

Developing an E-learning Course on Serious Games: A Multidisciplinary Approach

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Abstract The use of serious games (SGs) for different purposes is increasing. The development of successful and effective SGs requires a team with professional knowledge from different areas and a joint understanding of the SG development process. The research goal was to find a way to educate multidisciplinary students via an e-learning course about SGs. An action research study was initiated, and social constructivism theory-based e-learning courses on SGs were developed. The Carpe Diem Learning design method was used in the planning phase, followed by three iterations on course development and implementation. The feedback and observations were analysed in each iteration, and changes to the courses were made according to them. This iterative development and incremental improvement of an online course according to feedback was found to be a good approach.

Keywords: • Serious Games • E-learning • Education

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1 Introduction

The primary objective of a serious game (SG) is more than simply entertainment (Djaouti, Alvarez, Jessel & Rampnoux, 2011; Susi, Johannesson & Backlund, 2007; Zyda, 2005). These games, also called applied games, can be used to either change a player's behaviour or motivate them in a particular way (Baranowski et al., 2013; Ryan, Rigby & Przybylski, 2006). Due to the many different potential applications of SGs (see, e.g. Zyda, 2005; Kempainen, Korhonen & Ravelin, 2014; Ricciardi & Paolis, 2014), their development requires the involvement of experts from a variety of disciplines. To develop effective SGs, meaning they effectively achieve their serious purpose, more education is needed (De Troyer, 2017). In this study, our research goal was to find a solution to educate a multidisciplinary audience about SGs.

The Internet and rapidly developed information and communication technology (ICT) have built new methods of education and learning (Gomez, Wu & Passerini, 2010). Especially, the role of e-learning has grown as part of the acquisition of new skills and knowledge. Despite its technical requirements, the pedagogical aspects should be noted, as well. To evaluate the effectiveness of e-learning, Yunus and Salim (2008) proposed a framework consisting of five dimensions (individual, knowledge, learning, content, and relationship between the instruction and the learner) to enable e-learning.

The main research question in this study was: *How to develop an e-learning course on SGs for multidisciplinary students?* To answer this question, the following sub-questions were asked:

- How to design an e-learning course with social constructivism theory as an approach?
- What kind of content is needed regarding SGs when designing a course for multidisciplinary students?
- How to utilise gamification to motivate students?

This research followed action research techniques. An action research study aims to solve current practical problems while expanding on scientific knowledge, typically using an iterative research process where researchers are part of the study (Baskerville & Myers, 2004; Baskerville, 1999; Coghlan & Brannic, 2014).

This paper describes an action research study of the development and implementation of e-learning courses on SGs, and it is organised into five major sections. The next section reviews related works. Section three presents the research methodology, and the results are presented after that. The paper ends with a discussion and conclusions.

2 Related Work

2.1 Pedagogical Background

ICT-based communication increases learning by activating students, and team-based methods in online environments improve the effectiveness of learning (Gomez et al., 2010). Third-generation distance education, meaning that student support is integrated with teaching, giving students possibility to create learning content instead of adopting ready-made content, is a

radical change for pedagogy. Also educational institutions are challenged to adopt technology that develops at a rapid pace. (Tait, 2014.)

The concept of learning related to this development work is based on social constructivism theory. In social constructivism theory, social interaction between people is seen as the primary source of cognitive development in a learning context. (Durairaj & Umar, 2015.) Knowledge is constructed by exchanging dialogue in a social setting and co-constructed in the environment with others (Shaikh et al., 2017).

Students acquire knowledge by interacting and collaborating with a knowledgeable individual. Involvement and interaction in group discussions provide students with the opportunity to generalise and transfer their knowledge. Social constructivism theory highlights the importance of feedback to help students construct their knowledge. (Durairaj & Umar, 2015.) Although learning happens through collaboration, it is an internal mechanism within the individual. Individual learning is a product of knowledge creation, and it happens when collaboration takes place and when knowledge itself is co-created in the environment. (Shaikh et al., 2017.)

The social constructivism approach has been applied in online courses (Shaikh et al., 2017). Online learning and self-study are seen possible in the social constructivism context because the learner has inherited evolved cultural tools deliberately devised for intentional learning (Marsh & Ketterer, 2005).

