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Playtesting for a Better Gaming Experience: Importance of an Iterative Design Process for Educational Games

Research-in-Progress

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Abstract

Digital game-based learning is a widespread trend in education. Nevertheless, many educational games fail because their designers concentrate on achieving learning goals instead of creating an enjoyable gaming experience with a balance between learning success and fun. Traditional game design processes including playtests are seldom used in the development of educational games. For this reason, in this paper playtesting is used to iteratively improve a game-based learning application in two revisions. Gaming experience is measured with the EGameFlow scale. The results show a significant improvement in almost all measured dimensions.

Keywords: Game-based Learning, Serious Game, Game Design, Playtest, EGameFlow

Introduction and Motivation

Game-based learning means the integration of game elements in education and is currently a widespread trend (Hamari et al. 2014). There are two possibilities to realize game-based learning applications: gamification and serious games. Gamification is defined as the integration of game elements in a non-game context, e.g. education (Deterding et al. 2011). Compared with this, a serious game is the implementation of a full-fledged game with fix rules and goals in a non-game context (Deterding et al. 2011). What both possibilities have in common is the use of game elements (e.g. points and story) as motivational incentive in the learning context. Therefore, learning becomes more fun and motivation is increased to deal more intensively with learning topics (Kapp 2012).

Nevertheless, one reason for the failure of many game-based learning applications is that learners don't have fun while playing. When developing such an application, the focus is on achieving learning objectives instead of creating an enjoyable gaming experience (Zichermann and Cunningham 2011). Fullerton (2014) emphasizes, first, testing and iterative development processes and, second, the need for an interdisciplinary team with diverse knowledge for designing a well thought-out game and game experience. Traditional game design processes are seldom used in the development of game-based learning applications, although playtests are strongly recommended (Boller and Kapp 2017). Mostly, applications are developed, used and evaluated. Iterative testing and improving is rare, although a good gaming experience can positively influence learning success (Hoblitz 2015).

Playtests should be conducted throughout the entire design process to determine whether the desired gaming experience has been achieved and how this can be improved (Fullerton 2014). Playtests are rare in the developing process of game-based learning applications. For example, the development of „Legend of Zyren" took place step by step together with students. Feedback was directly gathered during conceptualization and included in further development (Knautz 2015). The development team of the educational game "Defense of Hidgeon" gathered information through game-play-based interaction (learner behavior in the game) and conducted interviews. From that, they derived concrete suggestions for improvements but did not used it for an upgrade (Markey et al. 2008). To the best of our knowledge, several playtests for determing the step-by-step development of the game experience have not yet been carried out.

Regardless of how much effort was involved in the game design and how much time developers have spent with testing, real feedback and insights occur when other people test it (Boller and Kapp 2017). In this paper, playtesting is used for an educational game. The gaming experience will be assessed using the EGameFlow scale developed by Fu et al. (2009) in two revisions, to show possible improvements and deteriorations through an iterative design process. This work is a first step in investigating the relationship between gaming experience and learning success.

Theoretical Background

Game Design Process and Learning-Game Design Process

Both, traditional game design process and learning-game design process are almost identical (see Figure 1). The traditional game design process starts with conceptualization. First of all, ideas are needed to develop a game. Next, ideas must be evaluated in terms of technical feasibility, market opportunities, artistic considerations and budget (time and money). This is followed by a refinement of the idea, including definition of key features of the game (Fullerton 2014, Macklin and Sharp 2016). The next phase of game design process is prototyping. It allows the creation of a working model of the idea and enables testing to make improvements to it (Fullerton 2014, Schell 2014). Playtesting may be the most important activity because the designer gains insights into whether the game is achieving the desired game experience (Fullerton 2014). Designing a game is an iterative process and for this reason playtesting often leads to a revision of the concept, prototype and so on (Fullerton 2014, Schell 2014, Boller and Kapp 2017).

