Chapter 37
Fostering Development of Work Competencies and Motivation via Gamification

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37.1 Introduction

Depending on the task and context, games and game-based environments can outclass traditional training settings regarding work competence development. The effectiveness of such environments has been demonstrated in different work contexts, for example, pilot training. In a study by Gopher et al. (1994), flight students who engaged in a game-based simulator outperformed students within a traditional training regarding their flight performance. Further results in the context of submarine training programs support the effectiveness of game-based training environments by showing improved performance and higher motivation when applying a game-based training (Garris et al. 2002; Garris and Ahlers 2001). Also in the context of medical education, game-based trainings and computer game usage are positively correlated with surgical skills of medical students (Rosser et al. 2007).

Games and game-based learning concepts are promising methods for the successful design of training environments and the development of work competencies. A major potential of such game-based environments is their motivational power, which can affect learning outcomes as well.

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The development of new work competencies or the further development of existing work competencies seems to be traditionally connected to off-the-job training and professional development. But recent approaches focus on the potentials of the workplace itself to learn and develop competencies. These workplace learning approaches meet a number of current challenges concerning the qualification of staff better than off-the-job learning (Illeris 2011). While the workplace is a place to work and perform, it can also offer opportunities to develop competencies by providing work conditions, which stimulate and support learning (Ellström 2011). A major advantage of such approaches is to learn with authentic problems and enable transfer of learning.

Gamification is a relatively new and innovative approach to stimulate and support learning while ensuring motivation and transfer. The central idea of gamification is to use the motivating power of games for non-gaming purposes in real-life contexts. In the context of the development of work competencies, gamification can take advantage of both game-based learning approaches and on-the-job training. It combines the motivating power of game design elements from games and the learning potential of the workplace itself.

This chapter will illustrate how gamification can be applied at work and how it effects the development of work competencies and motivation. A gamification case example in the field of intralogistics shows a possible implementation of gamification. An empirical investigation of that case example will provide insights about effects of gamification.

In section 2, competence models and strategies to develop work competencies will be investigated, and the role of motivation will be discussed. In section 3, the concept of gamification will be introduced, and its possible effects on competence development and motivation will be discussed. In section 4, a case example in the field of intralogistics including empirical findings from an experimental study will be presented. Section 5 will conclude with a discussion of the potential of gamification for the development of work competencies and its theoretical and practical implications.

37.2 Competence and Motivation in the Workplace

Competencies can be described as “the latent cognitive and affective-motivational underpinning of domain-specific performance in varying situations” (Blömeke et al. 2015, p. 3). Consequently competence is a complex construct consisting of cognition and affect-motivation, which give rise to observed behaviour (Blömeke et al. 2015).

In the workplace context, work competence can be defined as a learned ability to adequately perform a task, role or mission (Roe 2002). As performance is the basis of organisational success, this definition emphasises the role of performance within a workplace setting. Staff competencies are therefore essential to enhance organisational performance. However, competencies themselves are not sufficient to perform

a work task. To actually apply work competencies and thereby develop new competencies and cultivate existing ones, learners need to be motivated. Motivation refers to those psychological processes that are responsible for initiating and continuing goal-directed behaviours (Schunk et al. 2010). It can be seen as an individual factor that seems to play a role in the development of competencies in the workplace (Bartram and Roe 2008).

As competencies and motivational action tendencies have a close relation to each other (Weinert 2001), an approach to foster both competence development and motivation in the workplace will be described later on. Firstly, competence models and approaches to foster competence development will be presented in section 2.1. Secondly, perspectives on motivation will be analysed in section 2.2.

37.2.1 Competence Models and the Development of Work Competencies

What are central work competencies? There are different approaches to answer that question. Some authors specify core competencies, which include soft competencies, such as teamwork and cooperation, customer service orientation or self-confidence, and hard competencies, such as technical expertise and conceptual thinking (Spencer and Spencer 2008; Rainsbury et al. 2002).

The problem with such lists, which include specific work competencies, is that they are not necessarily generally transferable to all work contexts. For this reason, another strategy is to compile a competence model based on the needs of a specific organisation. These organisation-specific competence models identify the competencies needed to operate within a specific job. Such behavioural job descriptions have to be defined for each function and each job (Fogg 1999).

A further strategy is to provide global sets of competencies and systematise them within taxonomies. These resulting models are described as common competence models. Within such models, categories of competencies are defined and complemented with subcategories on different levels. For example, the "KODE®-Kompetenzatlas" postulates four classes of key competencies: (1) *personal competence*, (2) *activity and action competence*, (3) *social-communicative competence* and (4) *professional expertise and methodological competence* (Erpenbeck and Heyse 2007). Within every key competence class, subtypes and subgroups consisting of 64 competence groups are defined. This competence model helps to assess competencies as well as self-evaluate ones' own competencies (Bäcker and Zawacki-Richter 2011).

As these approaches in the field of competencies are very diverse, it is difficult to discern a coherent theory or framework for competencies (Weinert 2001). Despite their diversity, all work competencies have in common that they describe conditions for success in meeting tasks, goals and success criteria in the field of action (Weinert 2001; Roe 2002).

As work competencies are action-orientated, promising approaches for developing work competencies, while ensuring transfer and relevance for practice, are work-oriented learning approaches. Here work-related and work-integrated learning approaches can be differentiated. In both cases, the workplace itself plays a major role. Work-*related* learning refers to competence development in authentic learning environments, while work-*integrated* learning refers to competence development directly at the workplace (Sonntag and Stegmaier 2007). The development of work competencies by work-integrated learning approaches helps to foster transfer, as learning is taking place directly at the workplace. Another advantage is the direct application of newly acquired or further developed competencies in authentic work environments. Especially for new staff, this approach is suitable to foster integration and learning processes.

