eSIGNALS RESEARCH

Haaga-Helia

Article

Building a pedagogical model for learning applied games design in UAS

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Abstract: There is a need to improve Finnish applied games design skills and come up with pedagogical models that are suitable for teaching applied games design in Finnish Universities of Applied Sciences. The Finnish game industry is booming, and applied games and gamified applications provide an additional boost for the industry. They will also benefit Finnish companies and help tackle some of the important global issues we are facing today, such as sustainability and digitalization. However, learning applied games design requires a much wider skillset than entertainment games. In our research, we attempt to tackle the need for a broad pedagogical approach by looking at phenomenon-based and project-based pedagogy to learn applied games design skills. We also concretized the learning process by utilizing service design methods and tools in pilot projects. Our research questions are: What kind of pedagogy supports the learning of applied games design concepts and prototypes in UAS? Which methods and tools deliver desirable learning outcomes in applied game design in UAS? The first part of the paper examines the foundations of the pedagogical model for learning applied games design in UAS based on a literary review of similar projects and academic writings on applied games. The second part focuses on assessing two sets of pilot projects where the learning model and tools were utilized with multidisciplinary student teams focusing on health care and welfare client projects. We collected two sets of quantitative data: twelve student team service design tool evaluations and 88 student feedback forms assessing their learning process and outcomes after taking the course. The results were all-around encouraging: all twelve student teams successfully utilized service design tools to create an implementable applied games concept and prototype for a client company. The clients were very satisfied with the results and many of them will continue the concept further into a finished applied game together with participating applied games companies. Student feedback was also highly positive, both towards the chosen pedagogical approaches and the service design tools used in learning applied games concept design. The set of service design tools used was also iterated in between the two courses to take in student feedback. The research indicates that there is a need for a specific learning model and tools for applied games design and that the chosen approach can be pursued further both in terms of new research and more pilot projects with client companies. This research paper is part or Luo Hype – Creative skills from applied games project, funded by the European Social Fund (ESF).

Keywords: applied games, gamification, applied games pedagogy, service design tools, educational games, game design, curricula, pedagogical planning.

Citation: Mäkeläinen, J. & Loijas, J. (2022). Building a pedagogical model for learning applied games design in UAS. *eSignals Research, 3*(2). http://urn.fi/URN:NBN:fi-fe2022121672061

Published online: 16.12.2022

1. INTRODUCTION

Universities of Applied Sciences (UAS) have a major role in developing higher education pedagogy that can tackle some of the biggest problems facing us today. The aging population, over consumption, climate change and pandemic recovery are global problems, which require new methods of influencing people's opinions and everyday choices. Influencing human behavior is at the heart of gamification, so digitalization and the digital transition of sustainability offer a fertile ground for gamified solutions and applied games.

Applied games are an important future driver for the blooming Finnish game ecosystem. The Finnish game industry association Neogames (2018), sees that Finland has the opportunity to become a frontrunner in applied games. The Luo Hype – creative skills from applied games project, funded by the European Social Fund (ESF), is one of the steps taken to further this goal. The two-year project is coordinated by Haaga-Helia University of Applied Sciences in cooperation with Tampere University of Applied Sciences' Games Academy. Its main focus is on looking at pedagogical models that suits the learning of applied games design in multidisciplinary teams. From this pedagogical model stems a design thinking based project model and tools for executing applied games concepts and prototypes for any industry or gamification process. The learning model is designed and iterated by the Haaga-Helia's project team using design thinking and service design tools as its core ideology.

The pedagogical framework of the proposed applied games design process is set in phenomenon-based learning and project-based learning. According to Silander (2015), phenomenon-based learning stems from constructivism, where learners are active builders of knowledge and new information is constructed from problem-solving. The holistic real-world phenomena assist learning when they are studied in their real context with boundaries between subjects crossing freely. Markham (2011) describes project-based learning as a way to integrate knowing and doing. Students learn by solving real-life problems and producing results that matter. The focus is on the students' collaborative experience, which helps to foster creativity, empathy, and resiliency. This led us to examine design thinking and service design tools as ways to master the project-based learning objectives.

