Douglas Cunningham, Petra Hofstedt, Klaus Meer, Ingo Schmitt (Hrsg.): INFORMATIK 2015
Lecture Notes in Informatics (LNI), Gesellschaft für Informatik, Bonn 2015

How Games and Game Elements Facilitate Learning and Motivation: A Literature Review

Christian Karl Grund[1]

Abstract: Games and game elements are increasingly used by organizations to facilitate learning and motivation, often without a clear understanding how they actually achieve these effects. This may lead to the insufficient design and use of serious games as well as gamified applications. Since the development of such applications is usually expensive, high costs and few realized benefits might result. In order to avoid such unfavorable outcomes, it is necessary to understand the underlying mechanisms that lead to learning and motivation. For this purpose, this study reviews research articles describing the use of games and game elements beyond entertainment and outlines their theoretical foundations. Based on the resulting insights, several theory-driven design guidelines for game-based learning and motivation are derived. This study therefore equips researchers with theoretical insights on how games and game elements facilitate learning and motivation, and practitioners with theory-driven design guidelines for their design and evaluation.

Keywords: Serious Games, Gamification, Games with a Purpose, Theoretical Foundation.

1 Introduction

Games and game elements are increasingly utilized by organizations to facilitate learning and motivation [LLS13]. They are employed for example as "serious games" to create experiential learning environments that fulfill more goals than simply entertaining players [Ab87]. Rather, they aim at advancing these players by improving their capabilities or knowledge [ZHR12]. Another possible use of games and game elements is "gamification" [De11]. Here, game elements are used in a non-game context in order to achieve motivational effects [Ka12]. Beyond that, there are games that solve real-world problems just by being played [ALB06]. In the game "Peekaboom" for example, players identify objects in pictures and thus enhance a computer vision algorithm [ALB06].

Despite successful applications already developed, previous research lacks systematic investigations of the mechanisms of gamification [Ka12], or how instructional theories can frame the design of serious games [Ch10]. Without such an understanding, serious games might end up as "drill and practice activities sugar-coated with game characteristics" [Ch10] and gamification might be perceived as "exploitationware" [Bo15] instead of intrinsically motivating participants. Since the development of such applications is usually expensive [Bo10], their insufficient design might result in high costs and few realized benefits. It is therefore necessary to understand how games and game elements

[1] University of Augsburg, Faculty of Business and Economics, Universitätsstr. 16, 86159 Augsburg, Germany, christian.grund@wiwi.uni-augsburg.de

lead to learning and motivation, because this understanding helps to frame the design and evaluation of "gameful" experiences for learning and motivation. In contrast to existing theoretical approaches, that focus mostly on motivation theories, this study provides a holistic view on games and game elements, which results in considering both motivation and learning theories. Hence, this study seeks to provide answers to the following two research questions:

RQ1: How do games and game elements facilitate learning and motivation?

RQ2: How can theory frame the design of game-based learning and motivation?

In order to answer these questions, this study conducts a literature review, as this research method can be used to establish a theoretical foundation for an emerging issue [WW02]. For this purpose, the theoretical foundations of research articles describing the use of games and game elements beyond entertainment are examined. Based on the resulting insights, this study suggests several theory-driven design guidelines for game-based learning and motivation, thus providing an answer to the second research question.

The remainder of this paper is organized as follows: Section 2 defines different ways of using games and game elements beyond entertainment. The method and search setup employed are described in section 3. A review of the theoretical foundation of using games and game elements for learning and motivation is afterwards conducted in section 4, followed by the resulting design guidelines for game-based learning and motivation in section 5. The paper closes in section 6 with a conclusion and possibilities for future research.

2 Using Games and Game Elements beyond Entertainment

When using games and game elements beyond entertainment, Deterding et al. [De11] propose three basic usage types: Gamification, serious games and games with a purpose. These usage types are described in the following.

Gamification can be defined as using game design elements in non-game contexts [De11]. Common game elements include points, badges, leaderboards and avatars [ZC11]. The aim of gamification often lies in motivating a specific behavior of users by implementing different (mostly social) reward structures [Ka12]. Considering this intention, gamification is defined in this paper as using game elements in non-game contexts in order to motivate a specific user behavior.

In contrast to using just game elements, serious games employ full-fledged games [De11]. They are often defined as games that are not limited to the purpose of entertainment [Ab87]. Serious games originate from the military, they are hence mostly concerned with acquiring new skills and teaching players educational content [Sm10]. In opposition to "educational games" (or "edugames"), this educational content can hardly be separated from the game mechanics, which is why learning takes place while playing

the game [Ch10]. Debriefing is also an important activity that fosters reflection on the content when using serious games [GAD02]. In order to accommodate the different purposes of serious games, they are defined in this paper as games that aim at entertaining players as well as improving their skills or knowledge.