37.2.2 Motivation as a Facilitator for the Application of Competencies

Motivation is important for performance and thereby should be involved in the concept of competencies as well (Blömeke et al. 2015). Therefore, it will be discussed as a component of work competencies.

The development of work competencies is of little use if they are not applied at the workplace or, in other words, if training transfer fails. Research has demonstrated that a number of factors are influential when it comes to training transfer. The classic model established by Baldwin and Ford (1988; Blume et al. 2010) differentiates influences on three levels; *training design*, *work environment* and *learner characteristics*, with motivation being one of the most important influences on the learners' level. Meta-analyses have shown that a number of motivational constructs, such as self-efficacy or locus of control, influence training transfer and, subsequently, performance at work (Colquitt et al. 2000).

On a general level, motivation can be understood to include those processes which initiate and maintain goal-directed behaviour (Schunk et al. 2010). In the workplace, where behaviour refers to the application or transfer of competencies, workplace conditions play an important role in fostering or inhibiting motivation. Studies have shown, for example, that support by colleagues or a general transfer-friendly climate can support transfer motivation (cf. Kontoghiorghes 2004).

Many different theoretical perspectives have been used to study motivation; among them are behaviourism, cognitive and social-cognitive learning theory (cf. Sailer et al. 2013). The self-determination theory of motivation (Ryan and Deci 2000; Deci and Ryan 2000) can serve as a general framework to underline the basic conditions for enabling (or inhibiting) motivation at the workplace and in other contexts. This framework postulates that three elementary needs have to be met for humans to become motivated: competence, autonomy and relatedness. Competence denotes experiencing that one is able to master a task or a situation (White 1959;

Vansteenkiste and Ryan 2013).; autonomy refers to the degree of individuals' behaviour being free from external control and in accordance with ones' own interests (Vansteenkiste et al. 2010, 2012; van den Broeck et al. 2010); relatedness refers to the need to belong to others and to be connected with them (Baumeister and Leary 1995; Deci and Ryan 1985). Accordingly, workplace and transfer motivation should generally profit from fostering feelings of competence, allowing for autonomy and supporting relatedness at the workplace.

37.3 Gamification as an Innovative Approach for Work-Integrated Learning

Gamification is an approach which can be used to support competence development and motivation. It can be described as an innovative concept to foster motivation, engagement, learning or problem-solving activities in non-gaming, real-world contexts (Kapp 2012). The basic idea of gamification is to apply game design elements in non-game contexts (Deterding et al. 2011b). Thereby gamification can be a work-integrated approach to foster competence development and motivation. The term gamification originates from the digital media industry. Although the term has been used as early as 2002 (Marczewski 2013), it did not receive broader attention until 2010 (Deterding et al. 2011a). At that time, it was mostly used in the context of marketing but quickly began to spread to other contexts including education (Kapp 2012) and business (Werbach and Hunter 2012). However, the idea of gamification is not a new one. Collecting virtual currencies in the form of so-called air miles in the airline industry and gaining a level-up like a silver or gold status in the context of credit cards are examples of game design elements in non-game contexts which everybody knows from everyday life (cf. Zichermann and Cunningham 2011; Nelson 2012; Seaborn and Fels 2015).

In Sect. 3.1, the concept of gamification will be discussed in detail. In Sect. 3.2 the focus will be on the core components of gamification. Next the question as to how gamification can help to support competence development and foster motivation will be answered in Sect. 3.3 and Sect. 3.4.

37.3.1 Gamification and Its Underlying Concept

Defining the term gamification reveals the main components which belong to its concept: Gamification is "the use of game design elements in non-game contexts" (Deterding et al. 2011a, p. 1). In this definition, the terms *game*, *element*, *design* and *non-game context* are central.

Games can be classified along a continuum with two endpoints. Caillois (1961) describes the endpoints with the terms *ludus* and *paidia*. The term *game* relates to

the category of *ludus* and characterises rule-based playing with determined goals (Groh 2012) and quantifiable outcome (Salen and Zimmerman 2004). The counterpart of *ludus* is *paidia*, which refers to free, unstructured and improvisational behaviours. These behaviours can be summarised under the term *play* (Caillois 1961). Although gamification focuses on gaming activities, these activities can also include forms of play, depending on the behaviour of the person interacting with the gamification system. Due to its primary attention in media and human-computer interaction literature, the focus of gamification systems seems to be on elements from digital games. This can be seen as an unnecessary restriction (Deterding et al. 2011b), as game design elements from all forms of games – digital and nondigital – are possible.

The term *element* in above-mentioned definition refers to the fact that gamification does not constitute complete games. In contrast to computer games, board games or serious games, gamification just uses parts of these. This blurry boundary between full games and gamification can be seen as a subjective, personal and social boundary (Deterding et al. 2011b). It is a process of negotiating how someone acts and behaves within a gamification system. The experience and interaction can be more or less playful and is thereby seen as a more or less holistic gaming experience.

Gamification refers to game *design* elements used in non-game contexts instead of other elements which belong to a wider game ecology (Deterding et al. 2011a). Examples of elements which belong to the game ecology, but which are not game design elements, are game controllers or graphic engines. Such elements could also possibly be used in non-game contexts, but do not necessarily constitute a gamification environment. Depending on their level of abstraction, game design elements can be interface design patterns, game mechanics, design principles, game models or game design methods (Deterding et al. 2011a).