In comparison to a traditional game design process, the learning-game design process starts with setting the learning foundation. Thereby, formulating instructional goals for the learning solution is necessary (Boller and Kapp 2017). The phase of conceptualization has a special factor within the learning-game design process. In addition to defining the key features of the game, learning must be linked with game design (Boller and Kapp 2017).

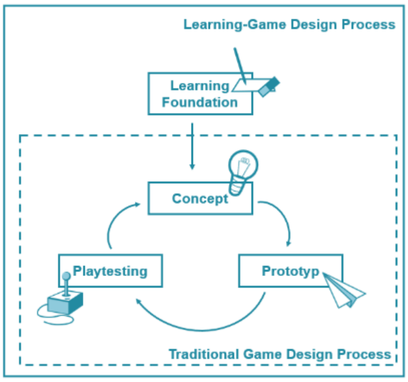

Figure 1. Game Design Process and Learning-Game Design Process

In this paper, we concentrate on playtesting as part of the game design process. Although playtests are important, they are often neglected for cost and time reasons (Fullerton 2014). Nevertheless, they are necessary to improve the gaming experience.

EGameFlow

Game-design-elements such as points, stories, challenges or virtual identities give players the feeling of being immersed in the game (Fu et al. 2009). This immersion is referred to as flow (Csikzentmihalyi 1990). Flow is the optimal mental state a person has during an activity that is not overstrained or underchallenged. Flow occurring in a game can lead to a better learning outcome within game-based learning applications and is therefore desirable (Hoblitz 2015). Sweetser's and Wyeth's (2005) GameFlow theory was developed on the basis of flow theory to explain a positive gaming experience. The aim of the model is to make the pleasure of games measurable. A model that is based on this work is the EGameFlow model (Fu et al. 2009). With this model the gaming experience of a game-based learning application is measurable. The scale consists of eight dimensions: concentration, clear goal, feedback, challenge, autonomy, immersion, social interaction and knowledge improvement. In order to maintain and increase concentration, in-game activities are provided to minimize learning overload. The more concentration a task requires, the more the learner immerses in a game (Sweetser und Wyeth 2005, Fu et al. 2009). Clear goals mean that goals should be clearly explained to the players at the beginning of the game (Fu et al. 2009). Feedback describes that players always know their current score and how much is still required to complete a task. In a game, challenges should be integrated that fit the players' abilities. Furthermore, the difficulty of levels should vary, with increasing skills of players (Sweetser und Wyeth 2005, Fu et al. 2009). Autonomy means that players have the opportunity to take the initiative (Pagulayan et al. 2003, Fu et al. 2009). Immersion enables players an effortless involvement in the game. Thereby, a carefree and changed sense of time should be perceived. Collaborating with other players in the game-based learning application is meant by social interaction. The dimension knowledge improvement describes that the player's knowledge should be increased by playing and learning within the game (Fu et al. 2009). In this paper, we use the EGameFlow model with all its dimensions because they reflect different game aspects. These dimensions allow extensively measuring gaming experience. Throughout an iterative design process based on playtests the EGameFlow model shows improvements and deteriorations of the game.

Study Design

Serious Game "Lost in Antarctica"

In this study, the open source serious game "Lost in Antarctica" for learning information literacy is used. Information literacy describes the ability of a person "to recognize when information is needed and […] to locate, evaluate, and use effectively the needed information" (ACRL 1989). According to the game design process, the development of "Lost in Antarctica" game concept was carried out in several iterative steps in a project course with the target group, students of mechanical engineering. Additionally, a graphic designer, a programmer and librarians worked on the project (Eckardt and Robra-Bissantz 2016).

The serious game "Lost in Antarctica" is designed as 'point-and-click' browser game with a story about a research expedition at the South Pole. Figure 2 shows two screenshots of the game.