As a last usage type of games and game elements beyond entertainment, "games with a purpose" are defined as games that solve real-world problems just by being played [De11]. They are being used for example by biologists to predict protein structures with the collective intelligence of players [Co10].

3 Method

For conducting a scientifically sound literature review about the theoretical foundation of using games and game elements for learning and motivation, this study employs the review setup suggested by Fettke [Fe06]. This categorization can be used to clarify the characteristics of a review study and is based on several recommendations from literature [Fe06]. According to this framework, this study presents a review in natural language that focuses on theory, takes a neutral perspective and highlights central aspects on the basis of selective literature (cf. Tab. 1).

Characteristic		Category			
1. Type		natural language		mathematical-statistical	
2. Focus		research result	research method	theory	experience
3. Aim	Mention	not mentioned		mentioned	
	Content	integration	criticism		central aspects
4. Perspective		neutral		position	
5. Literature	Selection	not explained		explained	
	Scope	key works	representative	selective	exhaustive
6. Structure		chronologically	thematically		methodically
7. Target Audience		common public	practitioners	researchers in general	specialized researchers
8. Future Research		not mentioned		mentioned	

Tab. 1: Characterization of this review based on Fettke [Fe06]

Games are gaining increasing relevance in the Information Systems (IS) domain as so-called "interactive hedonic systems" [LB10]. This review therefore starts with examin-

ing publications from this domain. Thus, a manual search of relevant research articles in the AIS Senior Scholars' Basket of Journals is conducted. Additional sources for the manual search are the journal "Decision Support Systems" (DSS) and a special issue on gamification in "Creativity and Innovation Management" (CAIM). Conference proceedings from the "International Conference on Information Systems" (ICIS) and the annual meeting on informatics in the "Lecture Notes in Informatics" (LNI) are also included in the search. The AIS Senior Scholars' Basket of Journals is considered since it comprises a widely accepted set of top journals in the field of IS research. The journals DSS and CAIM are selected because of their relevance to business and information systems engineering. Last, the conference proceedings from the ICIS and LNI are considered since they provide current publications from manifold research communities, such as human computer interaction. The investigation period covers the years 2009 to 2014. Every title as well as (in case of relevant terms) every heading is searched for formulations which indicate that games or game elements are being used beyond entertainment. The result of this manual search consists of 42 relevant publications.

In a next step, journals for a structured literature search are identified by looking up the references of the relevant publications mentioned above for journals that are specialized on the usage of games and game elements. This identification revealed the journals "Simulation & Gaming" (S&G) and "Games and Culture" (G&C). These journals are therefore being used for a structured keyword search considering all publications until 2014. The search terms employed are the usage types of games and game elements beyond entertainment presented by Deterding et al. [De11]. Since the term "Serious Gaming" is often used synonymously with "Serious Games", both search terms are used for serious games. The search terms are depicted in Tab. 2.

Usage type	Search term(s)
Serious Games	("Serious" AND "Games") OR ("Serious" AND "Gaming")
Gamification	"Gamification"
Games with a purpose	"Games" AND "purpose"

Tab. 2: Search terms employed in the keyword search in the journals S&G and G&C

Keyword search in the journals S&G and G&C revealed another 25 relevant publications. Together with the publications already identified by manual search, the literature sample consists of 67 publications. Since Ping et al. [PGT10] and Goh and Ping [GP14] report about the same study, only the more recent publication is considered for the literature sample. Hence, 66 publications remain in the literature sample for this review.

4 Theoretical Foundation of Using Games and Game Elements for Learning and Motivation

In the literature sample investigated, we can distinguish between theory-based publications and non-theory-based publications. A publication is hereby called theory-based, when it explains how games and game elements facilitate learning and motivation by referring to theories. Only 34 publications can be called theory-based according to this definition. They name 28 different theories, of which 6 are mentioned more than twice. Since this indicates their relevance in the field, these theories are selected and presented in Tab. 3.

Theory	Focus	Number of Mentions
Flow Theory of Motivation	Motivation	17
Self-determination Theory	Motivation	10
Experiential Learning Theory	Learning	6
Goal-setting Theory	Motivation	4
Bloom's Taxonomy	Learning	3
Constructivist Learning Theory	Learning	3

Tab. 3: Theories mentioned more than once in the literature sample

In order to characterize the theoretical foundation of using games and game elements for learning and motivation, these theories as well as the extent to which they are employed in the respective publications are described in the following.