The above-mentioned game design elements are implemented in a *non-game context*. There is no restriction as to the details of this context. Exemplary contexts, in which gamification systems have already been applied and investigated, are schools (Goehle 2013), universities (Kumar and Khurana 2012; Domínguez et al. 2013), production environments (Castellani et al. 2013), enterprise businesses (Hate 2013; Jung et al. 2010), healthcare (Ahola et al. 2013; Jones et al. 2014) and more specific activities like driving cars (Diewald et al. 2014) or filling in online surveys (Downes-Le Guin et al. 2012; Rapp et al. 2013).

Gamification can also be differentiated by the goals pursued. Gamification has been investigated in respect of the following goals it is supposed to fulfil: fostering motivation (Hense et al. 2014; Gears and Braun 2013; Hakulinen et al. 2013), increasing engagement (Reeves et al. 2011; Barata et al. 2013a; Muntean 2011), increasing well-being (Oprescu et al. 2014), enhancing participation (Vassileva 2012; Barata et al. 2013b), fostering learning (Cheong et al. 2013) and fostering collaboration and interaction (Raftopoulos and Walz 2013; Jung et al. 2010; Fernandes et al. 2012).

In a nutshell, gamification systems can be categorised by the *context* in which they are implemented, by the *goals* they aim to achieve and by the *target group* they

address. One differentiation, which focuses on the target group of gamification and originates from the business field, is the distinction between internal, external and behaviour-change gamification. Here, the questions of who will be addressed and who will benefit from the gamification system are relevant. In *internal gamification*, the target group is already part of a given community, like a company someone is working for. *External gamification*, on the other hand, involves customers or prospective customers outside a company. *Behaviour-change gamification* focuses on changing behaviour for the good, no matter in which context. While in internal and external gamification the organisation's goals are primary, *behaviour-change gamification* focuses on personal benefits of individuals (Werbach and Hunter 2012).

Speaking of the development and application of work competencies, internal gamification is relevant. As gamification is implemented directly at work, it can also be understood as a work-integrated approach for the development and application of work competencies. Work-integrated approaches for learning are characterised by their proximity to the workplace and their supporting effects for transfer and learning (cf. Sonntag and Stegmaier 2007). As gamification is about integrating game design elements into the workflow, thereby fostering the development and application of competencies, this internal gamification approach focuses on the social contextual conditions of the workplace. These social contextual conditions in the workplace are significant for motivation (cf. Deci and Ryan 2012) and thereby for the development and application of competencies.

37.3.2 Game Design Elements: The Core Components of Gamification

After this detailed look into the concept of gamification, the focus of this section will be on concrete gamification systems. In particular, game design elements, which constitute these environments, will be analysed. Two examples from practice might help to illustrate how such game design elements could possibly look.

The *Bottle Bank Arcade Machine*, which was developed in the context of the Volkswagen initiative *the fun theory* (c.f. www.thefuntheory.com), aims at fostering consumers' recycling behaviour by making recycling of glass more fun (de Valk et al. 2012). A bottle bank was transformed into an arcade machine with a display and several holes with lights on top of them. When the lights switch on, the players have to throw their glass in the corresponding hole. The players receive points for this, which are directly fed back on the display. Obviously, the quite simple idea of symbolically rewarding certain behaviours with points constitutes a game design element. In addition, the immediate feedback of the display is a typical game design element. Depending on the playing behaviour, the experience can become social and competitive, which is a crucial part of some games, too.

Another example, but with a different choice of game design elements, is *Zombies Run!* (c.f. www.zombiesrungame.com). This smartphone application

gamifies jogging by adding a story to the running experience. To start the game, players must plug headphones into their smartphone, select a mission in the application and go for a run outside (Southerton 2013). During running, players hear a catchy and fictional story about a zombie invasion, from which the listener has to escape by running. If the escape from single zombie attacks fails, it will result in the loss of potentially valuable supplies, which can be collected for the players' base. The base has to be protected from zombies as well and resources help to defend the base. Within that gamification application, the story plays a central role. That element is also very crucial to many other games and can be seen as a game design element. Further elements are the resource system that accompanies resource management, which is also very widespread in the context of board games or strategy games.

From an analytical perspective, these game design elements are the core components of gamification environments. Attempts to create lists, taxonomies and category systems of such elements have been made by different authors (cf. Werbach and Hunter 2012; Robinson and Bellotti 2013; Kapp 2012; Zichermann and Cunningham 2011). They use different approaches to structure game design elements and to convey an impression of what shape these elements take. One approach is to create liberal sets of elements found in any game. Lists like that do, however, tend to trivialise the phenomenon and to get lost in endless lists of elements. Another approach is to provide a constrained set of elements, which are unique to specific games. By providing lists of game design elements which are characteristic to most games and which play an important role in gameplay, there is an attempt to meet both approaches (Deterding et al. 2011a; Werbach and Hunter 2012). Nevertheless, this choice of elements is a subjective one. Besides the approach of listing game design elements, another approach is to structure the elements by certain functions or their level of abstraction.

It is worthwhile to discuss three of these approaches that aim to structure game design elements in more detail.

Werbach and Hunter (2012) start with a triad of points, badges and leaderboards which they describe as typical game design elements within gamification. Based on that, they propose the categories *dynamics*, *mechanics* and *components* which refer to the level of abstraction of game design elements. They present these categories as a hierarchy; every component is tied to one or more mechanisms, and every mechanism is tied to one or more dynamics which represent the highest level of abstraction (Werbach and Hunter 2012). To give an example, levels (component) provide the player with feedback (mechanism) and create a sense of progression (dynamic). Within these categories, exemplary non-exhaustive lists of game design elements are included. This differentiation works well at first sight, but boundaries between those categories can become blurred in some cases.