The first part of the paper examines the foundations of the pedagogical model for learning applied games design in UAS based on a literary review of similar projects and academic writings on applied games. The second part focuses on assessing two sets of pilot projects where the learning model and tools were utilized with multidisciplinary student teams focusing on health care and welfare client projects.

2. AIM OF THE STUDY

The Luo Hype project aims to boost the Finnish applied games competence by developing a pedagogical model for learning applied games design and prototyping in UAS, and creating a design thinking based set of methods and tools to design applied games concepts with client companies in multidisciplinary student teams. The main hypothesis of the research work is that improving the learning of the applied games design stems from a wide understanding of game design, business development and service design methods and tools. Applied games are designed to influence human behavior, so to fully understand the needs of the end user, an interdisciplinary approach to the game concept design is needed. This means widespread cooperation, not just between education providers, but also between companies and communities operating around applied games.

When doing background research for the project, we discovered that most Finnish applied games projects were solely focusing on the process of making applied games, not so much on the theoretical and pedagogical methods behind it. Many projects use different versions of the Design Sprint by Knapp, Kowitz, and Zeratsky (2016), which is a service design based agile method for simplifying the design process to its core, first used at Google Ventures. By conducting a literary review of Finnish research projects around applied games,

we concluded that making applied games is especially difficult because of the sheer number of viewpoints you have to consider. This is also why many applied games projects have failed to reach their full potential. However, not many attempts have been made to look at the pedagogical models that would tackle these issues and to create a set of service design based methods and tools to assist the learning process of designing applied games. All in all, we found very few projects that had been utilizing extensively service design tools and methods to learning applied games design.

The research questions of the Luo Hype project are:

- What kind of pedagogy supports the learning of applied games design concepts and prototypes in UAS?
- Which practical methods and tools deliver desirable learning outcomes in applied game design in UAS?

3. METHODOLOGY

To improve the teaching of applied games design in Finnish UASs, we approached the pedagogical issues with the design-based research (DBR) method. Wang & Hannafin (2005) describes the method best suited for improving educational practices with a systematic, flexible and iterative review, analysis, design, development and implementation. It is based on collaboration between researches and practitioners in real-life surrounding, leading to common design principles or theories. It is used extensively to design pedagogical models with the overall aim to build a strong connection between a real-world problem and research (Amiel & Reeves, 2008; Wang & Hannafin, 2005).

A literature review on current academic writing around phenomenon and project based learning and applied games development was reinforced by ongoing conversations with Finnish applied games companies and academics, as well as practicing service designers. The need for a holistic approach to learning applied games design led us to frame our model on phenomenon and project based learning, design thinking and service design tools. We also utilized Concept-Knowledge (C-K) design theory, Self-Determination Theory (SDT) and Flow theory.

The pedagogical model for learning applied games design was tested in Autumn 2021 and in Spring 2022 by two sets of six multidisciplinary higher education student groups, consisting of marketing students from Haaga-Helia, nursing students from TAMK and game design studies interns from TAMK Games Academy. Health care sector was chosen because gamification and applied games can have a great potential in helping people to live healthier and fuller lives. On both rounds, a slightly different set of service design tools was tested for their suitability to the applied game design process. Both quantitative and qualitative research methods were used to assess how well the service design tools fitted their purpose. After completing their applied games concept and prototype, all six participating student groups graded the service design tools from 1-5 (1 being least useful and 5 being most useful). After the first round, we collected the results and iterated the learning tools according to the feedback. We repeated the process for the second group and after these two iterations we were able to present a preliminary model for learning applied games design.

To evaluate the learning process in multidisciplinary student teams, we used a structured questionnaire, which is common to all European social fund funder

RDI projects. All 88 participating students filled in the questionnaire to evaluate the success of the chosen pedagogical approach as well as their views on how the course has benefitted their career options. There were twelve questions in total, each answer graded from 1-5 (5 being the highest score). We also gathered qualitative feedback from the students as well as the client companies after each course to assess the usefulness of the pedagogical model and its applicability to client projects. The first findings of these pilots are discussed in this paper.

4. THEORETICAL FRAMEWORK

Two key terms used in this paper are gamification and applied games. Gamification is widely defined as 'the use of game design elements in nongame contexts' (Deterding et al., 2011), or in the context of service marketing, 'a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation' (Huotari and Hamari, 2012).