4.1 Flow Theory of Motivation

Flow theory of motivation is the most cited theory in the literature sample. It describes a so-called "flow state", in which people forget about their surroundings and lose their sense of time [Cs91]. The state of flow is characterized by intense concentration, merging of action and awareness, loss of reflective self-consciousness, a sense that one can control one's actions, distortion of temporal experience and experience of an activity as intrinsically rewarding [NC02]. When being in flow, an individual operates at full capacity which means they even neglect hunger, fatigue or discomfort in order to continue pursuing an activity [NC02]. However, in order to experience the flow state, the challenge of the activity has to be in balance with the skills of the individual: Too much challenge causes anxiety, whereas too little challenge leads to boredom [NC02]. Flow has been described as a part of the gameplay experience in the literature sample [Al12; Be12; DBS13; Ha13; Ka12; KH13; LLS13; Mu11; Na12; OL13; Ok13; PR14; RUO14; SW13; WS14; WR12; WSR11]. Bedwell et al. [Be12] link various game attributes to learning outcomes. The game attribute "conflict/challenge" can thus lead to a flow state, if the degree of challenge automatically adapts to the skill level of the player. Kankan-

halli et al. [Ka12] reference Chen [Ch07] who states that flow is important for a game experience. The challenge of a game therefore has to match the player's skills [Ka12]. Koops and Hoevenaar [KH13] note that serious games are likely to trigger a flow state. However, they argue that flow might even distract the player from learning, since deeper reflection on the content of the game does not take place while being in flow [KH13]. Liu et al. [LLS13] agree that challenge has to match the player's skills. However, since their publication focuses on competition in games, they define the challenge of a game as the opposing player's skills. Hence, they conclude that both players' skill levels have to match in order to enter the flow state [LLS13]. Mueller et al. [Mu11] examine the use of virtual worlds as knowledge management platforms. In their study, they found that users of virtual worlds reported a flow-like state [Mu11]. They hence propose that because of the game-like characteristics of a virtual world, a flow state is achieved which in turn leads to important knowledge-related activities [Mu11]. Nadolski et al. [Na12] investigate architectures for multiuser learning scenarios and declare flow as the optimal learning state. They conclude that it is important for these architectures to ensure a flow state e.g. by logging player data in order to inform design [Na12]. Oksanen [Ok13] refers to flow as one of the seven core game experiences during gameplay and agrees that challenge has to match the player's skills in order to enter the flow state. The remaining publications also mention flow as a part of the gameplay experience and important for player motivation [Al12; DBS13; Ha13; OL13; PR14; RUO14; SW13; WS14; WR12; WSR11]. In summary, flow can be seen as a core experience of gameplay and is achieved by the challenge of a game corresponding to the player's individual skills.

4.2 Self-determination Theory

The main aspects of self-determination theory are motivation and personality, thus it can be called a motivation theory [RD00]. Different psychological needs are a central construct of this theory [RD00]. Every human thus has the need for competence, relatedness and autonomy. Fulfilling these needs leads to motivation, whereas neglecting them results in discouragement [RD00]. In the literature sample, publications mention self-determination theory to describe motivational effects of gamified applications [Ka12; LHC12; LLS13; MK14; Sc15; SW13; Te13; WS14; WR12; WSR11]. However, self-determination theory is not a crucial element in most of these publications; it is rather mentioned among others in their literature overviews. Only Kankanhalli et al. [Ka12] and Liu et al. [LLS13] link the psychological needs of self-determination theory with digital video games by referencing Ryan et al. [RRP06]. Following this argumentation, autonomy is achieved in games by letting players choose sequences of actions [RRP06]. Perceived competence is enhanced by tasks within the game that provide optimal challenges, and a feeling of relatedness can be achieved for example in multiplayer games, where players interact with each other [RRP06]. Taking a look at competitive elements, Liu et al. [LLS13] note that competition can have both positive and negative impacts on the enjoyment of the gameful experience: External incentives might for example undermine the feeling of autonomy, since the player is pushed into a certain direction. However, they also claim that competition can satisfy the player's need for competence

[LLS13]. Mutter and Kundisch [MK14] agree that external rewards like badges can lower the player's perceived autonomy. While this may lead to an increase in the quantity of player contribution, the contribution quality might suffer [MK14]. To sum it up, self-determination theory can be linked to video games in general, and also describes how intrinsic motivation in gamified applications can be achieved [Sc15; SW13; WS14; WR12; WSR11].