Robinson and Bellotti (2013) provide six elaborated and detailed categories referring to the content or functions of different elements. The category g*eneral framing* refers to the content of a gamified system or a story framework. *General rules and performance framing* are main activities which have to be executed, like reaching the top of a leaderboard. *Social features* include relationships or

interactions. *Incentives* can be intrinsic, such as a challenge within a game, or extrinsic, such as a lottery. *Resources and constraints* are bounds within which the player has to operate. Finally, *feedback and status information* provide the player with visual or auditory information about what is going on, what they must do next or what has been achieved (Robinson and Bellotti 2013). These categories can be applied to different game design elements in different non-game contexts.

Kapp (2012) presents a list of common elements, which contribute to gameplay. These involve elements like *goals, rules, conflict, competition, cooperation, time, reward structures, feedback, levels, storytelling* and *aesthetics*. Besides that, these elements are completed by characteristics of games, such as the fact that they are *abstractions of concepts and reality*, that they have a *curve of interest* and that they can be *replayed*. These elements and characteristics are located at different abstraction levels and in different categories. They are elements which can be found in most games (Kapp 2012).

All three attempts should help to give an impression of how varied game design elements can possibly look like and how one can structure them, but they should be understood as non-exhaustive lists of game design elements. From a functional perspective, a single element does not necessarily lead to a successfully functioning gamified environment. It is the interaction between different elements which constitute powerful gamification environments (Kapp 2012). Furthermore the process of implementation of these game design elements plays a major role (Werbach 2014).

To examine gamification in the work context, a closer investigation of a selection of game design elements is necessary. These seven selected elements are crucial in many games and become relevant for the implementation of game design elements in the work context in order to foster the application and development of work competencies. Again, this selection does not claim to be exhaustive:

Points are very basic game design elements. They can be accumulated for certain activities, as in the above-mentioned gamified bottle bank (Werbach and Hunter 2012, 2015; Zichermann and Cunningham 2011).

Badges are visual representations of achievements which can be collected during play. They are awarded to players for certain activities, usually for fulfilling certain steps towards a goal or reaching a certain benchmark (Anderson et al. 2013; Antin and Churchill 2011).

Leaderboards are lists of all the players, usually ranked by their success (Costa et al. 2013). These boards can be individual leaderboards which compare results of single players or team leaderboards which compare teams with each other.

Performance graphs visualise players' performance parameters over time and compare them with previously achieved results (Günthner et al. 2015). Possible parameters are in-game results like points but also work results like the quantity of processed orders or errors.

Meaningful stories provide a framework for gamification environments (Sailer 2016). Stories can be introduced in a tutorial or enfold during game play. They are more or less present during the interaction with the environment. The above-mentioned application *Zombies Run!* is an example of a story which is elementary for the application.

Avatars are visual representations a player can choose within gamification. Avatars can be either simple and static or complex and modifiable (Werbach and Hunter 2015). Depending on the elaboration of the avatar system, the following game design element, which is more abstract, becomes relevant.

Profile development refers to the development of avatars and attitudes belonging to such avatars. The players can hereby adjust their chosen avatar and develop it throughout the gamified experience.

Within the next two sections, the effects of this selection of game design elements will be theoretically investigated. Section 3.3 focuses on effects on work competence development, while section 3.4 focuses on motivation.

37.3.3 How Gamification Helps to Develop Work Competencies

Work-integrated learning approaches are promising approaches for developing work competencies directly on the job (Sonntag and Stegmaier 2007). Gamification can be seen as such a work-integrated approach, which focuses on the social contextual conditions of the workplace.

The central idea for fostering competence development within a gamification environment is to link job-relevant competencies with game design elements and to transpose these competencies on the game level. For example, an elaborated avatar and attribute system could help to focus workers' attention and efforts on specific aspects of the game. These attributes can reflect or express certain competencies or requirements for the development of certain competencies. Badge systems can work in a similar way as they can be awarded for certain steps, a worker takes within a gamified system. These steps or goals can be linked with steps in the development of certain competencies as well. Furthermore such goal setting function can be helpful in regard of motivation (Schunk et al. 2010).

Another important job-related factor, which is likely to have a strong impact on the application and development of competencies, is feedback (Ellström and Kock 2008; Ellström 2006). In the workplace, feedback loops usually take place after certain events and thereby feedback loops are slow. Gamification environments are potent feedback systems, which have the advantage of providing feedback immediately (Stampfl 2012). Points are one very simple way of providing performance feedback on the job.

A more sophisticated possibility to provide content-based feedback is to implement performance graphs, which represent the relevant benchmarks for performance and the needed competencies over time. Such graphs can help to indicate potentials for improvements and provide an overview of one's performance. By doing so, workers can indicate errors or performance fluctuations just in time. This helps to increase the awareness for the workers' own competence development processes and to intervene by changing inadequate or inexpedient behaviour. Furthermore feedback based on the workers' own performance over time can help to foster mastery orientation, which is positively related with competence development (cf. Nicholls 1984; Dweck 1986).

Choosing the relevant dimensions of such feedback systems should be aligned with an existing competence profile, which describes necessary work competencies of the related position. Accordingly, the needed competencies become transparent for staff, and the progress regarding each work competence becomes visible.