Applied games are also referred to as serious games to distinguish them from purely entertainment games. We are using the term 'applied games', as it highlights the fact that the game is always applied to a company, organization or business sector. Michael and Chen (2006) define applied games as 'games that do not have entertainment, enjoyment, or fun as their primary purpose'. Several scholars have argued that a definition based on design objectives is problematic (Laamarti et al. 2014). A more specific definition is offered by Marsh (2011), who defines serious games as 'digital games, simulations, virtual environments and mixed reality/media that provide opportunities to engage in activities through responsive narrative/story, gameplay or encounters to inform, influence, for well-being, and/or experience to convey meaning'.

Viudes-Carbonell et al. (2021) evaluated many of the key frameworks and methodologies used to design applied games. The most important thing is to start designing as small as possible, which follows the design sprint ideology of first ideating the MVP (minimum viable product). He emphasized the need for rapid prototyping, testing and redesign as iterations tend to correlate with the quality of the end product. If the design cycle starts very small, more prototyping iterations can be conducted. Braad et al. (2016) also place special emphasis on end user understanding, motivation, flow and learning environments. Different types of design sprints are widely used in game jams and rapid game design challenges as an iterative design model fits well with the game development process and provides a solid foundation for exploring the different phases of the game development process.

Concept knowledge (C-K theory) theory has also played an important part in framing the pedagogical model for designing applied games. The C-K design theory introduced by Hatchuel and Weil (2003) addresses the innovation process and helps us understand how new concepts are developed within the spaces of concepts and knowledge. It emphasizes the co-expansion of these two spaces. Knowledge offers the potential seeds for innovation in the design process, where various design iterations form new knowledge. A design square is formed by the interdependencies between the concept and knowledge during the design process. An innovation can be born in either space, but for it to be effectively developed, it needs both parts.

We shaped our learning process on the double diamond service design model, introduced by the Design Council in 2007. The model consists of four design stages: discover, define, develop and deliver. Later the Design Council developed

the model further by adding the idea of system-shifting design, which discusses merging systems and design thinking to address the complexity, interconnectedness and need to design for system change (Design Council 2021).

The service design ideology is implemented through the use of various service design tools. In this project, we used two sets of Creative Commons licensed service design canvases, one from Haaga-Helia's Lab8 service design laboratory and one from Futurice's Lean Service Creation tools. Both tool sets had a different approach utilizing the service design tools, Futurice's set being much more business-focused.

Additionally, the team utilized online games design materials and tools, such as the WikiHow (2022) document How to design a video game, co-written online by 149 indie game developers. The game design process also followed Hunicke et al. (2004) MDA (standing for Mechanics, Dynamics, and Aesthetics) framework of dichotomy between designers and players used to define how mechanics, dynamics and aesthetics of the game influence the player experience.

When designing serious games, Braad et al. (2016) put special emphasis on end user understanding, motivation, flow and learning environments. In terms of motivation, we looked closely at Cook and Artino's (2016) Self-Determination Theory (SDT), which addresses the different factors of human motivation and personality. The theory describes the roles of intrinsic and extrinsic motivation in cognitive and social development, which are both elemental in designing applied games. Csikszentmihalyi (1990) was one of the first to address flow as an experience that is influenced by the person's interests, control and focused attention when performing a task. Flow theory looks at the balance between the challenge and the user's skills to find an optimal balance. This is vital in applied games because if the game is too easy, it leads to boredom, if it is too difficult, it leads to anxiety. Both usually result in the player dropping out quickly.

The developed model consists of three horizontal viewpoints to learning applied games design: business, gamification and end users. This ensures that none of these vital viewpoints are overlooked during the design process. The model also consists of five stages: four from the double diamond model and a fifth stage to address the need for disseminating the initial game concept idea to stakeholders who can help it become a published game. At this stage, monetization of the game concept becomes the key focus and development is carried out together with the client company and small applied games companies. The tools and methods used in each phase are also included in the model, as are the deliverables.