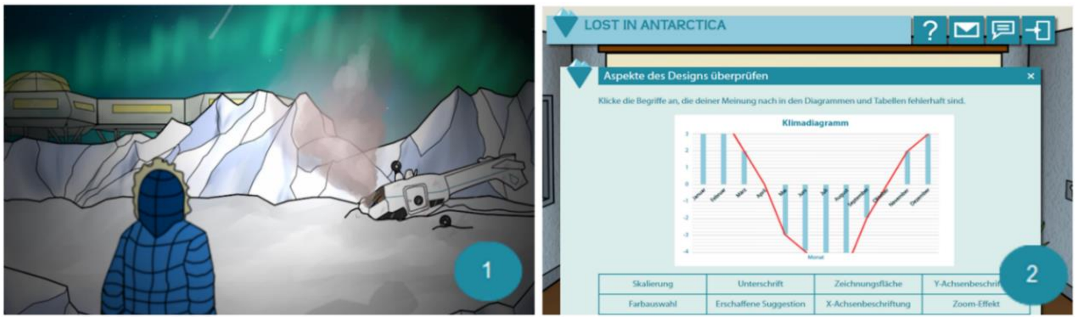

Figure 2. Screenshots of the Serious Game

During the research expedition, students travel as a group of scientists to the South Pole. Due to a snow storm, they have crash-landed (screen 1). As a result of this, the students must repair the defective airplane in addition to their scientific research (Eckardt and Robra-Bissantz 2016). At the beginning of the game, students can create an avatar and choose a nickname. The game consists of twelve levels representing different information literacy topics (e.g. research strategies, scientific writing and copyright). Each level is embedded in the accompanying background story and is structured identically. The students have to alternately acquire knowledge and solve tasks (screen 2). The knowledge transfer is done based on presentations, scroll down stories or videos. The associated tasks vary from cloze texts, multiple choice questions, drag and drop, crossword puzzles, memory games, free text tasks, tasks where students have to collect lines and tasks that students have to solve as team (e.g. votes or case studies). Students need only 200 out of 300 possible points to successfully complete a level. On a market place, additional points can be exchanged in mini games (e.g. pnake). These mini games are just for fun and represent a kind of reward. Furthermore, for each successful level completion students get an airplane component to repair the defective airplane (Eckardt and Robra-Bissantz 2016).

Participants

In winter semester 2016/17, a sample of 82 students were invited to participate in the study. The students consisted of 69 males and 13 females, with the mean age being 22. In comparison, 142 students participated in the study in winter semester 2017/18. The students consisted of 118 males and 24 females, with the mean age being 22. All students share approximately the same level of knowledge and must write a Bachelor thesis in the coming semesters. Therefore, they are intrinsically motivated to learn some aspects regarding information literacy. For this reason, the participants are well suited as the target audience.

Procedure

The participants are student groups of the winter semester 2016/17 and 2017/18. Figure 3 shows the research procedure, which is divided into two phases.

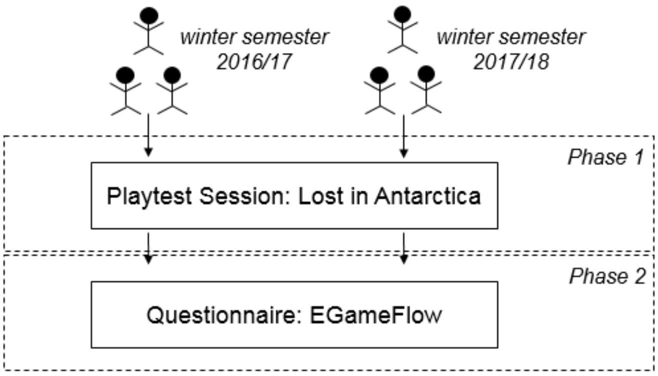

Figure 3. Study Design

Phase 1: Playtest Session. Both student groups had a one month learning phase with the serious game. They decided where they wanted to play (e.g. at university or at home). Furthermore, the students were able to decide the rate and scope to perform the game. Additionally, the repetition of tasks was possible.

Phase 2: Questionnaire. After the playtest session, the students were required to fill out a questionnaire for gathering information about their perceptions of the game.

