Creativity, Innovation and Entrepreneurship, Vol. 31, 2022, 150–158
https://doi.org/10.54941/ahfe1001517

Evaluation of Systematically Developed Gamification Strategies Using Game-Balance Simulation Tools

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ABSTRACT

Gamification describes the "use of game design-elements in non-game contexts" and is a modern method of motivational design. It aims to motivate people to perform *Desired Actions* in a specific context. The development of successful gamification strategies requires a consistent, systematic approach. This consists of context and user analysis, technology ideation, and mechanics design. Ultimately, in the practical application, the so-called testing, it must be examined what influence the gamification strategies actually have in order to make eventual adjustments before the implementation takes place in the target context. A prior, objective evaluation possibility does not exist and is therefore often limited to the empirical experience of gamification designers. The balancing of video games can be tested with digital simulation tools (e.g. machinations.io), which show the described relationships in flow charts. This research work shows that gamification strategies for products can be mapped and evaluated with the help of game balancing simulation tools to make better statements about the probability of success. Conclusions and requirements for the general simulation of gamification strategies with game balancing tools are drawn from an exemplary application. A structured process with instructions for the implementation of gamification strategies in game-balance simulation tools helps gamification developers in practical applications.

Keywords: Gamification, Game balancing, Gamification evaluation, Gamification simulation, Machinations, User type hexad

INTRODUCTION AND PROBLEM STATEMENT

Gamification is a modern approach to increase motivation by using "game design elements in non-game contexts" (Deterding, 2011). The goal of gamification is mostly to extrinsically and intrinsically increase people's motivation to perform certain actions, behaviors, or decisions by introducing video game-related elements into real-life situations. Gamification projects in most cases follow a structured design process to support successful development. A challenging aspect of this is the evaluation of the developed strategy. This is usually done by a prototypical implementation with a small test group followed by an empirical analysis of the impact. The implementation in test environments and the empirical methods are mostly very time-consuming and offer only sufficient indications of the actual effectiveness of the gamification strategy since the results depend on the respective boundary conditions of the tests. Furthermore, it is difficult to map different user types in a realistic relation, the relation between user types and assigned or unassigned gamification elements and the resulting decision to take a *Desired Action* with the methods mentioned above. Other options have not yet been established (Morschheuser et al., 2017). An objective simulation approach would add significant value to the evaluation of gamification strategies by summarizing, exploiting, and illustrating various empirical findings in the field of gamification concerning individual contextual influences.

Game balancing describes the adaption of parameters, scenarios, and behaviors in video games to create a balance between frustration due to too high demands or boredom due to underchallenge (Koster, 2004). Machinations.io is a browser-based game balancing tool. Through flowcharts, video game contexts can be visualized and actively simulated. The goal is to optimize games in terms of user experience and to identify potential problems and errors, such as game scenes that cannot be overcome by gamers (Machinations, 2021).

This research investigates the principal suitability of machinations.io as a simulation tool for gamification strategy projects. In an explorative study, the relationships between user types, game elements, motivation, and performance of *Desired Actions* are examined. Implications for future simulations of gamification strategies are provided.

THEORETICAL BACKGROUND

Gamification

The term gamification first appeared in 2002 in a paper by management consultant Nick Pelling and has gained more and more attention in many areas over time. In 2011, the first scientific conference on the topic was held (Fleisch, 2018). Gamification is a relatively young approach that started in the field of software development. In the meantime, gamification methods are already successfully used in many companies (Ellenberger et al., 2020; Kessing & Löwer, 2020; Reiners & Wood, 2015). The concept of gamification attempts to use the potential of video games in a meaningful and targeted way. The goal is to increase people's motivation by offering new incentives to increase interest in activities and make overcoming challenges more attractive. By systematically designing gamification strategies, positive motivation potentials are developed and *Desired Actions* can be triggered. As gamification aims to influence the behavior of the users, *Desired Actions* define the target of a gamification project (Chou, 2016).

User Types

User Types provide a characterization of the users in a gamification context regarding their attitude or core motivation to use a respective context. Marczewski combined the concept of Bartle's Four Player Types (Bartle, 1996) with the Self-Determination Theory (Deci & Ryan, 1980) to create the User Types HEXAD (Marczewski, 2015). Marczewski describes the six

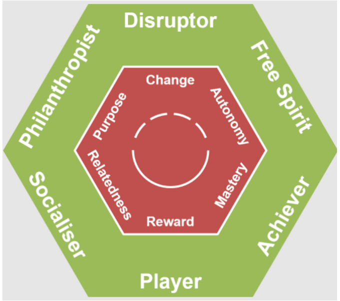

Figure 1: Gamification user types HEXAD according to Marczewski (Marczewski 2021).

different User Types, which have different basic motivations. The intrinsically motivated types are *Achiever, Socialiser, Philanthropist, and Free Spirit*. They are motivated by relatedness, autonomy, mastery, and purpose. The other two types, whose motivations are extrinsic rewards and change, are *Disruptor and Player*. The HEXAD model enables the classification of people in gamified applications (see Fig. 1).