The tension between the synchronous and asynchronous delivery of online courses is recognised. Shared deadlines result in improved motivation, and in contrast, asynchronous delivery gives students more freedom. (Shaikh et al., 2017.) Considering the dropout rate, Onah, Sinclair and Boyatt (2014) note that in most MOOC (Massive Open Online Course) courses, less than 13% of students finished the course.

In online courses, it is challenging to provide individual help to students, and to guarantee that the course outcomes have been achieved. Crowdsourcing has been seen to have the potential to answer these questions. Crowd formation in an online setting related to specific knowledge domains can connect students and make interacting and collaborating with knowledgeable individuals possible. (Shaikh et al., 2017.)

2.2 Design Method

Kali, Levin-Peled and Dori (2009) reported about the challenges to design courses that promote collaborative learning in higher education. According to them, teachers willing to adopt socio-constructivist pedagogies often face challenges related to fulfilling their objectives without the thorough application of carefully planned design methods. They also encouraged teachers to formulate and refine guidelines to fit with the objectives and to find sensible methods in the design.

Carpe Diem Learning design method describes a team-based, collaborative online learning design process, that typically comprises two or three academics (Salmon et al., 2014; Salmon & Wright, 2014). This method is suitable for designing new courses. Carpe Diem focuses on learning design needs for specific units of study. The basic process is delivered in a two-day workshop, and the basic idea is that people are designing something that could be put into

immediate use with participants. By the end of the workshop, there will be a unit or module partly built in the online environment and an action plan to support it. (Salmon & Wright, 2014.)

2.3 Serious Games as a Topic

The concept of a SG involves a digital game whose main purpose is something other than pure entertainment, and it is designed to be used in training, education, and healthcare (Loh, Sheng & Ifenthaler, 2015).

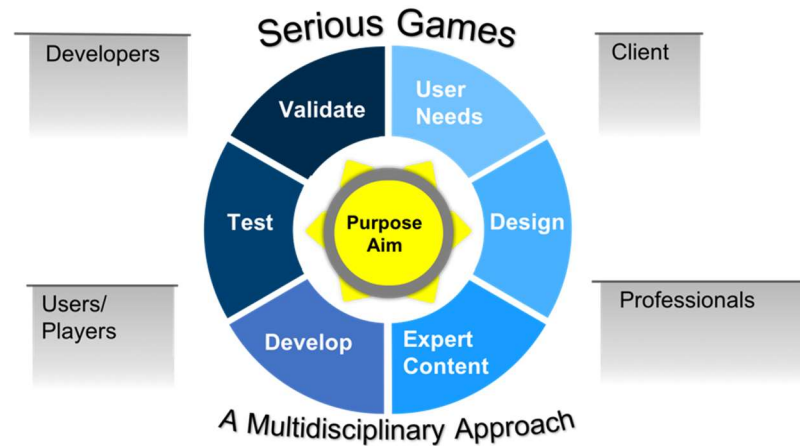


Figure 1: Phases and actors in SGs development.

Developing a SG requires not only game development skills and an understanding of good game design, but also the ability *“to solve an organizational need or to be of utility in some other aspect beyond entertainment”* (Backlund et al., 2017, p. 15). SG development is seen as an interdisciplinary scene (see Fig. 1.), where input is needed from many domains (Backlund et al., 2017). Client procurement skills are seen as a challenge: they have significantly high or low expectations, and they lack knowledge of possible solutions regarding gamification and SGs (Backlund et al., 2017). The education and consultancy of customers could be considered a solution for this challenge. De Troyer (2017) also presents the need for multidisciplinary tools to assist during the development of SGs, guidelines for developing SGs, and knowledge of SGs.

Several disciplines should be involved when designing and implementing SGs. Professionals participating in the development process should acquire knowledge and an understanding of the SG development process. (Korhonen et al., 2017.)

The term multidisciplinary expertise refers to the gathering of professionals from multiple academic disciplines to solve collaboratively a defined problem (Nancarrow et al., 2013). Furthermore, game development requires a team of experts with different backgrounds, and the development of SGs requires the participation of professionals in the target content area (Kempainen et al., 2014; Korhonen & Halonen, 2017a). Figure 1 illustrates the aspects

of SG design: SGs are designed using basic game design techniques, but for the defined purpose (Loh et al., 2015) and users.