4.3 Experiential Learning Theory

Experiential learning theory underlines the influence of experience on learning success [Ko84] and can hence be called a learning theory. A central construct of this theory is the so-called learning cycle which is composed of concrete experience, reflective observation, abstract conceptualization and active experimentation [Ko84]. These stages are attached to corresponding activities (i.e., feeling, watching, thinking, doing) which result in different learning styles (i.e., diverging, assimilating, converging, and accommodating) [Ko84]. Diverging refers to individuals who prefer feeling and watching (e.g., looking at concrete situations from several different viewpoints), assimilating embraces watching and thinking (e.g., thinking through logical explanations for observed phenomena), converging covers doing and thinking (e.g., applying theoretical knowledge to practical applications), and accommodating incorporates doing and feeling (e.g., trying things out rather than thinking them through) [Ko84]. Taking into account these learning styles might lead to more effective learning [Ko84]. The publications in the literature sample argue that experiential learning is supported by interactivity in games [Al12; Be10; KH13; Le13; ML11; Na12]. In contrast to other approaches in the sample, Koops and Hoevenaar [KH13] directly incorporate elements from experiential learning theory as a part of their "Serious Gaming Lemniscate Model" which consists of a learning cycle and a gaming cycle. Hereby, they provide a link between flow theory of motivation and experiential learning theory: While the gaming cycle corresponds to an experience similar to flow, the learning cycle is consistent with the learning cycle in experiential learning theory. The authors argue that by manipulating a game's difficulty, a transition between the gaming cycle (i.e., the flow state) and the learning cycle takes place [KH13]. Hence, their model provides a first link between learning and motivation theories in the literature sample [KH13]. Monk and Lycett [ML11] describe a modified (which means strongly simplified) version of experiential learning theory by using a learning cycle that consists only of act, reflect and understand. Alklind Taylor et al. [Al12] further simplify experiential learning theory by only stating that practical experience has to precede theoretical discussion of educational content. Nadolski et al. [Na12] cite Kebritchi and Hirumi [KH08] who link the pedagogical foundations of learning games with experiential learning. Ben-Zvi [Be10] and Legner et al. [Le13] call games a form of experiential learning without further justification. We summarize that experiential learning can take place in serious games, as long as they provide possibilities to go through the stages of the learning cycle.

4.4 Goal-setting Theory

Goal-setting theory describes how goals influence motivation and task performance of individuals. Locke and Latham [LL02] draw on 35 years of empirical research on goal-setting theory, pointing out goal mechanisms and moderators of goal effects. The four goal mechanisms described consist of a directive function (goals direct attention toward goal-related activities and away from goal-irrelevant activities), an energizing function (high goals lead to greater effort than low goals), goals affecting persistence (hard goals prolong effort) and goals affecting action indirectly (goals lead to the arousal, discovery, and/or use of task-relevant knowledge and strategies). Especially the last mechanism hints at goals also leading to learning outcomes. One of the most important moderators of goal effects is goal commitment [LL02]. High goal commitment leads to a strong goal-performance relationship. The more difficult the goal, the more commitment is needed. Goal commitment is supported by the perceived importance of the goal. This perceived importance can be raised e.g. by individuals making a public commitment to the goal or letting them choose their own goals. Self-efficacy is also important for goal commitment, especially when it comes to difficult goals. It can be raised by providing success experiences, finding role-models to identify with, and persuasive communication that the individual can reach the goal (e.g., by providing solution strategies). The remaining moderators of goal effects are feedback (revealing progress in relation to the goals), task complexity (high complexity of the goal requires the ability to discover appropriate task strategies), personal goals as mediators of external incentives (i.e., taking into account personal goals and self-efficacy of a person when assigning goals), and satisfaction (achieving goals leads to satisfaction). In the literature sample, goal-setting theory is used to describe why players want to achieve certain accomplishments in gamified applications [Ha13; MK14; Op14; SW13]. Mutter and Kundisch [MK14] investigate a gamified Q&A-community and argue that goal-setting theory applies to badges in gamified applications, since badges can resemble a valuable goal to players, mostly because of their function as status symbols. Oppong-Tawiah et al. [Op14] propose that using specific, difficult and obtainable goals has a strong effect in persuasive gamified applications that foster pro-environmental behavior. Haas et al. [Ha13] and Scheiner and Witt [SW13] do not refer directly to goal-setting theory, but to self-efficacy, which is part of goal-setting theory. These publications therefore provide a theory-based explanation how goals in gamified applications lead to player motivation and performance.

4.5 Bloom's Taxonomy

Bloom's taxonomy describes several consecutive steps of the cognitive process that consist of remembering, understanding, applying, analyzing, evaluating and creating [AK01]. The publications in the literature sample use Bloom's taxonomy to describe the learning outcomes of serious games [Be10; Le13; ML11]. Ben-Zvi [Be10] proposes Bloom's taxonomy as an assessment framework for the outcomes of experiential learning. Monk and Lycett [ML11] suggest using serious games as a way of testing knowledge in higher education by aiming at the higher levels of Bloom's taxonomy

(e.g., analyzing and evaluating). Last, Legner et al. [Le13] link the learning outcomes of business simulation games with Bloom's taxonomy. In summary, Bloom's taxonomy is used to define and to assess the learning outcomes in serious games.