Through a survey on his website, Marczewski performed a distribution of people into User Types HEXAD (Marczewski, 2021): *Philanthropists* 27%, *Free Sprits* 22%, *Achievers* 17%, *Socialiser* 16%, *Players* 15%, and *Disrupter* 3%. However, this list only represents the dominant user types of the test participants. For a detailed description, Marczewski also presents further sub-types, proposes a user type evolution, and defines mixed user types to form a more realistic framework.

Gamification Elements

Gamification elements form the basic repertoire for gamification design. Gamification elements are elements derived from video games, which are used there for a specific purpose. Classic examples are points, rankings, and badges. These elements have already been categorized in various frameworks and described as solution-neutrally as possible for the application in gamification projects. Based on a previous analysis in a gamification project, suitable gamification elements can be selected and then designed for the individual use case. The "Periodic Table of Gamification Elements" by Marczewski consists of 52 gamification elements, which are assigned to the six User Types HEXAD and two general categories (Marczewski, 2015). Santos et al. also showed that the assignment of specific gamification elements to certain user types is possible (Santos et al., 2021a).

Game Balancing and machinations.io

Game balancing describes a continuous process in video game development to optimize the gaming experience. Therefore, even after the release of a video game, so-called balance patches are often implemented to address game balance issues. This is especially necessary for games that regularly release new content for the players since the influence of the new elements can only be tested under the appropriate test conditions. However, necessary changes often arise only when the dynamics of the game evolve through a large number of players (Becker & Görlich, 2021).

Machinations.io is a browser-based platform for designing, balancing, and simulating game systems. It allows displaying arbitrary game systems in an interactive diagram, to set parameters, define elements and their relations to each other, and to visualize how the systems work. This allows to identify and fix potential balance problems before the release of video games and without extensive programming effort (Machinations, 2021). Various basic tools are available that can be combined to create complex logics. A source generates elements according to determinable conditions, a pool collects elements at intermediate points, and a gate can distribute elements. Resource connections route elements, while state connections represent conditions. Registers can mathematically compute relationships. The End-Condition terminates the run.

RESEARCH QUESTIONS AND METHODS

The explanations above show that the evaluation of developed gamification strategies has so far taken place through exemplary implementation in a test environment with subsequent empirical evaluation. The implementation in test environments and the empirical methods are mostly very complex and offer only insufficient indications of the actual effectiveness of the gamification strategy since the results depend on the respective boundary conditions of the tests. Furthermore, it is difficult to map different user types in a realistic relation, the relation between user types and assigned or unassigned gamification elements and the resulting decision to take a *Desired Action* with the methods mentioned above. An objective, solution-neutral and effort-reducing way to simulate gamification strategies does not exist yet. Game balancing tools like machinations.io are not used as they are not designed for this use-case.

This leads to the following research questions:

RQ1: Can gamification strategies be simulated in game balancing tools?

RQ2: What are the core elements which have to be modeled to simulate gamification strategies in game balancing tools?

RQ3: How can the relationships between the identified elements be defined?

The approach consists of four main steps: 1. Defining the necessary elements to represent motivational relationships in game balancing. tools. 2. Linking the identified elements with relations based on scientific literature to a theoretical model. 3. Basic exemplary implementation of the theoretical model to machinations.io. 4. Fundamental evaluation of the implementation. The first step is performed using model matching from the literature. For this, explicit literature from gamification and gamification application is used to define recurring elements and schemes. The linkage of the elements is given by logical connections and by an adaption of scientific findings. The implementation to machinations.io is performed by an explorative modeling study. The evaluation will take place by an exemplary execution of the model.

MODELING GAMIFICATION

By analyzing scientific literature on gamification, the necessary elements of gamification design can be defined. According to Deterding (2017) ("The use of game design-elements in non-game contexts"), there are at least the *elements of game design* (or *gamification elements* according to Marczewski) and the *context* to be gamified. Chou defines gamification as *human*-focused design in contrast to function-focused design, which is intended to increase the *motivation* to perform a specific *Desired Action* (Chou, 2016). As already explained before, the classification of characters via *user types* plays an important role. Accordingly, the following central aspects result, which have to be considered in a simulation: *User, User Types, Gamification elements, Motivation, Context impact, Desired Actions*

The relations between the elements are defined as follows. The people in the gamified context (users) are divided into different user types according to their characteristics and the user spectrum of the context to be gamified. The user types have an average basic motivation to perform the *Desired Action*, which is defined by the target of the gamification project. This motivation is influenced positively, negatively, or not by gamification elements. Gamification elements have an individual influence on the different user types. The adapted motivation influences the decision to take a *Desired Action*. The following questions have to be answered to complete the theoretical model: What is the percentage distribution of users across User Types HEXAD? What is the relation of a possible motivational change due to gamification elements and user types? How does a motivational change affect the decision to take a *Desired Action*?