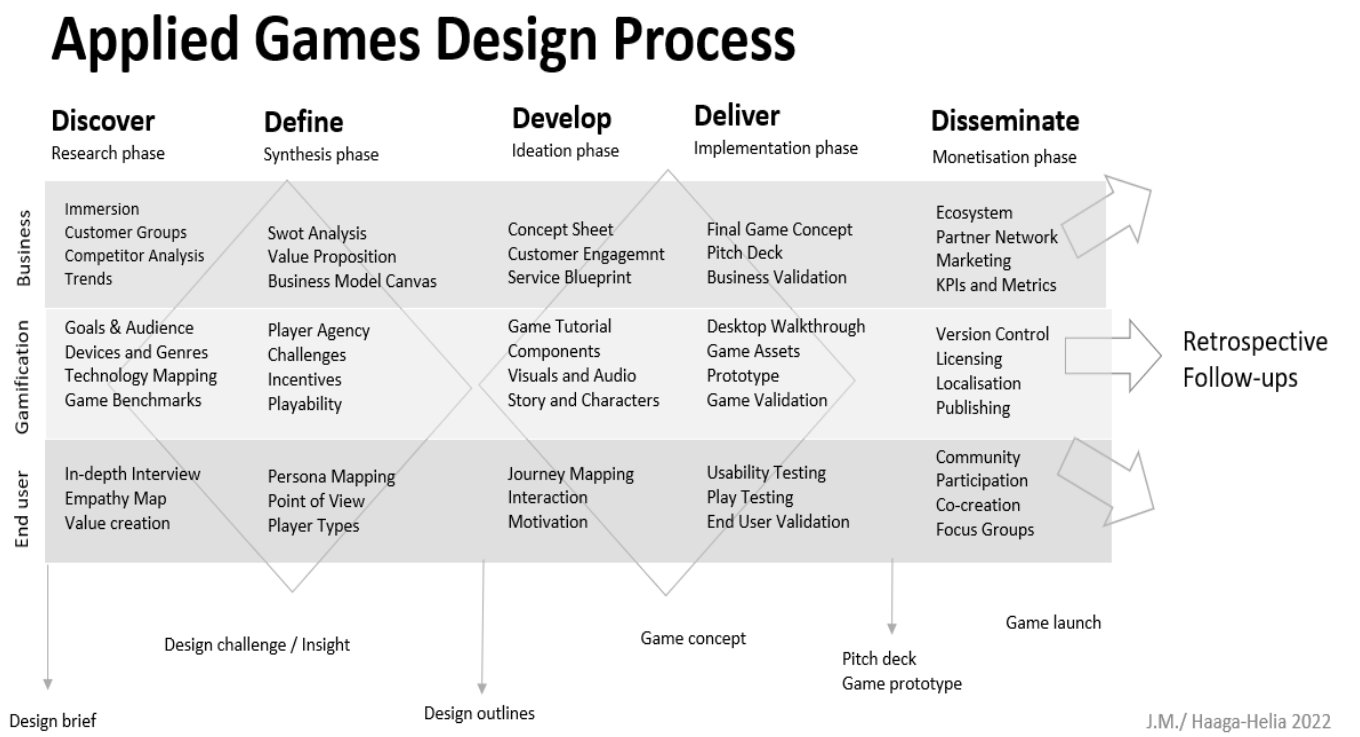

Figure 1: Proposed model for learning applied games design

5. RESULTS AND FINDINGS

In September 2021, the first set of students began working in six groups, each with their own health care related client project. The student teams had 16 working weeks to complete the design task. The clients, chosen by Haaga-Helia's and TAMK's project team, were The Finnish National Opera and Ballet, BabyTrail parenthood game, eXerium XR game chair, Gymrail home gym, Premius XR rehabilitation and TAMK with patient needle anxiety. Each student team had a briefing session and debriefing meetings with the client. The students also interviewed applied games companies, end users and other significant stakeholders. During the project, each team made a game concept, a pitch deck and an applied game prototype using service design tools and canvases. During the design process they had feedback from the clients, games professionals, game interns, health care students and coaches. The multidisciplinary student project covered stages 1-4 of the design model (see figure 1). Also several projects were developed further for the dissemination phase together with participating applied games companies. As a part of their design tasks, the students also rated each design tool they used. This allowed the project team to assess, which tools were most useful and to revise the design model for the second pilot round taking place in Spring 2022.