Study Results

Table 1 shows the results of the study. Thereby, a seven point Likert scale was used (1 = extremely disagree, … 7 = extremely agree) for the EGameFlow model (Fu et al. 2009). Mean values (MV) and standard deviations (STD) are shown for winter semester 2016/17 and 2017/18.

Table 1. Results EGameFlow Model

Factor	Content	Winter semester 2016/17		Winter semester 2017/18	
		MV	STD	MV	STD
Concen-tration	The game grabs my attention.	3.95	1.55	4.34	1.37
	The game provides content that stimulates my attention.	3.46	1.43	4.34	1.44
	Most of the gaming activities are related to the learning task.	4.98	1.44	5.00	1.45

	No distraction from the task is highlighted.	4.02	1.37	4.53	1.34
	Generally speaking, I can remain concentrated in the game.	4.25	1.53	4.63	1.54
	I am not distracted from tasks that the player should concentrate on.	4.48	1.54	4.78	1.54
	I am not burdened with tasks that seem unrelated.	4.62	1.54	4.66	1.54
	Workload in the game is adequate.	4.44	1.66	4.51	1.68
Goal Clarity	Overall game goals were presented in the beginning of the game.	4.44	1.58	4.91	1.43
	Overall game goals were presented clearly.	4.63	1.47	5.03	1.34
	Intermediate goals were presented in the beginning of each scene.	4.91	1.18	5.11	1.24
	Intermediate goals were presented clearly.	4.67	1.37	5.07	1.31
	I understand the learning goals through the game.	4.87	1.46	5.19	1.36
Feedback	I receive feedback on my progress in the game.	5.02	1.42	5.29	1.56
	I receive immediate feedback on my actions.	5.00	1.35	5.17	1.51
	I am notified of new tasks immediately.	4.63	1.31	5.35	1.53
	I am notified of new events immediately.	4.85	1.32	5.50	1.44
	I receive information on my success (or failure) of intermediate goals immediately.	5.45	1.08	5.64	1.43
	I receive information on my status, such as score or level.	5.91	1.12	5.55	1.62
Challenge	I enjoy the game without feeling bored or anxious.	3.28	1.68	4.18	1.66
	The challenge is adequate, neither too difficult nor too easy.	4.85	1.35	4.81	1.37
	The game provides ‘‘hints” in text that help me overcome the challenges.	4.98	1.23	4.78	1.43
	The game provides ‘‘online support” that helps me overcome the challenges.	4.33	1.28	4.56	1.43
	The game provides video or audio auxiliaries that help me overcome the challenges.	5.72	1.05	5.32	1.40
	My skill gradually improves through the course of overcoming the challenges.	4.46	1.43	4.84	1.39
	I am encouraged by the improvement of my skills.	3.94	1.51	4.57	1.45
	The difficulty of challenges increase as my skills improved.	3.91	1.23	4.56	1.35
	The game provides new challenges with an appropriate pacing.	4.61	1.18	4.93	1.41
	The game provides different levels of challenges that tailor to different players.	3.78	1.42	4.54	1.49
Autonomy	I feel a sense of control the menu (such as start, stop, save, etc.).	4.80	1.59	4.99	1.44
	I feel a sense of control over actions of roles or objects	4.50	1.57	4.51	1.39
	I feel a sense of control over interactions between roles or objects.	4.38	1.54	4.41	1.37
	The game does not allow players to make errors to a degree that they cannot progress in the game.	3.85	1.92	3.98	1.84
	The game supports my recovery from errors.	4.94	1.50	5.09	1.48
	I feel that I can use strategies freely.	3.74	1.73	4.25	1.52
	I feel a sense of control and impact over the game.	3.66	1.72	4.55	1.41
	I know next step in the game.	3.64	1.46	4.12	1.52
	I feel a sense of control over the game.	3.79	1.69	4.56	1.43
Immersion	I forget about time passing while playing the game.	2.23	1.63	3.31	1.72
	I become unaware of my surroundings while playing the game.	2.14	1.46	3.25	1.60
	I temporarily forget worries about everyday life while playing the game.	2.00	1.45	3.11	1.66
	I experience an altered sense of time.	2.93	1.98	3.77	1.67
	I can become involved in the game.	3.23	1.52	4.01	1.63
	I feel emotionally involved in the game.	2.13	1.34	3.28	1.70
	I feel viscerally involved in the game.	2.46	1.53	3.53	1.59
Social Interaction	I feel cooperative toward other classmates.	2.93	1.42	4.04	1.68
	I strongly collaborate with other classmates.	2.78	1.47	3.25	1.74
	The cooperation in the game is helpful to the learning.	3.27	1.55	3.88	1.68
	The game supports social interaction between players (chat etc.).	3.58	1.59	3.54	1.69
	The game supports communities within the game.	3.14	1.49	3.64	1.74
	The game supports communities outside the game.	2.91	1.62	3.28	1.70