4.6 Constructivist Learning Theory

Constructivist learning theory is rather a philosophical view of comprehension and knowledge in general [SD95]. A central construct of this theory is the view that knowledge does not exist on its own but is constructed in each individual's mind [SD95]. Several so-called constructivist learning methods stem from this theory [SD95]. The publications in the literature sample mention these constructivist learning methods in combination with serious games [Ch10; Na08; Th06]. Charsky [Ch10] claims that more and more experts call for constructivist learning methods. Some of these learning methods can thus be fulfilled by serious games. A scientific evaluation of this claim, however, has still to be executed [Ch10]. Thomas [Th06] mentions constructivist learning as one of the concepts on which their so-called "pervasive learning" is based. Nadolski et al. [Na08] report a high demand for constructivist learning methods. They justify the link between serious games and constructivist learning methods only by educational experts' opinions that serious games can meet this demand. The literature sample does therefore not contain any publication that rigorously links serious games with constructivist learning methods or that references such a publication.

4.7 Summary and Discussion

The literature review disclosed 6 relevant theories used to explain how games and game elements facilitate learning and motivation. It also showed to which extent they are incorporated in the literature sample, reaching from "mentioned in the literature overview" to "substantial part of the publication". For most of the theories, a sufficient link to games and game elements is provided. As mentioned above, this is not the case for constructivist learning theory. One possible explanation for this is the broad scope of this theory, being rather a philosophical view of understanding and knowledge in general. Although basically being a promising possibility for future theorizing, this theory is taken out of consideration in this paper. The remaining learning theories (i.e., experiential learning theory and Bloom's taxonomy) show the different stages of the learning cycle (i.e., concrete experience, reflective observation, abstract conceptualization, and active experimentation) and provide a framework for categorizing and assessing the desired learning outcomes (i.e., remembering, understanding, applying, analyzing, evaluating, and creating). The motivation theories (i.e., flow theory of motivation, self-determination theory, and goal-setting theory) show that player motivation depends on the challenge of a gameful experience corresponding to the player's skills, the player perceiving competence, autonomy, and relatedness, as well as the player trying to reach several goals.

5 Theory-driven Design Guidelines for Game-based Learning and Motivation

In the following, 10 design guidelines for game-based learning and motivation are derived from the theoretical insights provided by the literature review. They result from checking every theory presented in section 4 for ways to enable learning and motivation. A short listing of the suggested design guidelines is presented in Tab. 4.

Design Guideline	Theoretical Foundation
Balance challenge and skill	Flow Theory
Enable perceived competence, autonomy, and relatedness	Self-determination Theory
Employ all stages of the learning cycle	Exp. Learning Theory
Consider different learning styles	Exp. Learning Theory
Set specific, difficult, and obtainable goals	Goal-setting Theory
Enable perceived goal importance	Goal-setting Theory
Enable goal-related self-efficacy	Goal-setting Theory
Constantly show progress in relation to goals	Goal-setting Theory
Remind of accomplished goals	Goal-setting Theory
Categorize and assess specific learning outcomes	Bloom's Taxonomy

Tab. 4: Theory-driven design guidelines for game-based learning and motivation

The first design guideline is called "balance challenge and skill" and corresponds to flow theory of motivation. Thus, the challenge of a game has to match the player's skills in order to enter the flow state (see section 4) [NC02]. This can for example be achieved by automatically adapting the level of difficulty in a game [Be12] or by matching players with equal skill levels in a competitive setting [LLS13]. Players might also be given the possibility to choose a difficulty level by themselves, which may in addition lead to higher goal commitment (cf. goal-setting theory). For example, a player that chooses a "hard" difficulty setting might feel more obliged to beat the game, than when given no choice. Being able to choose an "easy" difficulty setting may on the other hand help players with low self-efficacy to gain confidence about being able to beat the game.

As described in section 4, games can foster self-determination and intrinsic motivation by providing the feeling of competence, autonomy, and relatedness [RRP06]. It is therefore important for the design of such gameful experiences to promote these feelings, which is expressed by the design guideline "enable perceived competence, autonomy, and relatedness". Autonomy is achieved in games by letting players choose sequences of actions [RRP06]. Perceived competence is enhanced by tasks within the game that provide optimal challenges and a feeling of relatedness can be achieved for example in multiplayer games, where interactions between players can take place [RRP06].

Experiential learning theory supports two design guidelines. The design guideline "employ all stages of the learning cycle" suggests that a gameful experience should encompass every learning activity (i.e., concrete experience, reflective observation, abstract conceptualization, and active experimentation) in order for players to go through the entire learning cycle (cf. section 4). This can be achieved in games by incorporating different gameplay mechanics (e.g., providing a notepad) and addressing these activities in debriefing. Taking into account different learning styles, for example by offering separate game modes for assimilating (thinking-oriented) or accommodating (action-oriented) learning styles, is addressed by the design guideline "consider different learning styles".