Regarding transfer of competencies from learning to working situations, gamification provides a suitable solution as the learning and working environment are identical. Especially for the training of new staff, interactive on-the-job trainings in form of a tutorial with an integrated story are reasonable approaches to develop competencies needed for the corresponding position, while ensuring transfer.

Besides the potential of gamification to develop competencies, it also targets the motivation of staff in the workplace. The next section discusses the motivational power of gamification from a theoretical perspective.

37.3.4 How Gamification Helps to Foster Motivation

Many authors promoting gamification, or related approaches such as serious gaming or game-based learning, suppose that these approaches have an inherent potential to foster motivation for learning and performance (e.g. Gee 2007). However, to substantiate such claims from a theoretical perspective, it is required to show how game design elements relate to specific mechanisms known to be influential in fostering motivation. Drawing on the self-determination theory of motivation (Ryan and Deci 2000; Deci and Ryan 2000), the potential of the above-described exemplary game design elements to address an individual's need for competence, autonomy or relatedness will be analysed.

- The need which can probably be addressed most easily by game design elements is the need for *competence*. Feelings of competence are associated with feelings of success and effectiveness (White 1959; Ryan et al. 2006; Rigby and Ryan 2011). Points, badges, leaderboards and performance graphs all have in common that they communicate and visualise success and progress. Each point won, each badge earned, each place gained on a leaderboard and each positive trend in a performance graph signals success in a previous task. It can be speculated that points and badges are most effective in this regard, as they can usually only signal success, while leaderboards and performance graphs can also signal failure. It has to be noted though that points or badges only serve as a means of feedback on a task and that the realisation to have mastered a task is the true source of feeling competent, not the simple increase of a number. This is why some gamification examples are rightfully labelled as "pointification" and have little potential for enduring motivational effects.
- Game design elements can also potentially evoke feelings of *autonomy*. Feelings of autonomy refer to psychological freedom and feelings of volition to execute a certain task (Vansteenkiste et al. 2010, 2012 ; van den Broeck et al. 2010; Rigby and Ryan 2011). In other words, autonomy can be expressed by the feeling of decision freedom and the feeling of doing something personal meaningful.

Decision freedom can be addressed by choices. Badges can represent different kinds of specialisation (e.g. speed and accuracy) and thus offer the freedom to prefer one specialisation over another. Avatars are another simple way of providing freedom of choice and self-expression, which remains visible throughout a game. Profile development is a more complex option for providing autonomy, as a virtual character can be improved and shaped to one's own liking throughout the life cycle of a gamification application. Besides that, feelings of *task meaningfulness* can be fostered by providing a meaningful story framework within a narrative.

- *Relatedness*, the third elemental human need postulated by self-determination theory, is probably the most difficult to foster by single game design elements. However, stories and narratives might be used to establish a social context and instil the fantasy of the player belonging to a collective. Certain badges may also express slight degrees of relatedness, e.g. as they communicate that one belongs to an "elite" group of accomplished players. The idea of using team leaderboards and referring to a group of players as a team is another promising strategy to create feelings of social relatedness. In case of relatedness, it is the interaction of several elements, which provoke feelings of being socially embedded.

This analysis of selected gamification elements in relation to one influential motivation theory, the self-determination theory, serves to illustrate two arguments. Firstly, it can be shown theoretically how specific gamification elements might trigger specific motivational mechanisms and that such mechanisms might be addressed by more than one element at a time. Secondly, it is quickly apparent that certain gamification elements seem to be able to simultaneously trigger a number of mechanisms, while others only have a singular influence. Badges, for example, seem to be able to address the need for competence, autonomy and relatedness at the same time to some degree, while performance graphs can only address one need, which is the competence need.

However, by looking at other possible motivational mechanisms, stories, for example, can serve to arouse interest or evoke positive emotions. It might be a rewarding effort, which is beyond the scope of this chapter, to conduct a more complete analysis matching game design elements with possible motivation mechanisms derived from other theoretical backgrounds (cf. Sailer et al. 2013).

37.4 A Gamification Prototype for the Development of Work Competencies of New Staff in Intralogistics

To further illustrate the notion of fostering competence development and motivation at the workplace with gamification, an experimental study conducted in the context of intralogistics will be presented. A prototype gamification environment was designed to gamify training and manual work processes. For this, a central intralogistics process was chosen as the examined work context, which is manual

order-picking. To understand why order-picking is the object of choice for this experimental study, it is crucial to understand the whole work environment and its classification in the in-plant material flow.

37.4.1 Gamification of Order-Picking

Order-picking, as one of the most important in-plant intralogistic process, refers to collecting parts from a warehouse to fulfil customers' orders (Arnold 2006). Intralogistics itself is concerned with the internal handling of materials and supplies within specific production sites (Arnold 2006). Intralogistics refers to so-called indirect or secondary range of processes in the production system. Indirect, in contrast to direct or primary processes, are all tasks in a production chain that do not add direct value to the product (Blecker and Friedrich 2005). That is why they are mostly not in focus of companies' *Continuous Improvement Process* (Bakerjian et al. 1993). The result is a work environment that is in most cases neither very stimulating nor motivating. Furthermore the development of work competencies for staff is lacking concepts and structures. Another aspect that has to be taken in account is that almost every task related to intralogistics does not require a high level of qualification. Exemplary tasks are taking products off a shelf, driving a fork-lift or carrying a box from A to B (Arnold 2006). Since these tasks are monotonous and repetitive, they result in high rates of fluctuation of unskilled low paid employees. This high fluctuation raises the need for a structured and elaborated development of work competencies of new staff. In practice, new staff members usually follow a senior employee for one or two days. Afterwards, they start their daily routine. Guidelines or concepts for that training phase do not exist.