The second batch began in January 2022 with again six student groups. The pedagogical methods proved to work, so no major iterations were done on the design model or its underlying pedagogical choices. However, some of the service design tools were changed and also we took out some of the least useful tools to have fewer tools in total based on student feedback. In the second batch the clients were the Finnish National Opera and Ballet, the Rescue Department, TAMK's fire safety game, Exerium XR Game Chair in Special eSports and Huoma and Surunauha organisations.

results of the two applied games design courses were all-around encouraging. Each student team got excellent feedback from the client companies, and several applied games concepts have been developed further by clients and participating applied games companies. Also the student feedback has been exceptionally positive. Open feedback gathered from the students praised the versatility of the course, the steep learning curve, as well as cooperation with multidisciplinary teams and real client cases. Also the coaches saw clear benefits in a methodological approach to the design process, utilizing service design tools, designing applied games in multidisciplinary teams and using project-based learning methods.

As part of Haaga-Helia's marketing students' course assignments, the students rated each service design tool they used during the applied games design process from 1-5; 1 meaning the least useful, 5 the most useful. This allowed the project team to revise the design model for the second pilot round. The average score in the first round was 3.6/5 and in the second round 3.5/5.

Service design tool assessment			
Autumn 2021	**Average**	**Spring** 2022	**Average**
Research phase		Research phase	
Immersion	4.3	Immersion	4
Customer Groups	3.5	Customer Groups	4
Business Model Canvas	4.2	Competitor Analysis	3.6
Competitor Analysis	4.3	Trends	3.3
Trends	3.6	Goals & audience	2.9
Business Objective	2.8	Devices & Genres	3
Goals & audience	4.8	Technology Mapping	2.4
Devices & Genres	4	Game Benchmarks	4.3
Value creation	3.7	Interview	5
Game benchmarks	3.7	Empathy Map	4.6
Interview	4.1	Value Creation	3.4
Empathy Map	4.5		
Experience Tour	4		
Synthesis phase		Synthesis phase	
SWOT Analysis	4.1	SWOT Analysis	4.3
Business Model	2.7	Value Proposition	3.5
Value Proposition	3.6	Business Model Canvas	4.3
How Might We	2.4	Player Agency	3.3
Player Agency	4	Challenges	2.8
Challenges	4	Incentives	2.5
Incentives	4.5	Playability	2.3
Playability	3.8	Persona Mapping	4.5
Persona Mapping	4.3	Point of View	3.3
Point of View	3.2	Player Types	3.2
Player types	2.9		

Ideation phase		Ideation phase	
SCAMPER	2.7	Concept Sheet	4.1
Impact Optimizer	2.4	Customer Engagement	2.9
Concept Sheet	4.2	Service Blueprint	3
Concept Evaluation	3	Game Tutorial	3.8
Game Scenarios	4	Components	3.8
Components	4.3	Visuals and Audio	3.9
Visuals and Audio	4.3	Story and Characters	2.8
Story and Characters	4	Motivation	3.2
Journey Mapping	3.6	Scenarios	3.3
Role Playing	2		
Interaction	2.7		
Motivation	3.3		
Total	3.6		3.5

Table 1: Team assessments of service design tools used in applied games projects, n=12.

The most interesting result from the service design tool assessment was that the score varied substantially depending on the client project. For some groups some tools were very useful, while others found them less suitable in their project. Therefore it is very difficult to put together a conclusive set of tools that would be useful for every project. In the second round we also had one client case that was more a social media campaign than an applied game project, which led the team to give low scores for tools that were taken onboard with applied games in mind. This reflects the width of different viewpoints we have to consider when designing applied games. Another issue with the service design tools was that we were using two different tool sets: one was Haaga-Helia's Lab8 toolset and the other one Futurice's Lean Service Creation tools. Both toolsets have their own logic and initial purpose, so combining them and applying them to a new use sometimes proved difficult. One clear finding from this project is that service design tools can be used effectively to design applied games concepts and prototypes, but the whole industry would benefit from a dedicated set of service design tools for applied games that would combine their best features with the applied games design features.

In addition to assessing the usefulness of the service design tools, we also gathered data from the students about the learning outcomes and the usefulness of the course in their chosen study track. This structured questionnaire was filled in by all students participating in the course, 88 in total. There were twelve questions on a scale from 1-5, 1 being 'completely disagree' and 5 being 'completely agree'. The questions are standard for all ESF funded projects.

