked the moderators and owners of several communities to re-post the link in their private groups so as to extend the range. The survey was active from May 4, 2016 to October 30, 2016. In that time, about 800 Ingress players responded to our call, and 233 players participated in the questionnaire. Similar to previous we-intention research, we asked the participants to identify a group of Ingress players they regularly play with (Bagozzi and Dholakia, 2006; Tsai and Bagozzi, 2014) so as to induce respondents to think about a real group of people and to better prepare them for the questions to follow. Since our study focuses on cooperative play, we excluded players who reported that they don't regularly play in a group from the analysis, resulting in 206 valid responses. Table 13 outlines the sample characteristics. Respondents were entered into a prize draw for one of three €15 Amazon gift coupons.

Gender	**#**	**%**	**When did you last play Ingress?**		**#**	**%**
Female	62	30.1		*today*	*134*	*65.0*
Male	144	69.9		*yesterday*	*59*	*28.6*
				> 1 day ago	*13*	*6.3*
Age	**#**	**%**	**Time playing Ingress**		**#**	**%**
< 20	19	9.2		*< 1 years*	*54*	*26.2*
20 to 29	49	23.8		*1 to 2 years*	*60*	*29.1*
30 to 39	70	34.0		*2 to 3 years*	*54*	*26.2*
40 to 49	50	24.3		*> 3 years*	*38*	*18.4*
50 and over	18	8.7				

Table 13. Demographic Information About Respondents, Including Gender, Age, Days Since Last Playing Ingress, and Time Playing Ingress

The questionnaire was answered by people from 15 countries. The average respondent age was 34.6. The sample consisted of 30.1% female and 69.9% male participants; 26.2% have been playing *Ingress* for less than a year, 29.1% between 1 and 2 years, 26.2% between 2 and 3 years, and 18.4% for more than three years. Respondents typically reported playing Ingress multiple times a day (68.4%, on a 6-item scale anchored between rarely and multiple times a day), play for 48 hours (median) per month, and have at least completed high school (89.4%) or a Bachelor's degree (43.8%).

Measures

We adopted the operationalization of we-intention and its antecedents from previous sources (see Table 12; Table 14). The items to measure the engagement with cooperative game features in Ingress were developed in two stages:

First, we played Ingress ourselves and conducted semi-structured interviews with eight experienced players to identify cooperative game features in Ingress. The interviews were conducted via telephone and lasted approximately 40 minutes. The participants (5 males, 3 females, average age 28, all had been playing Ingress regularly for at least six months) were recruited in Ingress user groups on Google+. We guided the interviews along a questionnaire that contained a large set of Ingress game design features, which we derived from the official Ingress user guide[5]. Following the above introduced classification framework (Figure 6), we asked the experts to separate the Ingress game features into *individualistic*, *competitive*, and *cooperative game features*. First, we comprehensively introduced these different feature categories. Next, we asked the participants to specify the nature (individualistic, cooperative, competitive) of the identified Ingress game design features on a 5-point Likert scale (strongly disagree – strongly agree) (see Appendix B1). We asked them to think aloud so we could take notes on their reasoning for placing the game features in the various categories. Several game features were perceived by the participants as having both competitive traits (at an intergroup-level) as well as cooperative traits (at an intragroup level). For such cooperative-competitive features (e.g. factions), we carefully identified the cooperative aspects. Based on the interviews, we noted that 12 features were mainly perceived as cooperative features and eight features were classified primarily as individualistic (Appendix B2). Based on these identified cooperative and individualistic game features, we developed items that measured a user's engagement with these features. Together, we used these items to operationalize the engagement with cooperative / individualistic game features in Ingress. We treated the constructs as formative, as its exposure happens through using those features or by perceiving them as important. Further, the identified features were not explicitly interchangeable, which contradicts reflective use (Diamantopoulos and Siguaw, 2006).

Second, we conducted a pre-study to evaluate the developed measurements and the constructs we adopted from the existing we-intention literature. We conducted the survey on two days in October 2015. In sum, 110 participants took part in the pre-study, which were recruited on Ingress user groups different to the groups of the main study. Since the pre-study revealed largely a high validity level of the used items, we made only small adjustments. We improved some of the items that had been

[5] https://support.ingress.com/hc/en-us.

developed to measure engagement with cooperative game features and added a third we-intention item based on Shen et al.'s work (2009).

We-intention (WE-I)	Tsai and Bagozzi (2014); Bagozzi and Lee (2002); Shen et al. (2009)
I intend that our group (i.e. myself and the group that I identified before) play Ingress together sometime during the next 4 weeks. (7-point "disagree" - "agree" scale) We (i.e., I and the group that I identified before) intend to play Ingress together sometime during the next 4 weeks. (7-point "disagree" - "agree" scale) We (i.e., I and the group that I identified before) plan to play Ingress together sometime during the next 4 weeks. (7-point "disagree" - "agree" scale)	
Group norms (GN)	Tsai and Bagozzi (2014); Bagozzi and Dholakia (2002)
Playing Ingress together sometime within the next 4 weeks with the group you identified before can be considered a goal. For each of the people listed below and for yourself, please estimate the strength to which each holds the goal. (7-point "very weak" - "very strong" scales) Average of the strength of group members' goal Strength of own goal	
Positive anticipated emotions (PAE)	Tsai and Bagozzi (2014); Perugini and Bagozzi (2001)
If I am able to play Ingress with the group I identified before during the next 4 weeks, I will feel: (1) excited, (2) delighted, (3) happy, (4) satisfied, (5) proud, (6) self-assured, (7) relief, (8) glad (7-point "not at all" - "moderately" - "very much" scales)	
Negative anticipated emotions (NAE)	Tsai and Bagozzi (2014); Perugini and Bagozzi (2001)
If I am unable to play Ingress with the group I identified before during the next 4 weeks, I will feel: (1) angry, (2) frustrated, (3) guilty, (4) ashamed, (5) disappointed, (6) depressed, (7) worried, (8) uncomfortable, (9) anxious (7-point "not at all" - "moderately" - "very much" scales)	
Joint commitment (JC)	Shen et al. (2009)
We (i.e., I and the group that I identified before) all know that all members are jointly committed to performing their parts of the common tasks. (7-point "disagree" - "agree" scale) We (i.e., I and the group that I identified before) all know that all members are jointly committed to contributing to the common success. (7-point "disagree" - "agree" scale) We (i.e., I and the group that I identified before) all know that all members are jointly committed to helping each other. (7-point "disagree" - "agree" scale) We (i.e., I and the group that I identified before) all know that all members are jointly committed to achieving the common goals. (7-point "disagree" - "agree" scale)	
Social identity (SI)	Bagozzi and Lee (2002); Tsai and Bagozzi (2014)
Cognitive social identity How would you express the degree of overlap between your personal identity and the identity of the group you identified before, when you are actually playing with members of the group? (8-point graphical "Far apart" - "Complete overlap" scale) Please indicate to what degree your self-image overlaps with the identity of the group you identified before, as you perceive it. (7-point "not at all" - "moderately" - "very much" scale) **Affective social identity** How attached are you to the group you identified before? How strong would you say your feelings of belongingness are toward the group you identified before? (7-point "not at all" - "moderately" - "very much" scale) **Evaluative social identity** I am a valuable member of the group I identified before. I am an important member of the group I identified before. (7-point "does not describe me at all" - "describe me moderately well" - "describe me very well" scale)	
Attitudes toward cooperation (ATT)	Tsai and Bagozzi (2014); Ajzen (1991)
Playing Ingress together with the group I identified before sometime during the next 4 weeks is: (1) "Foolish" - "Wise", (2) "Bad" - "Good", (3) "Harmful" - "Beneficial" and (4) "Punishing" - "Rewarding" (7-point semantic differential)	

Engagement with cooperative game features (CG)	Constructed formative measure
How important is it to you to create control fields in order to obtain Mind Units (MU)? How often do you create control fields in order to obtain Mind Units (MU)? How important is to you to see the faction's progress during a cycle? How often do you look at the faction's progress during a cycle? How important is it to you to upgrade portals of other players? (upgrade = deploy Mods, deploy additional Resonators, upgrade Resonators to higher level) How often do you upgrade portals of other players? (upgrade = deploy Mods, deploy additional Resonators, upgrade Resonators to a higher level) How important is it to you to recharge Resonators of other players? How often do you recharge Resonators of other players? How important is it to you to communicate with other players via chat? How often do you communicate with other players via chat? How important are First Saturday (FS) events to you? How often do you participate in First Saturday (FS) events? How important are XM Anomalies to you? How often do you participate in XM Anomalies? How important are Mission Days to you? How often do you participate in Mission Days? (7-point "not at all important" - "very important" / "never" - "every time" scales)	
Engagement with individualistic game features (IG)	Constructed formative measure
How often do you look at your personal achievements? (e.g. Mission Badges, Medals, Action Points) How important are your personal achievements to you? (e.g. Mission Badges, Medals, Action Points) How often do you look at your personal level? How important is your personal level to you? How often do you look at the visualization of your avatar? How important is the visualization of your avatar to you? How often do you look at your personal stats? (statistics about number of portals, MUs, links, control fields, etc., under your control) How important are your personal stats to you? (statistics about number of portals, MUs, links, control fields, etc., under your control) How often do you play missions? How important is being able to play missions to you? How often do you use Power Cubes? How important are Power Cubes to you? (7-point "not at all important" - "very important" / "never" - "every time" scales)	

Table 14. The Measurement Items

Validity and Reliability

We tested the model via the component-based partial least squares structural equation modeling in SmartPLS 3 (Ringle et al., 2015), which is considered a suitable structural equation modeling method for prediction-oriented studies such as this, while covariance-based structural equation modeling is better suited for testing which models best fit the data (Anderson and Gerbing, 1988; Chin et al., 2003). We also used component-based structural equation modeling, since the model includes both formative and reflective constructs (e.g. see Lowry and Gaskin, 2014).

We assessed convergent validity (see Table 15) with two metrics: average variance extracted (AVE) and composite reliability (CR). Convergent validity was met (each construct's average variance extracted should be > 0.5, each construct's composite reliability should be > 0.7) (Fornell and Larcker, 1981). We examined the discriminant validity first through the comparison of the square root of the average variance extracted of each construct to all of the correlations between it and other constructs (see Fornell and Larcker, 1981) (Table 15), where all of the square roots of the construct's average variance extracted should be greater than the correlations between the corresponding construct and any other construct (Chin, 1998; Jöreskog and Sörbom, 1996). Second, we checked discriminant validity through calculating the heterotrait-monotrait ratio of correlations (Henseler et al., 2015). In our data, no value between two constructs exceeded 0.85, which is the threshold for discriminant validity (Henseler et al., 2015). Third, we assessed discriminant validity by confirming that each item had the highest loading with its corresponding construct. We can conclude that the discriminant validity and the reliability were acceptable. The sample size (N = 206) satisfies several different criteria for the lower bounds of sample size for component-based partial least squares structural equation modeling (Anderson and Gerbing, 1988; Chin, 1998).

	AVE	CR	CG	IG	ATT	GN	JC	NAE	PAE	SI	WE-I
CG	n/a	n/a	n/a								
IG	n/a	n/a	n/a	n/a							
ATT	0.631	0.872	0.451	0.269	**0.794**						
GN	0.734	0.847	0.415	0.219	0.423	**0.857**					
JC	0.693	0.900	0.439	0.364	0.450	0.366	**0.833**				
NAE	0.680	0.950	0.232	0.115	0.223	0.195	0.237	**0.824**			
PAE	0.623	0.929	0.535	0.392	0.566	0.390	0.552	0.457	**0.789**		
SI	0.637	0.897	0.575	0.317	0.397	0.416	0.520	0.402	0.619	**0.798**	
WE-I	0.760	0.950	0.503	0.226	0.591	0.566	0.551	0.370	0.657	0.594	**0.872**

Table 15. Validity and Reliability

4.1.4 RESULTS

First, investigating the direct relationships between the different game features and we-intentions (without including the *group dynamics* mediators), we found a statistically significant association between *engagement with cooperative game features* and *we-intention* ($\beta = 0.476$, $p < 0.001$), but no significant effect between *engagement with individualistic gamification features* and *we-intention* (ß = 0.087, $p > 0.1$). In total, the engagement with these game features account for 25.7% of the variance of *we-intention*, out of which *cooperative game features* explain all most all the variance.

Second, when adding the hypothesized mediators pertaining to *group dynamics* into the model, we found that, together, *engagement with the game features* and *group dynamics* account for 62.8% of the variance of *we-intention* (Figure 10). Further, we found that these *group dynamics* together fully mediate the effect between *engagement with cooperative game features* and *we-intention.* Therefore, hypothesis 6 is supported. *Engagement with cooperative game features* accounts mainly for the variance of group dynamics to the following magnitudes: 17.5% of *group norms*, 32.0% of *positive anticipated emotions from playing together*, 5.4% of n*egative anticipated emotions from missing out*, 33.7% of *social identity*, 23.2% of *joint commitment*, and 21.1% of *attitudes toward playing with the group*. Based on how much variance is accounted for in the model, we can conclude that a) *engagement with cooperative game features* accounts for about one-quarter of users *we-intentions* directly, however, b) the effect of *engagement with cooperative game features* also significantly increases all facets of *group dynamics*, which c) further increases the model's explanatory power towards *we-intentions* up to 62.8%. Therefore, we can further conclude that *cooperative game features* and the mediating *group dynamics* are a powerful set of predictors for people *willing to work together*. The results pertaining to the hypotheses about the relationships between *engagement with cooperative game features* and singular facets of *group dynamics* indicate that *engagement with cooperative game features* is positively associated with all the constructs of *group dynamics*: *H1a group norms* ($\beta = 0.393$, $p < 0.01$), *H2a positive anticipated emotions* ($\beta = 0.449$, $p < 0.01$) *H2c negative anticipated emotions* ($\beta = 0.233$, $p < 0.05$) *H3a social identity* ($\beta = 0.536$, $p < 0.01$), *H4a joint commitment* ($\beta = 0.348$, $p < 0.01$), and *H5a attitude* ($\beta = 0.410$, $p < 0.01$) (see Figure 10 and Table 16).

Concerning the relationships between *group dynamics* and *we-intentions*, the results indicate that *group dynamics* are associated with *we-intentions* in the following manner: *H1b group norms* ($\beta = 0.253$, $p < 0.01$), *H2b positive anticipated emotions* ($\beta = 0.254$, $p < 0.01$), *H3b social identity* ($\beta = 0.155$, $p < 0.1$), *H4b joint commitment* ($\beta = 0.151$, $p < 0.05$), and *H5b attitude* ($\beta = 0.205$, $p < 0.01$) are positively associated with *we-intentions*. However, there is no evidence for a significant relationship between *H2d negative anticipated emotions* and *we-intentions* ($\beta = 0.063$, $p > 0.1$) (see Figure 10 and Table 16).

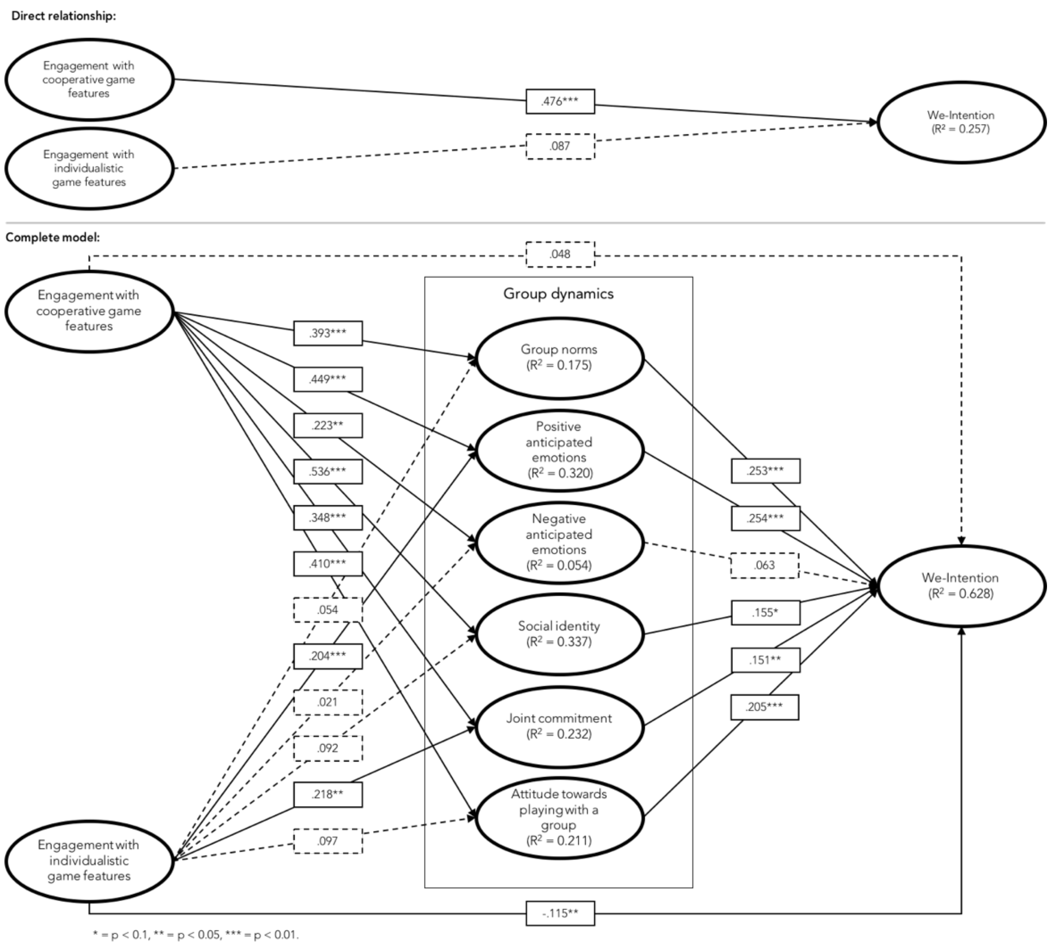


Figure 10. Results

In the complete model with group dynamics, we found that *engagement with individualistic game features* also have no significant effect on we-intention in total (β = 0.019, $p > 0.1$). In absolute terms, our results thus indicate that H7a is supported. However, if we investigate the relationship between individualistic game features and group dynamics, we find that this relationship is more complex. Our findings show that e*ngagement with individualistic game features* can negatively affect *we-intention* (β = -0.115, $p < 0.05$), compensated by invoking of *positive anticipated emotions* (β = 0.204, $p < 0.01$) and *joint commitment* (β = 0.218, $p < 0.05$). Consequently, H7a and H7b were not fully supported. Combining cooperative game features with other, more individualistic features seems to be able to influence the emergence of we-intentions in positive but also in negative ways. Overall, however, the influence of individualistic game features on group dynamics and we-intentions is very low, and can almost be neglected compared to the strong relationships between cooperative game features, group dynamics, and we-intentions.

Independent variable	**Dependent variable**	**Beta**	**CI95 LO**	**CI95 HI**	**p**
The relationships between engagement with cooperative game features and group dynamics					
Cooperative game features	Group norms	0.393	0.258	0.541	0.000
	Positive emotions	0.449	0.349	0.599	0.000
	Negative emotions	0.223	0.060	0.408	0.012
	Social identity	0.536	0.413	0.642	0.000
	Joint commitment	0.348	0.210	0.527	0.000
	Attitude	0.410	0.250	0.582	0.000
The relationships between engagement with individualistic game features and group dynamics					
Individualistic game features	Group norms	0.054	-0.103	0.261	0.559
	Positive emotions	0.204	0.077	0.374	0.008
	Negative emotions	0.021	-0.145	0.252	0.830
	Social identity	0.092	-0.029	0.261	0.212
	Joint commitment	0.218	0.047	0.395	0.014
	Attitude	0.097	-0.076	0.328	0.338
The relationship between group dynamics and we-intention					
Group norms	We-intention	0.253	0.145	0.356	0.000
Positive emotions		0.254	0.078	0.392	0.002
Negative emotions		0.063	-0.026	0.169	0.207
Social identity		0.155	0.003	0.320	0.055
Joint commitment		0.151	0.024	0.263	0.011
Attitude		0.205	0.078	0.347	0.003
The total effect between engagement with game features and we-intention					
Cooperative game features	We-intention	0.495	0.352	0.647	0.000
Individualistic game features	We-intention	0.019	-0.075	0.243	0.814

Table 16. Results

4.1.5 Discussion

In this study, we have investigated how games can induce and cultivate *we-intention* of working as a group. Specifically, we investigated how engagement with cooperative game features affect different forms of group dynamics and how they further translate into we-intentions. We employed data from Ingress users (N = 206), a popular location-based augmented reality game. The results show that cooperative game features can induce we-intentions (directly explains one-quarter of the variance), whereas individualistic game features seem to have no direct effect on we-intentions. Further, this study revealed that the relationship between cooperative game features and we-intention is fully mediated by group norms, social identity, joint commitment, attitudes toward cooperation, and anticipated positive emotions.

The study findings extend previous research in several ways. First, by empirically investigating how game design features can invoke we-intentions in games, this study closes a gap in current game (Goh and Lee, 2011; Liu et al., 2013) and gamification research (Bui et al., 2015; Chen and Pu, 2014; Liu et al., 2017). In addition to previous research that has focused on the behavioral outcomes (Goh and Lee, 2011; Marker and Staiano, 2015; Peng and Hsieh, 2012; Plass et al., 2013; Siu et al., 2014) and the design features of cooperative games (El-Nasr et al., 2010; Rocha et al., 2008; Zagal et al., 2006), this study connected both research streams and provided a comprehensive understanding of how engaging with such features can invoke collective intentions towards cooperative behavior. Further, this study has contributed to better understanding the effects of different game features in the sense that the results show that cooperative game features are positively related to we-intentions, while individualistic features are not. Therefore, these findings provide not only a novel contribution for understanding cooperation and participation in multiplayer games, such as Ingress, Pokémon Go, and World of Warcraft. Moreover, the knowledge we gathered can easily be transferred to current gamification research that investigates the differences between various game features in order to derive more precise design principles for designing successful gamification approaches (cf. Hamari et al., 2014; Morschheuser et al., 2017d).

Second, our results provided support for the postulations that enriching information and communication technologies with gamification that promote shared goals instead of competition or individualistic goals may support digital cooperation (Peng and Hsieh, 2012). The present results support this notion by demonstrating that engagement with cooperative game features significantly relates to group dynamics, which operationalize the presence of shared goals. Especially, the strong relationship between group norm and cooperative game features are an indication for the presence of a shared goal between users in a group, since group norms represent the "attempt of individuals to meet idealized values or goals, shared with others" (Tsai and Bagozzi, 2014, p. 147). Further, the identified influences of cooperative game features on anticipated emotions regarding achieving a shared goal and joint commitment to contribute to the realization of a shared goal, support this theory. Thus, our study can act as an anchoring point for future research into the effects of singular cooperative game features such as shared goals on psychological and behavioral outcomes of individuals in groups.

Third, our findings extend previous we-intention research (Dholakia et al., 2004; Oliveira and Huertas, 2015; Tsai and Bagozzi, 2014) that have neglected we-intention formation in games. Although the influence of design features on individual intentions in games and game-inspired approaches (i.e.

gamification) have often been investigated (Hamari et al., 2015b; Hamari and Koivisto, 2015b; Hsiao and Chiou, 2012; Wu and Liu, 2007), to our best knowledge, no other study has investigated we-intentions in this context. More importantly, little knowledge exists about how design features of information systems can influence we-intentions. Our study results suggest that cooperative games are particularly efficient at invoking we-intentions. This finding not only contributes to the general understanding of we-intentions, but also extends previous research in the sense that the results highlight the use of cooperative game features as a promising approach to invoke we-intentions.

Considering our results in the context of recent we-intention research (Table 12), we confirmed that group norms, social identity, joint commitment, attitudes toward cooperation, and anticipated positive emotions explain changes in we-intention reasonably well, also in the context of games. This significant overlap between our study and previous we-intention research contributes to the generalizability of the presented results and provides a foundation for bringing community research and game research closer together. This implies that game and gamification researchers should also turn to existing community research, and vice versa, in order to extend understandings of digital cooperation.

Practical Implications

Clearly, cooperation is of great importance in society today; we work, study, and carry out most leisure activities together. However, true cooperation often forms organically without external enforcement and is hard to cultivate. Many practitioners face the challenge of designing organizational structures and digital communities that promote cooperation, without knowing how design features can promote cooperation. When looking at video/online games, one can observe that cooperation effortlessly arises between people who might not even have had previous connections, and not just between individuals, but across a wide spectrum of people. To better understand how the potential of games can be successfully wielded in non-game organizations and information systems, this study has investigated how games are able to cultivate cooperation. The study results support the hypothesis that engagement with cooperative game features can influence collective intentions (we-intentions) of working in a group. This can provide practical insights for those seeking to cultivate cooperation in digital communities and organizations.

Our results suggest that cooperative design features in games – such as shared goals, cooperation enabling game mechanics and rules, and communication possibilities – offer great and as yet untapped potential for cultivating cooperation outside games. Designers of information systems and collaborative technology who seek to cultivate cooperation should consider the implementation of such design features known from cooperative games when gamifying their systems (Hamari et al., 2014; Huotari and Hamari, 2017; Morschheuser et al., 2017d).