Knowledge Improvement	The game increases my knowledge.	5.15	1.28	5.12	1.51
	I catch the basic ideas of the knowledge taught.	5.28	1.29	5.24	1.39
	I try to apply the knowledge in the game.	5.02	1.32	4.96	1.45
	The game motivates the player to integrate the knowledge taught.	4.62	1.54	4.75	1.49
	I want to know more about the knowledge taught.	3.83	1.72	4.49	1.35

In the winter semester 2016/17, students positively evaluated the dimensions feedback, goal clarity and knowledge improvement. The dimensions concentration, challenge and autonomy only achieved results with a slight positive trend. In comparison, immersion and social interaction were negatively assessed (MV ≤ 4) and should be improved. Good values in the EGameFlow model do not guarantee a successful game-based learning application. It is also possible to create a good game that only achieves in individual dimensions good values. Learners have different personality traits and also represent different player types (e.g. killer, achiever, socializer and explorer). For this reason, creating a game-based learning application that achieves good values in all dimensions is advisable. Several dimensions are then important for some learners and other dimensions for others. This promotes the provision of a learning application with which as many students as possible have fun while learning. The dimensions of the EGameFlow model with poorer values are therefore improved.

After the evaluation, some changes were made to the serious game. For example, changing the narration of game story should lead to an improvement of immersion. More graphic dialogues support the story instead of texts. Additionally, game introduction now takes place via a video with sound (Sweetser and Johnson 2004; Schell 2014). For increasing social interaction, the integrated team chat is repeatedly pointed out, e.g. by displaying new messages in the game. Further cooperative and competitive game elements are also in focus (e.g. a market place for exchanging components with other players to repair the airplane or a ranking within the mini games to permit comparisons with each other) (Lazzaro 2004). Furthermore, solution hints now support students understanding of many tasks. This promotes the dimensions goal clarity and concentration. A more detailed analysis of the task results is added to improve the feedback dimension. Some levels have been graphically redesigned because more detailed game worlds also promote concentration (Johnson and Wiles 2003). Allowing players additional scope within the game through less static game structure should increase autonomy (Sweetser and Johnson 2004).

These changes led to better assessments in all dimensions in winter semester 2017/18 compared to winter semester 2016/17. The dimensions concentration and challenge now are positively evaluated in addition to the dimensions feedback, knowledge improvement and goal clarity. The remaining dimensions autonomy, immersion and social interaction achieved results with a slight positive trend. The mean values over all items of the respective dimensions are comparatively visualized in a network diagram in Figure 4.