The distribution of the users to the user types is dependent on the individual use case of the prospective gamification project. Hence, this distribution is assumed as given. In this particular research, the survey results of Marczewski (2021) are taken as they have a high participation rate and thus validity for a general assumption (see chapter "User Types").

The correlation of whether a motivational change is triggered by a gamification element among the user types is derived numerically from the findings of Tondello et al, 2017. Tondello et al. describe the relations of gamification elements (gameful design elements) to the User Types HEXAD in an exploratory factor analysis. In an online survey, participants were analyzed regarding their user type and then asked for their preferences in given game design elements. The results can be calculated to a direct correlation factor. For example, the gameful design element *Guilds/Teams* is defined by a socialization value of .668 and an altruism value of −.430. The user type *Free Spirit* shows correlations of .003 to socialization and .149 to altruism. The socialization and the altruism values are each multiplied and then added up to the direct correlation factor. In this example, the *Guilds/Teams* element has an influence of −.0621 (or −6.21%) on the *Free Spirit* user type. For the implementation in the simulation model, this value is interpreted as a 6.21% probability for the *Free Spirit* users to be negatively influenced in its motivation to take the *Desired Action*.

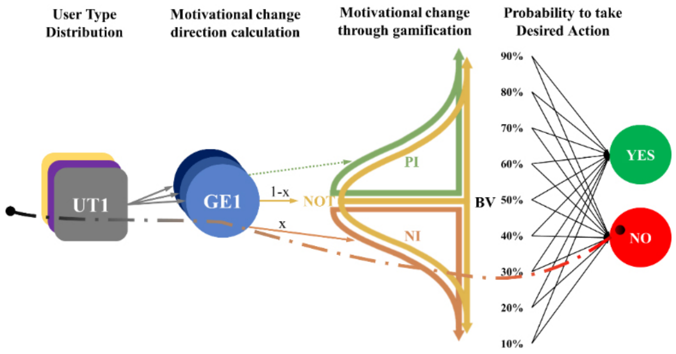

Figure 2: Theoretical model and example user journey (pointed line) (UT = User Type, GE = Gamification Element, x = calculated influence of GE1 on UT1 based on Tondello et al. 2017, PI = positive influenced users, NI = negative influenced users, NOT = not influenced users, BV = motivational base value (here 50%)).

As a negative influence on the motivation does not automatically lead to a decision to not take the *Desired Action*, a logical relation between the motivational change and the decision for the *Desired Action* has to be implemented. As there are no concrete scientific findings on this relation yet, a statistic distribution is considered here. The basic distribution of the probability to take a *Desired Action* without the influence of gamification elements is modeled as a Gaussian distribution on a 0 to 100 percent scale around the pre-defined motivational base-value of the corresponding user type with sigma being 10%. Hence, if the motivational base value to take the *Desired Action* is 50%, the users will spread from 10% to 90% probability to take the *Desired Action*, with sigma1-interval to be between 40% and 60%, sigma2-interval from 30% to 70% (sigma=2), etc. If a user is influenced positively or negatively by a gamification element, he will only be distributed on the respective positive or negative half of the Gaussian distribution. For example, a *Free Spirit* user is influenced negatively by the element *Guilds/Teams*. The base value to take the *Desired Action* is 50%, so the user has a 68.2% chance to be distributed to the sigma1-interval. This follows a 50-40% probability to take the *Desired Action*.

The theoretical model and the example user are shown in Figure 2.

RESULTS

According to the model described in the chapter before, the impact of gamification elements on the decision of users to perform a *Desired Action* depending on user type characteristics is modeled exemplarily for one user type and two gamification elements with machinations.io. The simulation model includes three sub-steps:

1. Calculation of motivation direction influence through gamification elements
2. Calculation of motivation change distribution
3. Calculation of the decisions for a *Desired Action*

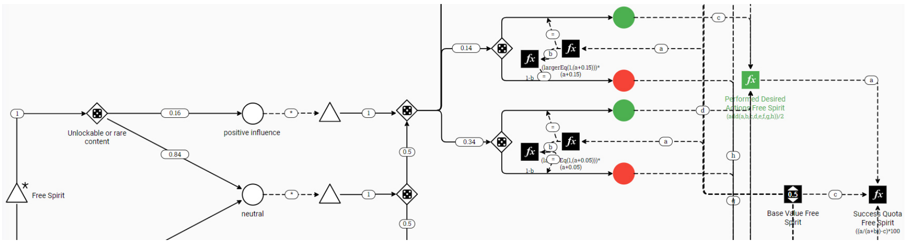

Figure 3: Excerpt from the model implementation in machinations.io.