In particular, our findings recommend the implementation of gamification features that influence group norms, invoke positive emotions when cooperating, and increase a member's identification with a group, in order to induce we-intentions and cultivate cooperation. First, designers and managers of communities should consider increasing the overlap of individual goals by carefully intertwining goals (El-Nasr et al., 2010; Rocha et al., 2008) or defining shared goals, such as team challenges or missions that can be completed by a group of users, to strengthen group norms. Second, the implementation of features that provide motivational rewards, such as the experience of mastery, competence, and social relatedness (Ryan et al., 2006), for achieving shared goals should be considered so as to increase the anticipated emotions of joint actions. Third, those seeking to cultivate cooperation should work on the representation and attractiveness of groups (cf. Tsai and Bagozzi, 2014), and should implement features that can trigger self-reflection processes (Bagozzi and Lee, 2002; Ellemers et al., 1999) in order to support the shaping of members' identification with a group. Cooperative games such as Ingress, Pokémon Go, or World of Warcraft provide a treasure of examples of concrete design features that can easily be transferred to other environments. For instance, Ingress uses competing factions and defines the victory of the own team as a clear shared goal for all players in a faction. Several game features, such as leaderboards that visualize the regional supremacy of a faction and its members, as well as story and media items that explain and motivate the shared goals, are implemented to support the cooperative goal structures and may influence group norms in factions, as well as in their locally organized subgroups. To support members' identification with a group, we recommend the use of uniform colors and logos that can convey a clear group affiliation, statistics for direct comparison between players that enable social categorization (Turner, 1975), and visual representations of users by avatars that can initiate self-reflection processes (Bessière et al., 2007; Klimmt et al., 2009), similar to Ingress. Examples such as virtual goods that have been found to influence a user's social identity (Huang, 2012) and could be used in some games as gifts to express commitment to other players, have already found their way from games (Hamari, 2015b; Hamari and Keronen, 2017b) into online communities, such as Facebook (Huang, 2012).

Further, our findings imply that practitioners who seek to increase cooperation should find that gamification inspired by cooperative games is more beneficial and preferable to individual-based gamification. We found that individualistic game features can have negative effects on we-intention, which in our study have been compensated through small positive effects on group dynamics. Individualistic game features are designed to motivate personal goals and try to promote egotistical behavior (see section 2.4). Previous research in the context of sports and education (for a review, see Johnson and Johnson, 1989, p. 173) indicate that mixing cooperative goal structures with individualistic goal structures can negatively affect the relationships between a group's members, since egotistical motives and behaviors may harm cooperative efforts and trust among group members. Such aspects could explain the negative relationships between individualistic game features and we-intention. On the other hand, our findings revealed that individualistic game features are positively related with positive anticipated emotions to play with others and joint commitment. We suspect that intertwining personal goals with the goals of others (El-Nasr et al., 2010; Rocha et al., 2008) – such as in Ingress – may increase the desire to play together with others when playing individually. For the same reason, players who are committed to their private goals may also be committed to their team's goal if it helps them to succeed in a game with intertwined goals. Overall, our findings indicate that practitioners should always carefully consider possible side-effects of mixing different game feature types. Further, cooperation cultivators should seek to design and implement gamification inspired by cooperative games instead of implementing individualistic game features, such as private badges or level systems, which are currently often used in communities and other collaborative technologies (Bullinger et al., 2010; Hamari et al., 2014; Hutter et al., 2011; Liu et al., 2017; Morschheuser et al., 2017a, 2016; Seaborn and Fels, 2015; Vasilescu et al., 2014).

By investigating Ingress, which is not only an augmented reality game, but also a crowdsourcing approach, this study provides particularly valuable insights for gamifying crowdsourcing initiatives and related systems. Compared to other outsourcing types, game-based crowdsourcing provides a new, cost-efficient way to generate content and carry out tasks by a mass of people who are reachable via the internet (Morschheuser et al., 2017a, 2016; Prestopnik and Tang, 2015). While this phenomenon is generally considered to be promising, there have been very few studies (see section 3.2) of participation by and motivations of crowdsourcees in crowdcreation and crowdrating approaches (Geiger and Schader, 2014). Ingress was designed to crowdsource the creation of an interactive map of public art. Our findings reveal that the implemented game features in Ingress represent an effective approach to cultivate strong and persistent cooperation. More than 73% of the respondents reported that they play Ingress for at least a year, and more than the half specified that when playing actively, they use the app multiple times per day. One possible reason for this strong engagement could be the great variety of applied game features. As highlighted in section 3.3, crowdsourcing approaches, which strive for collaborative, emergent outcomes, may benefit from implementing manifold gamification approaches. By providing the opportunity to satisfy a broad spectrum of needs, the use of manifold gamification designs can engage broad target groups. Accordingly, managers and designers of crowdsourcing communities should consider applying manifold game design features when designing incentive mechanisms. On the other hand, for the reasons discussed above, designers should carefully consider possible effects of mixing cooperative, individualistic and competitive game features.

Limitations and Future Research

Similar to other studies conducted by online surveys, a shortcoming of this research is that the data were self-reported and that the participants were self-selected. Respondents of such surveys might not represent the entire population of a service or game, but might represent a population that shares a strong positive affinity to the object under investigation. In the context of our study, it can safely be assumed that the survey participants were highly engaged with the game and that less active users may be underrepresented in the sample. Thus, our findings may have neglected less active and less engaged players. This issue might be addressed in future research that particularly examines the intentions of less active players or players with little experience in cooperative games.

Previous research indicates that less experienced users are inclined to follow suggestions and beliefs of those with whom they share goals rather than rely on their own knowledge, which may influence their group norms (Shen et al., 2011). On the other hand, experienced users are more likely to develop closer relationships with other group members and therefore perceive a stronger social identity with a group (Bagozzi and Dholakia, 2006). The study results show a more substantial relationship between cooperative gamification features and social identity as opposed to group norms. Future research could consider the effects of players' experience on group dynamics and we-intentions. Further, longitudinal studies will be needed to determine the psychological and behavioral outcomes of cooperative game features in relation to players' lifecycles.

Also, this study was conducted in the context of a particular cooperative game that seems to have implemented a set of successful game features that can invoke and cultivate we-intentions. However, these identified and investigated cooperative game features strongly depend on the considered context. Although there are no a priori reasons to assume that our study context has influenced the findings on how games induce we-intentions, the results might be somewhat context-dependent. For instance, the strength of the effects between cooperative game features, group dynamics, and we-intentions may vary depending on the context and the applied cooperative game features. Future research that compares our study findings across different contexts could add to the generalizability of our results. Further, future research should try to increase the robustness of findings presented in this study by combining de facto usage data with survey-based measured intentions and perceptions.

Finally, we encourage researchers to refine the understanding of moderating influences that may impact the cultivation of cooperation in games and gamified systems. Prior research in the context of gamification indicate that demographic and personality traits moderate perceptions and intentions of game features (Codish and Ravid, 2014; Hamari and Koivisto, 2015b; Koivisto and Hamari, 2014). On the other hand, moderators such as group size (Brewer and Kramer, 1986) or culture (Tsai and Bagozzi, 2014) may moderate group dynamics and cooperative behaviors. In the special context of anticipated emotions, the moderating effects of gender and the extent of personal investment might be a reason why we have found no significant association between negative anticipated emotions and we-intentions among mostly male participants (cf. Bagozzi and Dholakia, 2006; Taylor et al., 2005). We thus call for additional research into possible moderating effects. Future research that expands the understanding of factors that influence cooperation in games will not only contribute to a better understanding of this phenomenon, but will also support the design of gamification for cultivating cooperation in information systems and organizational contexts.

4.2 Study II: Designing Cooperative Gamification Features for Crowdsourcing[6]

4.2.1 Introduction

During recent years, gamification has seen significant interest in industry (IEEE, 2014) and academia (Hamari et al., 2014; Huotari and Hamari, 2017; Morschheuser et al., 2016). Several reviews of gamification studies (Hamari et al., 2014; Morschheuser et al., 2016; Seaborn and Fels, 2015) have shown that gamification can positively influence persons' motivations and behaviors (Deterding, 2015; Hamari et al., 2014; Morschheuser et al., 2016; Seaborn and Fels, 2015) and seems to work in most contexts where it is applied. In particular, practitioners often apply gamification in crowdsourcing approaches (De Franga et al., 2015; Morschheuser et al., 2016; Sigala, 2015), online communities (Hamari, 2017, 2013), and intranets (Morschheuser et al., 2015a; Schacht and Maedche, 2015; Thom et al., 2012). While various empirical studies report findings that suggest the effectiveness of specific gamification implementations, we still lack a comprehensive understanding of the phenomenon (Hamari et al., 2014; Morschheuser et al., 2016). Most studies have focused on the study of approaches that motivate people by social comparison and competition or by gamification features such as private badges that seek to motivate people on an individual level (e.g. Bui et al., 2015; Hamari, 2013; Jung et al., 2010; T. Y. Lee et al., 2013; Mekler et al., 2013; Morschheuser et al., 2015a; Zuckerman and Gal-Oz, 2014). Gamification approaches that engage individuals to cooperate and to work together to achieve a shared goal or purpose (Deutsch, 1949; Tuomela, 2000) have seen less attention in research into gamification (Bui et al., 2015; Chen and Pu, 2014; Goh and Lee, 2011) and game-design research (Liu et al., 2013). This lack of knowledge is surprising, since information systems that support users in creating joint outcomes, such as crowdcreation platforms (Geiger and Schader, 2014), innovation communities (Blohm et al., 2011; Hutter et al., 2011), or co-creation approaches – are increasing and demand incentive approaches that promote cooperation rather than competition.

Thus, *this study seeks to understand the design of cooperative gamification features for positively influencing motivations and participation of individuals in crowdsourcing.*

This study draws on social interdependence theory (Deutsch, 1949; Johnson, 2003) and previous work about gamification (Deterding, 2011; Huotari and Hamari, 2017) and cooperative games (El-Nasr et al., 2010) to investigate the design of cooperative gamification features and their effects on psychological and behavioral outcomes, by using the case of an innovation community of a large German engineering company. The study presents an exemplary design of a cooperative gamification approach and evaluation results gathered by conducting a controlled experiment and a large field study. Finally, it

[6] This section is based on Morschheuser et al. (2017b)

closes with a discussion on the findings, gathered insights on the design of cooperative gamification, and an outlook on future research.

4.2.2 Design Characteristics and Requirements of Cooperative Gamification Features

According to the conceptualization of cooperative gamification features in section 2.4, two essential design characteristics of cooperative gamification features can be derived:

First, cooperative gamification features *apply goal structures that can invoke positive goal interdependence between two or more individuals*. Second, in accordance with the general conceptualization of gamification (Deterding, 2011; Hamari et al., 2014; Huotari and Hamari, 2017), cooperative gamification features *offer motivational affordances for gameful experiences* (Huotari and Hamari, 2017). The combination of the two describes cooperative gamification features as a unit consisting of the cooperative nature and the expected effects. These characteristics can also be seen as requirements for the design of cooperative gamification features. Research into cooperation, cooperative games, and motivational affordances can help us to further understand these characteristics and to support the design of cooperative gamification features.

Research in the context of social interdependence theory has identified that situations in which individuals cooperate require positive goal interdependence between two or more individuals, in other words, the "amount or probability of a person's goal attainment is positively correlated with the amount or probability of another obtaining his goal" (Deutsch, 2006, p. 24). In such situations, individuals can benefit if they combine their efforts and cooperate. As described above, gamification commonly uses goal-setting and immediate feedback as mechanisms to influence behaviors and psychological outcomes (Hamari, 2013; Hamari et al., 2014; Jung et al., 2010; Mekler et al., 2013; Zuckerman and Gal-Oz, 2014). Studies into in the context of sports (Tauer and Harackiewicz, 2004) or education (Johnson, 2003; Mesch et al., 1988) indicate that situations with positive goal interdependence can be designed by setting *shared goals* or by creating positive correlations between individual goals. Research into cooperative games design (El-Nasr et al., 2010; Rocha et al., 2008) has found that cooperative video games typically implement shared goals by simultaneously providing many players with quests or challenges that can be completed through cooperation in a group. In addition, several design patterns for creating positive correlations between individual goals and for stimulating promotive interactions can be found in cooperative video games (El-Nasr et al., 2010; Rocha et al., 2008). These patterns include for instance *special abilities* (abilities that can only be used to support other players), *complementarity* between players (e.g. abilities that complement each other), *special rules for teams* (e.g. rules that protect users who cooperate), *limited resources* (limitations that encourage sharing), or *intertwined goals* (the setting of different goals, which require mutual support for their achievement) (El-Nasr et al., 2010; Rocha et al., 2008). Empirical studies into these patterns' effects indicate that most of them, especially the setting of shared goals, can have strong effects on enjoyment, excitement, and cooperative behaviors (expressed in the form of active knowledge exchange, mutual assistance, and the development of shared strategies) in several popular cooperative video games (El-Nasr et al., 2010). Similar results have been found by psychological studies about the effects of cooperative goal structures on perceived enjoyment and performance (Tauer and Harackiewicz, 2004). Thus, we assume that design patterns of cooperative games, especially the setting of shared goals, are promising approaches to design cooperative gamification features. The positive effects of the abovementioned cooperative game design patterns on enjoyment (El-Nasr et al., 2010) indicate that the application of these patterns may be suitable to invoke gameful experiences in gamified applications. However, since cooperative game design generally (Liu et al., 2013) and cooperative gamification in particular (Bui et al., 2015; Chen and Pu, 2014; Goh and Lee, 2011) have seen less attention, little is known about the motivational affordances of cooperative gamification features.

Theory of motivational affordances is used in the context of gamification to conceptualize and design gamification approaches (Deterding, 2011; Hamari et al., 2014; Huotari and Hamari, 2017; Jung et al., 2010). This conceptualization highlights that gamification affords a subject opportunities to experience the satisfaction of motivational needs when interacting with a gamified artifact. Based on this theoretical consideration, the gamification literature recommends designing gamification features with the intention to satisfy needs in the way as games commonly do (e.g. focus on mastery, curiosity, or competence satisfaction) (Deterding, 2015; Huotari and Hamari, 2017; Jung et al., 2010). One possible approach to design motivational affordances has been suggested by Zhang (2008a, 2008b), who proposes 10 design principles related to five different motivational sources for the design of motivational affordances. These principles focus on the fulfilling of basic human needs and include design for (1) *autonomy and the self*; (2) *competence and achievement*; (3) *social relatedness*; (4) *power*, *leadership*, *and followership*; and (5) *emotion and affect*. Previous research on gamification has identified *competence satisfaction* as a core factor for the experience of enjoyment in individualistic and competitive gamification approaches (Deterding, 2015; Hamari and Koivisto, 2015a; Jung et al., 2010; Rigby, 2015). The setting of challenging goals and instant feedback are part of Zhang's design principles for *competence and achievement* and are often applied by designers of gamification approaches with the aim to create motivational affordances for gameful experiences (Bui et al., 2015; Deterding, 2015; Hamari et al., 2016a, 2014; Huotari and Hamari, 2017; Jung et al., 2010; Malone, 1981; Rigby, 2015). In cooperative video games, challenging goals are often designed as team challenges that can only be overcome or lead to better results via cooperation and mutual support (El-Nasr et al., 2010; Rigby and Ryan, 2011; Rocha et al., 2008). Research into motivational factors in online multiplayer games indicate that, in addition to *competence*, cooperative games can satisfy the need for *social relatedness* (4) (Rigby and Ryan, 2011; Ryan et al., 2006). Especially s*ocializing* with other players, the desire to form *meaningful relationships* *with others*, and satisfaction from *being part of a group effort* have been identified as key motivational gratifications of players of online games with cooperative features (Scharkow et al., 2015; Yee, 2006).

Thus, we assume that cooperative gamification features may provide motivational affordances for gameful experiences through both competence satisfaction via goal-setting and instant feedback, as well as the experience of social relatedness by means of its social aspects. Therefore, it may be recommended that designers of cooperative gamification features should focus on Zhang's design principles (2008a, 2008b) for *competence satisfaction* (2), but also the principles for *social relatedness* (3), which include the support of human-human interaction and the representation of social boundaries.

4.2.3 Research Design

With the aim to investigate the design of cooperative gamification approaches and their practical application in crowdsourcing systems, we apply the design science research methodology (Hevner et al., 2004; Peffers et al., 2007). Design science research seeks to extend the boundaries of extant research by creating and evaluating new and innovative artifacts that solve practical problems based on theoretical and conceptual knowledge (Hevner et al., 2004). Hevner (2007; 2004) describes design science projects as an "embodiment of three closely related cycles" (Figure 11). First, the relevance cycle, which inputs practical problems of a contextual environment and provides opportunities for field studies. Second, the rigor cycle, which provides grounding theories as well as existing design knowledge and adds new design knowledge from the research to the growing scientific knowledge base. Third, the design cycle, which is the core of every design science project and comprises the iterative construction, evaluation, and refinement of a design artifact. Our project focuses on the practical problem of engaging cooperation and participation in crowdsourcing systems. Following the presented conceptualization of gamification and social interdependence theory (section 2.2), we suggest that cooperative gamification may be an appropriate approach for motivating cooperation in crowdsourcing.

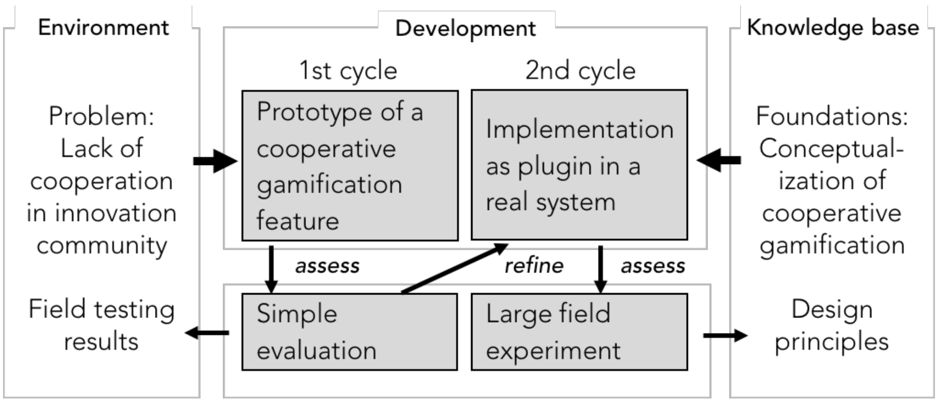


Figure 11. Design Science Research Project (based on Hevner (2007; 2004))

According to the design science research methodology, we build an exemplary instantiation of a cooperative gamification approach as artifact and evaluate it in two design cycles (Hevner, 2007; Hevner et al., 2004). Cycle 1 encompasses the development a functional prototype of the abovementioned theoretical concept of cooperative gamification and its evaluation in a simple experiment. Cycle 2 consists of the instantiation of the developed gamification feature and a long-term evaluation in a field experiment (Figure 11).

Second, during the past few years, activity in this community has decreased noticeably. Third, research into cooperation has identified peer feedback and knowledge exchange (such as comments in an innovation community) as a typical form of cooperative interaction (Johnson, 2003; Pee et al., 2010). Fourth, traditionally, competitive gamification is implemented in innovation communities (Hutter et al., 2011; Jung et al., 2010; Moradian et al., 2014; Scheiner, 2015; Zimmerling et al., 2016), while various studies indicate that cooperative gamification may be more useful than competitive gamification approaches (Björk et al., 2011; Blohm et al., 2011; Hutter et al., 2011; Scheiner, 2015; Ye et al., 2012).

The innovation community we selected gives employees possibilities to submit new ideas and evolve them those over four stages from ideation to realization. By using a comment feature, community members can discuss ideas, exchange knowledge, and rate ideas. Previous studies on innovation communities showed that cooperation by participants in the form of constructive discussions and the sharing of knowledge is crucial for such systems' output quality (Blohm et al., 2011; Franke and Shah, 2003; Sawhney et al., 2005; Ye et al., 2012). For this reason, and by considering research into gamification in innovation communities (Hutter et al., 2011; Kavaliova et al., 2016; Scheiner, 2015; Zimmerling et al., 2016), we assume that a cooperative gamification approach, which increases the motivation to exchange knowledge and to provide peer feedback, can be beneficial for the investigated community. We will now describe the design of a cooperative gamification approach for this community.

4.2.4 Designing a Cooperative Gamification Feature

In order to design a cooperative gamification feature, we followed a two-step approach. First, we conducted interviews with active users of the innovation community, to better understand the context and the target group. Second, we designed a cooperative gamification feature for this community that instantiates the defined design characteristics of cooperative gamification features.

The majority of methods on designing gamification (for overviews, see Deterding, 2015; Morschheuser et al., 2017d) suggest a detailed context and user analysis to comprehensively understand the situation before designing a gamification solution. Thus, we conducted semi-structured interviews with active users of the innovation community. The system administrator carefully selected 15 participants from different hierarchical levels and with different ages, genders, and experience in using the system, in order to represent the entire user population. The interviews were conducted in German during working hours on a voluntary basis, and took 26 minutes on average (for the interview guidelines, see Appendix C). The interview guidelines were grounded in goal-setting (Jung et al., 2010; Landers et al., 2017; Locke and Latham, 1990) and knowledge-sharing (Bock et al., 2005) theories, contained open questions, and focused on concrete use cases in the system. Here, we took a specific look at experiences, individual motivations, and personal problems relating to knowledge-sharing and the discussion of ideas in the innovation community. The results indicate that almost all interviewees that have published ideas wish to get more peer feedback to their ideas, especially in the first stages of the stage-based ideation process. We also identified that the lack of motivation to provide feedback on others' ideas relies mainly on the following perceptions: (1) that inputs are not recognized by others; (2) that feedback has no or little influence on ideas; and/or (3) that using the system is boring and work-related. During our analysis, we identified three user types: (I) users who are generally not interested in supporting others' ideas, (II) users who are motivated to give peer feedback but expect that their contribution will not be recognized, and (III) users who often give feedback and like the possibility to share thoughts, help others, and enjoy socializing in the community. A detailed analysis of these user types showed that community members who are intrinsically interested in an idea are also generally willing to contribute to this idea. Further, the interviews indicate that users who have provided feedback in the past did so with the intention to support the success of ideas and to help the inventors. However, we also recognized that several users of the system who have given feedback often did not perceive themselves as part of a team that develops the idea.

Guided by our theoretical approach and based on the insights from the interviews, we designed a cooperative gamification feature for this innovation community. Several interviewees reported that their contribution behavior is positively linked to the goal to support an idea's success. Thus, we decided to choose an idea's success as the core of our gamification feature. Inspired by the idea that a rocket development could be used as visual metaphor for an idea's development and success, we created a set of graphics that could be used to visualize an idea's success in the community's four-stage ideation process. For stage 0 (the initial setup of a new idea), we used the visualization of an inventor's garage, for stage 1 (ideation) the development of the rocket engine, for stage 2 (maturation) the development of the main body, and for stage 3 (project preparation) the nose and the launching of the rocket (Figure 12, Figure 13). Further, we designed a set of different unlockable visual objects for each of these four visual scenes. We linked the unlockable visual objects of each stage to the writing of comments. If no comments were provided the visualization of the rocket was 'naked', but by writing comments, community members had the possibility to unlock various visual rocket elements, such as color strips, engines, wings, windows, etc., and background elements such as planets, UFOs, a mobile sculpture, robots, etc. (see Figure 13).

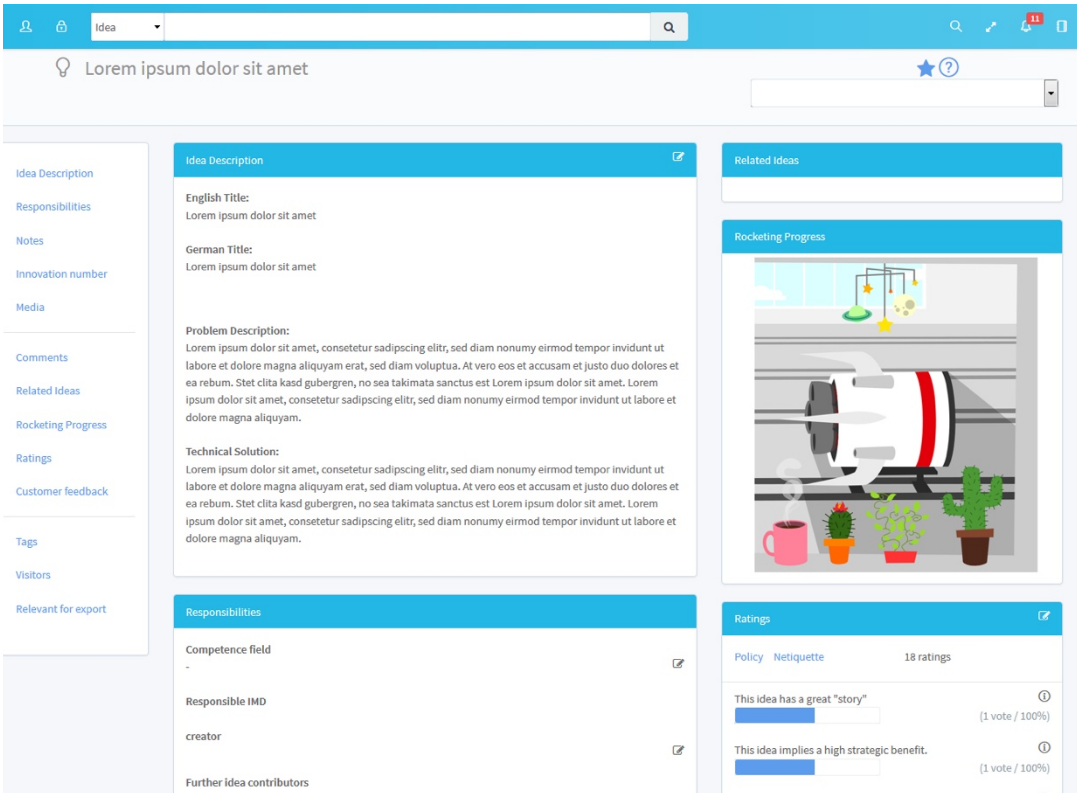


Figure 12. Screenshot of an Idea in the Gamified Innovation Community

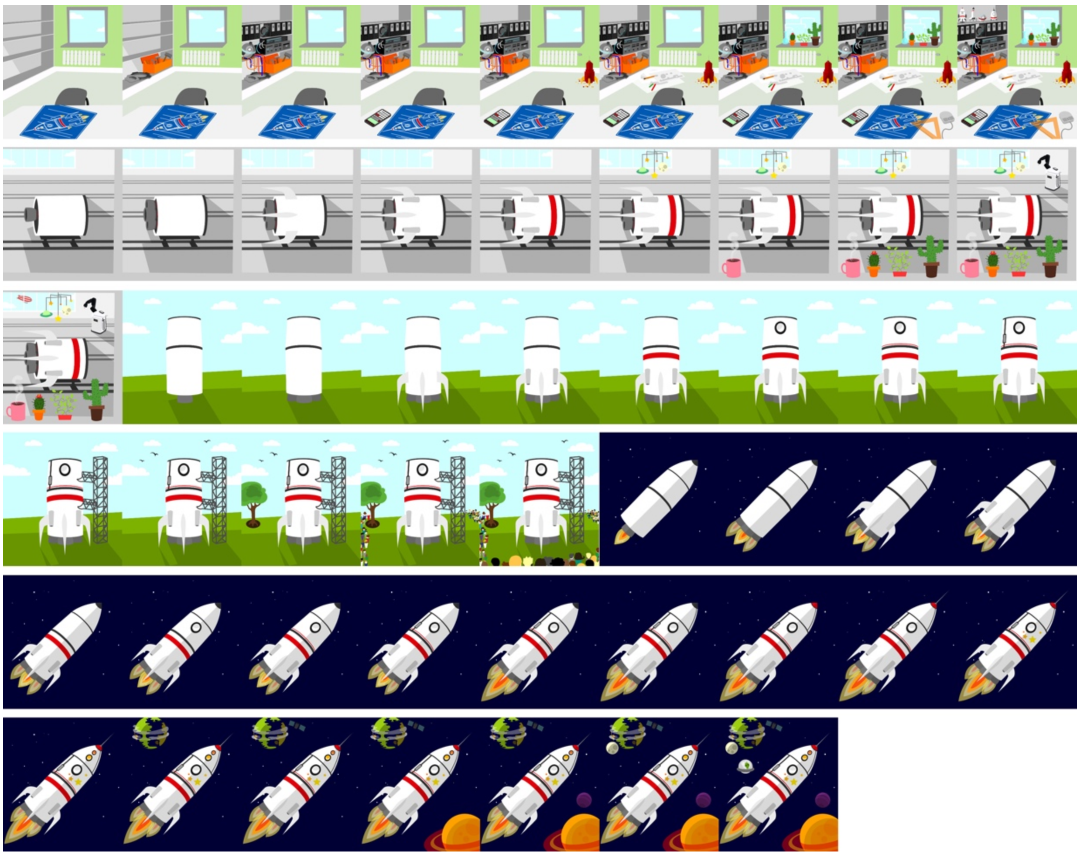


Figure 13. Examples of Unlockable Elements

In other words, we have created a mechanism that rewards the writing of comments for an idea by unlocking visual objects for the visualization of an idea. We assume that the possibility to achieve a 'rich' visualization of an idea could act as a *challenge* and a *shared goal* for users who are interested in this idea's success. The implementation of our mechanism ensured that contribution by different users is required to unlock all visual features of an idea rocket (cf. the *special abilities* pattern of Rocha et al. (2008)). Thus, a rich visualization can only be achieved through cooperation. Based on Johnson (2003, p. 935), positive goal interdependence exists when individuals perceive that they "can attain their goals if and only if the other individuals with whom they are cooperatively linked attain their goals". Therefore, we expect that our gamification feature, which defines a rich visualization of an idea as a clear shared goal and creates mechanism-based mutual dependences between the users, could arouse positive goal interdependence, especially among users who share an affinity for a particular idea and are interested in its public representation.