3 Research Methodology

Action research aims to solve current practical problems while expanding scientific knowledge, typically using an iterative research process where researchers are part of the study (Baskerville & Myers, 2004; Baskerville, 1999). As a concept, action research was introduced by Lewin (1946), who studied workers' intergroup relations and actions, as well as the barriers the workers met at work.

Specifically, action research is an effective research method in cases that include active participation in organisations that are in the process of changing and that raise research interest among researchers. In practice, the change can be carried out by professional researchers who want to develop their work processes and practices in their environment. Action research appears in a cyclical process, and it is collaborative in nature. (Coghlan & Brannic, 2014.)



Figure 2: Action research cycle in developing an e-learning course on serious games.

In the current study (see Fig. 2), two of the authors were involved in developing the course as part of the organisation and its practitioners: one from information systems with technical background in gaming and one from healthcare expertise area. They observed the overall process of developing the course, and they participated in practical work as developers (see Coghlan & Brannic, 2014).

4 Development of the Course on Serious Games

This section presents the phases in the development of the course on SGs that apply the cycle of action research (see Fig. 2). Planning started with research on the-state-of-the art in SG courses, and it continued by applying the Carpe Diem Learning design methodology. This was followed by content selection and creation in a learning management system (LMS), including

the use of gamification techniques. Observation took place during three implementation phases, and all feedback was analysed and used in the iterative development of the course.

4.1 The State-of-the-Art in Serious Game Education

At the time of this study, year 2016, there were few online SG courses and education available in English, and the quality and content of the courses varied greatly. There were no courses in Finnish. After searching using Google, we listed courses that were found in English and offered as online courses. Then the search was narrowed down to courses that suited also to experts outside game development (see Table 1).

Course name	Table of available online SG courses - top3		
	Link	Syllabus	Remarks
Serious Gaming	https://www.coursera.org/learn/serious-gaming	<i>“You will learn the ins and outs of games that are designed with exactly those purposes in mind: serious games.”</i>	Most suitable for a multidisciplinary audience.
Serious Game Design and Development	https://iversity.org/en/courses/serious-game-design	<i>“Students will go through all the steps of the development of a Serious Educational Game.”</i>	Ended 2015.
Design and Development of Games for Learning	https://www.edx.org/course/design-development-games-learning-mitx-11-127x-0	<i>“We will hear from experts working on many aspects of learning games from design to development to implementation.”</i>	No verified certificate available.

Table 1: Available SG Online Courses

Table 1 describes the three courses that were offered as online courses on SGs and considered to suite for non-game development audiences.

4.2 Planning the Course

In planning the online course in higher education (HE) level on SGs, a Carpe Diem Learning design method (see Salmon et al., 2014) was applied. This method was chosen because it is effective, creative, student-centred, and multidisciplinary teamwork was needed in planning the brand-new course. The process started with the guidance of the facilitator. There were six steps in the process (see Salmon et al., 2014):

1. Write the blueprint – envision the future.
2. Make a storyboard – become a designer.
3. Build your prototype online.

4. Check reality.
5. Review and adjust.
6. Plan your next step.

First, HE healthcare and sports bachelor's students were selected as the pilot course's primary target group. While writing the blueprint, the mission for the online course from the students' viewpoint was defined. The mission was set (see Table 2), and the look and feel of the course was described as creative, playful, professional, and engaging. After that, it was time to define what was supposed to be achieved after the course: *"By the end of the course, I will be able to generate ideas concerning SGs, and I will know how to go further with them."* Then, it was explored how to assess these outcomes and how to fulfil the promises made. For example, to be engaging, course methods included peer-reviewing and rapid feedback. For assessing knowledge, there were online tests and a game evaluation assignment. The learning objectives of the course are described in Table 2.

	Online course on SGs
Target group	Primary: Higher Education healthcare and sports students (Bachelor's level). Secondary: All interested students and professionals
The mission	<i>"I have courage to generate SG ideas and go further with my ideas."</i>
Learning objectives	Student will.. <ol style="list-style-type: none"> 1. get familiar with the concept and the development process of serious games and gamification. 2. find out about the owner's role in a serious games development project and learn a variety of innovation methods for developing your game ideas. 3. learn to understand the technological perspective behind gamified solutions.
The methods	Gamification, peer discussions, peer-reviewing, online tests.