Step 1: This step defines if the gamification elements have a positive, neutral, or negative influence on the motivation of the users with respect to their user type. In this particular example, the user type *Free Spirit* is considered. The two chosen gamification elements are *Guilds or teams* with a calculated value of −6.21% and *Unlockable or rare content* with a value of 16.18%. The user type is implemented as a source that represents the users. Each user interacts with both gamification elements, which are implemented as random gates. The chances of the paths to positive, neutral, or negative influence are related to the calculated values based on Tondello et al. (2017). The motivational changes are represented by a pool each. As one user generates two simulation elements, the pools have to be normalized later in the simulation.

Step 2: This step defines how much the motivation changes based on a Gaussian distribution. The users who are positively influenced by the gamification elements are distributed on the positive half of a Gaussian distribution while the negatively influenced users are arranged in a negative half. Neutral influenced users are distributed randomly in the Gaussian distribution positive and negative which is realized by a 50/50 chance to be distributed negative or positive. Every simulation element which represents a motivational change in the pools triggers a source that distributes the elements via a random gate on a Gaussian distribution.

Step 3: This step defines how the motivational change influences the decision of the users to perform the *Desired Action*. For this, a scale from 0 to 100% is used which represents the probability to perform the *Desired Action*. A base value for each user type, which is determined by the context can be preset and manually adjusted via an active slider during the simulation. The sigma value of the Gaussian distribution is set by 10%. If a user gets distributed to the respective interval, he is assigned to the middle value. The formulas in the simulation diagram also realize that the Gaussian distribution does not generate probabilities over 100% and below 0%.

Finally, the calculated values are combined and analyzed. With different combinations of the pools of taken and not taken *Desired Actions*, the success rates of the gamification elements for the user types can be calculated (see Fig. 3).

In the given exemplary implementation for the *Free Spirit* user type with a base value of 50% and the *Guilds or teams* and *Unlockable or rare content* gamification elements, the simulated success quota results in 5 to 10% more performed *Desired Actions* in comparison to the base value.

CONCLUSION

This research shows that in general the simulation of the influence of gamification elements on the motivation and thus the decision for or against a *Desired Action* is possible. Hence, RQ 1 can be answered positively. Gamification strategies can be simulated in game balance tools.

The core elements, which have to be implemented to complete a simulation model have been identified, which are *User, User Types, Gamification elements, Motivation, Context impact,* and *Desired Actions*. Thus, RQ 2 can also be answered positively. Also, it was possible to connect the simulation elements with logical relations based on scientific findings from Marczewski, Tondello et al., and a Gaussian distribution. This results in a final simulation model with comprehensive and consistent simulation results. Thus, RQ 3 can also be answered positively.

IMPLICATIONS AND LIMITATIONS

There exist some limitations to this study that have to be mentioned to support future research on this topic.

The target of simulating gamification strategies for evaluation purposes is not to precisely predict the impact of gamification elements on the performance of *Desired Action* but to give an objective orientation on how different gamification elements might work in a given context. In general, motivation and the impact of gamification is highly dependent on individual factors. These factors have to be analyzed more in future research to create the possibility for a better consideration in simulation contexts.

The number of identified simulation objects in RQ 2 gives a basis for simulation purposes but can definitely be increased. Especially the elements which represent the individual context influence have to be examined more intensively and summarized to give simulation users a more intuitive interface.

There exist alternatives to the research studies chosen for connecting the simulation elements with logical connections. The User Types HEXAD from Marczewski are a common framework for categorization of human behavior in gamification research contexts but other frameworks exist that might also apply for the purpose of simulating gamification such as Bartle's four Player Types (Bartle, 1996) or BrainHex (Nacke et al, 2014).

The influence of gamification elements on user types is currently a highly relevant topic in gamification research and several approaches exist such as (Santos et al, 2021a) or (Krath & von Korflesch, 2021). Tondello et al. (2017) give a direct possibility to generate numeric relations between user types and gamification elements, but this has to be handled as an approximation as humans on average do not only fit to one user type (Marczewski, 2021) and also change user types over time (Santos et al. 2021b).

The Gaussian distribution on the amount of motivational change is an approximation due to missing research findings in this area. When there are findings available they have to be implemented to the simulation model to describe this relation more realisticly.

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