Further, we followed Zhang's principles (2008a, 2008b) with the aim to design an approach that provides motivational affordances. Zhang recommend the use of *challenging goals* and *instant*, *positive performance feedback* in order to extend information systems with motivational affordances for competence satisfaction. Research into knowledge-sharing indicates that helping others by providing valuable knowledge can be challenging and a source of competence satisfaction, especially in organizational contexts (Lin, 2007; Wasko and Faraj, 2005). Our approach seeks to support this by providing instant positive performance feedback after submitting a comment to an idea. This feedback appears in form of a popup with a short 'thank you' message and the option to unlock one of three randomly selected visual elements for the corresponding idea rocket. Research has shown that the use and promotion of unlockable visual objects as rewards for performing specific activities is a common goal-setting practice in gamification (Hamari, 2017, 2013). Further, Jung et al.'s (2010) study showed that such gamification-based positive performance feedback related to the submitting of comments provides a suitable approach to create motivational affordances for competence satisfaction in innovation communities. Thus, we assume that unlocking visual features by writing comments may offer motivational affordances for competence satisfaction.

To address the need for social relatedness, we designed our gamification feature with the intent to make cooperative behavior clearer and more tangible. According to Zhang's (2008a, 2008b) design principles, we designed the cooperative rocket graphic as a visualization that demonstrates that each individual contribution is part of a group effort. Previous research emphasizes that the perception of being part of a cooperative effort may cause experiences such as social relatedness, social relevance, and – again – competence satisfaction (Rigby and Ryan, 2011; Ryan et al., 2006). Thus, we expect that our approach may provide a motivational affordance for the experience of social relatedness, similar to other cooperative game designs with shared goals (Rigby and Ryan, 2011; Ryan et al., 2006; Scharkow et al., 2015).

To summarize, grounded on the abovementioned theories, we assume that the presented gamification approach fulfils both requirements of cooperative gamification features (Table 17). Consequently, we expect that our designed cooperative gamification feature may increase cooperation in the form of knowledge exchange and peer feedback in the considered community.

Theoretical justification	Derived requirements	Design decisions
Social interdependence theory (Johnson, 2003)	Cooperative gamification features should create situations with positive goal interdependence.	Setting a shared goal that can be achieved by cooperation and the visualization of cooperation progress.
Motivational affordance theory (Zhang, 2008a, 2008b)	Gamification features should provide motivational affordances for gameful experiences.	Providing opportunities for competence satisfaction, as well as the experience of social relatedness.

Table 17. Meta-requirements and Design Decisions

4.2.5 Cycle 1 Evaluation of the Developed Artifact in a Simple Experiment

Following Hevner (2007; 2004), design science research iteratively implements and evaluates design artifacts to investigate a design concept's feasibility and effectiveness for its intended solution. In the first evaluation cycle, we conducted a simple experiment to evaluate the developed cooperative gamification feature. According to Hamari's gamification conceptualization (Hamari et al., 2014; Huotari and Hamari, 2017) and the concept of motivational affordances (Jung et al., 2010; Zhang, 2008a, 2008b), gamification features are typically designed to influence users' motivations and behaviors. Thus, we focused on both the motivational and behavioral effects of our designed cooperative gamification approach.

A gamification approach's motivational outcomes are commonly operationalized by measuring the users' perceived enjoyment in previous research (Hamari et al., 2014; Morschheuser et al., 2016, 2014). Further, recent reviews of empirical studies into gamification (Hamari et al., 2014; Morschheuser et al., 2016) found that perceived enjoyment is typically considered as an indicator for the motivational affordances a gamification approach provides. Especially motivational affordances that promote intrinsic motivation by satisfying innate human needs, such as the need for competence or social relatedness, have been identified as source of enjoyment (Huotari and Hamari, 2017; Ryan et al., 2006; Yee, 2006). Since the abovementioned prototype was designed with the intention to provide motivational affordances for satisfying such intrinsic needs, we assume that *the users' perceived enjoyment is higher with the developed gamification approach than without it* (H1).

In order to operationalize the behavioral intention to participate in our innovation community, we measured the users' *intentions to share knowledge* in the considered community. Several empirical studies indicate that, generally, gamification approaches can have positive effects on participation behavior (Goh and Lee, 2011; Jung et al., 2010; T. Y. Lee et al., 2013; Massung et al., 2013; Morschheuser et al., 2016) and knowledge-sharing (Vasilescu et al., 2014) in similar crowdsourcing and community systems. On the other hand, studies in organizational (Pee et al., 2010) and educational (Johnson, 2003) contexts indicate that promotive interactions, such as knowledge-sharing (Johnson, 2003; Pee et al., 2010), are typical outcomes of positive goal interdependence. The gamification approach we present has been designed with the intention to support positive goal interdependence and engage cooperative behavior in the form of peer feedback and knowledge exchange. Thus, we propose that the *developed cooperative gamification approach will increase the intention to share knowledge in the considered innovation community* (H2).

Participants and Procedure

We developed a complete new user interface for the considered innovation community so as to minimize the novelty effects of a solely gamification plugin. Based on this interface, we created two versions, one with gamification (treatment T) and one without (control C). We carried out the experiment in a meeting room at our partner company with current users of the innovation community. Fifty users were selected by the system administrator and were invited to participate in voluntary individual sessions of 60 minutes during working hours. Finally, 42 participated. We randomly divided the participants into a treatment group and a control group, with 21 participants each. We performed the experiment on a computer, opening one of the two implemented versions. Participants of the treatment group started with a predefined set of ideas on the screen. We asked them to select an interesting idea and to comment on it. In this context, the cooperative gamification feature (the rocket) was visualized next to the idea. After posting a comment, the participants were informed by a popup about the unlocked rocket feature and were able to witness the sequence-change of the rocket visualization. During the experiment, this task was repeated with other ideas, in order to demonstrate that further parts can be unlocked for the rocket. Next, we asked the treatment group participants to submit a new idea. Finally, the profile page was shown to the users, where in the gamified version, the personal achievements (e.g. overview of supported rockets, a score that represents the personal contribution performance and unlocked badges) could be explored. The control group participants followed a comparable process in which they searched for an idea, selected one, comment on it, and submitted a new idea. Finally, their profile pages in the new interface design were also demonstrated.

Measures

We collected all data using a digital questionnaire immediately after the simulation. We collected demographic information, experience level with the analyzed community (five-point Likert scale very low to very high), and frequency of use (five-point Likert scale very seldom to very often) as control variables. In order to validate the experiment's realism, we asked the participants to rate the experiment's perceived realism with two items *"I think the simulation was realistic"* and *"I believe it is likely that I execute the simulated activities during work"* (Webster and Sundaram, 1998) on a seven-point Likert scale (strongly disagree to strongly agree). Differences between the two groups were measured by eight items in the questionnaire (Table 18), which asked for perceived enjoyment (four items) and knowledge-sharing intention (four items) on seven-point Likert scales (strongly disagree to strongly agree). All items were based on previously published research and were asked in random order.

Perceived enjoyment	based on Hamari (2015b)
I find the experience of using the innovation community enjoyable.	Cronbach's α = 0.792
I find the experience of using the innovation community pleasant.	
I find the experience of using the innovation community exciting.	
I find the experience of using the innovation community interesting.	
Knowledge-sharing intention	based on Bock et al. (2005)
I intend to provide my information about manuals, methodologies, and models to members of the innovation community more frequently in the future.	Cronbach's α = 0.917
I intend to share my experience or know-how with other members of the innovation community more frequently in the future.	
I intend to provide my 'know-where' and 'know-whom' to other members of the innovation community more frequently in the future.	
I will try to share my expertise from my education or training with other members of the innovation community more often.	

Table 18. Questionnaire Constructs, Corresponding Items, and the Constructs' Reliability

Age	**< 30**	**30 to 39**	**40 to 49**	to 60	**> 60**
#	C: 2, T: 2	C: 9, T: 13	C: 6, T: 6;	C: 4, T: 0	0

Table 19. Participant Ages

Results

Age (Table 19), gender (each group 4 females, 17 males), experience levels with the analyzed community (mean C: 3.09, T: 3.14), and frequency of use (mean C: 2.83, T: 2.85) was homogeneously distributed in the two groups. The application of Pearson's chi-squared tests found no significant difference between the two groups.

We conducted Mann-Whitney tests to investigate the effects of gamification on the dependent variables, according to H1 and H2. For perceived enjoyment and knowledge-sharing intention, the medians were higher in the group with gamification, and the tests showed one-tailed significant differences between the control group and the treatment group (Table 20).

The experiment's realism was rated high, with a median value of six for each group and item, which is equal to *I agree*. This gives an indication that the participants perceived the experiment as realistic, which supports the evidence of the measured effects. We assessed the dependent variables' internal consistency by computing Cronbach's alpha coefficients for each of the constructs. Both (0.792 and 0.917) showed an acceptable internal consistency (Table 18).

Dependent variables		**Perceived enjoyment**			**Knowledge-sharing intention**		
	n	M	SD	p	M	SD	p
Control	21	5	1.4	0.000**	4	1.4	0.001*
Treatment	21	6	1.1		5	0.9	
M = median (1 = low; 7 = high); * exact p < 0.01; ** exact p < 0.001 (1-tailed).							

Table 20. Results

These findings indicate that the analyzed gamification approach increases the intrinsic motivations (perceived enjoyment) of users of the innovation community. This result is in line with numerous gamification studies (e.g. Hamari and Koivisto, 2015b; Koivisto and Hamari, 2014; Morschheuser et al., 2014) (for a review, see Hamari et al., 2014) and is typically interpreted as a psychological outcome of the motivational affordances a gamification approach provides (Hamari et al., 2014; Huotari and Hamari, 2017; Morschheuser et al., 2016). Thus, it could be assumed that the presented cooperative gamification approach enriches the innovation community with motivational affordances. Further, we measured a significant increase in knowledge-sharing intention in this innovation community. This indicates that the developed gamification approach can indeed increase community members' motivation to exchange knowledge, provide peer feedback, and support other community members in the development of their ideas.

4.2.6 Cycle 2: Instantiation and Evaluation of the Developed Artifact in a Field Experiment

To increase our results' external validity and in order to evaluate the long-term effects of the developed gamification feature, we implemented the feature as functional plugin in the considered innovation community and examined the feature's effects on user behaviors in a field experiment. By conducting an experiment in a real system rather than in a laboratory setting, we were able to measure de facto usage of the system and avoid using self-reported data, which could bias results (Donaldson and Grant-Vallone, 2002; Koivisto and Hamari, 2014).

Based on observations during the first study, we made several small usability optimizations prior to the field experiment. First, we optimized the selection process of rocket features in order to make this reward more conscious. In the new selection dialog the users were able to select one of three random rocket elements visually and then click a 'select' button to add the selected feature to the rocket (Figure 14). Second, we added an information button below the rocket visualizations, in order to give users the possibility to get a brief explanation of the feature (Figure 15). Third, besides the writing of comments, we also allowed users to unlock rocket features by rating an idea, since this was mentioned as a possible improvement by various experiment participants. Fourth, we tested and optimized the browser-specific representation of the cooperative gamification feature, to ensure its usability in all popular browsers.

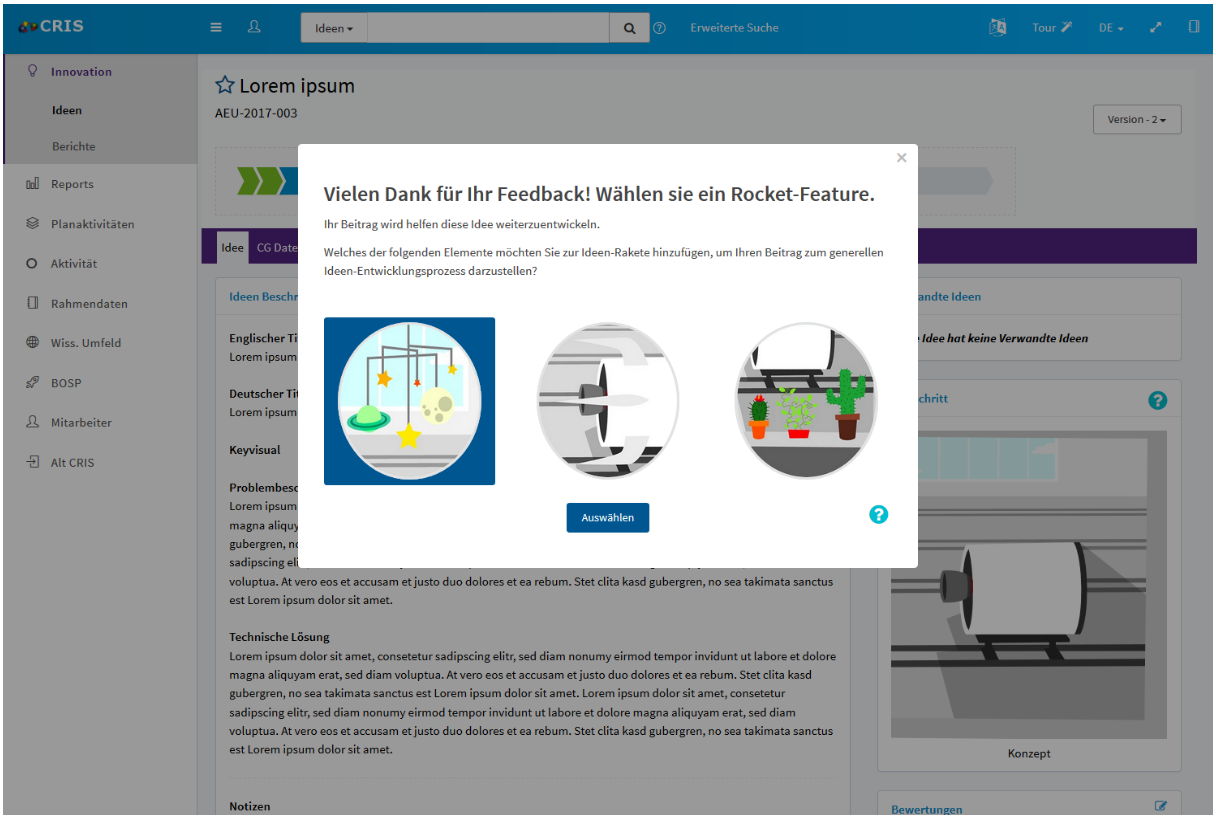


Figure 14. Dialog for Selecting Rocket Features

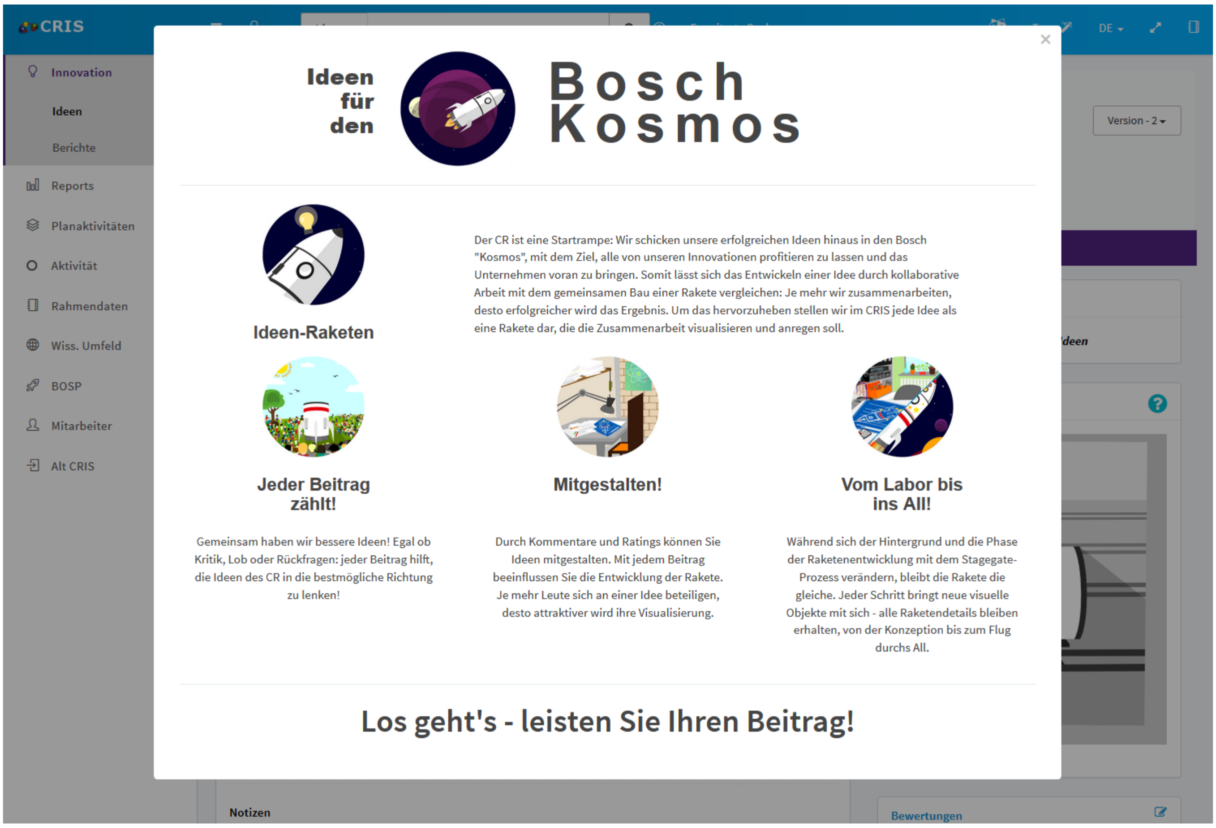


Figure 15. Explanation of the Gamification Feature in the System

Participants and Procedure

We conducted the field experiment in the innovation community of our partner company, as part of a comprehensive rollout of a newly developed user interface for the community. Overall, 1,400 users had access to the system. 80% of the users were male and 20% female and on average 41 years old. 89.6% of the users were located in Germany, 6.5% in the US, 3.6% in Asia-Pacific and 0.4% in Russia. The system administrator divided all the system users into two groups of equal sizes – a group with the gamification feature (treatment T) and a group without it (control C). Based on the workers' council regulations and to achieve homogenous experiment groups, the allocation was done based on an anonymized list of employee identities, which were clustered along the organizational structure in departments and teams. To ensure that users that work together were in the same experiment group, the system administrator ensured that users of a team were assigned to the same experiment group. However, for homogenous distribution, the system administrator also ensured that teams of one department where present in both experiment groups.

By sending a newsletter, all users of the innovation community were informed about the new user interface. A link allowed users to access the new user interface, while the old interface could still be used by the users during the entire experiment. Users of the treatment group who accessed the new user interface could see and interact with the gamification feature, as described above. Users of the control group could also access the new user interface, but without the gamification feature.

The experiment was designed as a long-term study to allow the identification of possible novelty effects of gamification (Kawajiri et al., 2014; Koivisto and Hamari, 2014). Thus, we collected data of one year, between July 2016 to end June 2017.

Measures

The experiment sought to investigate the cooperative gamification feature's effects on the users' participation in cooperative efforts. In the considered setting, we operationalized the participation as the users' supportive and promotive interactions (Johnson, 2003), measured as the number of comments per user, the number of ratings per user on users' ideas in the innovation community' new interface. Further, we collected the number of ideas created by users and how often a user viewed ideas in the innovation community's new interface to be able to compare the comment and rating behaviors with general system usage.

Results

During the study period, 1,183 users viewed at least one idea in the new user interface. The number of ideas published by users in the new interface was homogenous in both groups. In the gamification group, (T) 195 ideas were created by 115 users; in the control group, (C) 200 ideas were submitted by 130 users.

However, we identified large differences in the users' participation in the discussion and rating of ideas between the gamified and non-gamified versions. In the gamified version, users shared 55% more comments on ideas than in the control group without gamification (T: 70 comments, C: 45 comments) and rated 58% more ideas compared to the non-gamified version (T: 90 ratings, C: 57 ratings). Figure 16 provides an overview of the overall user participation, including comments and ratings (the values have been normalized between 0 and 1 before summation). The figure shows that, in most of the months, the gamification group wrote more comments and rated more ideas compared to the group without gamification (Jun, Jul, Oct, Nov, Dec, Jan, Feb, Mar). However, participation did not seem to have increased as much as system usage. While the overall usage of the new user interface steadily increased over the year and more users began to use the new interface (instead of the old one), the interaction with the comment and rating functions did not increase to the same extent. However, several peaks in the gamification group's participation (Jul, Oct, Nov, Feb) could be identified that interrelate with peaks in the overall system usage. This suggests that the gamification function may have had a positive effect on some users of the new interface in the gamification group, but also that this possible effect only lasted for a short time (Koivisto and Hamari, 2014).

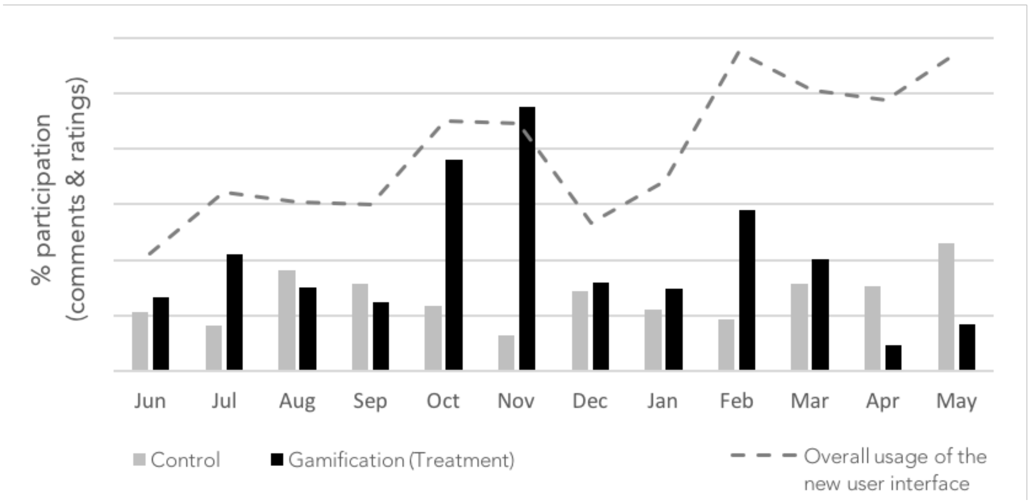


Figure 16. Overall User Participation (ratings and comments, normalized) with the Gamified and Non-gamified Versions, as well as Overall User Interface Usage (system usage)

Table 21 provides a detailed overview of the descriptive statistics of both groups. The data indicated that while almost the same number of users wrote at least one comment or one rating in both groups, users of the gamified version were more likely to write additional comments and rate more ideas. The data also showed that the participation generally followed a heavy tailed distribution with a high right-side skewness. This phenomenon is typical for participation in online communities and crowdsourcing approaches (Ortega et al., 2008; Varshney, 2012), which commonly follow Nielsen's participation inequality rule (Nielsen, 2006).

Variables	**Comments**					**Ratings**					**Total** (ratings and comments)				
	N	M	SD	Mx	Sk	N	M	SD	Mx	Sk	N	M	SD	Mx	Sk
Control	36	1.3	0.6	3	2.2	29	2.0	2.5	13	3.5	52	2.0	2.4	16	4.3
Treatment	32	2.2	3.3	19	4.5	28	3.2	6.2	33	4.5	50	3.2	5.6	35	4.4
N = number of users with at least one comment/rating; M = mean; SD = standard deviation; Mx = maximum; Sk = skewness.															