Goal-setting theory supports several design guidelines. The first one is to "set specific, difficult, and obtainable goals", since it has been shown that setting a specific and difficult goal leads to higher performance than simply urging players to do their best [LL02]. These specific goals can for example be badges or quests in gameful experiences. As perceived goal importance leads to higher goal commitment, an additional guideline is to "enable perceived goal importance". This can be done by letting players make public commitments to their goals (e.g., by showing their goals to other players) or letting them choose their own goals. Another guideline is to "enable goal-related self-efficacy", since this also leads to higher goal commitment. Self-efficacy can be raised by providing success experiences (e.g., easier goals for beginners), presenting role-models (e.g., players close in a leaderboard or a coaching system with experienced players), and persuading players that they are able to reach a goal (e.g., by providing hints). According to goal-setting theory, it is also important to "constantly show progress in relation to goals", e.g. by providing progress bars or quest logs. Since accomplishing goals leads to satisfaction, another idea is to "remind of accomplished goals" to raise player satisfaction.

To help clearly point out the desired learning outcomes of gameful experiences, Bloom's Taxonomy can be utilized. Before the development of an application/game, the desired learning outcomes may be mapped to the different steps of the cognitive process. This is due to the fact that learning outcomes like "remembering" might need different game mechanics than for example developing the ability to "evaluate". When assessing the learning outcomes after a gaming session, this categorization can be used again to see if the players actually acquired the respective capabilities [Be10]. This design guideline is referred to as "categorize and assess specific learning outcomes".

In summary, designers of game-based learning and motivation should pay attention to the underlying mechanisms that lead to learning and motivation in order to develop successful applications. It is important to note, however, that these design guidelines are not meant to be mandatory, hence not every design guideline has to be fully executed in every application for game-based learning and motivation.

6 Conclusion and Future Research

This study provides a basic understanding of how games and game elements facilitate learning and motivation. It also presents 10 theory-driven design guidelines for game-based learning and motivation. In contrast to existing approaches, it examines both motivation and learning theories. Since this study is a first step towards identifying the theoretical foundation of using games and game elements for learning and motivation, a limitation of these results is the restriction of the search space. It is in the nature of this research method, that one single literature review can impossibly cover all relevant publications that exist on the topic. However, this does not affect the usefulness of this paper, since it only means that future works can add to the theoretical foundation identified by this review. Future research may also focus on developing a specific theory for serious games or gamification e.g. by combining the presented learning and motivation theories. In addition, the suggested design guidelines can be empirically evaluated, e.g. by examining if existing games are violating these guidelines and how this affects the intended outcomes. After this evaluation, the presented design guidelines can be used in future research to develop scientifically sound serious games and gamified applications.

Bibliography

[Ab87] Abt, C. C.: *Serious Games.* University Press of America, 1987.

[AK01] Anderson, L. W.; Krathwohl, D. R.: *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* Longman, New York, 2001.

[Al12] Alklind Taylor, A.-S.; Backlund, P.; Niklasson, L.: *The Coaching Cycle: A Coaching-by-Gaming Approach in Serious Games*. In: Simulation & Gaming 43/5, p. 648–672, 2012.

[ALB06] von Ahn, L.; Liu, R.; Blum, M.: *Peekaboom: a Game for Locating Objects in Images*. In (Grinter, R. et al. Eds.): Proceedings of the SIGCHI conference on Human Factors in computing systems. Montréal, p. 55–64, 2006.

[Be10] Ben-Zvi, T.: *The efficacy of business simulation games in creating Decision Support Systems: An experimental investigation*. In: Decision Support Systems 49/1, p. 61–69, 2010.

[Be12] Bedwell, W. L. et al.: *Toward a Taxonomy Linking Game Attributes to Learning: An Empirical Study*. In: Simulation & Gaming 43/6, p. 729–760, 2012.

[Bo10] Borrajo, F. et al.: *SIMBA: A simulator for business education and research*. In: Decision Support Systems 48/3, p. 498–506, 2010.

[Bo15] Bogost, I.: *Why Gamification Is Bullshit*. In (Walz, S. P.; Deterding, S. Eds.): The Gameful World - Approaches, Issues, Applications. MIT Press, Cambridge, MA, p. 65–80, 2015.

[Ch07] Chen, J.: *Flow in games (and everything else)*. In: Communications of the ACM 50/4, p. 31, 2007.

[Ch10] Charsky, D.: *From Edutainment to Serious Games: A Change in the Use of Game Characteristics*. In: Games and Culture 5/2, p. 177–198, 2010.

[Co10] Cooper, S. et al.: *Predicting protein structures with a multiplayer online game*. In: Nature 466/7307, p. 756–760, 2010.

[Cs91] Csikszentmihalyi, M.: *Flow: The psychology of optimal experience.* HarperPerennial New York, 1991.

[DBS13] Döpker, A.; Brockmann, T.; Stieglitz, S.: *Use Cases for Gamification in Virtual Museums*. In (Horbach, M. Eds.): Informatik 2013. Ges. für Informatik, Bonn, p. 2308–2320, 2013.