Within order-picking a customer can be an end consumer within retail companies or a production process in the in-plant material flow (Feld 2000). Production processes usually run on a very tight schedule, because in modern material-flow-oriented production systems, there is only a very small buffer for pre-products between production steps (or even none at all). So, if material is missing for one process, the whole interlinked production will come to a standstill (Takeda 2006). This time pressure is equally applicable to the order-picking processes, which need to deliver the right set of materials at exactly the right time (Cheng and Podolsky 2008).

The prototype gamification environment, which has been developed, should help to counteract these problems. On one hand, the environment supports the development of work competencies required for the job and on-boarding of new staff. On the other hand, the gamification environment should help to foster motivation of employees in this monotonous and non-stimulating work environment.

To gamify the task of order-picking, the central work process itself has to stay the same. Every active interaction with the gamification environment has to take place either between a sequence of process steps during breaks or during a process step itself. Additional interaction was barred from the beginning so as to not create even more time pressure on the employees. Skipping the details, the normal workflow of

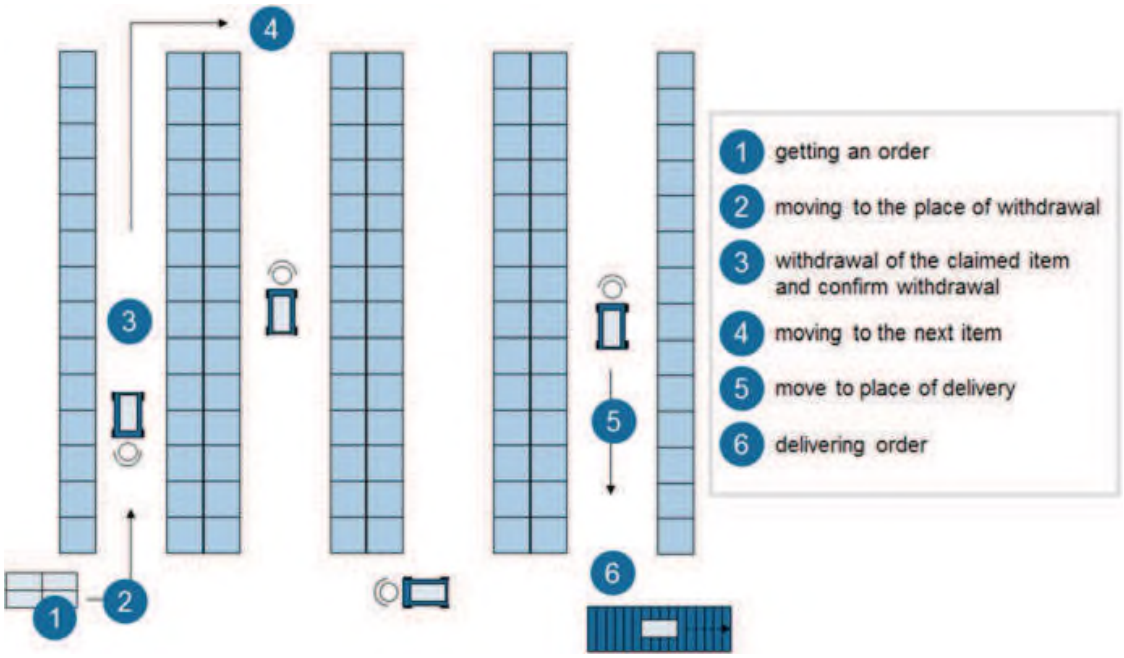

Fig. 37.1 Order-picking work flow

such an environment consists of six major process steps: *getting an order*, *moving to the place of withdrawal*, *withdrawal of the claimed item* (repeat, until the last item of the order has been picked), *confirm withdrawal*, *move to place of delivery* and *delivering order* (ten Hompel et al. 2011) Fig. (37.1).

The steps of getting an order, confirming withdrawal and delivering order usually come along with communication between the order-picker and the system landscape. In most cases, the order is sent to a handheld device on which it gets displayed for the employee. The order-pickers then take the handhelds with them and scan barcodes to confirm every item of the order list. When delivering the order, the system gets a fulfilment notice to know that the employee is ready for the next order. These already existing interactions between the order-picker and the system were used for the interaction between the order-picker and the gamification environment. They are used to calculate each employee's points.

The chosen game design elements to be implemented in the work context are the above-described elements: *points*, *badges*, *leaderboards*, *performance graphs*, *avatars* and *profile development*. They were combined in a *story*, which represents a virtual order-picking league.

At the beginning, order-pickers create their own avatars on a computer station choosing from six different characters, which differ in their attributes. In total there are three attributes, namely, *speed*, *strength* and *accuracy*, and these are linked to the three major operating numbers in order-picking: *picking time*, *number of picks* and *picking errors*. The attributes work as multipliers to gain points. The faster order-pickers finish their orders, the more points they get through the attribute *speed*; the more picks they make, the more points they get through the attribute *strength*; the fewer the number of errors order-pickers make, the more points they

can earn through the attribute *accuracy*. These attributes and operating numbers also represent the basis of the needed work competencies for the position of order-pickers.

After creating an avatar, order-pickers get access to their own game profiles. Here they can find an overview of their characters' attributes, scores, leaderboards, summaries about their performance in the game (performance graphs) and a list of all badges. Badges can be earned during the game by reaching certain goals. For example, a badge is awarded for a series of ten orders without any error. Badges are rewarded with *attribute points*, and these can be used to upgrade the character's three attributes (speed, strength and accuracy). From the performance graphs in the profile, the order-pickers can see how many points they have already got in each of the three sections and develop their avatars in a certain direction.