Table 21. Descriptive Statistics

Owing to the large variability in the data, parametric tests were not effective for comparing differences between the groups. According to Engmann and Cousineau (2011), k-sample Anderson-Darling tests are recommended when analyzing heavy-tailed distributed data, with differences in the tail ends. Thus, we conducted k-sample Anderson-Darling tests (Scholz and Stephens, 1987) to analyze whether the measured differences between the two groups were significant and found that users of the gamification version wrote significantly more comments compared to users of the control group (Anderson-Darling test statistic: 1.428; $p = 0.08 < 0.1$). However, the identified differences in the ratings between the groups were not significant (Anderson-Darling test statistic: -0.150; $p > 0.1$).

4.2.7 Discussion

In this study, we examined the design and the effects of cooperative gamification features. Following design science methodology (Hevner, 2007; Hevner et al., 2004), we derived meta-requirements for the design of cooperative gamification features and developed an exemplary cooperative gamification approach for an innovation community of a large German engineering company. Further, we evaluated the developed artifact in two experiments, a controlled, survey-based experiment and a field experiment. The results justified the applied design decisions and provide insights on the effects of cooperative gamification approaches.

Specifically, we found that people using the designed cooperative gamification approach reported a higher enjoyment level (intrinsic motivation) and a higher knowledge-sharing intention, compared to the users of the non-gamified version. By conducting a field experiment, we further showed that users of the cooperative version wrote significantly more comments in the gamified community than users of the non-gamified version. According to social interdependence theory, the results, particularly the higher knowledge-sharing intention (Johnson, 2003) and the higher participation in the gamified version, indicate that our developed cooperative gamification feature may indeed have induced a positive goal interdependence between the users. Based on these findings, we assume that the presented gamification approach fulfills the derived meta-requirements and represents an example of cooperative gamification.

The study findings extend previous research. First, to our best knowledge, this is the first study that considers the design of explicit cooperative gamification features. While previous gamification research has continuously focused the design and investigation of individualistic or competition-based gamification, this study has filled a gap in current gamification research (Bui et al., 2015; Liu et al., 2017). We identified cooperative goal structures that invoke positive goal interdependence between two or more individuals, as well as features that offer motivational affordances for gameful experiences, as design requirements of designing cooperative gamification features. The findings indicate that adherence to these principles can indeed support the design of a cooperative gamification feature with positive effects on motivations and behaviors.

Second, the study's empirical findings indicated that enriching information and communication technologies with gamification that promote shared goals could support cooperation (Peng and Hsieh, 2012). The study emphasized the role of goal structures in gamification and paved the way for a more frequent use of shared goals instead of competition or individualistic goals in gamification research. Further, the study suggested that gamification features can influence how individuals are interdependent in a social environment. Accordingly, the investigation of gamification designs should not be limited to disjointed components, such as points, badges, and/or leaderboards (cf. Hamari et al., 2014), but should considered holistically (Morschheuser et al., 2017d), including the goal structures and interdependencies a gamification feature invokes in a specific environment.

Third, the study results supplement earlier gamification research, which has highlighted that differences exist in how people perceive gamification features and that novelty effects commonly have a strong influence (Koivisto and Hamari, 2014). Similar to previous research, the results indicated that only a few people were engaged by the developed gamification feature, and the engagement seems not to have correlated with the overall system usage. Thus, future research should carefully consider the moderating roles of personality traits (Bartle, 1996; Hamari and Tuunanen, 2014; Koivisto and Hamari, 2014) on gamification features and differences in the perceptions of for instance cooperative and competitive gamification features.

Practical Implications

The study's empirical results indicated that the motivations and participation of users in cooperative efforts, such as the development of ideas in innovation communities or the creation of emergent artifacts with crowdcreating, can be positively influenced by cooperative gamification. Thus, practitioners who seek to enhance motivations and behaviors in cooperative environments should consider the use of cooperative gamification. The application of patterns of cooperative games (El-Nasr et al., 2010; Rocha et al., 2008), such as shared goals and cooperative game mechanics, as well as principles for designing motivational affordances (Zhang, 2008a, 2008b) seems apt for supporting the design of cooperative gamification features. Our approach can act as a guideline for designing such features. This study has broken ground and has advanced the understanding of the design of cooperative gamification; however, this understanding is still in its early development. Future research that continues the thoughts of this study is needed to estimate the full potential that is hidden in cooperative gamification approaches. Further, comparative studies that compare cooperative, competitive, and individualistic approaches are needed for better evaluate these possibilities.

Limitations and Future Research

Although the study provides some reasonable indications for possible effects of cooperative gamification, the small sample size and the generalizability of the two experiments are limitations of the study. Research is needed to investigate the design and the effects of cooperative gamification features across different contexts and to understand the differences between different gamification feature types. Nonetheless, we are convinced that the approach presented in this study has extended the boundaries of current gamification research (Bui et al., 2015). The developed artifact demonstrated that cooperative gamification can be an interesting alternative, especially for application scenarios where practitioners aim to support cooperation, such as crowdsourcing platforms, innovation communities, co-creation approaches and other contexts of computer-supported cooperative work. With an eye on the great success of cooperative approaches in massive multiplayer online games (Chen et al., 2008; Cole and Griffiths, 2007; El-Nasr et al., 2010; Islas Sedano et al., 2013; Nardi and Harris, 2006; Scharkow et al., 2015; Yee, 2006), cooperative gamification could be emphasized as a promising but under-researched area. Thus, we trust that the presented study will encourage other researchers to develop and investigate cooperative gamification approaches.

4.3 Study III: Differences Between Cooperative and Competitive Gamification in Crowdsourcing[7]

4.3.1 Introduction

During the past decade, advances in modern information and communication technologies have enabled novel forms of economic coordination of under-utilized resources be it human capital, information goods, material goods, or even funding. Perhaps the most noteworthy Internet-based developments that have made resource coordination more effective in recent years are crowdsourcing (Estellés-Arolas and González-Ladrón-de-Guevara, 2012; Howe, 2006; Prpić et al., 2015a), crowdfunding (Agrawal et al., 2014), and the sharing economy (Hamari et al., 2016b; Sundararajan, 2016). Crowdsourcing in particular commonly uses the Internet to simplify the coordination of human capital and to employ the 'crowd' – a mass of people reachable via the Internet (Brabham, 2013; Estellés-Arolas and González-Ladrón-de-Guevara, 2012; Howe, 2006; Nakatsu et al., 2014) – for distributed cooperative problem-solving (Brabham, 2013; Doan et al., 2011; Prpić et al., 2015a). Especially crowdsourcing initiatives where large groups of people explicitly work together to jointly create solutions (Doan et al., 2011) has drawn attention in recent years. Popular examples, such as Wikipedia (a crowd-generated comprehensive online encyclopedia), OpenStreetMap (a crowd-generated digital world map), Waze (a navigation system with real-time, crowd-generated traffic information), TripAdvisor (an online portal for crowd-generated reviews of hotels, restaurants, and travel locations) Yelp (a crowd-generated world-

[7] This section is based on Morschheuser et al. (under review)

spanning business directory), or Ingress (an augmented reality game with a crowd-generated database of landmarks and public art) have spawned comprehensive crowd-created solutions that have made our lives easier (Budhathoki and Haythornthwaite, 2013; Geiger and Schader, 2014; Haklay and Weber, 2008; Levina and Arriaga, 2014; Morschheuser et al., 2017d; Nakatsu et al., 2014; Nov, 2007; Prpić et al., 2015a; Takahashi, 2014). Inspired by these successful approaches, many organizations are now attempting to harness the collective potential of crowds in order to face the increasing need for extensive databases as part of the emerging digitalization. This includes initiatives such as the crowd-based collecting of data for smart cities (Cardone et al., 2013), the crowd-creation of ground truths for machine learning approaches (Rosani et al., 2015), or the distributed gathering of location-based data to enable autonomous driving (Hu et al., 2015).

However, any crowdsourcing initiative's success strongly depends on the willingness of a reserve of people to participate in collective value creation (Brabham, 2013; Doan et al., 2011; Law and Ahn, 2011). The design of appropriate incentive mechanisms that get people to participate in crowdsourcing and motivate active crowdsourcees to invite others via word of mouth is thus of great relevance for the designers and operators of crowdsourcing initiatives (Kaufmann et al., 2011; Zhao and Zhu, 2014a, 2014b). Studies have shown that extrinsic incentives, such as financial compensations or utilitarian benefits that arise from the purpose of a crowdsourcing initiative, often play a subordinate role in crowdsourcees' motivations (Kaufmann et al., 2011; Soliman and Tuunainen, 2015; Zhao and Zhu, 2014b). Various studies indicate that crowdsourcees are driven by intrinsic aspects, such as altruism, the sense of accomplishment, self-development, curiosity, competence satisfaction, or relatedness with a community of peers (Kaufmann et al., 2011; Lakhani and Wolf, 2005; Nov, 2007; Nov et al., 2010; Soliman and Tuunainen, 2015; Zhao and Zhu, 2014b).

Therefore, crowdsourcing systems are increasingly *gamified* (Hamari et al., 2014; Morschheuser et al., 2017a, 2016), that is, designers enrich crowdsourcing systems with design features from games that address humans' innate intrinsic needs in order to positively influence the intrinsic motivation of people towards participating in crowdsourcing systems and their behaviors (Hamari and Koivisto, 2015b; Morschheuser et al., 2017a). While literature reviews have revealed that crowdsourcing is one of the most popular application areas of gamification (Hamari et al., 2014), and while most implementations of gamification seem to positively influence crowdsourcees' motivations and behaviors (Table 11), there is a lack of comparative studies across different gamification designs. The research has primarily investigated the differences between gamified and non-gamified crowdsourcing (Brito et al., 2015; Massung et al., 2013; Prandi et al., 2016) or the effects of a specific gamification feature (Bowser et al., 2013; Pothineni et al., 2014); however, the differences between various gamification design features and particularly the effects of features that invoke different goal structures such as competition, cooperation, and inter-team competition have been largely ignored in gamification (Bui et al., 2015; Liu et al., 2017) and game design research (Liu et al., 2013). This knowledge gap prevents us from designing gamification that optimally harnesses the full potential of the crowd. Thus, while there is clear potential to use gamification in crowdsourcing applications, more granular research result would afford more effective gamification designs for crowdsourcing and similar systems where people cooperatively create emerging outcomes.

To address these gaps, this study investigates *how crowdsourcees' intrinsic and extrinsic motivations, behaviors (system usage, crowdsourcing participation, engagement with the gamification feature)* and *willingness to recommend crowdsourcing approaches are influenced by the use of cooperative, competitive, and inter-team competitive gamification in crowdsourcing systems.*

Therefore, this study draws on the above introduced conceptualization of cooperative, competitive, and cooperative-competitive gamification (section 2.4) and investigates their effects on crowdsourcees' motivations and behaviors by conducting a large field experiment with a gamified crowdsourcing application called *ParKing*, which has been developed for the purpose of this research. Pursuing this research advances the understanding of competitive and cooperative settings in gamification and provides design knowledge relating to orchestrating competition and cooperation, especially in context of gamified crowdsourcing as well as in related fields.

4.3.2 Related Work and Theoretical Foundations

Gamification in Crowdsourcing

As introduced above, crowdsourcing harnesses the potential of the Internet to reach large groups of people – the so-called *crowd* (Brabham, 2013; Doan et al., 2011; Estellés-Arolas and González-Ladrón-de-Guevara, 2012; Howe, 2006) – and involve them in distributed problem-solving. Crowdsourcing has become popular in recent years as organizations have begun to increasingly employ the crowd instead of traditional employees or supplies (Doan et al., 2011; Gatautis and Vitkauskaite, 2014; Geiger and Schader, 2014; Zuchowski et al., 2016).

A particular type of crowdsourcing is *crowdcreating*, where large groups of crowdsourcees explicitly work together to create emerging solutions (e.g. cooperatively created databases or repositories such as Wikipedia, Yelp, OpenStreetMap, or TripAdvisor) (Doan et al., 2011; Geiger and Schader, 2014). Such crowdsourcing systems appear in various manifestations and involve open collaboration (Prpić et al., 2015b) and mass collaboration approaches (Doan et al., 2011; Tapscott and Williams, 2010). Since an active crowd with many participants is crucial for any crowdsourcing initiative, we need to understand the design aspects and incentives that are capable to sustainably engage large groups of people (Brabham, 2013; Doan et al., 2011; Law and Ahn, 2011; Zhao and Zhu, 2014a).

Although crowdsourcing systems are among the most popular application areas of gamification (Hamari et al., 2014; Morschheuser et al., 2017a, 2016; Seaborn and Fels, 2015), the comparison of different gamification designs and particularly the comparison of competitive, cooperative, and inter-team-competitive gamification features have been largely ignored by previous research. Further, using gamification to engage explicit cooperation between crowdsourcees has been less researched, even though cooperative value creation is a key aspect of crowdsourcing, especially in crowdcreating (Doan et al., 2011; Geiger and Schader, 2014; Morschheuser et al., 2017a). Table 22 provides an overview of studies on the gamification of crowdsourcing systems that seek to collectively create emerging outcomes such as in crowdcreating, based on Morschheuser et al. (2017a).

Name of the example (source)	**Purpose of the example**	**Type of implemented gamification features**	**Results of the study on gamification**
Biotracker (Bowser et al., 2013)	Generating a database with plant phenology data	Competitive (leaderboard with the most active users) and individualistic (individual badges that could be unlocked)	Quantitative study: Significant correlations between perceptions of the gamification features and continued uses and participation intentions.
CampusMapper (Martella et al., 2015)	Creating a database/map with geospatial data	Competitive (conquer virtual territories; a leaderboard) and individualistic (individual points, badges, and levels)	Qualitative study: Participants preferred gamified version over a non-gamified version.
Close the door (Massung et al., 2013; Preist et al., 2014)	Generating a map with shops that close their doors during cold weather to reduce energy waste	Competitive (leaderboard with most active users) and individualistic (individual badges)	Mixed-method study: Gamification increases performance but not significantly compared to a non-gamified version. Competitions can be demotivating when poorly designed.
Geo-Zombies (Prandi et al., 2016)	Creating an interactive map with urban impediments for people with disabilities	Individualistic (collecting ammunitions to stay alive while fighting zombies on a map)	Mixed-method study: The gamified version led to a significant higher participation than the non-gamified version. Users perceived the app as more engaging than HINT! and were more willing to change their normal behaviors.
HINT! (Prandi et al., 2016)	Creating an interactive map with urban impediments for people with disabilities	Individualistic (collecting image parts of a puzzle; when completed, the image can be used as a voucher)	Mixed-method study: The gamified version led to a significant higher participation than the non-gamified version.
Ingress (Morschheuser et al., 2017c; Sheng, 2013)	Creating an interactive map with landmarks and locations of public art	Inter-team competitive (two factions that fight each other; conquer virtual territories for your team) and individualistic (individual badges)	Preliminary (poor or no empirical results).
Knome (Pothineni et al., 2014)	Creating a corporate knowledge database	Individualistic (performance points) and cooperative (karma / reputation points)	Quantitative study: Gamification can influence contributions and user behaviors.
REfine (Snijders et al., 2015)	Collaborative requirement elicitation and refinement	Mainly competitive (several leaderboards on which users can compete; limited coins/resources that can be spent to perform actions and earn points)	Qualitative study: Gamification seems to be effective for increasing engagement compared to traditional approaches.
Urbama (De Franga et al., 2015)	Generating an interactive map with real-time traffic events, restaurant ratings, and weather information	Competitive (leaderboards) and individualistic (self-representation with avatars; points; levels; medals)	Quantitative study: Participation increased with gamification features compared to the period without the features.
WikiBus (Brito et al., 2015)	Creating an interactive map with real-time information about public transportation	Mainly individualistic (individual challenges; ownership of locations; individual points)	Preliminary (poor or no empirical results).

Table 22. Gamified Crowdsourcing Approaches with Emergent Outcomes

Since the implemented game designs differ greatly across individual studies, the extant studies' results are hardly comparable. Thus, we lack a comprehensive understanding which gamification feature types (e.g. cooperative vs. competitive features) are most effective to influence crowdsourcees' motivations and behaviors in crowdsourcing, particularly in crowdcreating with emergent outcomes.

Theoretical Underpinning
Research into why people participate in different initiatives and carry out given activities generally lean on the notion and theory that motivations can be chiefly categorized into *intrinsic* and *extrinsic*. Intrinsic motivation refers to a person's desire to take part in an activity for its own sake, while an extrinsic motivation refers to behavior driven by a person's expectation to receive external rewards or utilitarian benefits (Deci, 1975; Deci and Ryan, 1985; Ryan and Deci, 2000). This conceptualization mainly stems from self-determination theory (Deci and Ryan, 1985; Ryan and Deci, 2000), which is canonically repeated in different variations in the technology adoption literature (Davis, 1989; Van der Heijden, 2004; Venkatesh et al., 2003), consumption theory (Hirschman and Holbrook, 1982), and media consumption theory, especially the uses and gratification theory (Katz et al., 1973). Therefore, the focus of what benefits people derive from the use of technology and what motivates them to use technology can be generally categorized into two broad main areas of 1) intrinsic/hedonic/enjoyable and 2) extrinsic/utilitarian/useful. In the context of crowdsourcing systems, several studies found that both intrinsic and extrinsic factors determine users' *participation* in crowdsourcing systems (Kaufmann et al., 2011; Nov, 2007; Nov et al., 2010; Soliman and Tuunainen, 2015; Zhao and Zhu, 2014b), suggesting that while people may pursue extrinsic utility from participating in crowdsourcing, they also seem to derive intrinsic benefits such as enjoyment from the activity. Self-determination theory claims that we perform better when we are intrinsically motivated and when an activity is autotelic, i.e. when we feel competent, autonomous, and connected to others. Thus, the gamification of crowdsourcing has been considered a fruitful avenue to pursue in attempts to enrich crowdsourcing systems with the goal to positively influence crowdsourcees' intrinsic motivations and therefore their behaviors (Morschheuser et al., 2017a).

However, *gamification* is a manifold design direction (Deterding, 2015; Morschheuser et al., 2017d), and different kinds of implementation of gamification and the *goals* gamification promote can lead to different motivational effects and behavioral outcomes (Hamari et al., 2014; Huotari and Hamari, 2017; Morschheuser et al., 2017a; Ryan et al., 2006). *Goals* have always been considered as a key design aspect of games and gamification (Deterding, 2015; Huotari and Hamari, 2017; Malone, 1982, 1981; Sweetser and Wyeth, 2005; Von Ahn and Dabbish, 2008). The structure and types of goals used determine whether a game is cooperative or competitive (Chen and Pu, 2014; Liu et al., 2013; Morschheuser et al., 2017b; Plass et al., 2013; Siu et al., 2014), i.e. how players are interdependent of one another and interact with each other in a game or a gamified environment. In social science, social interdependence theory (Johnson, 2003; Johnson and Johnson, 1989) is widely used to explain how an environment's goal structures influence the interaction of individuals, such as whether they act individualistically and/or whether they cooperate or compete. This theory has also applied to the context of video games to distinguish between *individualistic*, *cooperative*, *competitive*, and *inter-team competitive* game designs (Liu et al., 2013; Plass et al., 2013; Morschheuser et al., 2017c). As introduced above (section 2.4), game designs can be classified as (1) *individualistic* when the goals of players are independent and individual actions have no effect on other players (no interdependence; e.g. single-player game designs); (2) *competitive* when goals are negative correlated and individual actions obstruct the goals and actions of others (negative interdependence; e.g. competitions in which player compete with each other); (3) *cooperative* when several players have a shared goal and individual actions promote the goals and actions of others (positive interdependence; e.g. shared challenges for a team of players); and (4) *inter-team competitive* when groups of players compete with other groups and thus several players share the goal to jointly obstruct the goals and actions of others (mixed; e.g. team competitions) (Liu et al., 2013; Peng and Hsieh, 2012; Tauer and Harackiewicz, 2004). Since gamification approaches apply the same goal structures as games (Deterding, 2015), this conceptualization has been also applied to classify gamification designs and their features (Morschheuser et al., 2017b).

According to prior research, gamified crowdsourcing systems commonly apply game design features such as leaderboards or rankings to invoke competitions between crowdsourcees, combined with individualistic game design features such as private badges, points, or levels to provide additional motivational affordances (Morschheuser et al., 2017a). This seems to also be the case in crowdsourcing types where people are supposed to explicitly work together (Table 22) (Morschheuser et al., 2017a). However, inter-team competitions (4) or cooperative gamification (3) may be also fruitful gamification avenues for such crowdsourcing initiatives (Table 22). Thus, there is a clear research gap in investigating which type of interdependence between crowdsourcees prompted by goals set by gamification are optimal for crowdsourcing performance. While the implementation of all four different goal structures have been used in crowdsourcing initiatives (Table 22) (Morschheuser et al., 2017a; Seaborn and Fels, 2015), we still lack empirical research into their effects and differences.

Social interdependence theory indicates that competition or cooperation between people can influence people's intrinsic motivations and behaviors in several ways (Johnson and Johnson, 1989). Research conducted on the psychological effects of competitions stressed that competitions are enjoyed by individuals owing to their great potential to satisfy a person's innate need for competence (Tauer and Harackiewicz, 2004; Zhang, 2008a). Competitions provide difficult challenges whose mastery can convey a strong sense of competence and afford performance feedback for direct competence valuation (Jung et al., 2010; Zhang, 2008a). Together, these aspects of competitions can give rise to intrinsic motivations and feelings, such as enjoyment (Epstein and Harackiewicz, 1992; Tauer and Harackiewicz, 2004) and flow (Csikszentmihalyi, 1990), as has often been shown in research on competition in games (Liu et al., 2013; Ryan et al., 2006). However, competitions can also have demotivating effects when opponents are unbalanced (e.g. skilled players compete against novices with little experience of a game) (Ipeirotis and Gabrilovich, 2014; Liu et al., 2013). Particularly in the context of gamified crowdsourcing previous research indicates that pure competitive structures can demotivate users with medium and low contributions when they directly compete with a small group of high-performing crowdsourcees (Massung et al., 2013; Preist et al., 2014).

Cooperative goal structures also provide opportunities to invoke intrinsic motivations (Roseth et al., 2008; Tauer and Harackiewicz, 2004). Being part of a team that works together towards a shared goal has been identified as motivational gratification for players of online games with cooperative features (Rigby and Ryan, 2011; Scharkow et al., 2015; Yee, 2006). Cooperative play allows players to overcome challenges that would be impossible to reach when playing alone. Mastering such challenges in a team may invoke the experience of competence satisfaction (Rigby and Ryan, 2011; Ryan et al., 2006). Cooperative situations also provide opportunities for socializing and the experience of social relatedness (Deci and Ryan, 2000; Roseth et al., 2008; Zhang, 2008a), which can further positively influence a user's intrinsic motivation and enjoyment in cooperative play (Rigby and Ryan, 2011; Ryan et al., 2006). However, there is also the possibility that pure cooperation can undermine intrinsic motivations when individuals perceive a cooperative structure as controlling or a joint commitment in a group is missing owing to a lack of an external contingency (i.e. an external assessment, competition, or reward) (Johnson and Johnson, 1989; Slavin, 1996; Tauer and Harackiewicz, 2004).

According to Tauer and Harackiewicz (2004), the benefits of cooperation can be even greater when combined with competition, for instance in the form of team structures where individuals cooperate in a team but compete as a team against other teams. Competition between groups can provide an additional incentive for the members of a group, motivating them to raise their individual performance compared to pure cooperation (Tauer and Harackiewicz, 2004). Further, combinations of cooperation and competition provide additional opportunities for competence satisfaction, which – in turn – can increase people's levels of enjoyment and performance in such situations (Erev et al., 1993; Okebukola, 1986; Tauer and Harackiewicz, 2004). Inter-team competitions provide clear goals in groups and create clear barriers between groups; taken together, these can invoke strong tribal instincts (Vugt and Park, 2010), social identification processes (Turner, 1975) and *we-intentions* (Tuomela, 2000) with positive influences on the group members' individual performances (Julian and Perry, 1967; Tuomela, 2000).

While research indicates that both cooperative and competitive goal structures positively influence intrinsic motivation, enjoyment, and performance of people in an activity (Epstein and Harackiewicz, 1992; Johnson, 2003; Johnson and Johnson, 1989; Roseth et al., 2008; Tauer and Harackiewicz, 2004), it has been shown that the combination of both goal structures, as in inter-team competitions, can lead to the highest enjoyment and performance levels (Johnson and Johnson, 1989) in sports (Tauer and Harackiewicz, 2004), at work (Erev et al., 1993), or in education (Okebukola, 1986). Thus, applying gamification designs that invoke inter-team competitions in crowdsourcing systems may be most effective for enhancing crowdsourcees' intrinsic motivations and enjoyment. Supported by the self-determination theory (Deci and Ryan, 1985; Ryan and Deci, 2000) and a broad body of literature relating to technology use (Davis, 1989; Van der Heijden, 2004; Venkatesh et al., 2003), it can be assumed that greater intrinsic motivation of crowdsourcees positively influence their *behaviors*, such as their *system usage* and/or the amount and quality of *participation*, depending on which specific behaviors the gamification rewards (Morschheuser et al., 2017a). Thus, inter-team competitions may be particular effective for supporting intrinsic motivation and behaviors in crowdsourcing, compared to pure cooperative or competitive gamification designs.