The weighted average score from the learning outcome assessment 3.96/5, which can be seen as a very good result for an experimental course still testing the tools and methods during the course. The highest scores were given to the positive learning environment and the expertise of the training provider, although all scores were very similar. The results indicate that the pedagogical model developed in the project is able to support students' learning outcomes and improve their professional skills.

Learning outcomes assessment						
n. 88 students	1	2	3	4	5	WA
The flexible and individual study path provided by the training has enhanced my learning.	0	9	19	31	27	3.86
The support and guidance provided during the training have enhanced my learning.	1	8	14	36	29	3.95
I find that the learning methods used in the training have increased my ability to respond to the changed needs of the labour market.	0	3	22	31	32	3.99
Based on my estimation, my possibilities for finding employment or continuing at work have improved as a result of the training/development measure.	1	8	22	40	17	3.73
I find that the training arrangements have been well-suited to my life situation and supported my learning.	1	8	18	29	32	3.94
I find that the physical environment of the training and the learning materials were of high quality and enhanced my learning.	2	3	20	36	27	3.94
I find that the good and functional connections to the labour market of the provider of the training have enhanced my learning.	1	4	22	37	24	3.90
I find that the expertise of the training provider responded to the objectives of the training and enhanced my learning.	2	4	16	34	32	4.02
According to my estimate, my professional competence has improved as a result of the training/development measure.	0	3	15	51	19	3.98
I find that my personal competence responds better to the changing needs of the labour market now, after the training / development measure.	0	7	15	46	20	3.90
I find that my professional self-confidence (or jobseeking motivation) has improved as a result of the training.	1	9	19	37	22	3.80
I find that the learning environment of the training was positive and supportive and enhanced my learning.	0	0	9	27	52	4.49
	Weighted average, total					3.96

Table 2: Individual learning outcome assessments from participating students. N=88.

6. DISCUSSION AND CONCLUSIONS

There is an ongoing debate on whether gamification works or yields positive results. Hamari et al. (2014) suggest that while the level of success when applying gamification methods varies, as a method gamification works, and in majority of cases, yields positive results. The most prominent factors that influence the outcome are the context being gamified and the qualities of users. Hamari's observations have been reinforced during the Luo Hype project, where we have successfully tested and piloted pedagogical models for learning applied games design.

To answer our main research question: What kind of pedagogy supports the learning of applied games design concepts and prototypes in UAS? Which methods and tools deliver desirable learning outcomes in applied game design in

UAS? Grounding the pedagogy on phenomenon and project based learning has resulted in positive outcomes for all interest groups; teachers, students and client companies. The main benefit of service design methods and tools can be seen in the level of end-user understanding reached in the projects. Each game concept was firmly based on understanding acquired by interviewing end users and other stakeholders. The students also leaned to assess when to design an applied game and when to use gamified elements. This is an important distinction when considering the end user's motivation. In one particular case, students redesigned a game into a gamified app as this serviced the purpose much better. They also learned to address available technologies critically and to design user first, not technology first. Critical evaluation of requirements and technological possibilities is a key skill in any field.

The scope of the pilot was very narrow, consisting just 12 multidisciplinary student teams designing applied games for one industry. However, the client cases were very different form one another, so the pedagogical model and tools were tested in a diverse environment. Each client case was very different and required quite specific design thinking, which is typical to applied games, but makes choosing tools very difficult. One of the main hindrances was the lack of specific canvases for designing applied games. Using fit-for-all service design tools sometimes confused the students and derailed their line of thinking.

Even if most of the students will not end up working in applied games companies, learning to design applied games and gamified applications will undoubtedly be an important asset in the future. Sustainability issues and digitalization any industry or process offer ample opportunities for applied games or gamification. Gamification will also be one of the cornerstones of the approaching metaverse. There is much to be gained from pursuing to develop applied games design methods further. More research is also needed to assess and influence the underlying motivational factors behind human behavior that applied games are attempting to alter.

REFERENCES

Amiel, T., & Reeves, T. C. (2008). Design-based research and educational technology: Rethinking technology and the research agenda. In *Educational Technology & Society, 11*(4), 29–40.

