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Development of an online concept for the use of the serious game EDIPS[2]

Abstract

Strategic thinking games development is an important topic in the modern world, and the digitalization wave also influences this movement. In this research paper, the possibilities of creating an online version of an educational game, called EDIPS2 (Edutainment for Designing Integrated Product-Service System), that requires communication, was researched and discussed. It is a German version of a serious game EDIPS, which was created by Shimomura Laboratory at the Department of System Design at Tokyo Metropolitan University. Its purpose is to promote strategic thinking and collaboration between experts in design and in business of product service systems (PSS) through playful online-entertainment.

Keywords

EDIPS, serious game, edutainment, digitalization, strategic thinking

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1 Introduction

Top performers are well equipped to meet the challenges of highly competitive pressure and increased market dynamics. However, they find it difficult to withstand cultural disruptions to their top performance. This is because they know too little about their capabilities. Mergers and acquisitions, for example, can destroy top performance. 'Those who do not know their treasures cannot defend them' (WOHLAND et al., 2004).

Hence, those who want to survive in today's market climate must always draw attention to themselves by presenting new and innovative concepts. Product-Service Systems (PSS) combine the products with service and therefore form the basis for a new business model. To make the concept a PSS provider clear, the Department of System Design at Tokyo Metropolitan University (TMU) has developed an educational business game called EDIPS: Edutainment for Designing Integrated Product-Service System.

In order to actively shape the digital transformation and due to this to use its opportunities as well as tackle its challenges the aim of this project work is to deliver a concept to transfer the analog board game EDIPS into the digital world. Even if the aspect of social interaction suffers from a digital game, the demand for digital board games has risen sharply, especially in recent years. A combination of different programs can make a computer version of the desired board game possible, even with simple means and without a deep knowledge of programming languages or game design. EDIPS[2] is no exception and can be converted into a digitally playable version using existing software. The use of free software is an important part of this and should be made accessible to everyone. The programs used for this work are therefore all freely accessible to students at the Technical University of Applied Sciences Würzburg-Schweinfurt.

2 Background of EDIPS[2]

EDIPS is grounded on several scientific theories, such as General System Theory (BERTALANFFY, 1968), Living Systems Theory (MILLER, 1977), and Principal-Agent Problem (BRUNNER, 1979). Game environment corresponds with the

definition of the open system and its parameters that include Interdependence, Non-summativity, Structure, Function, Evolution, Openness, Equifinality and Hierarchy (PACE, 2018, pp. 4–5). These parameters, or tenants, were written based on the work of Fisher, (1978) and General System Theorists (BERTALANFFY, 1968; BOULDING, 1956; RAPOPORT, 1986) (PACE, 2018, pp. 3–4).

Additionally, Adams et al., (2014) indicated that systems theory is a collection of specific statements that have been integrated to enhance our comprehension of systems. This leads to an improved experience with interpretation, which is of great importance for those working in system practice. Studies show that system theory has evolved over time to provide a variety of variance theories. However, the systems logic structure emphasizes the need to consider feedback mechanisms in order to identify causality mechanisms in social systems (FANG et al., 2018, p. 1306).

There are three research papers about EDIPS that were published by the creators of the game at TMU. These research papers explain in detail the development of EDIPS and the game itself along with the subsequent research that was conducted.

The first article shows the situation in Product-Service Systems in Japan and why it is an important topic today. One of the most important things mentioned there is the definition of "PSS design" and the steps that are needed to create one, which are Value Analysis, Embodiment, and Evaluation (SHIMOMURA et al., 2014). For a better understanding of PSS, several projects were developed and conducted, according to the defined steps. As a result, the authors found several problems that appeared when companies wanted to create a company as a PSS Provider or shift from Product Provider to PSS Provider. One of the issues companies encountered was transitioning to a mindset that was needed to design a PSS, especially for people who studied in a rather traditional engineering approach. The authors also stated that this was the reason why very few companies were changing their model to PSS. To help foster a better understanding of PSS design and in general the importance of PSS for the modern world the authors developed this game.

The second article is about board games, and it describes all the physical elements and rules that must be followed. To prove the effectiveness of EDIPS several workshops with students were conducted. Afterwards participants were asked to fill out an evaluation sheet that included questions from Figure 1 (UEI et al., 2014).

Numbers	Items
Q1:	Basic understanding of product life cycle
Q2:	Need to consider the compatibility between product and service
Q3:	Strategy selection based on features of own product/service and circumstances
Q4:	Importance of cooperation with others to enhance the value of products or services
Q5:	Free answer

Figure 1: Evaluation sheet (UEI et al., 2014)

According to the authors, all the questions were rated high, which led them to believe that "this game is an effective way to introduce PSS to designers who do not have much knowledge of PSS" (UEI et al., 2014). Furthermore, participants mentioned the importance of discussions and collaboration. Another important point for game development – discovered issues, which resulted in unwanted outcome. These issues were resolved in the next stage of game development, which is described below. Further research in the field of digitalization of the game was suggested as well.

The concluding article of Nemoto et al. (2014) was about the final version of EDIPS and showed research on different types of strategic thinking that needed to be used and the effectiveness of the game. In particular, the authors allocated 16 different types of strategic thinking from 3 different categories: product provider's view (P), service provider's view (S), and general view (G), which can be found in Figure 2 (NEMOTO et al., 2014). For evaluation, several workshops were conducted, and an open-answer questionnaire was given to participants before and after. Results showed that after playing the game, participants recognized the importance of partnership and cooperation, an important part of PSS psychology. Therefore, the game can be considered a proper part of education for PSS designers.