Besides a motivated and active crowd (Doan et al., 2011; Morschheuser et al., 2017a) operators of crowdsourcing approaches must also continually attract new participants to compensate for crowdsourcee churn. Thus, it is important that active users who enjoy voluntary participation in a crowdsourcing approach invite others to also participate in the initiative and thus recommend the system. In crowdcreating systems, crowdsourcees commonly benefit from an increasing number of supporters, since the overall usefulness of cooperatively created outcomes typically increases with a larger group of active crowdsourcees (Geiger and Schader, 2014). These reciprocal benefits may motivate people to invite others to participate in crowdsourcing. Cooperative gamification designs that further enhance these benefits by motivating working together instead of competing may encourage crowdsourcees to invite others for achieving the shared goals (Hamari and Koivisto, 2015a). Therefore, cooperative gamification may lead to higher word-of-mouth compared to competitive gamification, where the general incentive for inviting further people to participate is undermined by the fact that more users increases competition between users. Further, a person's willingness to recommend a system via word-of-mouth is strongly related to their satisfaction with a system (Kim and Son, 2009; Richins, 1983). Thus, gamification features with goal structures that invoke high levels of intrinsic motivation and enjoyment may also relate to a higher intention to recommend crowdsourcing approach (Hamari and Koivisto, 2015a; Plass et al., 2013).

4.3.3 Empirical Study

We conducted a large field experiment to shed light on the research question and to investigate the motivational and behavioral effects of cooperative, competitive, and inter-team competitive gamification in crowdsourcing. With the intention to provide a high external validity, we performed the experiment in the field with a crowdsourcing app called ParKing, which we developed as an experimental platform for performing this research.

ParKing is a gamified crowdcreating system designed to create an interactive map of on-street parking spaces, including the location of parking spaces and their conditions (e.g. prices; restrictions such as residents' parking; time and day restrictions; free parking). Thus, ParKing seeks to effectively provide parking information to people looking to park. The gamification component of ParKing attempts to motivate people to participate in the collective data collection by sharing location-based parking information. ParKing directly visualizes the user-generated and aggregated data on a map, so that users who are unfamiliar with a city's parking situation can easily see where (free) parking is possible and where not (Figure 17). A button enables users to switch between the *visualization of the data* and the *game mode*, in which parking information can be shared and users can interact with the app's gamification features (Figure 17).

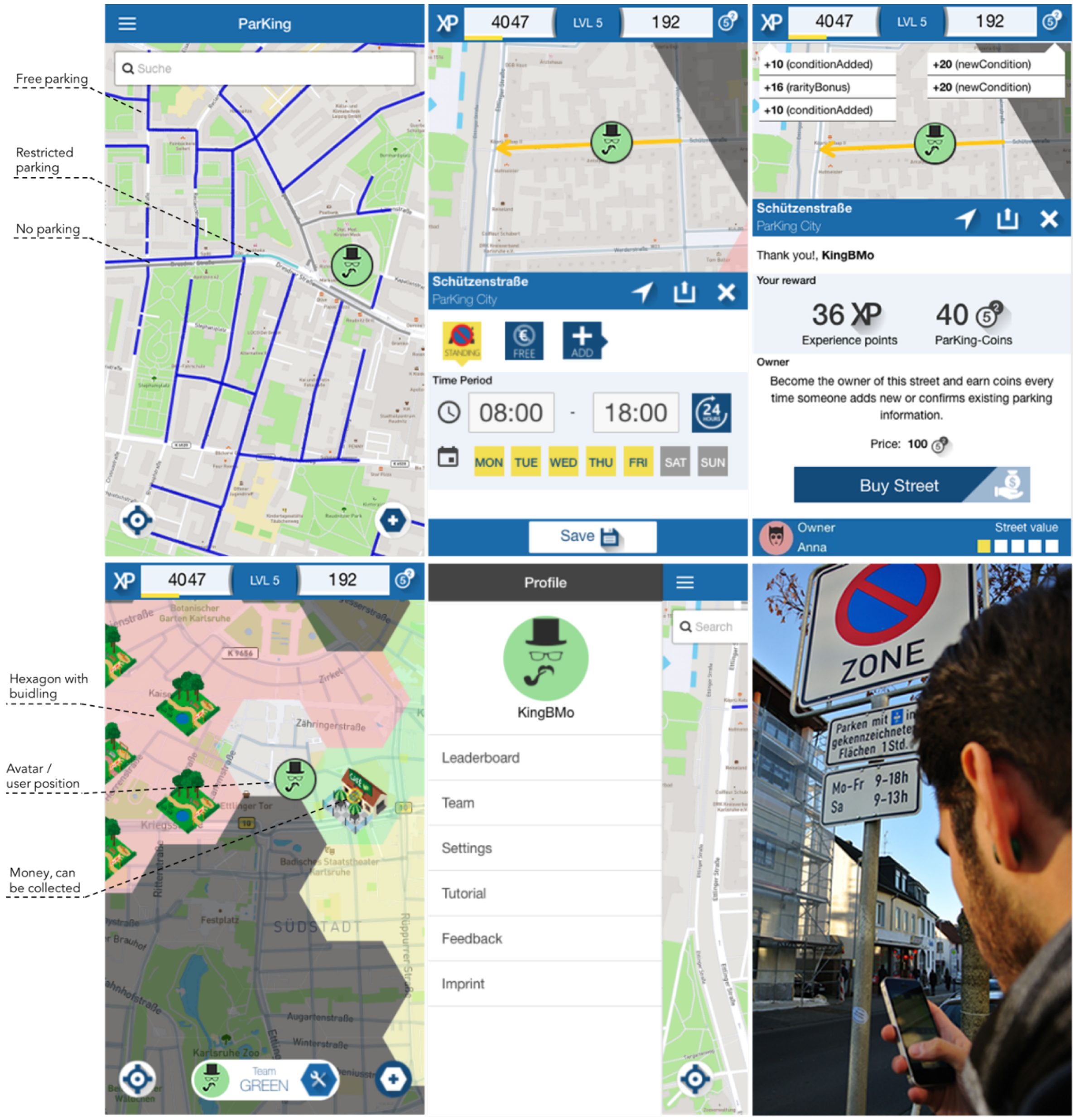


Figure 17. The ParKing App

Notes: Top left: A map with collected parking information. Top middle: Sharing parking information. Top right: Rewards for sharing parking information. Bottom left: The game mode (the screenshot shows the inter-team competition). Bottom middle: Menu. Bottom right: A user playing ParKing.

We chose this context since the search for on-street parking is a problem that affects many people, and we lack comprehensive digital solutions that holistically focus on this problem. Current digital maps, including crowdsourcing approaches such as OpenStreetMap and Waze don't as yet provide detailed on-street parking information. Further, simplifying parking could have great economic and ecological consequences, since searching for parking in urban areas is a primary cause of traffic congestions in large cities (Arnott et al., 2005; Axhausen et al., 1994; Shoup, 2006, 2005). Studies conducted in different cities around the world revealed that around 30% of prevailing traffic is due to cruising for parking (Shoup, 2006, 2005). Searching for parking is responsible for tons of carbon dioxide emissions every day, and strongly influences other drivers' time and fuel consumption (Shoup, 2006, 2005). With ParKing, we sought to generate a comprehensive information platform that allows drivers to easily get an overview of parking and non-parking areas. In our view, such a platform can reduce cruising for parking by drivers unfamiliar with a city's parking situation, such as tourists or business travelers. Further, current efforts in the context of autonomous driving, shared mobility, and smart cities will need highly qualitative maps, in particular in the parking context (Coric and Gruteser, 2013; Margreiter et al., 2015).

The design followed the conceptual framework for gamified crowdsourcing systems by Morschheuser et al. (2017a). The app gives users the functionality to jointly generate an emergent map with parking information (solution) by sharing street-based parking information (task) on a digital map in a smartphone app. The user interface is comparable with other crowdsourcing apps that seek to collect geographical data (Brito et al., 2015; De Franga et al., 2015; Liu et al., 2011a, 2011b; Martella et al., 2015; Massung et al., 2013; Prandi et al., 2016; Sheng, 2013) and consists mainly of a map on which users can select street segments in their near vicinity (approximately a 130m radius) to share parking information (Figure 17, top middle).

To gamify ParKing, we followed the method of Morschheuser et al. (2017d), the latest gamification design framework developed as a synthesis of 17 previous gamification design frameworks. We developed the game design features in several iterations and with an interdisciplinary team of six M.Sc. students and a PhD student. Inspired by popular games such as Monopoly, SimCity, Pokémon Go, and Ingress, as well as other gamified crowdsourcing apps (Table 22), ParKing's core game mechanism is the conquering of virtual territories (*hexagons*) on a map and the constructing of buildings in these territories, visible to the other users of the app (Figure 17). The gameplay is simple; users can earn virtual coins by sharing parking information. These coins can be spent to purchase street segments or construct buildings. Buildings can only be constructed on virtual hexagons, which have been generated and mapped on the real map. The user who owns the most streets in the area of a hexagon automatically owns the overlying hexagon and can construct one building on it. We created a set of different building types from which the users can choose. Some of these buildings have effects on their environment (e.g. increased income from other users' inputs, increased value of the streets, additional regular income from the building), so that the users have to make strategic decisions when choosing a building. Further, these buildings' prices differ and some can be further upgraded to increase their influence.

To motivate users to share correct information, we followed Von Ahn and Dabbish's (2008) design principles and implemented an output-agreement mechanism: a user can receive bonus coins if they confirm the data previously shared by other users. Further, a street owner can receive bonus coins if other users confirm their street's data (Table 23). Thus, to think and act like others is the winning strategy and can motivate people to share qualitative data instead of wrong data (Von Ahn and Dabbish, 2008).

The current geographical position of a user and those of other users in the vicinity are visualized by small customizable avatars that are also used to represent the user in the app, for instance, as the owner of a street or a hexagon. We implemented several badges (Hamari, 2017) connected with clear goals (e.g. conquer five related hexagons, buy a first street, use the app for several days) that allow one to unlock new costumes for the avatars, such as a special hat or glasses.

Interaction	User reward	Street owner reward
User adds parking conditions	$coins \mathrel{+}= 20 + c$ $xp \mathrel{+}= 10 + r$	If street has an owner, the owner receives: $coins = 5 + v + r + b$
$c = confirmation\ bonus = Min(x \cdot 2\ ;\ 10)$ $r = rarity\ bonus = Max(20 - p\ \cdot 2\ ;\ 0)$ $x = number\ of\ conditions\ that\ match\ conditions\ of\ previous\ posts\ from\ other\ users$ $p = overall\ number\ of\ posts\ per\ street\ segment$ $v\ =\ value\ of\ the\ street\ segment;\ between\ 1\ and\ 5$ $b\ =\ influence\ of\ buildings\ in\ the\ vicinity\ \ e.g. =\ 50\ *\ marketlevel$		

Table 23. Rewards Rules in ParKing

Experimental Conditions

Based on the above described game mechanics of ParKing, we developed three different versions, with three different primary goal structures. According to the framework of Morschheuser et al. (2017b) and the social interdependence theory (Johnson, 2003; Johnson and Johnson, 1989), we created (1) a *cooperative* version where users' primarily goal was to enlarge the joint 'ParKing realm' by conquering as many hexagons together as possible; (2) a *competitive* version where the overall goal was to become the 'ParKing' (the user with the most conquered hexagons); and (3) an *inter-team competition* where the users could join one of three competing teams (cf. Tauer and Harackiewicz 2004), with the overall goal to jointly conquer and defend the largest ParKing realm with the most hexagons. In each version, users had to click through a short onboarding tutorial explaining the gamification features and the overall goal of the gamification version a user was playing. Further, we applied different rules and color schemes to realize these three gamification approaches. In the *cooperative* version, all conquered hexagons by players were colored in green and users were unable to buy streets already owned by other users. In the *competitive* version, own hexagons were colored in green and other users' hexagons in red. In the *inter-team competition*, the hexagons were colored in the team colors: red, green, and yellow (Figure 17, bottom left). In *competitive* and the *inter-team competitive* versions, users were able to buy streets from their opponents by paying a coin price related to the value of the streets. On the other hand, by paying virtual coins, users of these two versions could increase their own street's values in order to protect them against opponents. The three variants were completely separate from one another so that, in a version, only players of that version could interact with one another and could perceive each other.

According to goal-setting theory (Locke and Latham, 1990) and as a common practice in gamification (Hamari et al., 2014; Morschheuser et al., 2017a, 2016), we implemented different types of leaderboards/statistics so as to give users immediate feedback on their performance. In the inter-team competition, users could see their team's overall participation and the performance of the top 10 players of each team; in the competitive version, we listed the top 10 users according to their individual performance; in the cooperative version, we showed joint success and individual contributions (Figure 18). In all groups, users could view these statistics and rankings for different time intervals: the last week, the last month and all-time (i.e. since the rollout of the app).

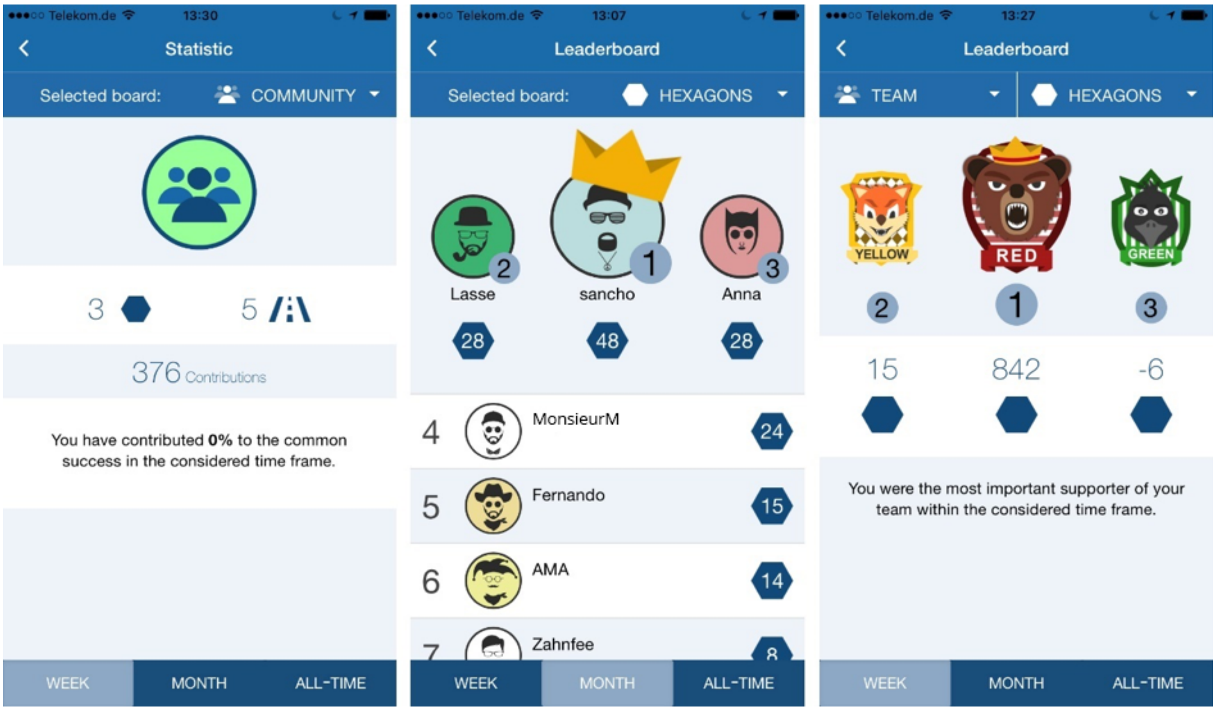


Figure 18. The Three Different Leaderboards

Notes: Left: the cooperative version, which showed the joint community progress. Users could further select another view to analyze their individual performance. Middle: the competitive version, which showed the current 'ParKing' with the most hexagons and their opponents, ranked by their performance. Right: the leaderboard of the inter-team competition, which showed an overview of the team success. Users could further select another view that showed the top 10 contributors of each team and could analyze the individual contribution of the team members.

Participants and Procedure

The experiment was conducted between January and April 2017 across Germany. Around 6,000 people were invited via mailing lists. We also advertised the study via forum posts on various mobility-related platforms. Interested people were asked to sign up for the field study on our website (http://parking-app.de) by providing their e-mail address, place of residence, and smartphone type. When starting the field experiment, we send everyone who had signed up to participate a residence-based invitation code and a tutorial for installing the app via Apple TestFlight or the Google Play Store. With the goal of facilitating interactions between users from the outset, we assigned the participants to the three groups based on their residence. We created three different invitation codes and started to roll out the competitive version in the area around Stuttgart and Düsseldorf, the inter-team version in Leipzig and Karlsruhe, and the cooperative version in Munich and Hannover.

During the three-month period, 459 persons downloaded the ParKing app, 214 on iOS and 245 on Android. Of these, 372 installed the app and created a user account in the app (*app users*); they all used the app (e.g. to find parking places). A subsample of 203 app users added at least one parking condition and can therefore be seen as *crowdsourcees*, since they participated in the app's crowdsourcing aspect. After a user has installed and used the app, they automatically received an e-mail after seven days with a request to participate in an online survey to measure motivations to use the app and willingness to recommend the app, as well as to gather demographic information, information related to the app's relevance, and feedback. In total, 170 users of all the *app users* took part in the survey; these *survey participants* formed another subsample of the app users. Depending on what is analyzed in the following, the data were based on one of these related samples. Table 24 provides an overview. All users with a user account were entered into a prize draw for one of 10 electric screwdrivers.

	Competition		**Inter-team competition**		**Cooperation**	
	N	%	N	%	N	%
App users	123	33.1	119	32.0	130	35.0
Crowdsourcees: app users with at least one crowdsourcing contribution	58	28.6	72	35.5	73	36.0
Survey participants:	50	29.4	61	35.9	59	34.7
Gender						
Female	14	28.0	11	18.0	8	13.6
Male	36	72.0	50	82.0	51	86.4
	Mean	SD	Mean	SD	Mean	SD
Age	32.7	9.90	28.1	10.7	32.2	12.3
Frequency of using mobile apps for driving assistance						
	2.8	1.2	2.7	1.1	2.6	1.1
Perceived difficulty of finding a parking spot						
In familiar cities	2.9	0.9	2.9	0.8	2.9	0.9
In unfamiliar cities	4.1	0.8	4.1	0.7	3.9	0.8
Average time to find a parking space	11.6 min	7.5 min	11.9 min	6.1 min	12.5 min	7.4 min

Table 24. Overview of the Samples

Measures

According to related research, we operationalized the users' *intrinsic motivations* as *perceived enjoyment* and their *extrinsic motivations* as *perceived usefulness* (Hamari and Koivisto, 2015b; Van der Heijden, 2004).

To investigate the different gamification conditions' effects on users' behaviors, we measured how they interacted with the system and its gamification and crowdsourcing features. First, we measured the overall *system usage* in the three alternative gamification conditions, which we operationalized as overall time of using the app per user. Second, as part of the system usage, we measured users' *crowdsourcing participation* and their *engagement with the gamification feature*. Thus, we collected the numbers of quantitative contributions (parking conditions) a user provided, as well as how many hexagons a user has conquered, since this activity represented the user engagement with the gamification feature's goal in all three conditions. Third, we collected users' *willingness to recommend* the app, operationalized as survey construct, following Kim and Son (2009).

Table 25 provides a detailed overview of the constructs and their operationalizations. We drew all survey items from previously published sources (Table 25; Appendix D) and measured them along a 7-point Likert scale (from *strongly disagree* to *strongly agree*).

Construct	**Definition**	**Operationalization**
Extrinsic motivation	Users' extrinsic motivations towards using the gamified crowdsourcing app	*Perceived usefulness*, survey construct according to Hamari and Koivisto (2015b) and Van der Heijden (2004)
Intrinsic motivation	Users' intrinsic motivation towards using the gamified crowdsourcing app	*Perceived enjoyment,* survey construct according to Hamari and Koivisto (2015b) and Van der Heijden (2004)
System usage	Overall usage of the gamified crowdsourcing app	Overall time of using the app per user in seconds (cumulative)
Crowdsourcing participation	Contribution level in the crowdsourcing aspect of the gamified crowdsourcing app	Number of parking conditions shared by a user in the app
Engagement with the gamification feature	Engagement level with the gamification feature of the gamified crowdsourcing app	Number of hexagons conquered by a user in the app
Willingness to recommend	Users' willingness to recommend the gamified crowdsourcing app to others	Willingness to recommend, survey construct according to (Kim and Son, 2009)

Table 25. List of Constructs, Definitions, and Operationalization

Besides the motivational and behavioral aspects, we also used the survey to collect control variables to check possible heterogeneities between the three independent groups, which could arise form *demographic differences* or *differences in the app's relevance* for participants. Thus, we collected age and gender of the participants, as well as the *frequency of using mobile apps for driving assistance* (5-point scale from 1 = *always* to 5 = *never*), the *perceived difficulty of finding a parking spot in familiar and unfamiliar cities* (1 = *very easy* to 5 = *very difficult*), and the *average time spent by users to find a parking space* (*in minutes*).

As secondary data, we further allowed users to share feedback in five open questions in order to better understand their motivations and behaviors regarding the usage of the app's different components. The participants were asked (1) *what aspects of the ParKing app they liked*, (2) *what we could improve*, (3) *why they used the app*, (4) *how they perceived the app's gamification features*, (5) *whether and how they came into contact with other users of the app*.

Validity and Reliability

We assessed convergent validity (see Appendix D) via three metrics: Cronbach's α, average variance extracted (AVE), and composite reliability (CR). All the convergent validity metrics were met and were clearly greater than thresholds in the literature (each construct's Cronbach's $\alpha > 0.7$, AVE > 0.5, CR > 0.7) (Fornell and Larcker, 1981; Nunnally, 1978). First, we examined the discriminant validity by comparing of the square root of each construct's AVE to all the correlations between it and other constructs, where, according to Fornell and Larcker (1981), all of the square roots of the AVEs should be greater than the correlations between the corresponding construct and any other construct. Second, we assessed discriminant validity by confirming that each item had the highest loading with its corresponding construct.

The application of Pearson's Chi-square test revealed no significant associations between the groups and gender. Further, we found no significant differences between the three groups by conducting one-way ANOVA tests regarding the age of the participants $F(2,167) = 3.028$, $p = 0.051$; the frequency of using mobile apps for driving assistance $F(2,167) = 0.462$, $p = 0.631$; the perceived difficulty of finding a parking spot in familiar cities $F(2,167) = 0.029$, $p = 0.971$ and unfamiliar cities $F(2,167) = 2.648$, $p = 0.074$ and the average time spent by the users to find a parking space $F(2,167) = 0.135$, $p = 0.874$.

4.3.4 RESULTS

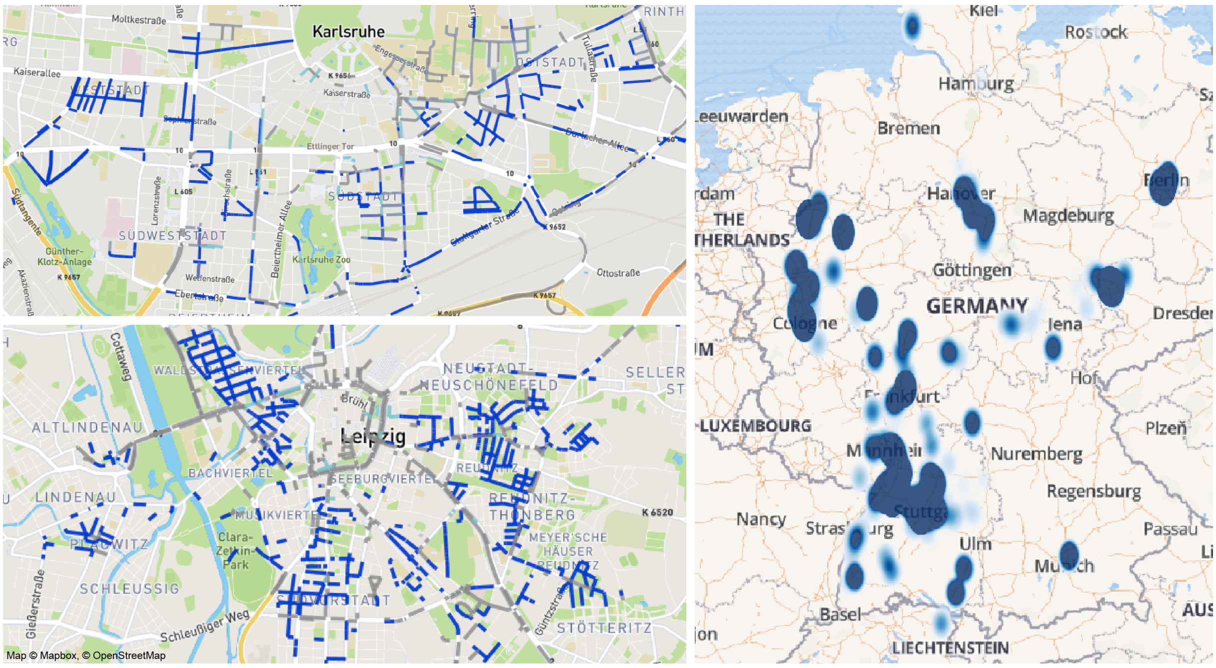


Figure 19. Overview of the Collected Parking Data in All Groups by Gamified Crowdsourcing

In total, the ParKing users collected 6,970 parking conditions all over Germany during the field study. Main activities were in Stuttgart, Karlsruhe, Leipzig, Mannheim, Cologne, and Dusseldorf (Figure 19).

Motivational Outcomes

First, we analyzed the users intrinsic and extrinsic motivations when using the app in the three gamification conditions. Table 26 provides an overview of the descriptive results. We conducted a one-way MANOVA test to determine possible differences between the experimental conditions regarding users' intrinsic and extrinsic motivations for using the app.

Overall, the analysis revealed no significant difference when comparing the motivational outcomes between the gamification conditions: $F(4,332) = 2.163$, $p = 0.073$, Wilk's = 0.025. We then tested the effects of the gamification conditions on different dependent variables separately using one-way ANOVA analyses. The tests revealed significant differences in the *perceived enjoyment* between the gamification conditions: $F(2,167) = 3.769$, $p = 0.025$**, partial $\eta^2 = 0.043$, but no significant differences when analyzing the *perceived usefulness* $F(2,167) = 1.873$, $p = 0.157$.

Next, pairwise comparisons were run between the individual gamification conditions using the Tukey-HSD test (Table 27). We found that users of the inter-team competitive design reported a significantly higher enjoyment level compared to users of the competitive design (p = 0.030**, diff = 0.629) and a weakly significant, higher enjoyment level compared to the users of the pure cooperative design (p = 0.099*, diff = 0.485).