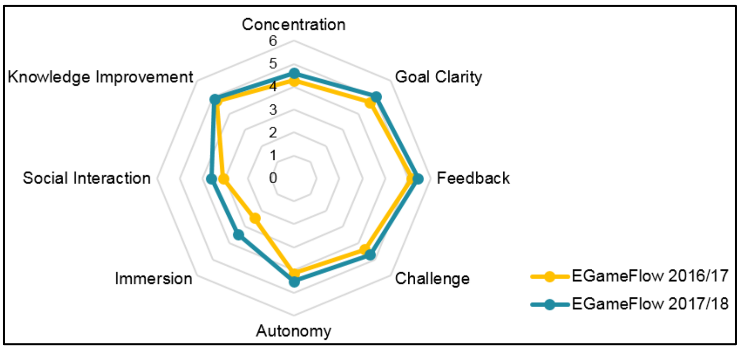

Figure 4. EGameFlow Network Diagram

A t-Test was performed to determine if the two samples significantly differ regarding dimensions. Table 2 shows the t-Test results of the EGameFlow dimensions for the two independent samples of the winter semester 2016/17 and winter semester 2017/18. The Levene test resulted in variance homogeneity for concentration, goal clarity, autonomy and knowledge improvement. For the remaining dimensions, the Levene test showed variance heterogeneity. Therefore, a t-Test with Welch correction was used.

Table 2. t-Test for two independent samples

Factor	Winter semester 2016/17		Winter semester 2017/18		T-test	
	MV	STD	MV	STD	T	p
Concentration	4.27	0.97	4.59	1.12	2.176	0.031 **
Goal Clarity	4.69	1.13	5.06	1.15	2.270	0.024 **
Feedback	5.14	0.94	5.41	1.29	1.769	0.078 *
Challenge	4.38	0.82	4.71	1.123	2.443	0.015 **
Autonomy	4.15	1.05	4.49	1.10	2.258	0.025 **
Immersion	2.44	1.16	3.46	1.42	5.754	0.000 ***
Social Interaction	3.11	1.19	3.61	1.50	2.664	0.008 **
Knowledge Improvement	4.78	1.17	4.91	1.29	0.738	0.462

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.001$

The t-Test resulted in significant changes for the dimensions concentration, goal clarity, challenge, autonomy, feedback, immersion and social interaction. Knowledge improvement showed no significant difference, which means that our changes from winter semester 2016/17 to 2017/18 have not led to an increase in this dimension.

Effect sizes are calculated for determing the relevance of the results. Determing the effect size follows Cohen (1992), because the group sizes differ greatly in size. Students evaluated the dimensions concentration, goal clarity, challenge, feedback, autonomy, immersion and social interaction better in winter semester 2017/18 than in winter semester 2016/17. The effect size of immersion is r=.38 and corresponds a medium value. In comparison, the other effect sizes range between $.15 \leq r \geq .17$ and correspond to a weak effect.

Conclusion and Future Research

All dimensions of the EGameFlow model result in significant improvements, with the exception of knowledge improvement. Particularly, immersion was noticeably increased compared to the previous year. Accordingly, the iterative game design process with playtests shows that an improvement of gaming experience is also possible in educational games.

To enable students benefits from the upcoming flow experience as in traditional games, instructional designers should focus more on traditional game design processes when creating an educational game. The iterative design process including playtests enables a good gaming experience and helps keeping well balanced fun and learning. During these development processes, focus should especially be on testing and iteratively designing with the target audience to ensure the creation of a learning application they want to play and learn with. But mostly, long development times and high costs hamper such a development for educational games (Fullerton 2014). Another potential area of research could therefore look into the reuse of such designed educational games and look if it is possible to exchange the learning content including knowledge transfer and tasks so that an identical gaming experience is perceived.

In a next step, we will examine the relationship between learning success and gaming experience. Learning success consists of different dimensions (e.g. subjective and objective knowledge gain and motivation) and therefore is difficult to measure (Kerres 2001). EGameFlow scale only measures the subjective knowledge improvement and this represents only a part of learning success. In this way, identifying an influence of learning success and gaming experience is difficult. Measuring learning success with different dimensions could show that an increased gaming experience has a positive influence on learning success. Compared with playtests and different development phases of an educational game, this could show a constant improvement of both, learning success and gaming experience. A balance between achieving learning goals and a good gaming experience is what designers of educational games and students want, but often not reach (Zichermann and Cunningham 2011).

In summary, it can be noted that playtests are important in the design process of educational games to create learning applications students want to play and learn with. Additionally, playtests allow refining integrated game elements and help solving conflicts between didactics, specific content aspects and game play.

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