Table 2: The SGs course plan.

During the storyboard phase, the progression of the course was planned. The ways how gamification (defined as *"using game design elements in non-game contexts"* (see Deterding et al., 2011)) can be used to motivate students. One gamified element was proceeding in LMS from level to level (see Fig. 3). Each level included a certain assignment to complete before proceeding to the next level. Social interaction was emphasised during the course via peer discussions included in the assignments. The delivery of the course was both synchronous and asynchronous. At first, the timetable for proceeding from level to level was set, but it was considered to limit the students. Thus it was possible to proceed at one's own pace but via the level structure of the course, the social interaction was ensured.

4.3 Content of the Course

The course content was selected so that students with a limited background in and knowledge of games could participate. The learning material covered videos, PowerPoint presentations with audio, web pages, and scientific and popular articles. The course could be studied independently, online, within the assigned timeframe, and the tasks required collaboration with peer students. The assignments consisted of group discussions, playing games, a competence test, a game evaluation, and an assignment where students brainstormed their own SGs. A literature research task was added to the final implementation. The basic course structure with levels is illustrated in Figure 3.

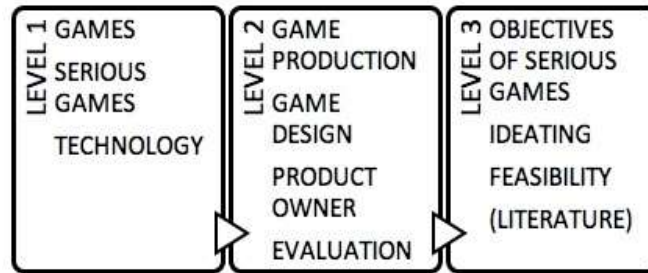


Figure 3: Basic Structure of the Planned E-learning Course on SGs.

Level 1 started with the definition of general terms related to games, gamification, and SGs. After the completion of an assignment at level 1, level 2 opened automatically. This part of the course consisted of deeper information about games, such as genres, different types of SGs, and game design and production, as well as how to act as a product owner or client in a SG project. In level 3, the content was more oriented toward SGs, especially regarding attitudes and motivation.

4.4 Iterative Course Development: Implementation, Observation, and Reflection

The course was built to the Moodle LMS and it proceeded from level to level according our storyboard. Some parts, like visual layout, were not possible to realise in the Moodle. The total study period was planned to be 2.5 months for 3 ECTS (European Credit Transfer and Accumulation System), which equates 81 hours of HE students' work. The teachers' role was active at the beginning, in the middle, and at the end of the course. Before releasing the course, feedback was given by colleagues, and some changes were made.

The course had three implementations with observation and reflection phases. The first implementation of the course in Finnish was realised as open online studies during summer 2016. A part of the material was delivered in English. The professional backgrounds of 21 enrolled students varied greatly. Among participants, there were, for example, nursing, healthcare and sports students, librarians, IT specialists, teachers, and physiotherapists. Eight

of the students completed the course on time (38%, see Fig. 5), and 15 of them gave feedback, which is described in Table 3.

The second implementation of the course was realised between autumn 2016 and winter 2017 on a new learning platform, a Moodle-based LMS, especially designed to serve open education and cross-institutional studies. This course was targeted to a multidisciplinary audience. In total, 28 participants signed up, and 25 of them completed the course (89%, see Fig. 5).

Implemen- tation of the open online course on SGs (ECTS)	Parti- cipants enrol- led (no.)	Participants that finished the course/ passed (%)	Positive feedback	Critical feedback and suggestions
Summer 2016, (3 ECTS)	21	38%	Peer discussions Positive attitude towards gaming Finding new interesting games to play Clear and beneficial assignments	Communication Outlook of the course Need for more teacher support Activating interventions Clearer and approachable materials
Autumn 2016 – Winter 2017 (3 ECTS)	28	89%	Course content	More material in Finnish. Better timetabling of assignments A chat channel for real-time peer communication The removal of technical problems
Summer 2017 (local language) (5 ECTS)	156	29.5%	Suitable for studying SGs The assignments were considered useful and helpful Peer work	Guided tutorial More feedback from the teachers Peer work Gamified tools (collecting coins)
Summer 2017 (English) (5 ECTS)	102	11.8%	Suitable for studying SGs	Clearer information about assignments Help in technical issues

Table 3: SGs course implementations during 2016-2017.