From their profile, order-pickers can join a team (shift) to participate in the order-picking league. When joining a team for the first time, the game starts with an interactive tutorial. This takes place directly in a warehouse setting and is shown on the so-called in-game screens. These are big screens which are placed directly in the warehouse between the shelves. The tutorial consists of an interactive movie sequence in which the order-picker is introduced to the background story of the order-picking league and to the rules of the gamification application. During the tutorial, the order-pickers learn how to handle the handheld device and how to orient themselves within the warehouse. Furthermore they have to fulfil exemplary orders. The rules of the gamification application contain the order-picking process steps mentioned before. In summary, the order-pickers are trained in playing the game and develop the needed work competencies for their daily work routine at the same time.

Afterwards, the game round starts. The *in-game screens* show a character-specific animation whenever an order-pickers' character earns a badge. Additionally, the current position of the team on the leaderboard, the remaining game-round time and the earned team-points are displayed. Team points are the added-up points of each individual order-picker participating in the game round. Individual points are only visible on the players' profiles and on the personal handheld device. So, the players can decide whether they want to share this information with others.

At the point of delivery, a *feedback screen* gives the order-pickers information about the finished order. The recently earned points, badges and personal performance graphs for each point category are shown. Between orders order-pickers can choose to develop their profiles by investing attribute points into certain attributes.

When a game round is finished, a short *debriefing film* is shown on the in-game screens. The content of the film varies according to the team's performance and result. In addition, the best order-pickers are honoured.

Technically, the gamification environment consists of different systems. A back-end server communicates with the warehouse management system. From the mentioned information, it creates game events and administrates the order-pickers' profiles and game rounds. A specific add-on for the handheld devices adds game information to the conventional order list. The feedback and in-game screens are

client programs, which communicate with the backend. The user profiles runs as a web application, which can be reached with every browser that is connected to the backend server. All components and clients get connected via a WiFi network. The only interface that needs to be set is between the operating warehouse management system and the backend server; hence, easy implementation of this prototype onto any operating system is granted.

37.4.2 Experimental Study

The goal of the gamification environment is to support the development of work competencies of new untrained order-pickers and to foster motivation. This leads to the following research questions:

(1) *To what extent can gamification work-integrated training environments foster the development of work competencies*?
(2) *To what extent can gamification work-integrated training environments foster experiences of competence, autonomy regarding task meaningfulness*, *autonomy regarding decision freedom and relatedness?*

To investigate these questions, an experimental design was applied. Within an experimental hall, a storage depot setting, created for test and training purposes, was established. Study participants were assigned to groups, which represent shifts of order-pickers. These shifts were randomly assigned to the above-described gamified training and working condition (gamified group) or a traditional training and working condition with all game design elements switched off (control group). The training phase took 8 min in both groups. Participants in the gamified group were trained by using an interactive tutorial video with a fictional story framework. Participants from the control group were trained by a supervisor. The training was followed by a working phase, which took 20 min in both groups. The working phase in the gamified condition consisted of the above-described gamification prototype. The working phase in the control condition was a traditional working condition common for the context of order-picking. $N = 103$ participants took part in the study, 24 % female and 76 % male; $n = 52$ participants were assigned to the gamification group, $n = 51$ to the control group. The average age was 25 years ($M = 24.65$). 85 % of the participants were students. The participants did not have any prior experience in the context of order-picking.

Order-picking work competencies are operationalised by quantitative and qualitative performance indicators during the study. These variables were measured using behavioural data, which consisted of the number of picks as a measure for *quantitative performance* and the accuracy rate of the overall picks as measure for *qualitative performance*.

Experiences of *competence*, *autonomy regarding task meaningfulness*, *autonomy regarding decision freedom* and *relatedness* are assessed by a post-test questionnaire based on the intrinsic motivation inventory (Tsigilis and Theodosiou 2003).

All items were assessed on a seven-point Likert scale. The scales show good Cronbach's alpha values for the *autonomy regarding decision freedom* scale (3 items; $\alpha = .81$) and the *relatedness* scale (3 items; $\alpha = .86$) and an acceptable Cronbach's alpha value for the *competence* scale (4 items; $\alpha = .72$) and the *autonomy regarding task meaningfulness* scale (3 items; $\alpha = .76$; cf. Sailer 2016).

Results are calculated by applying a single factor, multivariate analysis of covariance (MANCOVA). As the size of the shifts varied across the sample, the shift size was included as a covariate. This statistical analysis shows the following results regarding the research questions:

1. *To what extent can gamification work-integrated training environments foster the development of work competencies*?

   - Regarding *quantitative performance*, the gamification group achieved 62.44 ($SD = 15.92$) picks on average, while the control group achieved 46.82 ($SD = 18.92$) picks. A MANCOVA indicates that this quantitative performance is significantly higher in the gamification group than in the control group, $F(1100) = 72.49$, $p < .01$, $\eta_p^2 = .420$.
   - Regarding *qualitative performance* , the gamification group achieved an accuracy rate of 94 % ($SD = .07$) on average. The control group achieved an accuracy rate of 87 % ($SD = .14$) on average. A MANCOVA indicates that this qualitative performance is significantly higher in the gamification group than in the control group, $F(1100) = 21{,}98$, $p < .01$, $\eta_p^2 = .180$.