Levene's tests revealed that in all cases, homogeneity of variance could be assumed (p > 0.1).

	Competition		**Inter-team competition**		**Cooperation**	
Dependent variable	Mean	SD	Mean	SD	Mean	SD
Intrinsic motivation (enjoyment)	4.06	1.35	4.69	1.14	4.20	1.36
Extrinsic motivation (usefulness)	4.10	1.53	4.60	1.21	4.41	1.36

Table 26. Means and Standard Deviations for Users' Intrinsic and Extrinsic Motivations

	Comparison		**Difference**	
Dependent variable	I	II	Mean (I to II)	p
Intrinsic motivation (enjoyment)	Competition	Inter-team competition	-0.629	0.030**
	Cooperation	Inter-team competition	-0.485	0.099*
	Cooperation	Competition	0.144	0.829
Extrinsic motivation (usefulness)	Competition	Inter-team competition	-0.503	0.133
	Cooperation	Inter-team competition	-0.196	0.713
	Cooperation	Competition	0.307	0.473
Notes: * p < 0.1; ** p < 0.05; *** p < 0.01.				

Table 27. Tukey-HSD Test Results on Differences in Users' Intrinsic and Extrinsic Motivations

Behavioral Outcomes

Second, we studied the differences in the behavioral outcomes of the gamification conditions. Using Kolmogorov-Smirnov (KS) tests, we found that the overall *system usage*, *crowdsourcing participation*, and *engagement with the gamification feature* followed heavy-tailed power-law and log-normal distributions (Clauset et al., 2009). Owing to the implementation of an onboarding tutorial that explained to users how to perform their first crowdsourcing contribution, around 55% of users shared at least one parking condition (Table 24). However, the overall crowdsourcing participation of users who shared one or more parking conditions also followed heavy-tailed distributions in the three groups. The literature indicates that this phenomenon is usual for crowdsourcing approaches (Ortega et al., 2008; Varshney, 2012). Commonly, Nielsen's participation inequality rule can be applied, which states that "90% of users are lurkers who never contribute, 9% of users contribute a little and 1% of users account for almost all the actions" (Nielsen, 2006). When considering the medians, the data showed that half of the users used the app for less than 22 minutes and shared around six parking conditions during the study period. However, when considering 10% of the most active users, we found that, on average, they had contributed 258 parking conditions and had used the app for more than 34 hours.

Due to the large variability in the data, standard descriptive methods or parametric tests are not effective for comparing differences between the groups. The standard deviation (SD) of heavy-tailed distributions can be very high, and medians as well as means underrepresent the tail of the distribution, which contained most of the relevant data (Alstott et al., 2013) (see Table 28).

Thus, following Clauset et al. (2009), we considered the complementary cumulative distribution functions and employed log-log plots, where both axes were on log scales, to investigate the effect of the three gamification conditions and to compare possible differences between the groups. Figure 20 shows our results generated with Powerlaw for Python (Alstott et al., 2013). In the first graph, the x-axis represents the total usage of the app in log scale; the y-axis represents the probability that a user would use the app for at least x seconds in log scale. In other words, a curve that extends further to the top and the right is likely to get more usage than a curve that near the lower left corner. The same applies to the other graphs, where the x-axis represents the crowdsourcing participation (number of parking conditions contributed to the community) and the engagement with the app's gamification feature (number of hexagons conquered by users) during the evaluation period.

At a glance, the results allow a comparison between the three experimental conditions. The probability that a user used one of the three versions for at least 22 minutes was fairly independent of the gamification design (Figure 20). However, the analysis indicated that the probability of a long-term engagement was higher with the competitive and the inter-team competitive designs compared to the cooperative design. The crowdsourcing participation and the interaction with the gamification feature differed greatly between the three groups. The data revealed that the probability for a specific crowdsourcing participation was nearly always higher in the inter-team competition than in the pure cooperative mode and the pure competitive mode. Further, the plotting of the gamification data indicates that all three versions motivated users to use the gamification features. However, the two competitive designs were more likely to engage users in interacting with the gamification features than the cooperative version. When comparing the user engagement with the gamification feature in the three groups, it became evident that around 10% of the users in the inter-team competition conquered many more hexagons than in the cooperative and competitive mode and were therefore much more committed to reach the goal of the gamification approach than other players in all three groups (Figure 20).

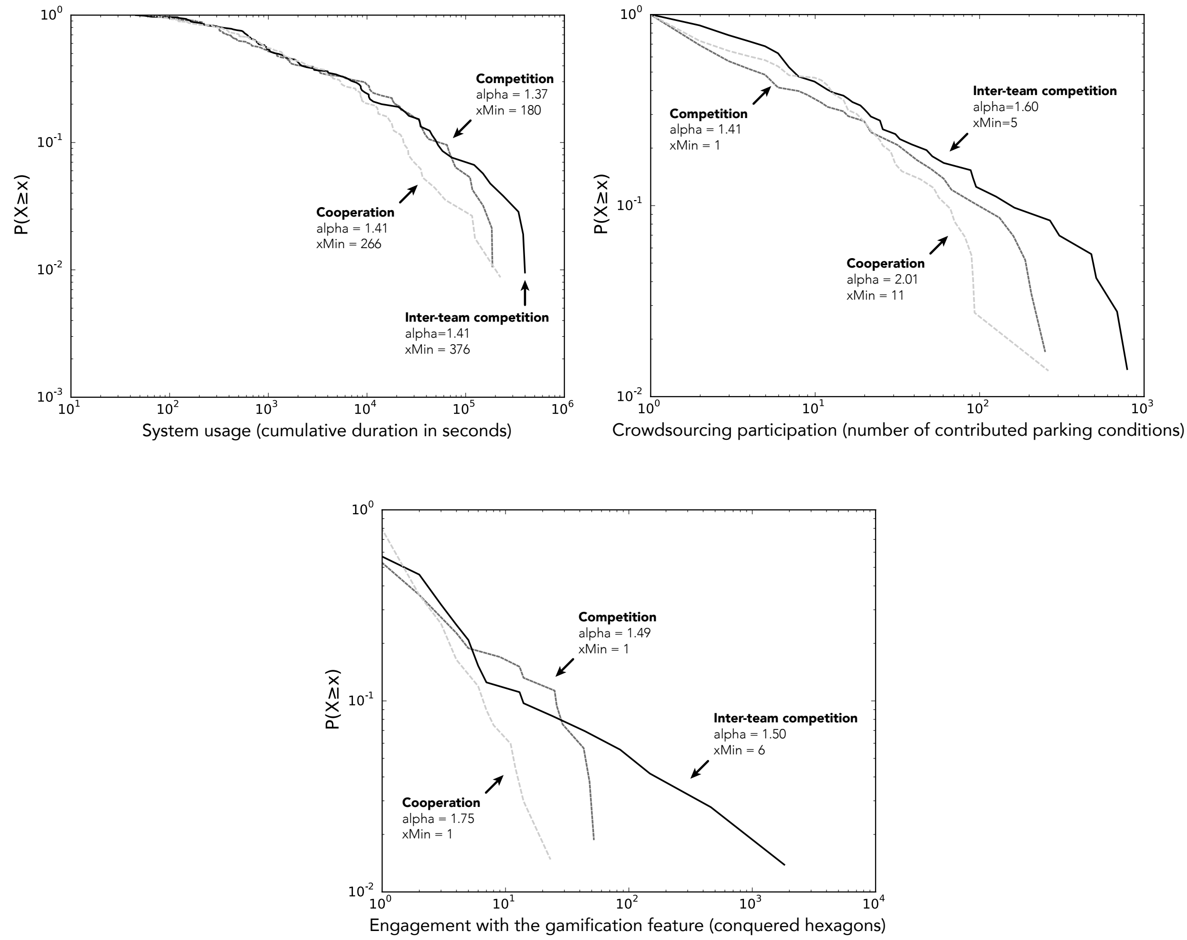


Figure 20. Log-log Plots of System Usage, Crowdsourcing Participation, and Engagement with the Gamification Feature

Notes: *Alpha* and x_{min} describe the calculated power law fits (Alstott et al., 2013). In the first graph, the x-axis represents the total usage of the app in log scale, and the y-axis the probability that a user would use the app for at least x seconds in log scale. In the second graph, the x-axis represents the crowdsourcing participation as number of contributed parking conditions in log scale, and the y-axis the probability that a user would at least contribute x parking conditions in log scale. In the third graph, the x-axis represents the user engagement with the gamification feature as the number of conquered hexagons in log scale, and the y-axis the probability that a user would at least conquer x hexagons in log scale.

To investigate whether the identified differences were significant, we conducted k-sample Anderson-Darling (AD) tests (Scholz and Stephens, 1987). According to Engmann and Cousineau (2011), k-sample Anderson-Darling tests are preferable compared to the commonly used Kolmogorov-Smirnoff tests when analyzing heavy-tailed distributed data with differences in the tail ends. The k-sample Anderson-Darling tests revealed no significant differences in the overall system usage. Thus, it could not be rejected that the system usage was homogeneous in all three groups, and the data were drawn from the same distribution (all $p > 0.1$). However, we found that the crowdsourcing participation differed significantly between the inter-team competition and the competitive version, as well between the inter-team competition and the cooperative version (Table 29). Comparing the crowdsourcing participation in the cooperative and competitive versions, it could not be rejected that the data were drawn from the same distribution ($p > 0.1$). The engagement with the gamification feature also differed significantly between the three groups. The analysis showed that the inter-team competition led to a significantly higher adoption of the gamification features compared to the cooperative version; users of the inter-team competition conquered more hexagons. Further, the competitive design led to a significant higher engagement with gamification features than the cooperative design.

When analyzing the gamification data in detail, we found some strategic patterns of *power players*, i.e. users with high engagement in the gamification features, in the competition and the inter-team competition. These users made specific strategic decisions, such as the purchasing of long street segments that ranged through several hexagons in order to conquer many hexagons with few resources. Further, we identified that, in the inter-team competition, users more actively sought to conquer territories owned by other users (37.5% more hexagons changed the teams in the inter-team competition compared to hexagons that changed the owner in the competitive version).

	Competition			Inter-team competition			Cooperation		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
System usage (in hours)	4:19 h	0:19 h	9:55 h	6:41 h	0:19 h	19:24 h	2:54 h	0:23 h	7:36 h
Crowdsourcing participation	26.96	4	54.34	59.85	7	149.36	19.97	6	36.86
Engagement with the gamification feature	5.56	1	12.20	37.54	1	219.00	2.39	1	3.77
Willingness to recommend	3.89	4	1.71	4.64	4.67	1.37	4.21	4.33	1.51

Table 28. Means, Medians, and Standard Deviations (SD) for the Behavioral Outcomes in All Three Groups

	Comparison		Difference	
Anderson-Darling test results	I	II	AD (I vs. II)	p
System usage	Competition	Inter-team competition	< 0	0.611
	Cooperation	Inter-team competition	< 0	0.580
	Cooperation	Competition	< 0	0.406
Crowdsourcing participation	Competition	Inter-team competition	3.675	0.011**
	Cooperation	Inter-team competition	1.854	0.055*
	Cooperation	Competition	< 0	0.600
Engagement with the gamification feature	Competition	Inter-team competition	< 0	0.675
	Cooperation	Inter-team competition	3.105	0.018**
	Cooperation	Competition	4.737	0.004***
Tukey-HSD test results	I	II	Mean (I - II)	p
Willingness to recommend	Competition	Inter-team competition	-0.753	0.028**
	Cooperation	Inter-team competition	-0.425	0.282
	Cooperation	Competition	0.328	0.504

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 29. K-sample Anderson-Darling and Tukey-HSD Test Results on the Differences in Users' Behaviors in the Different Groups

Based on the survey data, we further analyzed users' willingness to recommend the app. Overall, users of the cooperative versions reported a positive willingness to recommend the app, while users of the competitive version on average rather disagreed to recommend the app. A one-way ANOVA analysis revealed significant differences between the gamification conditions: $F(2,167) = 3.406$, $p = 0.036$**, partial $\eta^2 = 0.039$.

Thus, we ran pairwise comparisons using the Tukey-HSD test (Table 29) and found that users of the competitive design had a significantly lower willingness to recommend the app compared to users of the inter-team competition ($p = 0.028$**, diff = -0.753). A Levene's test revealed that homogeneity of variance could be assumed ($p > 0.1$).

Qualitative User Feedback

The answers to the open questions were grouped by their content into thematic clusters by open coding, following the grounded theory methodology (Corbin and Strauss, 1990).

Overall, a large number of users highly appreciated the concept of gamified crowdsourcing. In particular, many users reported that they like the idea behind ParKing. Typical statements were: "The idea is awesome. Collecting data with gamification, to provide benefits for many – great"; "Nice idea, collecting useful data in a gameful manner"; "Innovative idea". Also, most users somehow positively highlighted the app's utility (e.g. "I am very interested in a parking atlas"; "I see clear benefits"; "the app could help to simplify the search for parking"). We received much positive feedback on the gamification design. In particular, participants positively highlighted the possibility to buy real streets in a virtual game environment and to construct buildings in augmented reality. However, three users expressed that overly strong attraction to the gamification features can undermine motivations to share qualitative parking data and may lead people to devise strategies for cheating.

Several users of the competitive version reported that they were particularly motivated by the competitive gamification feature: "the leaderboard is interesting"; "personal ambition through the leaderboard"; "competition with other players". Also, the goal of the competition was highlighted by participants (e.g. "to become the king"; "ascend to the throne"). One user reported that he had fun fighting his neighbor, but was demotivated when the latter no longer played. Another user of the competitive design explicitly expressed the desire for more cooperation: "playing together instead of against each other"; this user also stated that the game's goal does not fit the crowdsourcing approach's goal – to jointly create a database. Three users reported that more users are needed to enable appealing regional competitions, otherwise the competition would be boring.

Users of the inter-team competition highlighted both the competitive aspect (e.g. "I use the app because of the competition") and the teams (e.g. "the team affiliation is motivating"). However, the competition was not mentioned as often as in the competitive version. Rather, socializing and teamwork were highlighted and thus seemed to play a key role. Five users of the inter-team competition reported that they discussed the game with other users, for instance, to share team strategies or optimal use of the app. Several other participants of the inter-team competition emphasized that they wanted to have more contact with other users and that features; for instance, a forum would be helpful to meet other team members. Here, we found a big difference compared to the pure competitive version, where only one user wanted more interaction with other users.

In the cooperative version, the most negative comments on the game were reported by participants; several perceived the game as uninteresting. Although the cooperative version was designed with the intention to motivate people to play together, two users explicitly noted that they feel alone in the game, and two other users mentioned that he wanted more contact with other users.

Besides the gamification features and the app's personal usefulness, 14 participants provided altruistic reasons when asked why they use the app (e.g. "to help others to find parking places", "to pass time and to give others useful information", "to help others"). Further, 25 participants reported that they used the app because they are generally interested in innovative ideas: "I like to test apps"; "I like to be the first player of a game"; "I'm a beta tester"; "I have fun with innovations". This shows that personality characteristics such as personal innovativeness and altruism may further influence users' motivations. The motivation to "explore the own city" was only mentioned by one participant. Three participants noted that they enjoy building a community or a collaborative created database (e.g. "adding information to a joint database, such as in OpenStreetMap"; "to help build a community").

4.3.5 Discussion

We investigated how competitive, cooperative, and inter-team competitive gamification affect motivations, user behavior, and the willingness to recommend crowdsourcing systems. By conducting a field experiment with three independent groups, which had used different gamified versions of a crowdcreating app, we found that inter-team competitions are particular effective in invoking intrinsic motivations and can engage the highest levels of crowdsourcing participation, compared to pure competitive or pure cooperative gamification. Further, the comparison of the three gamification conditions showed that users were more likely to recommend crowdsourcing approaches when the gamification included cooperation. While the participation differed significantly between the groups, the system usage was similarly distributed in all three groups. Further, the gamification conditions did not lead to any significant difference in the extrinsic motivations.

The identified positive effects of inter-team competitions on intrinsic motivations and behaviors are in line with previous research into the social interdependence theory conducted in education, economics, and sports (Bornstein et al., 2002; Erev et al., 1993; Johnson and Johnson, 1989; Tauer and Harackiewicz, 2004). In particular, the results of this study are consistent with the findings of Tauer and Harackiewicz (2004), who showed that the intrinsic motivations and behaviors of people in inter-team competitions can surpass the motivations and behaviors of those in pure competition or pure cooperation. The research has theorized that inter-team competitions lead to stronger psychological and behavioral outcomes than pure competitive and cooperative goal structures, since their combination provides the richest set of motivational affordances for satisfying innate human needs (Tauer and Harackiewicz, 2004). On the one hand, competitive contexts can also be intrinsically motivating as they offer individuals interesting challenges and opportunities for evaluating the own performance, thereby affording possibilities for the satisfaction of needs such as competence, mastery, and achievement (Epstein and Harackiewicz, 1992; Reeve and Deci, 1996; Tauer and Harackiewicz, 2004). On the other hand, helping a team to achieve a shared goal in a cooperative scenario has also been identified as an opportunity to satisfy needs and experience feelings such as competence and achievement (Johnson and Johnson, 1989; Rigby and Ryan, 2011; Ryan et al., 2006). Thus, inter-team competitions, which combine both aspects, offer a larger variety of possibilities to satisfy competence needs and thus may better promote intrinsic motivations and behaviors driven by the feeling of being competent in an activity (Deci and Ryan, 1985). In addition to the innate need for competence satisfaction, cooperative scenarios can further provide motivational affordances for the experience of social relatedness, which is the satisfaction of the innate need for having meaningful connections with others (Deci and Ryan, 2000; Roseth et al., 2008). Both motivational gratifications have been identified in inter-team competitive play (Rigby and Ryan, 2011; Ryan et al., 2006; Yee, 2006). Thus, our study results, gathered in the context of gamified crowdsourcing, as well as prior literature, suggest that inter-team competition provides the richest set of motivational affordances for intrinsic motivations which, according to self-determination theory, can further influence users' behaviors and performance (Deci and Ryan, 1985; Przybylski et al., 2010; Tauer and Harackiewicz, 2004), such as participation in crowdsourcing.

Besides the pure motivational aspects that can explain the behavioral effects of inter-team competitions, the general social structures of the crowdsourcing context likely play a key role (Morschheuser et al., 2017c; 2017d). Cooperation theories (Gilbert, 1999; Johnson and Johnson, 1989; Shen et al., 2014; Tuomela, 2000) emphasize that cooperative situations, such as crowdsourcing, can induce social commitment and obligations between cooperating individuals. Crowdsourcees who explicitly work together in a crowdsourcing approach share a commitment to working together to support a crowdsourcing initiative (Morschheuser et al., 2017c; Shen et al., 2014). Competitive gamification designs may undermine these dynamics. On the other hand, pure cooperative gamification may not be sufficient to invoke social commitments and obligations, since previous research found that, in the absence of some external contingency (e.g. competition or rewards), people in a cooperative setting will perform similarly than when working individually (Johnson and Johnson, 1989; Slavin, 1996). Thus, we theorize that inter-team competitive gamification, where users share the goal to win against other teams, may be most effective in invoking cooperative commitments and obligations between users. Cooperative contexts such as crowdcreating approaches may therefore particularly benefit from inter-team competitive gamification, as is evident in our results. The feedback from the participants also seem to support this theory, since some users of the competitive mode mentioned that the spirit of competition does not necessarily feel relevant if they felt that the crowdsourcing is an activity towards common outcomes. These notions add to the previous research that suggests that a context's social structures should be carefully considered when designing gamification features (Morschheuser et al., 2017d).

Specifically, the results of this study contribute to the ongoing discussion on the positive and negative consequences of competitions in gamification approaches (Ipeirotis and Gabrilovich, 2014; Koivisto and Hamari, 2014; Landers et al., 2017; Massung et al., 2013; Morschheuser et al., 2017a; Preist et al., 2014). Previous research has postulated that competition between unbalanced opponents with a high likelihood of defeat of one party can demotivate both parties (Chen and Pu, 2014; Epstein and Harackiewicz, 1992; Liu et al., 2013; Massung et al., 2013; Morschheuser et al., 2017a; Preist et al., 2014). In other words, people become demotivated in competitive scenarios where they see no chance of winning, as well as when they have a very high chance of winning because no suitable opponents are available. Our results suggest that inter-team competition can counter these demotivating aspects of mere competition – both the demotivating effect of individual loss/inability to fare well and lack of challenging competition. One reason seems to be that playing in competing teams may increase the balance of the competition, as winning and failing is the result of the collective rather than of a single individual (Erev et al., 1993; Tuomela, 2000). Further, team structure may relativize the demotivating aspects of pure competitions by motivating individual contributions towards a shared goal and shifting possible losses that arise from not achieving of the shared goal to the community. All in all, gamification design where teams compete each other cherry-pick the best aspects of competition and cooperation. Future research should continue to investigate the psychological effects of inter-team competitions compared to pure competitions, drawing on the results of this study.

Considering users' willingness to recommend the app, users in the two gamification conditions that included cooperation (cooperation and inter-team competition) reported a higher willingness to recommend the crowdsourcing app. In particular, users of the inter-team competition were significantly more willing to recommend the app than users of the competitive version. We assume that these differences result from two aspects: First, user enjoyment of the competitive version was lower, which may negatively affect their loyalty and willingness to recommend the app (Plass et al., 2013; Teng and Chen, 2014). Second, it can be expected that users in competitive situations have no interest in inviting others, since an increasing number of participants in a competition reduces an individual's chance to win a competition. However, in cooperative scenarios, where the success of an individual depends on the support of others, people can benefit from convincing others to work together towards a common goal (Tuomela, 2000). This aspect may be particularly important in inter-team competitions, where the external competition gives the users of a team a clear, appealing shared goal (Erev et al., 1993; Johnson and Johnson, 1989; Tauer and Harackiewicz, 2004). When people are organized in cooperative manner, higher positive network effects exist (Shapiro and Varian, 1998). Feedback from the participants also supported these notions: in conditions that include cooperation, teamwork and socializing were mentioned as important.

The results indicate that there was no significant difference between the gamification conditions concerning users' extrinsic motivations relating to using the system. This finding suggests that even though, in different implementation of gamification, users may find participation more intrinsically motivating and may participate more actively, they still equally seek to derive instrumental outcomes from system use or participation. It could be argued that higher participation in crowdsourcing would indirectly increase the instrumentality of crowdsourcing to its participants via the accumulation of the information generated by the platform from individual contributions (Geiger and Schader, 2014). However, in the experiment's short timeframe, this effect to instrumentality is likely to not have been detected, if it existed. Future research, particularly long-term studies, should investigate possible effects of different gamification designs on crowdsourcees' extrinsic motivations (Zhao and Zhu, 2014b).

One of the questions regarding gamification has been whether it can actually positively affect de facto productive behavior beyond just increasing the extent of the system usage (Hamari, 2017, 2013; Mekler et al., 2013; Morschheuser et al., 2015a). The findings of this study, in fact, seem to show that the different gamification conditions did not influence the system itself was used but rather it precisely affected the productive behavior in the system, i.e. how much users contributed. These findings support the optimistic view of gamification (Hamari et al., 2014; Morschheuser et al., 2017a). Similarly, the fact that the system usage did not differ between gamification conditions further strengthen the internal validity of the present study, since we are fairly confident that the heightened productive behavior on the platform was not caused by an overall higher system use in one of the three groups.

Further, this study indicates that motivational and behavioral outcomes of gamification features, such as leaderboards can differ according to the specific design of a gamification feature. This highlights that gamification research should not be limited to the investigation of recurring gamification features such as points, badges, and leaderboards (Hamari et al., 2014; Morschheuser et al., 2017a), but should also be extended to key design characteristics of gamification features. In particular, goal structures should be considered as it became evident in this study (Deterding, 2015; Landers et al., 2017; Morschheuser et al., 2017b).

Besides these insights, this study suggests the following practical guidelines for implementing gamification:

Design implication 1: Practitioners looking to increase intrinsic motivations and participation are advised to prefer cooperative rather than competitive gamification, but especially inter-team competition, which is a combination of beneficial aspects of both may yield best results.

Design implication 2: To increase users' willingness to recommend and invite new users to a platform, designers should prefer cooperative goal structures, but especially inter-team competitions, since people prefer to increase the number of individuals they cooperate with rather than compete against.

Design implication 3: Designers should consider the inequality in participation when implementing gamification. Different users may need a differentiated set of gamification features. As a singular design choice, inter-team competitive gamification seems to be able to address a wider breadth of motivational needs, since it combines cooperation and competition and may therefore be suitable for larger portion of users. This notion is in line with Nielsen's participation inequality rule (Nielsen, 2006); gamification designs should be able to address and engage a motivated group of core contributors, but also a large number of 'light' contributors. Inter-team competitions seem to be particularly effective to reduce free-riding in cooperative work (Erev et al., 1993) and may thus be the most effective.

Limitations and Future Research

The present study has limitations, which offer points of departure for future inquiry. First, since we gathered our findings as part of a large field experiment, the results may be biased by extraneous variables. Since we assigned the participants to the three experimental conditions based on their residence, location-based differences such as the weather, availability of mobile Internet access, and other local conditions may have influenced the results. Future research could address these issues by executing controlled and fully randomized experiments, similar to Tauer and Harackiewicz (2004). Second, the field experiment survey respondents were self-selected, and survey data were self-reported, as with all voluntary questionnaires. Although our analysis showed that the collected data followed the typical rules of crowdsourcing initiatives (Nielsen, 2006), the results may overemphasize the perceptions and intentions of users with a higher personal interest in the application. This could be addressed in future long-term studies. Third, we conducted this study in the specific context of crowdsourcing (in the domain of traffic information) through a specific gamification system. The results may differ in another context or when gamified differently. Fourth, differences in user base, such as demographic factors (Koivisto and Hamari, 2014) or users' orientations towards games (Bartle, 1996; Hamari and Tuunanen, 2014; Yee, 2006) may also affect the results. Thus, we recommend that researchers further investigate the same research problem in different settings.