Table 3 sums up the main feedback from the course. The course was stated to be suitable for studying SGs and the positive attitude related to gaming was mentioned as one positive remark.

Students needed more clearer instructions in some assignments, better or free timetable of assignments, and reported technical problems specially at the beginning of the course. Teacher's presence was wished (activating interventions, feedback, support) even when it had been stated that the course was independently studied on-line course. Peer discussions were seen both as positive and negative issue.

A few game companies were interviewed and their viewpoint regarding the content required to educate adequate SG experts were asked. Certain main categories emerged from companies' responses: game technology; business-related topics, such as budgeting, sales, and marketing; service design; and understanding the entire nature of game development, which involves multidisciplinary teamwork. The course was refined to bring closer subject area and game development experts.

The third implementation (see Fig. 4) took place during summer 2017, one course in Finnish and one in English. The course was designed as a self-learning, online course, and it was upgraded to 5 ECTS. It was refined based on the feedback given by former course students, especially related to timetabling and technical problems. A chat for peer communication was also created. Besides the existing level structure, new tools for gamification were added: a progress bar that showed the activity completion, a top active student list and a stash that meant collectable coins (six) hidden in the course area.

Basics of Serious Games (5 ects) - independent studies

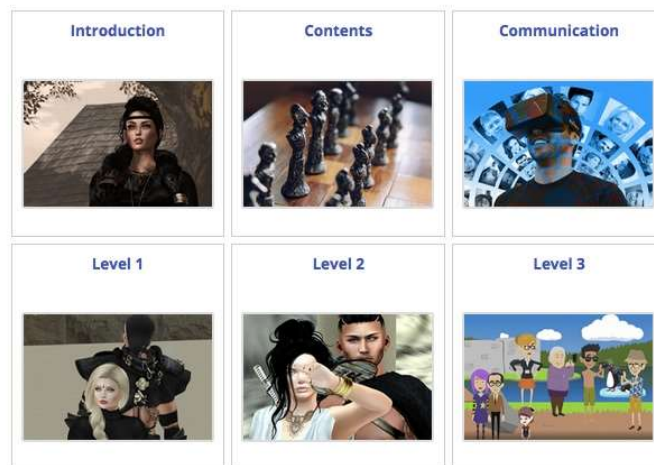


Figure 4: Final course on new LMS (part of the user interface).

In total, 156 participants signed up to participate in the course in Finnish, and 46 (29.5%) of them completed the course (see Fig. 5). As well, 102 students joined the English course, and 12 (11.8%) of them finished with an accepted grade. Some of the students signed up to take both of courses and completed only one of them. Because courses were offered freely in national level for HE or professionals without any fee as summer studies, the interruption rate was quite high. Table 3 describes the main feedback.

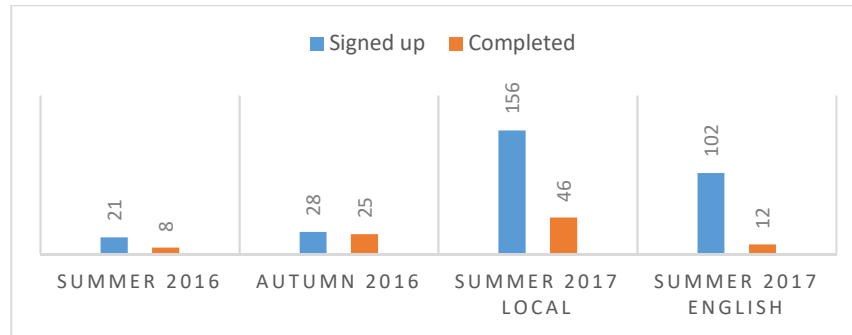


Figure 5: Participants, that signed up and completed SGs courses in 2016-17.