[De11] Deterding, S. et al.: *From game design elements to gamefulness: defining "gamification"*. In (Lugmayr, A. et al. Eds.): MindTrek '11: Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, p. 9–15, 2011.

[Fe06] Fettke, P.: *State-of-the-Art des State-of-the-Art*. In: Wirtschaftsinformatik 48/4, p. 257–266, 2006.

[GAD02] Garris, R.; Ahlers, R.; Driskell, J. E.: *Games, Motivation, and Learning: A Research and Practice Model*. In: Simulation & Gaming 33/4, p. 441–467, 2002.

[GP14] Goh, K.-Y.; Ping, J. W.: *Engaging Consumers with Advergames: An Experimental Evaluation of Interactivity, Fit and Expectancy*. In: Journal of the Association for Information Systems 15/7, p. 388–421, 2014.

[Ha13] Haas, P. et al.: *Der Einfluss von Gamification auf die empfundene Selbstwirksamkeit von Teilnehmern von Online-Ideengenerierungswettbewerben über die Zeit*. In (Horbach, M. Eds.): Informatik 2013. Ges. für Informatik, Bonn, p. 2321–2335, 2013.

[Ka12] Kankanhalli, A. et al.: *Gamification: A New Paradigm for Online User Engagement*. In (Huang, M.-H.; Piccoli, G.; Sambamurthy, V. Eds.): Proceedings of the 33rd International Conference on Information Systems (ICIS). Shanghai, p. 1–10, 2012.

[KH08] Kebritchi, M.; Hirumi, A.: *Examining the pedagogical foundations of modern educational computer games*. In: Computers & Education 51/4, p. 1729–1743, 2008.

[KH13] Koops, M.; Hoevenaar, M.: *Conceptual Change During a Serious Game: Using a Lemniscate Model to Compare Strategies in a Physics Game*. In: Simulation & Gaming 44/4, p. 544–561, 2013.

[Ko84] Kolb, D. A.: *Experiential learning: Experience as the source of learning and development.* Prentice-Hall Englewood Cliffs, NJ, 1984.

[LB10] Lin, C.-P.; Bhattacherjee, A.: *Extending technology usage models to interactive hedonic technologies: a theoretical model and empirical test*. In: Information Systems Journal 20/2, p. 163–181, 2010.

[Le13] Legner, C. et al.: *Designing Capstone Courses in Management Education: Knowledge Activation and Integration Using an ERP-based Simulation Game*. In (Baskerville, R.; Chau, M. Eds.): Proceedings of the 34th International Conference on Information Systems (ICIS). Milan, p. 1–19, 2013.

[LHC12] Li, Z.; Huang, K.-W.; Cavusoglu, H.: *Quantifying the Impact of Badges on User Engagement in Online Q&A Communities*. In (Huang, M.-H.; Piccoli, G.; Sambamurthy, V. Eds.): Proceedings of the 33rd International Conference on Information Systems (ICIS). Shanghai, p. 1–10, 2012.

[LL02] Locke, E. A.; Latham, G. P.: *Building a Practically Useful Theory of Goal Setting and Task Motivation*. In: American Psychologist 57/9, p. 705–717, 2002.

[LLS13] Liu, D.; Li, X.; Santhanam, R.: *Digital Games and Beyond: What Happens When Players Compete*. In: MIS Quarterly 37/1, p. 111–124, 2013.

[MK14] Mutter, T.; Kundisch, D.: *Behavioral Mechanisms Prompted by Badges: The Goal-Gradient Hypothesis*. In (Myers, M.; Straub, D. Eds.): Proceedings of the 35th International Conference on Information Systems (ICIS). Auckland, p. 1–17, 2014.

[ML11] Monk, E.; Lycett, M.: *Using a Computer Business Simulation to Measure Effectiveness of Enterprise Resource Planning Education on Business Process Comprehension*. In (Beath, C.; Myers, M.; Wei, K.-K. Eds.): Proceedings of the 32nd International Conference on Information Systems (ICIS). Shanghai, p. 1–10, 2011.

[Mu11] Mueller, J. et al.: *Virtual worlds as knowledge management platform - a practice-perspective*. In: Information Systems Journal 21/6, p. 479–501, 2011.

[Na08] Nadolski, R. J. et al.: *EMERGO: A methodology and toolkit for developing serious games in higher education*. In: Simulation & Gaming 39/3, p. 338–352, 2008.

[Na12] Nadolski, R. J. et al.: *Architectures for Developing Multiuser, Immersive Learning Scenarios*. In: Simulation & Gaming 43/6, p. 825–852, 2012.