2. *To what extent can gamification work-integrated training environments foster experiences of competence*, *autonomy regarding task meaningfulness, autonomy regarding decision freedom and relatedness?*

   - Regarding the *experience of competence*, the gamification group scored 4.81 ($SD = 1.40$) on a seven-point Likert scale, while the control group scored 4.11 ($SD = 1.13$). A MANCOVA indicates that participants from the gamification group have significantly higher experiences of competence than participants from the control group, $F(1100) = 8.11$, $p < .01$, $\eta_p^2 = .075$.
   - Regarding the *experience of task meaningfulness (autonomy)*, the gamification group scored 5.46 (SD = 1.06) on a seven-point Likert scale, while the control group scored 4.34 ($SD = 1.38$). A MANCOVA indicates that participants from the gamification group have significantly higher experiences of task meaningfulness than participants from the control group, $F(1100) = 18.90$, $p < .01$, $\eta_p^2 = .159$.
   - Regarding the *experience of decision freedom (autonomy)*, the gamification group scored 4.03 (SD = 1.49) on a seven-point Likert scale, while the control group scored 3.64 ($SD = 1.58$). A MANCOVA indicates that participants from the gamification group have significantly higher experiences of decision freedom than participants from the control group, $F(1100) = 4.03$, $p < .05$, $\eta_p^2 = .039$.

- Regarding the *experience of relatedness*, the gamification group scored 3.31 ($SD = 1.47$) on a seven-point Likert scale, while the control group scored 1.93 ($SD = .99$). A MANCOVA indicates that participants from the gamification group have significantly higher experiences of relatedness than participants from the control group $F(1100) = 27.85$, $p < .01$, $\eta_p^2 = .218$.

These results show that the gamification environment was superior in regard to performance and motivational indicators and succeeded in fostering the development of work competencies. Both *qualitative* and *quantitative performance* show evidence for the effective training of order-picking work competencies by using gamification compared to a traditional training by a supervisor. Regarding psychological need satisfaction, the gamification group reached higher levels of *competence*, *autonomy* (regarding *task meaningfulness* and *decision freedom*) and *relatedness* need satisfaction.

Gamification environments like the one described above seem to be a promising solution for developing work competencies and solving motivational problems, especially in barely stimulating working and learning contexts like intralogistics.

From a competence assessment perspective, the above-described study uses two types of performance measures to assess work competencies – number of picks and accuracy rate. Generally, competencies can be viewed and measured on a continuum including cognitive and affective-motivational traits that underlie perception, interpretation and decision-making that lead to performance in real-world situations (Blömeke et al. 2015). Looking at competence measurement from such an integrative perspective, the study covers the performance side of work competencies as well as the affective-motivational aspect. As gamification is theorised to have strong influences on motivation, this focus on motivation and performance is comprehensible. Nevertheless cognitive aspects of work competence development by gamification, which were not in focus of this empirical study, should be in focus of further research.

37.5 Conclusions

Gamification is quite a new approach in the field of game-based environments. Hence, most researchers investigate gamification from a media-science or business perspective, as it is from these areas that gamification originates. Theory-driven research from a psychological perspective is scarce (Hamari et al. 2014; Seaborn and Fels 2015). Based on the theoretical investigation from a psychological perspective, gamification seems to be a promising work-integrated approach for the development of work competencies. Gamification within working and training contexts takes advantage of the learning potential of the workplace itself while ensuring motivation by applying game design elements. By applying a psychological

perspective on competence development via gamification, mechanisms and effects of game design elements can be theoretically explained and led to the following assumptions: points, badges and leaderboards provide feedback and are thereby relevant for the development of work competencies as well as motivation by satisfying competence needs. Performance graphs provide more elaborated feedback and are particularly relevant for the optimisation of learning processes. A story framework can be efficient in ensuring motivation during the first stages of competence development and by addressing feelings of autonomy regarding task meaningfulness. Elaborated avatar systems with the opportunity for profile development can help to foster motivation by addressing psychological needs for autonomy regarding decision freedom and relatedness.

The lack of theory-driven empirical research on effects of gamification, which uses proper experiments or proper psychometric measurements (Hamari et al. 2014; Seaborn and Fels 2015), is addressed by the above-described study. This study is one step towards filling the empirical research gap regarding effects of gamification on competence development and motivation. The study showed that gamification is a feasible approach to be implemented within a training process directly on the job. Moreover results indicate that the development of order-picking work competencies can be fostered by applying a gamification environment within manual handling processes. Within barely stimulating and monotonous working contexts like intralogistics, gamification also helps to foster motivational outcomes including psychological need satisfaction. The theoretically described mechanisms of certain game elements are supported by the empirical results, although no differentiated and empirically validated statements about the impact of single game design elements can be made, which leads to further research.

Further research should concentrate on empirical and experimental studies from psychological perspectives to investigate cognitive aspects regarding competence development, which can possibly be affected by gamification. Besides that, further research should focus on the impact of single game design elements or single game design element groups. The study described in this chapter was executed within a storage depot setting in an experimental hall. Although the setting was designed to be as similar as possible to real working contexts in intralogistics, it still cannot be described as such. Effects of gamification on the development of work competencies in the real world have to be investigated in implementation studies. This would also help to get insights regarding long-term effects of gamification, which should be addressed by further research as well.

From the practitioners' perspective, the gamification case example provided evidence for the feasibility of gamification within manual handling processes. Within the case example, gamification was applied in existing intralogistics infrastructures and its underlying technical system. The case example showed that gamification can be implemented in existing technical infrastructures without changing the basic workflow itself.

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