5 Discussion[8]

Gamification and crowdsourcing are two interwoven phenomena that are increasingly employed by organizations to outsource various tasks related to the inventing, producing, funding, or distributing of their products and services to the crowd. However, a lack of coherent understanding of the phenomenon and a dearth of knowledge on its different facets, such as on how gamification could be designed and used to support cooperation in crowdsourcing systems, have prevented us from designing the most effective solutions. Thus, this dissertation presented an integrated conceptual framework for gamified crowdsourcing systems, a comprehensive review of the research into the gamification of crowdsourcing systems and three empirical studies to address these research gaps and to advance the understanding of gamifying crowdsourcing systems. The insights gathered as part of this research provide comprehensive theoretical and practical contributions.

5.1 Theoretical Contributions

Owing to the novelty of using gamification in crowdsourcing (Hamari et al., 2014), previous research has lacked a structured conceptualization of gamified crowdsourcing systems. Thus, this dissertation has presented a coherent conceptual framework for gamified crowdsourcing systems that characterizes the phenomenon's key aspects and facets (Figure 5). This framework simplifies the comparison of different gamified crowdsourcing systems, as demonstrated in the review of the gamified crowdsourcing research in chapter 3, and can act as an anchoring point for future studies on the gamification of crowdsourcing systems. Further, a classification framework was developed that allows one to categorize gamification features into cooperative, competitive, and individualistic gamification features according to the goal structures and interdependencies they induce between their users (Figure 6). Although various research into gamification repeatedly has highlighted the importance of goals in gamification (Bui et al., 2015; Deterding, 2015; Hamari, 2017; Landers et al., 2017), the differences of gamification features that invoke different goal structures, such as competition or cooperation, have been largely overlooked in gamification research. Previous gamification research has primarily classified and investigated gamification approaches along its implemented design elements, such as points, badges, and/or leaderboards (cf. Bui et al., 2015; Hamari et al., 2014; Seaborn and Fels, 2015) and missed the crucial aspect of the goal structures that different gamification features induce. Thus, the developed framework fills a gap in the gamification research, can guide further investigations into the psychological and behavioral effects of different gamification features, and can function as a theoretical lens for further theorization about the various design aspects of gamification.

[8] Parts of this chapter are based on Morschheuser et al. (2017a, 2017c, 2016, under review)

Based on this conceptual work, this dissertation has comprehensively investigated *how gamification has been studied and implemented in extant crowdsourcing research* (RQ1). Thus, this dissertation has presented a comprehensive review of previous research on gamified crowdsourcing and have examined how extant research used different forms of gamification in different types of crowdsourcing, the orchestration of gamification with additional monetary rewards, the types of work that have been crowdsourced, the types of crowdsourcees, and the domains in which gamification in crowdsourcing has been applied. Furthermore, the empirical findings of previous research, particularly the reported effects of gamification on psychological and behavioral outcomes of crowdsourcees, has been studied. The findings revealed that gamification seems to work in most configurations and can positively affect motivations and behaviors of crowdsourcees, particularly participation in various forms crowdsourced work and the output quality of crowdsourcees. However, the dissertation has also found that there are differences between various forms of crowdsourcing. In particular, it has been found that the crowdsourcing of homogeneous tasks has most commonly used simple gamification implementations, such as points and leaderboards, while crowdsourcing implementations that seek diverse and creative contributions typically employed more manifold gamification designs with a richer set of mechanics. Also, it has been determined that additional monetary rewards were most commonly added in simpler gamification designs, while manifold gamified crowdsourcing approaches typically just apply gamification features without additional financial incentives. Further, the review has shown that gamification features are typically implemented in crowdsourcing to induce competitions between crowdsourcees rather than motivating cooperation. To the best of my knowledge, this review is the first comprehensive overview of extant research on gamified crowdsourcing. This meticulous mapping has advanced the understanding of gamifying crowdsourcing systems by demonstrating that there are differences between various forms of crowdsourcing. Further, the overview has shown that the understanding of the phenomenon is still in its infancy. Although points and leaderboards are clearly the most common gamification features in research into gamified crowdsourcing, the review that has been conducted as part of this dissertation found that research is needed that captures the phenomenon's different facets. In particular, the support of (explicit) cooperation with gamification in crowdsourcing and the differences between various gamification feature types in crowdsourcing have been under-researched. Since cooperation is a key aspect of crowdsourcing (Doan et al., 2011), this dearth of knowledge has prevented us from gaining a holistic understanding of gamified crowdsourcing systems. Further, the lack of empirical studies on the effects of motivational and behavioral outcomes of different gamification features in crowdsourcing has inhibited us from designing the most effective solutions. Accordingly, this dissertation further focused on these gaps in the research and conducted three empirical studies in order to advance the theoretical understanding of gamifying crowdsourcing systems.

The first study (study I), investigated *how cooperative games and their features cultivate we-intentions of working as a group* (RQ2). By conducting an empirical study with users of the augmented reality game and crowdsourcing approach Ingress, it has been shown that cooperative games induce we-intentions via positively increasing group norms, social identity, joint commitment, attitudes towards cooperation, and anticipated positive emotions. Further, the findings revealed that individualistic game features had no direct effect on the users' we-intentions. Therefore, when seeking to increase cooperation, the use of features of cooperative games seems beneficial and preferable over individual-based gamification efforts. These findings extend previous research in several ways. First, this study contributed to game and gamification research, which have largely neglected the aspect of cooperation between players (Bui et al., 2015; El-Nasr et al., 2010; Liu et al., 2017, 2013). The study showed that players' use of design features of cooperative games is associated with various group dynamics that mediate the relationship between the use of cooperative game features and we-intention. These aspects should be considered when further investigating and theorizing cooperation in games. Second, the study extended previous we-intention research that has comprehensively investigated the antecedents of we-intentions in various forms of digital communities (Bagozzi and Dholakia, 2006; Dholakia et al., 2004; Oliveira and Huertas, 2015; Tsai and Bagozzi, 2014), but has omitted how design features of information systems can cultivate we-intentions. By demonstrating that the use of design features of cooperative games – such as shared goals, game mechanics and rules that support cooperation, and communication features – can influence we-intentions, the study provided foundations for investigating the design of information systems for cultivating we-intentions and cooperation in future research.

Building on these findings, study II analyzed the research question: *how to design cooperative gamification features in order to increase motivation and participation in crowdsourcing?* (RQ3). Following design science methodology (Hevner et al., 2004; Peffers et al., 2007), this study investigated the design of cooperative gamification features by developing a cooperative gamification plugin for an innovation community and evaluated this plugin in two empirical studies. The results revealed that designing cooperative gamification features, which provide motivational affordances (Huotari and Hamari, 2017; Zhang, 2008a, 2008b) and invoke positive goal interdependence (Johnson, 2003; Johnson and Johnson, 1989; Liu et al., 2013) between users, can positively influence the users' motivations, their knowledge-sharing intentions to cooperatively support others, and users' de facto participation in cooperative efforts. Thus, cooperative gamification seems to be an effective approach for engaging cooperation and promoting interaction in cooperative work environments, such as crowdsourcing systems. While previous gamification research has mainly focused on the investigation of gamification approaches that encourage competitions, but has largely ignored the support of cooperation (Bui et al., 2015; Liu et al., 2017), this finding contributes to the overall understanding of gamification. In particular, the results highlight that gamification should not be limited to competitions or individualistic gamification approaches. Further, the presented design principles have advanced the theoretical understanding of designing cooperative gamification approaches and can provide clear directions for further studies, aiming to engage collaborative problem-solving (such as crowdsourcing), to strengthen relationships in teams, or to enhance human performance in social situations (Liu et al., 2017; Thiebes et al., 2014).

Study III examined differences between individual gamification features, specifically *how crowdsourcees' motivations and behaviors differ when implementing various types of gamification in crowdsourcing, such as cooperative or competitive gamification* (RQ4). A field experiment was conducted in which pure competitive, pure cooperative, and cooperative-competitive gamification designs were compared. The study investigated these gamified conditions' effects on users' intrinsic and extrinsic motivations as well as on their behaviors (system usage, crowdsourcing participation, engagement with the gamification feature, and willingness to recommend the crowdsourcing application). The results revealed that the combination of cooperation and competitions, such as in inter-team competitions, are most likely to lead to higher intrinsic motivation and participation by crowdsourcees, as well as to a higher willingness to recommending the system. Further, the findings indicated that designers should consider cooperative instead of competitive approaches to increase users' willingness to recommend crowdsourcing systems. These insights are in line with previous research conducted in the context of sports (Tauer and Harackiewicz, 2004), work (Erev et al., 1993), and education (Okebukola, 1986), which have followed social interdependence theory (Johnson, 2003; Johnson and Johnson, 1989) to explain and investigate how the type and structure of goals influence the interaction between individuals. Thus, the findings showed that social interdependence theory (Johnson, 2003; Johnson and Johnson, 1989) also applies in the context of games and gamification for explaining how goal structures in gamification features influence users' psychological outcomes and behaviors. Further, the results added relevant findings to the ongoing discourse about the roles of different competition types in gamification designs (Ipeirotis and Gabrilovich, 2014; Koivisto and Hamari, 2014; Landers et al., 2017; Massung et al., 2013; Preist et al., 2014) and suggest that designers and operators of crowdsourcing systems should implement gamification with competing teams instead of typically used competitions between individuals. The outcomes of study II extend these findings and provide additional insights regarding RQ4. By demonstrating that the use of cooperative game features in an inter-team competitive environment is related with we-intentions, while individualistic game features do not determine a user's we-intention, study II revealed that, in situations where cooperation is needed, cooperative gamification features are preferred. However, to further sharpen these insights, further research is necessary to continue to compare the psychological and behavioral outcomes of the implementation of various gamification features, by drawing on the results of this dissertation.

Table 30 provides a summarizing overview of the abovementioned contributions of this dissertation. Overall and primarily, these insights contribute to the emerging research field of gamified crowdsourcing. This dissertation provided a conceptualization of the phenomenon and an overview of previous research, which indicated that, overall, gamification is effective for increasing participation in crowdsourcing but that there are differences in the optimal gamification of different crowdsourcing system types. Further, the empirical studies conducted as part of this dissertation have advanced the understanding of gamifying crowdsourcing systems by demonstrating that not only competitive and individualistic, but also cooperative gamification features, can support crowdsourcing approaches (studies I, II) and that combining cooperation and competition in inter-team competitions can induce the highest levels of intrinsic motivation, word-of-mouth, and crowdsourcing participation (study III). Since both the investigation of cooperative gamification features in crowdsourcing, as well as comparative studies, have been largely overlooked by previous research, these findings have added relevant insights to better understand the uses of gamification in crowdsourcing. Further, design knowledge has been gathered that can support future research into the gamification of crowdsourcing systems (review, studies I, II, III) (for an overview, see section 5.2).

However, the results gathered by this dissertation are not limited to the field of gamified crowdsourcing. The identified antecedents of cooperation in games (study I) are comparable with findings of studies conducted in online communities (Cheung et al., 2011; Oliveira and Huertas, 2015; Tsai and Bagozzi, 2014) and professional teams (Algesheimer et al., 2011; Bagozzi and Dholakia, 2006). Thus, the results of this dissertation seem easy to transfer to related contexts such as online communities and classical work environments. In particular, the findings of study I, which investigated how features of cooperative games can support cooperation, but also the results of study II, which examined the design of cooperative gamification, fill general gaps in gamification research (Bui et al., 2015; Liu et al., 2017). Further, the empirical comparison of gamification features (study III) and the classification of gamification features (Figure 6) add to a more precise understanding of the gamification phenomenon (Bui et al., 2015; Hamari and Koivisto, 2015b; Liu et al., 2017; Seaborn and Fels, 2015).

Besides findings with a specific focus on motivating crowdsourcees with gamification features, the studies in this dissertation have also revealed knowledge that is crucial beyond this scope. The empirical investigation of crowdsourcees' behaviors in several crowdsourcing systems (studies II, III) showed that crowdsourcing participation is commonly distributed unequally: A very small portion of all crowdsourcees are responsible for most of the outcomes. This adds to previous research (Ortega et al., 2008; Varshney, 2012) that proposes that crowdsourcing follows Nielsen's participation inequality rule (Nielsen, 2006). Further, the conducted review revealed a comprehensive overview of the multifaceted faces of crowdsourcing systems, including the domains in which crowdsourcing is applied, the different types of crowdsourced work and an overview of classes of crowdsourcees (see section 3.2). This adds to the overall understanding of crowdsourcing that has been missing in previous reviews of crowdsourcing systems (Geiger and Schader, 2014; Prpić et al., 2015a; Zhao and Zhu, 2014a).

Chapter	Key contributions
Theoretical and Conceptual Foundations	• Gamified crowdsourcing systems are problem-solving approaches that utilize gamification features to influence motivations and behaviors of crowdsourcees. • Gamification features can be classified along the interdependencies and goal structures they induce between users.
Review of the Current State of Gamified Crowdsourcing Research	• Extant studies are unanimous that gamification has been an effective approach for increasing crowdsourcing participation and the quality of crowdsourced work. • There are differences between different crowdsourcing types: research in the context of crowdsourcing of homogenous tasks has most commonly used simple gamification implementations, such as points and leaderboards, whereas crowdsourcing implementations that seek diverse and creative contributions employ gamification with a richer set of mechanics.
Study I: Examining Cooperation in Games	• In cooperative games, players' use of cooperative game features is associated with we-intentions and is mediated by group dynamics: group norms, social identity, joint commitment, attitudes towards cooperation, and anticipated positive emotions. • Players' use of single-player / individualistic game features are not associated with we-intentions, while players' use of cooperative game features is.
Study II: Designing Cooperative Gamification Features for Crowdsourcing	• Cooperative gamification features should offer motivational affordances and should invoke positive goal interdependence between users. • Cooperative gamification features can increase intrinsic motivation, knowledge-sharing intentions, and crowdsourcing participation in cooperative crowd work. • Cooperative gamification seems to only engage small portions of people, and novelty effects may influence their motivational and behavioral outcomes.
Study III: Differences Between Cooperative and Competitive Gamification in Crowdsourcing	• The combination of cooperative and competitive gamification, as in inter-team competitions, is particularly effective in invoking intrinsic motivation and can engage the highest crowdsourcing participation levels, compared to pure competitive or pure cooperative gamification. • Users are more likely to recommend crowdsourcing approaches when a type of gamification is used that includes cooperation, but in particular when gamification is implemented as inter-team competition. • The implementation of different gamification features does not influence users' extrinsic motivations relating to using a system. • Participation in gamified crowdsourcing follows Nielsen's participation inequality rule (Nielsen, 2006). Thus, different sets of gamification features seem to be needed to address all users. Inter-team competitive gamification that combines cooperation and competition seems to be most suitable to reach large portions of users.

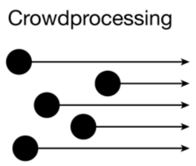
Table 30. Theoretical Contributions at a Glance

5.2 Practical Contributions

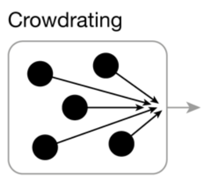
The comprehensive and meticulous mapping of previous research into gamified crowdsourcing and the empirical findings of the studies conducted as part of this dissertation provide comprehensive insights for crowdsourcing system designers and operators.

Overall, a primary finding of previous gamified crowdsourcing research was that gamification positively affects crowdsourcing work, either in the form of increased motivations of or contributions by crowdsourcees (Table 10). Thus, generally, using gamification in crowdsourcing can be recommended. However, this dissertation found large differences in the implementation of gamification between the various crowdsourcing types and in the spectrum of applied gamification features. Thus, it is less important to investigate whether gamification works as a whole; instead, practitioners need a comprehensive understanding of which specific design choices are successful in the various crowdsourcing system types. In the following, this dissertation thus summarizes these recommendations for gamifying crowdsourcing systems, with a specific focus on the different types of crowdsourcing systems and the various types of gamification features.

5.2.1 Recommendations for Different Crowdsourcing System Types

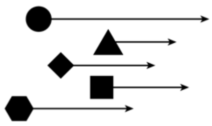


Homogenous non-emergent tasks are easily enumerable. Thus, most *crowdprocessing* approaches reward the *quantitative participation* of crowdsourcees (e.g. number of completed tasks (Itoko et al., 2014), number of correct answers (Ipeirotis and Gabrilovich, 2014), or the number of visited locations (Uzun et al., 2013)). These simple, commonly *point-based mechanisms* are usually combined with further gamification features such as *level systems* and/or *public leaderboards* to achieve *self-competitive or other-competitive* engagement (Ipeirotis and Gabrilovich, 2014; T. Y. Lee et al., 2013; Runge et al., 2015). Since homogenous tasks are commonly simple, repetitive, and quick to complete, using rich game designs such as full-fledged games could be redundant and excessive (Dumitrache et al., 2013; T. Y. Lee et al., 2013). Empirical studies (Table 10) found that the use of simple, *individualistic*, and *competition-based* gamification approaches is efficient and therefore cost-effective for such tasks (e.g. Feyisetan et al., 2015). However, competitions should be carefully designed. Empirical studies on the use of leaderboards in *crowdprocessing* systems showed both positive and negative results (Ipeirotis and Gabrilovich, 2014; T. Y. Lee et al., 2013). Unbalanced competitions can demotivate participants (Liu et al., 2013).



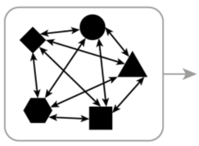
In the case of *crowdrating*, crowdsourcees' contributions represent votes on a given topic, from which collective values emerge (Geiger and Schader, 2014). Thus, crowdsourcees are often rewarded for the *quantity* and the *quality* of their contributions. Scoring mechanisms are used that reward the quality of a contribution in the context of the emergent outcome and motivate users to emulate others and to "think and act like the community" (e.g. other users rate a user's contributions and thus determine the reward for that user (Dumitrache et al., 2013), or the system determines the extent of similarity/agreement with other crowdsourcees' contributions (Eickhoff et al., 2012; Goncalves et al., 2014; Harris, 2014; Saito et al., 2014)). Similar to crowdprocessing, *points systems* in crowdrating are often combined with *leaderboards* (see Table 5) or *time pressure* (Eickhoff et al., 2012; Harris, 2014; Kacorri et al., 2014) to create *competition-based* settings in which a user can compete against others or against their previous performance.

Crowdsolving



Crowdsolving tasks strive for heterogeneous, non-emergent contributions, which could vary in complexity and commonly require a wide spectrum of skills sets. Thus, practitioners should carefully consider task characteristics and especially task complexity when designing gamification approaches for crowdsolving systems. While practitioners may be more interested in rewarding the quality than the quantity of crowdsourcees' participation, the individual characteristics of the crowdsourced tasks seem to determine the applicable scoring mechanisms. However, owing to task heterogeneity, the value of individual contributions can be difficult to evaluate via technical solutions and may thus prevent practitioners from implementing mechanisms that reward quality (Von Ahn, 2009). Since heterogeneous tasks commonly require a wide spectrum of skills sets, *manifold gamification* designs that provide opportunities to engage broad target groups in the short term and/or long term seem helpful (Table 5). Besides *competitive* designs, the review of extant research revealed that several studies also applied *cooperative* or *cooperative-competitive gamification* designs in crowdsolving (Table 6). Cooperative gamification seems to be apt for supporting high-quality heterogonous solutions (Blohm et al., 2010). Study II provided an example of how gamification could be applied to motivate crowdsourcees to work together to create diverse solutions and may guide practitioners to design similar systems with cooperative gamification features. Further, the review indicated that designers of crowdsolving solutions should consider explicitly highlighting possible gamification rewards for a task so as to increase the quality of the crowdsourced work and engagement of crowdsourcees (Choi et al., 2014). Choi et al. (2014) also showed that engagement can be increased by implementing opportunities to achieve greater rewards depending upon the quality of the crowdsourced work.

Crowdcreating



Crowdcreating systems typically seek to gather comprehensive artifacts based on heterogeneous contributions. While previous research has mostly overlooked the gamification of crowdcreation, this dissertation has advanced understanding. Since crowdcreation relies on the cooperation and creativity of users, gamification that supports diverse contributions and cooperation is needed. This dissertation presented several detailed insights on designing gamification features for supporting cooperation (studies I, II, and III). Study I's findings revealed that practitioners aiming to support *we-intentions* and therefore cooperation in crowdcreation should focus on the implementation of *cooperative* and *cooperative-competitive* gamification features instead of individualistic ones. By comparing competitive, cooperative, and cooperative-competitive (i.e. inter-team competitive) gamification features, study III further showed that the combination of cooperation and competition, such as in inter-team competitions, can cause the highest levels of intrinsic motivation and participation of crowdsourcees in cooperative crowd work. It has also been shown that inter-team competitive gamification can support users' willingness to recommend crowdcreating systems and can therefore help in the distribution of crowdcreating systems. In cases where crowdsourcees' contributions are easy to process via technical solutions, mechanisms that reward both quantitative and qualitative participation seems suitable, such as what was implemented in study III.

5.2.2 Recommendations on Different Types of Gamification Features

The results of the empirical studies conducted as part of this dissertation highlighted that gamification features' goal structures significantly influence motivational outcomes and behaviors of crowdsourcees. Although points (especially points that reward quantitative participation) and leaderboards are the most commonly implemented gamification features, I recommend not implementing these elements too hastily. Rather, it can be recommended that practitioners should consider the results of extant empirical studies, as presented in this dissertation (Table 10 and studies I to III) and theoretical frameworks on the design of game mechanics for crowdsourcing work (Von Ahn and Dabbish, 2008), in order to optimally incentivize right activities. In particular, this dissertation recommended considering the goal structures that specific gamification features induce.

Competitive Gamification: The comprehensive review of extant research showed that most gamified crowdsourcing systems implement points and leaderboards to induce competitions between crowdsourcees (Table 5, Table 6). Further, several empirical studies indicate that leaderboards/rankings seem to be very effective in motivating certain crowdsourcing community users to increase their contribution levels (T. Y. Lee et al., 2013; Runge et al., 2015). However, the concrete design of a competition decisively determines the motivational and behavioral outcomes (Liu et al., 2013) (cf. in the context of *crowdprocessing* (Ipeirotis and Gabrilovich, 2014; T. Y. Lee et al., 2013) and *crowdrating* (Massung et al., 2013; Preist et al., 2014)). While various studies reported positive effects of using competitions in crowdsourcing, research by Massung et al. (2013), Preist et al. (2014), Straub et al. (2015), and Ipeirotis and Gabrilovich (2014) indicate that competitions can demotivate crowdsourcees and can have negative effects on the overall outcome of the crowdsourcing. In particular, when opponents were unbalanced, negative effects were reported (Ipeirotis and Gabrilovich, 2014; Liu et al., 2013). Further, the studies in this dissertation revealed that, in crowdsourcing approaches that strive for collaborative outcomes (e.g. crowdcreating systems), competitions may have negative effects on users' intentions to invite others, since an increasing number of participants in a competition reduces an individual's chance to win (study III). Thus, practitioners should carefully assess whether a competition is appropriate for a specific crowdsourcing approach and should carefully examine competitions' effects in crowdsourcing (Straub et al., 2015).

Individualistic Gamification: In contrast to rankings that generally encourage people to compare their efforts with others, level systems or private badges could be used to motivate by visualizing individual achievements. Further, time pressure or leaderboards on which crowdsourcees can compete against their own performance are often found in crowdprocessing and crowdrating (Eickhoff et al., 2012; Harris, 2014; Kacorri et al., 2014). However, previous research indicates that the use of social (i.e. competitive or cooperative) gamification features seems to be slightly more effective than individualistic gamification (T. Y. Lee et al., 2013). The dissertation findings further extended these results. Study I's results imply that practitioners who seek to engage in cooperative efforts should prefer cooperative gamification instead of individualistic gamification features. Individualistic gamification features could be effective as an addition in competitive situations (T. Y. Lee et al., 2013), but as the research in this dissertation showed, the use of such individualistic gamification features can even have negative effects in cooperative situations, where the individualistic goals of a gamification feature negatively affect the relationships to other persons whom a person should cooperate with (study I).

Cooperative and Cooperative-Competitive Gamification: Neither in the context of crowdsourcing nor in general gamification research (Bui et al., 2015; Liu et al., 2017) has the support of cooperation by using design features of games, in particular, cooperative games, been comprehensively investigated before. However, via an integrated conceptualization and several empirical studies, this dissertation has generated comprehensive insights on the possible cultivation of cooperation by using cooperative gamification features (studies I, II). The findings suggested that design features of cooperative games – such as shared goals, cooperation-enabling game mechanics and rules, and communication possibilities – offer great potential for cultivating cooperation outside games, for instance in crowdsourcing systems (studies I, II). Thus, designers of information systems and collaborative technology who seek to cultivate cooperation should consider implementing features of cooperative games, i.e. cooperative gamification features. Further, in this dissertation has examined the differences between harnessing cooperative and competitive gamification features in crowdsourcing (study III); the findings revealed that practitioners who seek to increase motivation and participation should prefer cooperative rather than competitive gamification, but especially inter-team competitions, which combine the beneficial aspects of both (study III). This dissertation also showed that practitioners should turn to cooperative and inter-team competitive gamification features when looking to increase users' willingness to recommend and invite new users to a platform, since people prefer to increase the number of people they cooperate with rather than compete against (study III). Besides these potentials for using cooperative and inter-team competitive gamification in crowdsourcing, this dissertation has also generated precise recommendations for designing such features: First, the dissertation found that designers of such features should specifically consider the implementation of gamification features that offer shared goals, such as team challenges (El-Nasr et al., 2010), or should intertwine the goals of individuals to promote collaborative action (studies I, II). Second, cooperative gamification features should provide opportunities for the satisfaction of innate human needs, such as the need for social relatedness and competence satisfaction, and should thus follow the design principles of Zhang (2008a, 2008b) for integrating such motivational rewards into information systems (Jung et al., 2010) (study II). Third, those seeking to cultivate cooperation via gamification should work on features that can trigger self-reflection processes (Bagozzi and Lee, 2002; Ellemers et al., 1999) and that support members' identification with a group. Visualizations of groups and their members, uniform group logos or colors, statistics for direct comparison between players that enable social categorization (Turner, 1975), and visual representations of users via avatars (Bessière et al., 2007; Klimmt et al., 2009) are examples known from games and could help to support and trigger such identification processes (studies I, II).