[NC02] Nakamura, J.; Csikszentmihalyi, M.: *The concept of flow*. In (Snyder, C. R.; Lopez, S. J. Eds.): Handbook of positive psychology. Oxford University Press, New York, NY, USA, p. 89–105, 2002.

[Ok13] Oksanen, K.: *Subjective Experience and Sociability in a Collaborative Serious Game*. In: Simulation & Gaming 44/6, p. 767–793, 2013.

[OL13] Oberdörfer, S.; Latoschik, M. E.: *Develop your strengths by gaming: Towards an inventory of gamificationable skills*. In (Horbach, M. Eds.): Informatik 2013. Ges. für Informatik, Bonn, p. 2346–2357, 2013.

[Op14] Oppong-Tawiah, D. et al.: *Encouraging Sustainable Energy Use in the Office with Persuasive Mobile Information Systems*. In (Myers, M.; Straub, D. Eds.): Proceedings of the 35th International Conference on Information Systems (ICIS). Auckland, p. 1–11, 2014.

[PGT10] Ping, J.; Goh, K.; Teo, H.: *Engaging Consumers with Advergames: An Experimental Evaluation of Interactivity, Relevancy and Expectancy*. In (Lacity, M.; March, S.; Niederman, F. Eds.): Proceedings of the 31st International Conference on Information Systems (ICIS). St Louis, 2010.

[PR14] Plennert, S.; Robra-Bissantz, S.: *Ein Serious Game als neue qualitative Erhebungsmethode für die Customer Journey beim Automobilkauf*. In (Plödereder, E. et al. Eds.): Informatik 2014. Köllen, Bonn, p. 383–398, 2014.

[RD00] Ryan, R. M.; Deci, E. L.: *Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being*. In: American Psychologist 55/1, p. 68, 2000.

[RRP06] Ryan, R. M.; Rigby, C. S.; Przybylski, A.: *The Motivational Pull of Video Games: A Self-Determination Theory Approach*. In: Motivation and Emotion 30/4, p. 344–360, 2006.

[RUO14] Romero, M.; Usart, M.; Ott, M.: *Can Serious Games Contribute to Developing and Sustaining 21st Century Skills?* In: Games and Culture 10/2, p. 1–30, 2014.

[Sc15] Scheiner, C. W.: *The Motivational Fabric of Gamified Idea Competitions: The Evaluation of Game Mechanics from a Longitudinal Perspective*. In: Creativity and Innovation Management 24/2, p. 341–352, 2015.

[SD95] Savery, J. R.; Duffy, T. M.: *Problem Based Learning: An instructional model and its constructivist framework*. In: Educational Technology 35/5, p. 31–38, 1995.

[Sm10] Smith, R.: *The Long History of Gaming in Military Training*. In: Simulation & Gaming 41/1, p. 6–19, 2010.

[SW13] Scheiner, C. W.; Witt, M.: *The Backbone of Gamification - a Theoretical Consideration of Play and Game Mechanics*. In (Horbach, M. Eds.): Informatik 2013. Ges. für Informatik, Bonn, p. 2372–2386, 2013.

[Te13] Teh, N. et al.: *Can Work Be Fun? Improving Task Motivation and Help-Seeking Through Game Mechanics*. In (Baskerville, R.; Chau, M. Eds.): Proceedings of the 34th International Conference on Information Systems (ICIS). Milan, 2013.

[Th06] Thomas, S.: *Pervasive learning games: Explorations of hybrid educational gamescapes*. In: Simulation & Gaming 37/1, p. 41–55, 2006.

[WR12] Witt, M.; Robra-Bissantz, S.: *Sparking Motivation and Creativity with "Online Ideation Games"*. In (Goltz, U. et al. Eds.): Informatik 2012. Ges. für Informatik, Bonn, p. 1006–1023, 2012.

[WS14] Wiegand, T.; Stieglitz, S.: *Serious Fun-Effects of Gamification on Knowledge Exchange in Enterprises*. In (Plödereder, E. et al. Eds.): Informatik 2014. Köllen, Bonn, p. 321–332, 2014.

[WSR11] Witt, M.; Scheiner, C. W.; Robra-Bissantz, S.: *Gamification of Online Idea Competitions: Insights from an Explorative Case*. In (Heiß, H.-U. et al. Eds.): Informatik 2011. Ges. für Informatik, Bonn, p. 1–15, 2011.

[WW02] Webster, J.; Watson, R. T.: *Analyzing the past to prepare for the future: Writing a literature review*. In: MIS Quarterly 26/2, p. 3, 2002.

[ZC11] Zichermann, G.; Cunningham, C.: *Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps.* O'Reilly Media, Inc., Sebastopol, CA, 2011.

[ZHR12] van der Zee, D.-J.; Holkenborg, B.; Robinson, S.: *Conceptual modeling for simulation-based serious gaming*. In: Decision Support Systems 54/1, p. 33–45, 2012.