Braad, E., Žavcer, G., & Sandovar, A. (2016). *Processes and models for serious game design and development* in R. Dörner, S. Göbel, M. Kickmeier-Rust, M. Masuch, & K. Zweig (Eds.), *Entertainment computing and serious games* (pp. 92-118). Springer. https://doi.org/10.1007/978-3-319-46152-6_5

Cook, D. & Artino, A. (2016). Motivation to learn: an overview of contemporary theories. *Medical Education 50* (10), pp 997–1014. https://doi.org/10.1111/medu.13074

Csikszentmihalyi, M. (1990). *Flow: the psychology of optimal experience*. New York: Harper Collins. https://doi.org/10.1080/00222216.1992.11969876

Design Council UK (2007). *11 Lessons: managing design in eleven global brands*. London: Design Council. Retrieved from: https://www.designcouncil.org.uk/our-work/skills-learning/resources/11-lessons-managing-design-global-brands/

Design Council UK (2021). Systems-shifting design report. London: Design Council. Retrieved from: https://www.designcouncil.org.uk/our-work/skills-learning/resources/download-our-systems-shifting-design-report-1/

Deterding, S., Dixon, D., Khaled, R., et al. (2011). *From game design elements to gamefulness: Defining gamification*. Paper presented at the proceedings of the 15th international Academic MindTrek Conference: Envisioning Future Media Environments (pp. 9–15), Tampere, Finland, September 28–30, 2011. https://doi.org/10.1145/2181037.2181040

Hatchuel, A. & Weil, B. (2003). A *new approach of innovative design: an introduction to C-K theory*. Paper presented at the proceedings of the International conference on engineering design, Stockholm, August 19–21, 2003.

Hamari, J., Koivisto, J., & Sarsa, H. (2014). *Does Gamification Work? – A Literature Review of Empirical Studies on Gamification*. Paper presented at the proceedings of the 47th Hawaii International Conference on System Sciences, Hawaii, USA, January 6-9, 2014. https://doi.org/10.1109/HICSS.2014.377

How to design a video game. WikiHow (n.d.). Retrieved from: https://www.wikihow.com/Design-a-Video-Game

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A Formal Approach to Game Design and Game Research, *Work. Challenges Game AI*, pp. 1–4, 2004.

Huotari, K., & Hamari, J. (2012). *Defining gamification – a service marketing perspective*. Paper presented at the proceedings of the 16th International Academic MindTrek Conference (pp. 17–22), Tampere, Finland, 3–5 October, 2012. https://doi.org/10.1145/2393132.2393137

Knapp,J., Kowitz, B., & Zeratsky, J. (2016). *Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days*. Simon & Schuster.
Laamaarti, F., Eid, M. & El Saddik, A. (2014). An Overview of Serious Games. *International Journal of Computer Games Technology*, October 2014. https://doi.org/10.1155/2014/358152

Markham, T. (2011). Project Based Learning. In *Teacher Librarian*, 39(2), 38-42.
Marsh, T. (2011). Serious games continuum: Between games for purpose and experiential environments for purpose. *Entertainment Computing 2*, pp. 61–68. https://doi.org/10.1016/j.entcom.2010.12.004

Michael, D. & Chen, S. (2006). *Serious games: Games that educate, train, and inform*. Boston, MA.: Thomson Course Technology.
Neogames (2018). Pelialan politiikkasuositukset vuosille 2019-2024. Retrieved from http://www.neogames.fi/wp-content/uploads/2018/11/Pelialan-politiikkasuositukset-vuosille-2019-2024.pdf

Silander, P. (2015). Digital Pedagogy. In P. Mattila, & P. Silander (Eds.) How to create the school of the future: Revolutionary thinking and design from Finland (pp. 9-26). University of Oulu, Center for Internet Excellence, Oulu. https://www.finpeda.fi/wp-content/uploads/2019/02/How-to-Create-the-School-of-the-Future_book.pdf

Viudes-Carbonell S.J., Gallego-Durán F.J., Llorens-Largo F. & Molina-Carmona R. Towards an Iterative Design for Serious Games. *Sustainability*. 2021; 13(6): 3290. https://doi.org/10.3390/su13063290

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments in *Educational Technology Research and Development*, 53(4), 5–23. https://doi.org/10.1007/BF02504682