Gamification Feature Orchestration: Typically, gamified crowdsourcing systems apply rich gamification designs with a diverse set of gamification features (Table 5). In particular, previous studies in crowdcreating and crowdsolving have reported a manifold use of gamification features, including points and leaderboards, but also virtual teams, weapons, storytelling, missions, or avatars (Prandi et al., 2016; Prestopnik and Tang, 2015; Tinati et al., 2016). Research by Massung et al. (2013) and Preist et al. (2014) recommended mixing several gamification elements for different target groups to increase the overall outcome, which could be particularly important in crowdcreating and crowdsolving systems that benefit from a diversity of participants. However, the experiment of T. Y. Lee et al. (2013) indicated that adding more motivational affordances does not always increase motivation, especially in homogenous scenarios such as crowdprocessing. These examples show that many different facets, such as context-specific and task-specific constraints, target group characteristics, or a specific goal behavior and outcomes may influence a gamification design. In particular, this dissertation recommends considering the interplay of goals of different gamification feature types before combining them into manifold gamification designs (cf. studies I, II, III). The conceptual and empirical work in this dissertation has advanced the understanding of individualistic, cooperative, competitive, and cooperative-competitive gamification feature types and their potential effects on motivational and behavioral outcomes. However, future work is still needed to understand the effects and optimal orchestration of gamification features.

Gamification and Financial Incentives: Overall, this dissertation found that gamification can induce motivation and participation in crowdsourcing without the use of additional financial incentives (Table 7; studies I, II, III). Thus, gamification provides a cost-effective opportunity to entirely replace financial incentives in crowdsourcing. However, practitioners may also consider using a combination of gamification and financial incentives. Considering how gamification is implemented in crowdsourcing (see Table 5), it appears that combinations of gamification and monetary rewards have most commonly been used in implementations that employ simpler gamification designs, i.e. points and leaderboards. Although studies suggest that extrinsic rewards (such as money) can potentially decrease intrinsic motivation (Deci, 1971; Deci et al., 1999), previous research found that gamification in combination with financial rewards can in fact increase participation, compared to only gamification (Massung et al., 2013; Preist et al., 2014). However, a study by Ipeirotis and Gabrilovich (2014) has indicated that the output quality of paid crowdsourcing can be worse, since payments may wipe out intrinsic motivation to accomplish high-quality outputs. Therefore, monetary incentives should be implemented with caution in combination with gamification.

Target Group Specific Gamification: The dissertation findings (studies II, III) are in line with previous research (Itoko et al., 2014; Koivisto and Hamari, 2014; Morschheuser et al., 2017d) that gamification designs are typically designed and thus effective for specific target groups. In particular, designers should consider inequality in participation (Nielsen, 2006) when implementing gamification. Study II and study III found that gamified crowdsourcing is typically only used by a small group of potential users. Thus, clearly, it is important that designers identify this group of core participants and choose the right incentives so as to engage these people. Several studies (Ipeirotis and Gabrilovich, 2014; Itoko et al., 2014; T. Y. Lee et al., 2013; Massung et al., 2013; study III) indicate that such users are often motivated by altruism and curiosity. Also, gamification-related literature suggests that users can have very different approaches towards games and how they interact with them. For instance, some users may be more motivated by seeking to reach achievements, and others by immersion-related designs (Ermi and Mäyrä, 2005; Hamari and Tuunanen, 2014; Koivisto and Hamari 2014; Yee, 2006). Thus, sustainable gamification designs should also consider personal factors as well as orientation to work and games (Morschheuser et al., 2017d).

5.3 Critical Reflection

Although in recent years, gamification has gained great popularity in research and practice, critics have questioned the phenomenon's ethical and moral grounds (Kim, 2016; Kim and Werbach, 2016; Selinger et al., 2015; Sicart, 2015). While the original idea behind gamification is to enhance the intrinsic motivations and thus the enjoyment of activities by making them more gameful (Deterding, 2015; Deterding et al., 2011; Huotari and Hamari, 2017; Rigby, 2015), critics note that gamification can also be used to *manipulate* or even *exploit* (Bogost, 2011; Kim, 2016). In gamification, the difference between motivation and manipulation is often blurred and thus raised discussions, especially concerning the gamification of labor (Kim, 2016; Kim and Werbach, 2016; Selinger et al., 2015). However, the ethical concerns of using gamification in the specific context of crowdsourcing have been under-researched. In this section, this dissertation thus provides a brief discussion of the potential ethical issues of using gamification in crowdsourcing.

Researchers have noted that gamification in labor, including crowd work, is *exploitation* when gamification is used in unfair ways and leads to situations in which individuals create values but don't participate in this value creation (Bogost, 2011; Kim, 2016). The comprehensive review of extant gamified crowdsourcing research in this dissertation revealed that gamification is often considered as a replacement for financial incentives in crowdsourcing. Following Kim and Werbach (2016), such a replacement of existing financial rewards with gamification or the addition of gamification that increases the performance of crowdsourcees, but not their financial outcomes, could lead to an unfair advantage for the system owner and therefore to *exploitation* of crowdsourcees. However, gamification designed to transform monotonous and meaningless crowd work into a joyful and intrinsically engaging experience can also offer crowdsourcees great hedonic advantages (Hamari and Koivisto, 2015b; Kim, 2016; Kim and Werbach, 2016; Liu et al., 2017; Melenhorst et al., 2015) (Table 9). Owing of the poor comparability of financial and hedonic advantages, Kim (2016) stressed that it is very hard to condemn gamification as exploitative. However, researchers and practitioners should be aware of this ethical aspect when using gamification in crowdsourcing. Further, gamification should be seen as an approach for increasing intrinsic motivation and enjoyment in crowdsourcing, rather than as a way to replace financial incentives.

The source of gamification, games, are widely known for their extensive distracting and addictive characteristics (Griffiths et al., 2012; Kuss et al., 2012; Schüll, 2012; Wan and Chiou, 2006). Thus, gamification can also be very distracting or even addictive for those using it. A fictitious example may help to illustrate this relationship: Let us assume that there is a gamified crowdsourcing approach in which a user sees two or more similar images and must decide whether or not these images contain the same object. By identifying and confirming similarities between the images, the users can earn points, calculated based on the decisions of other users. These points are prominently visualized in the application and can provide instant positive feedback, together with a motivating sound upon user interactions with the system. Further, the system allows users to climb levels, to compete against others, and to earn financial rewards. In the review in this dissertation, many such gamified crowdsourcing approaches were found for tasks relating to object recognition in images and image classification (e.g. Brenner et al., 2014; Deng et al., 2016; Mason et al., 2012). Considering this example and its implemented gamification features, many similarities can be found to slot machines. For instance, slot machines commonly also use points, rich instant visual and audio feedback, competitions, levels, and financial rewards (Harrigan et al., 2010). However, it is widely known that, in slot machines, these features are implemented to make people addicted to using the system (Harrigan et al., 2010; Kim and Werbach, 2016; Schüll, 2012). Designers should be aware of these potential distracting and addictive characteristics of games when borrowing their features in gamification. According to Kim and Werbach (2016), distracting and addictive effects of gamification can undermine self-reflection, self-determination, and autonomy in decision processes without a person becoming aware of this. Such unjustifiable losses of self-determination and autonomy in decision processes is commonly referred to as *manipulation* (Gorin, 2014; Kim and Werbach, 2016). Therefore, using gamification in crowdsourcing possess risks the manipulation of crowdsourcees. This aspect should be carefully considered when gamifying crowdsourcing systems. Understanding gamification as *motivational affordances* (Zhang, 2008a, 2008b) according to the conceptualization of this dissertation may help to overcome this issue. According to Gibson (1977), affordances are defined as actionable properties between an object and an actor that are voluntary to use and don't force a user to use them. Even if this does not imply that gamification is not manipulating its users, it highlights that voluntary, self-determined use is a key aspect of gamification (Huotari and Hamari, 2017; Liu et al., 2017; McGonigal, 2011).

Besides possible manipulation or even exploitation of crowdsourcees, gamification used in crowdsourcing at least influences crowdsourcees' behaviors (see studies I, II, III) (Hamari et al., 2014; Huotari and Hamari, 2017). This influence can be unconscious, since behavioral effects of gamification features are commonly mediated by social dynamics and psychological processes (study I) (Hamari et al., 2014; Huotari and Hamari, 2017; Ryan et al., 2006) and are difficult to understand from an end-user perspective. This may invoke ethical concerns, especially when this influence leads to possible *physical* and *psychological consequences* for the users of a gamified crowdsourcing system (Kim and Werbach, 2016), for instance, when gamification leads to physical and mental over-exertion. Further, gamification has been used to create anxiety (Kim and Werbach, 2016), such as situations in which crowdsourcing operators use leaderboards to expose and therefore compromise underperforming crowdsourcees (Chen and Pu, 2014; Massung et al., 2013; Preist et al., 2014). Cooperative and cooperative-competitive gamification features that motivate people towards collegiality and cohesion may thus be preferable compared to pure competitions, as also shown by the empirical findings in this dissertation (studies I, II, III).

Finally, the *ways to reward activities* by gamification incentives and a gamified crowdsourcing approach's *task characteristics* can provide grounds for ethical concern. For instance, a gamification approach that repeatedly rewards the same behavior by giving of points or badges can sustainably change behavior via behavior conditioning (Kohn, 1993, p. 5). One of the most popular experiments for demonstrating the possibility of behavior conditioning by the use of repeated rewards is the Skinner box (Skinner, 1948). Using a chamber with an apparatus that automatically gives pigeons and rats a reward (e.g. food) when performing a particular behavior (e.g. pushing a button), B.F. Skinner demonstrated that repeated rewards can sustainably change behaviors, since the animals still continued the rewarded and therefore trained behavior even when the rewards were given without checking the behavior (Skinner, 1948). Ethical concerns can also be justified when a gamified crowdsourcing approach motivates crowdsourcees to violent behavior, such as taking of pictures of prohibited areas, unethical behaviors, such as the analyzing of data that compromises other people's privacy, or potentially dangerous behaviors, such as reporting information while driving a car (Harris and Srinivasan, 2013; Kim and Werbach, 2016). Further, there may be crowdsourcing approaches with tasks that should not be gamified from an ethical perspective; for instance, approaches to support terrorism, propaganda, or war (Kim and Werbach, 2016). Thus, the ways of rewarding and the characteristics of the rewarded activities should be considered before implementing gamification incentives in crowdsourcing.

Although this demonstrates that the use of gamification in crowdsourcing provides several ethical and moral concerns which should be considered by practitioners, one should not demonize the gamification of crowdsourcing. The studies conducted as part of this dissertation revealed that the right use of gamification in crowdsourcing can significantly increase the enjoyment of participation in crowdsourcing (studies II, III). Similar results were reported by most of the reviewed studies that examined the psychological outcomes of different gamified crowdsourcing systems (Table 9). Using gamification in crowdsourcing can transform monotonous, boring, and sometimes meaningless crowdsourcing tasks into fun and exciting experiences. Thus, gamification can provide great hedonic benefits for crowdsourcees that are satisfied insufficiently in many traditional, non-gamified crowdsourcing approaches (Kaufmann et al., 2011; Nov, 2007; Nov et al., 2010; Soliman and Tuunainen, 2015; Zhao and Zhu, 2014b). However, it is important that practitioners comprehensively understand gamification – as it sought by this dissertation – to be able to use this instrument in ways that allow to flourish its hedonic advantages and to sustainably improve crowdsourcing work for crowdsourcees (Bui et al. 2015; Hamari and Koivisto, 2015b; Liu et al., 2017; Melenhorst et al., 2015; Morschheuser et al., 2017d).

5.4 Limitations and Future Research

While this dissertation has improved the understanding of applying gamification in crowdsourcing systems, there are also limitations that should be discussed as they provide avenues for future research. Since specific limitations concerning the individual studies in this dissertation (the review, studies I, II, III) have been already articulated at the end of each study, the following section discusses general limitations of this dissertation.

In order to provide a coherent and comprehensive overview of the phenomenon, this dissertation has conducted a review of the scientific literature on the gamification of crowdsourcing systems. This structured overview revealed how previous research has studied and applied gamification in different forms of crowdsourcing systems and has helped to identify issues and gaps that call for more precise investigation. This dissertation has presented a summarizing research agenda that guided the studies in this dissertation (section 3.3.1). The empirical studies of this dissertation considered two crucial points of this research agenda: (i) the better understanding of the design of cooperative gamification features for crowdsourcing systems and their effects when implemented in crowd communities; and (ii) the comparison of different gamification features' effects in comparative studies. Although these aspects were extensively investigated in this dissertation, there is still a need for future research that considers the other agenda points raised. For instance, researchers should investigate the design of optimal incentive structures for combining gamification with financial incentives, should conduct additional longitudinal studies to increase the reliability and generalizability of extant findings, or should study the overall cost-efficiency of applying gamification in crowdsourcing systems (see section 3.3.1 for the full list of identified research agenda points).

The studies in this dissertation were conducted in specific crowdsourcing systems. While this diversity contributes to the overall generalizability of the dissertation results, and there is no obvious a priori reason to expect that these studies' results were affected by the considered crowdsourcing approaches, it is feasible that the results are somewhat context-dependent. For instance, the effects of cooperative and competitive gamification features on crowdsourcees may differ between different types of crowdsourcing systems, such as crowdrating and crowdcreating approaches. Future research that compares the dissertation findings across different types of crowdsourcing system could enhance the results' generalizability.

Besides context characteristics, personality traits of the studied crowdsourcees may also have influenced the dissertation findings. The review of previous research revealed that there are differences in how individuals perceive gamification features (Hamari, 2013; Kobayashi et al., 2015; Koivisto and Hamari, 2014). For instance, there may be a big difference between crowdsourcees who experience participation in gamified crowdsourcing approach as work or as play. Further, previous research has found that personal characteristics, such as gender and cultural background, can strongly influence how people react to rewards as they are typically used in gamification of crowdsourcing (Kohn, 1993, p. 19 ff.). As mentioned in the research agenda (section 3.3.1), the influences of such personal, demographic, and cultural characteristics have been under-researched in the literature on gamified crowdsourcing systems; this provides opportunities for future research. In this context, researchers should specifically consider current developments in machine learning and artificial intelligence that promise the design of more personalized gamification solutions. Such data-driven, adaptive gamification approaches may allow one to design incentives that precisely fit a crowdsourcee's character and needs and may therefore increase crowdsourcees' motivations and output quality, similar to what is known from traditional work environments (Pink, 2009; Ryan and Deci, 2000).

This dissertation has primarily focused on aspects concerning the design and the psychological and behavioral effects of using gamification in crowdsourcing systems. Possible consequences for society and the economy fall outside the scope of this work. However, it is clear that further growth of crowdsourcing, which changes the ways work was traditionally performed and organized, will strongly affect these areas (Howe, 2006; Kittur et al., 2013; Prpić et al., 2015a). Thus, future research should examine possible social and economic consequences of gamified crowdsourcing for society, the labor market, and organizations. Likewise, the ethics of using gamification in crowdsourcing calls for further research. This dissertation has provided a brief overview of relevant points that can guide further research in this direction. Existing knowledge about the design of fair and protective working conditions could be transferred to the field of gamified crowd work (Gadiraju et al., 2015; Irani and Silberman, 2013; Kittur et al., 2013) and could help to increase the enjoyment of participation in crowdsourcing approaches.

The gamification of crowdsourcing is a rapidly growing phenomenon and current developments, such as machine learning, virtual realities, artificial intelligence, sharing economies and the connection of everything, will expand the design space of current gamified crowdsourcing systems. These developments provide great room for future research. The research undertaken in this dissertation provides solid foundations for such research efforts and can act as an anchoring point for studies which seek to further advance the understanding of using gamification in crowdsourcing systems.

6 Conclusion

In summary, this dissertation sought to advance the understanding of the gamification of crowdsourcing systems by addressing research gaps that have prevented us from comprehensively understanding this phenomenon and designing effective solutions. Thus, this dissertation presented an integrated conceptualization of gamified crowdsourcing systems and a comprehensive review of the research into the gamification of crowdsourcing systems. Further, this dissertation provided empirical insights into the social and psychological dynamics and the design of cooperative gamification features for crowdsourcing systems, empirical findings on the motivational and behavioral effects of applying cooperative gamification features in crowdsourcing, and an empirical comparison of the use of competitive, cooperative and inter-team competitive gamification features in crowdsourcing systems. Based on these studies, this dissertation summarized practical guidelines for the implementation of gamification in different types of crowdsourcing systems. Further, a critical discussion of the of the moral and ethical concerns of the phenomenon has been given. Overall, this dissertation thus provided comprehensive contributions that have improved the theoretical and practical understanding of gamified crowdsourcing systems and their design.

7 References

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Appendix

Appendix A: Review – List of Search Hits

The full list of the hits from Scopus with the citation and categorization information.

ID	Citation	Paper categorization
1	Ahmed, N., Mueller, K., 2014. Gamification as a paradigm for the evaluation of visual analytics systems, in: Proceedings of the 5th Workshop on Beyond Time and Errors: Novel Evaluation Methods for Visualization. ACM, Paris, France, pp 78–86.	Preliminary work
2	Albarqouni, S., Baur, C., Achilles, F., Belagiannis, V., Demirci, S., Navab, N., 2016. AggNet: Deep learning from crowds for mitosis detection in breast cancer histology images. IEEE Trans. on Med. Im., 35. 1313-1321. doi: 10.1109/TMI.2016.2528120	Excluded due to not being relevant
3	AlRouqi, H., Al-Khalifa, H.S., 2014. Making Arabic PDF books accessible using gamification, in: Proceedings of the 11th Web for All Conference on - W4A '14. ACM Press, Seoul, Republic of Korea, pp. 1–4. doi:10.1145/2596695.2596712	Preliminary work
4	Altmeyer, M., Lessel, P., Krüger, A., 2016. Expense control: A gamified, semi-automated, crowd-based approach for receipt capturing, in: Proceedings of the 21st International Conference on Intelligent User Interfaces - IUI '16. ACM Press, New York, USA, pp. 31–42. doi:10.1145/2856767.2856790	Empirical with results on gamification
5	Ansari, S., Kleiman, R., Binder, J., Hayes, W., Hoeng, J., Iskandar, A., Rhrissorrakrai, K., Norel, R., O'Neel, B., Peitsch, M., Poussin, C., Talikka, M., Schlage, W., Stolovitzky, G., DiFabio, A., Pratt, D., Boue, S., 2013. On crowd-verification of biological networks. Bioinform. Biol. Insights 7, 307–325. doi:10.4137/BBI.S12932	Preliminary work
6	Armisen, A., Majchrzak, A., 2015. Tapping the innovative business potential of innovation contests. Bus. Horiz. 58, 389–399. doi:10.1016/j.bushor.2015.03.004	Conceptual/framework paper
7	Bainbridge, D., 2015. And we did it our way: A case for crowdsourcing in a digital library for musicology, in: Proceedings of the 2nd International Workshop on Digital Libraries for Musicology - DLfM '15. ACM Press, Knoxville, TN, USA, pp. 1–8. doi:10.1145/2785527.2785529	Preliminary work
8	Benjamin, M., 2016. Problems and procedures to make wordnet data (retro)fit for a multilingual dictionary, in: Proceedings of the 8th Global WordNet Conference (GWC). Bucharest, pp. 27–33.	Preliminary work
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Appendix B1: Study I – Interview Questions

Questions asked to determine the nature of a game design feature in Ingress

I find that the game feature "XXX" (*«Description of the functionality»*) ...

… is of individual nature (5-point Likert scale: *strongly disagree* - *strongly agree*)

… is of competitive nature (5-point Likert scale: *strongly disagree* - *strongly agree*)

… is of cooperative nature (5-point Likert scale: *strongly disagree* - *strongly agree*)

Appendix B2: Study I – Results of the Ingress Feature Categorization

Identified game feature of Ingress	**Individualistic game features**	**Cooperative game features**	**Competitive game features**
Factions		X*	
Action points (AP)	X		
Mind units (MU)		X*	
Agent level	X		
Medals	X		
Mission badges	X		
Agent stats	X		
Deploy resonators		X*	
Recharge resonators		X*	
COMM (in-game chat)		X*	
First Saturday (FS) events		X	
XM anomalies		X*	
Personal avatar	X		
Weapons			X
Power cubes	X		
Mods		X*	
Playing of missions	X		
Mission days	(x)	X	
Hacking of portals	C	C	C
Attacking portals			X
Takeover portals		X*	
Upgrade portals		X*	
Checkpoints and cycles		X*	

X = primary perceived category of the game feature.

(x) = secondary perceived category of the game feature. A minority of experts perceived this feature as part of the corresponding category.

* = features that were perceived as having both competitive traits (on an intergroup level) as well as cooperative traits (on an intragroup level). For such cooperative-competitive features (e.g. factions), we sought to carefully identify the cooperative aspects before developing the corresponding survey items.

C = feature that was perceived as a core game mechanic of the game. Thus, no clear assignment to one of the feature categories could be made.

Appendix C: Study II – Interview Guidelines

Interview guideline for the interview with users of the innovation community (translated from German to English).

Introduction:

1. Welcome
2. Interview introduction and background
   - Explanation of the innovation management module
   - Reason for this interview
3. Additional notes
   - Interview can be interrupted at any time
   - Questions can be skipped
   - Interview is anonymous and approved by the workers' council
4. Consent to recording and transcription the interview
   - Information that this record will be transcribed immediately after the interview and deleted (full anonymization)

Introductory Questions:

1. How long have you been using the innovation management module of the system?
   1.1. How often do you use the module?
2. What is your goal, when using the module?
3. How many ideas have you submitted already?
4. What is your motivation for submitting ideas?
   4.1. What would motivate you to submit more ideas?
5. Overall, how satisfied are you with the innovation management module of the system? On a scale of 1 (very unsatisfied) to 10 (very satisfied).

Main Questions:

1. System Use

1.1. Which advantages and disadvantages do you see in the innovation management module of the system?

1.1.1. What benefit do you see for yourself?

1.1.2. What benefit do you see for the company?

1.1.3. Do you enjoy using the innovation management module of the system?

1.1.4. What are the reasons for using the module in the future?

2. Process Operations

2.1. Do you find the process of the innovation management to be easy to understand?

2.1.1. How is the process realized in the innovation management module of the system? Is it easy to understand?

2.1.2. Do you think the processes of the module are transparent?

2.1.3. Do you sometimes wish for help with the process steps in the module?

2.1.4. What do you think about “guided user operation”?

3. Communication

3.1. How satisfied are you with the Feedback of other users?

3.1.1. What influence has it on your work?

3.1.2. How about Feedback from the System?

3.1.3. Would you be motivated more to push your ideas, if you get more and earlier feedback?

3.2. Do you use the comment and rating function of the innovation management module of the system?

3.2.1. How often do you use it?

3.2.2. Did you experience any negative Feedback?

3.2.2.1. Did it demotivate you?

4. System Accessibility

4.1. What do you think of the fact that a submitted idea can be viewed by every user of the system?

4.1.1. How does this influence your behavior?

4.1.2. Are you happy about reactions from other employees to your idea?

4.1.3. Would you hold back an idea, if you expect it to be not highly successful?

4.1.4. Would it motivate you, if colleagues can see the success of your idea?

4.2. Are you also interested in ideas from areas of competence other than your own?

4.2.1. Are you willing to comment on such ideas?

4.2.2. Do you also submit ideas to other areas of competence, to support the company?

Appendix D: Study III – Survey Constructs

Survey constructs, items, construct reliabilities and sources

Construct	Item	Construct reliability	Source
Extrinsic motivation (usefulness)	Using the app makes it easier for me to get parking information (e.g. price, location, …) Using the app enables me to be more productive with regard to finding parking information (e.g. price, location, …) I feel more effective with regard to finding parking information (e.g. price, location, …) when using the app I find the app to be useful for getting parking information (e.g. price, location, …)	Cronbach's α = .940, CR = .957, AVE = .847	Hamari and Koivisto, 2015b; Van der Heijden, 2004; Davis, 1989
Intrinsic motivation (enjoyment)	I find using the app interesting I find using the app not a waste of time I find using the app fun I find using the app not boring I find using the app enjoyable	Cronbach's α =.904, CR = .929, AVE = .880	Hamari and Koivisto, 2015b; Van der Heijden, 2004; Tauer and Harackiewicz, 2004
Willingness to recommend	I will say positive things about the app to others I will recommend the app to others who seek my advice I will refer my acquaintances to the app	Cronbach's α = .932, CR = .956, AVE = .880	Kim and Son, 2009

Appendix E: Supplementary Material and Attribution

The empirical data and materials of this dissertation is stored persistently.

Data and supplementary materials belonging to study I and study III have been published by *KITOpen* and can be accessed via https://doi.org/10.5445/IR/1000074116.

The data and supplementary materials of study II are stored in the central storage for scientific data of the Corporate Research of the Robert Bosch GmbH. Please contact Benedikt Morschheuser or Franz Grzeschniok at Bosch (kontakt@bosch.de) for any questions related to this dataset.

Attributions

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Curriculum Vitae: Benedikt Morschheuser

09/2014 – 09/2017:	**Ph.D. student and researcher** Corporate Research, Robert Bosch GmbH, Renningen, Germany and Karlsruhe Institute of Technology, Karlsruhe, Germany
07/2005 – 12/2016:	**Owner** Benedikt Morschheuser Software Solutions, Heilbronn, Germany
05/2013 – 09/2014:	**Researcher and consultant** Competence Center Sourcing, University of Leipzig, Leipzig, Germany and University of St.Gallen, St.Gallen, Switzerland
03/2012 – 09/2012:	**Diploma thesis** Forschungszentrum Informatik, Karlsruhe, Germany
10/2006 – 09/2012:	**Diploma studies** in Business Engineering (Wirtschaftsingenieurwesen) Karlsruhe Institute of Technology, Karlsruhe, Germany
09/2003 – 07/2006:	**University entrance diploma** (Abitur) Wilhelm-Maybach-Schule, Heilbronn, Germany

Publication List: Benedikt Morschheuser

Journal Articles

Benedikt Morschheuser, Marc Riar, Juho Hamari and Alexander Maedche (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. doi:10.1016/j.chb.2017.08.026

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