5 Discussion and Conclusions

The purpose of the study was to identify how to build an e-learning course on SGs for multidisciplinary students. Earlier knowledge revealed the need for experience in several disciplines, including understanding behavioural (Baranowski et al., 2013), pedagogical (Durairaj & Umar, 2015; Shaikh et al., 2017), and expertise (Kemppainen et al., 2014) -related aspects. Additional challenges were related to the online environment (see Gomez et al., 2010) and using two languages.

To answer the main research question related to developing an e-learning course and to identify a way to educate multidisciplinary audiences about SGs, an action research project was initiated. The solution was sought by first analysing state-of-the-art knowledge and then planning the course. After that, content for the course was defined, and finally, an iterative approach was applied in the development of the three implementations.

Social constructivism theory was used as a pedagogical approach in designing an e-learning course on SGs. The social interactions and dialogue between students were based on peer discussions and chats. Knowledge construction in a social setting was one of the main ideas of the course, and crowdsourcing was used by taking advantage of the multidisciplinary knowledge of the students. Social constructivism theory emphasises the importance of feedback, and in this course, the feedback method was peer feedback. The idea of intentional learning was the basis in planning the independent conduct of the course (Durairaj & Umar, 2015; Shaikh et al., 2017).

The heterogeneous student group online brought up new challenges for the content: different backgrounds and starting levels on the topic of SGs had to be considered. This gap was covered by maintaining joint interest and goals in learning (see Shaikh et al., 2017).

The feedback from students revealed that the discussions were considered fruitful, though some activating interventions were proposed. Positive attitude changes toward gaming were reported. Assignments and material received mixed feedback: some of the students felt they were clear and beneficial, while some needed more structured content and help with assignments. A teacher's presence, such as for support, communication, and feedback, was

expected, even though the courses were noted to be studied independently. These findings support the suggestions of Yunus and Salim (2008).

As a summary, the study revealed nine attention points:

1. Carpe Diem method (Salmon et al., 2014) supports multidisciplinary work in planning an online course.
2. The schedule in online course must be set but not too tight. An asynchronous model for online courses gives students more freedom (see also Durairaj & Umar, 2015).
3. Assignments and timetables have to be as clear as possible.
4. Peer discussions are an important part of e-learning, and they support social constructivism theory (Durairaj & Umar, 2015; Shaikh et al., 2017; Marsh & Ketterer, 2005). Enabling chat supports discussions.
5. Peer evaluation does not replace the feedback and presence of a teacher. Using too much peer work can be seen as forced.
6. Students who are more advanced in the topic can utilise their expertise in discussions and propose new ideas and materials to their peers.
7. Gamification integrated into course structure, such as levels and a progress bar, can be considered motivating, if they work well. Gamification without connection to course structure (e.g. collecting coins) can be seen as irritating.
8. Even in an independent online course, a teacher is needed: to help with technical issues, to clarify assignments if needed, and to activate discussions (see Tait, 2014).
9. The iterative development and incremental improvement of an online course according to feedback is a good approach (see Fig. 6).

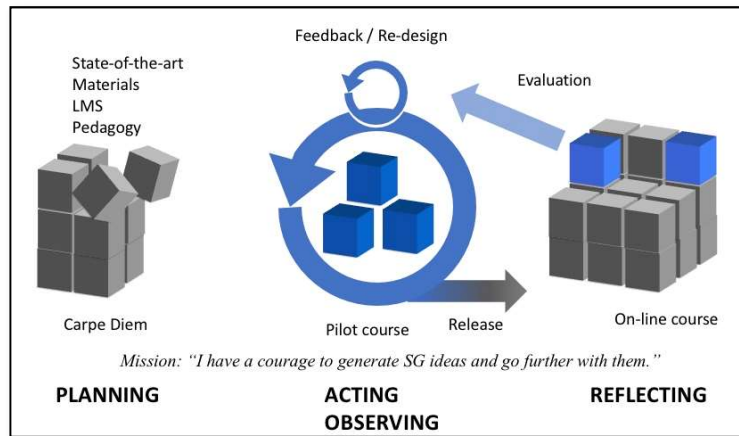


Figure 6: Phases in action research study on developing an e-learning course on SGs.

The current work continues within the multidisciplinary education on SGs. One expansion will be courses targeted to specific professional areas, such as nursing and healthcare. In these holistic courses on SGs, the developed online course will work as a background material, and it will be completed with hands-on SG prototyping workshops.

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