No.	Type of strategic thinking
P-1	Produce and sell products according to one's own resources and capabilities
P-2	Enter into different product fields to enhance business opportunities
P-3	Improve profits by increasing the price of one's own product
P-4	Produce and sell products considering market saturation
P-5	Produce products considering ecological constraint
P-6	Sell products considering their life cycle
P-7	Increase business efficiency by cooperation with a service provider
P-8	Add the ability to provide services by oneself
S-1	Develop services according to one's own resources and capabilities
S-2	Launch services to various fields
S-3	Invest to services considering conditions of the market and competitors
S-4	Launch services considering compatibility with products in the market
S-5	Increase competitiveness of their services by cooperation with a product provider
S-6	Add the ability to produce products by oneself
G-1	Prepare for any contingency
G-2	Conclude an alliance smoothly considering partner's needs

Figure 2: Types of Strategic Thinking (NEMOTO et al., 2014)

All these research papers suggested that further development of the game is needed, as the game has great potential for educational purposes. One of the issues is that the research was done in Japan. This meant EDIPS needed to be adapted for the German market, which was done by Prof. Dr. Panshef in a project work with students of the faculty for Business and Engineering at the Technical University of Applied Sciences Würzburg-Schweinfurt (THWS).

Essentially, EDIPS is a simplified version of the real product-service market, and therefore can be used as a training model for students, as well as companies' representatives. A person can gain an understanding of the processes on the product-ser-

vice market, strategies that can be used in different situations, as well as how the behavior of one company can influence the whole situation. Because of that, this game has already been used in the classroom at THWS, for instance as part of the Strategic Thinking course.

One of the biggest challenges the world is facing right now is the wave of digitalization (AMANKWAH-AMOAH et al., 2021), making the future of cooperation and collaboration unclear. More and more companies are establishing online or hybrid cooperation and this can lead to many changes. For instance, the first Paul Watzlawick's communication axiom says that "One cannot not communicate," which is about non-verbal collaboration (BENDER, 2018; PATRZEK, 2008). And a very important part of this type of communication is body language, as well as reactions and face expressions.

New network tools, such as apps and virtual platforms, provide more potential for cooperation and innovation within and across teams as technology develops (OMILION-HODGES & PTACEK, 2021). To extend the application of EDIPS, global use was required. Transferring the game online was necessary in order to research possibilities for globalization of the game, and also research the change in communication and decision making from a global point of view. As a result, the necessity for intercultural unification and the constant advancement of technology makes an online version of EDIPS[2] essential. This paper is the first step in further research of the adaptation of the game for online-teaching and online-training purposes.

3   State of the art

Extensive studies on learning through gamification have been conducted over many years. According to Wortley (2015), "the concept of using gameplay to train, educate and motivate is as old as humankind itself" (p. 45). There are many research papers about different types of games that can be used for learning. For example, the books Simulation and Serious Games for Education (CAI et al., 2017; SOURINA et al., 2015), from the book series, called Gaming Media and Social Effects.

There are many successful examples of games used for education. The Odyssey game (VAN DER MOLEN et al., 2017) is one example. This is an education game, created by students. It is based on the Odyssey by Homer, and it proved to be useful in schools for lessons on cultural history (VAN DER MOLEN et al., 2017). Another example is the simulator of heavy crane operations that was created to help with vocational trainings (CAI et al., 2017).

An example of the situational game, created to raise a safety awareness in people with professions that require many safety measures (for example, construction workers), is the game Play It Safe (WARTENA et al., 2015). The game simulates building a tower and protecting it from threats. However, it was designed to train situation awareness and consider the situation as a whole. This can help a person in real life to react and find the solution to problems faster (WARTENA et al., 2015, p. 24).

Another important book, with a similar focus to EDIPS, is Gamification for Innovators and Entrepreneurs (BREUER et al., 2022). It describes several games and their influences on the players. Every game in this book is assigned to the groups by the main characteristic it seeks to develop. Also, each game is described through methodology, purpose, gameplay, etc. (BREUER et al., 2022, pp. 87–91). One of the factors considered in each game is whether it is online or an offline game. The authors state that both online and offline methods have their advantages and disadvantages (BREUER et al., 2022, p. 88). An example of the game that was considered is Lego Serious Play, which is also well-known and has been in use for quite some time already. This game is used by organizations to "unleash the full potential of their people" (BREUER et al., 2022, p. 132).

The authors also mentioned games when used in the university with students, have a big potential to train the students for the work environment and reduce the needed training time in the beginning of a carrier (BREUER et al., 2022, p. 142).

Throughout the research much positive evidence of the teaching through the gamification was found, however there was no evidence of games that were transferred online from a board game. All the serious games that were discovered were either created as a computer or video game or only had a board game version. At the same time there were many examples of the general board or card games with an online version for example, Codenames (*Codenames*, 2023) or Monopoly (*Rento Fortune*, 2023). Online adaptation of such games is usually realized as a website, such as Ta-

bleTop Simulator version, or an application for the smartphone. No evidence of free software use was found.

4 Case study

In the research papers discussed above the case study method was used. To stay consistent with the original paper this research paper is based on, it was decided to use this method as well. In addition, further reasons supporting this decision are discussed in this chapter. According to the comparison between different research methods (YIN, 2018, p. 9), the most appropriate methods for this research are the method of experiment and the method of the case study. Yin in his work describes 4 case study designs: 2 for single-case studies, and 2 for multiple-case studies (YIN, 2018, pp. 39–40). This research uses one case used in project limits. Therefore single-case study designs are considered. As mentioned previoiusly, there are two types: holistic and embedded. Embedded case-study design has subunits and more complex structures, where several different analyses and approaches are needed. In comparison to holistic design, used for one case only, it analyzes one set of events (YIN, 2018, pp. 39–46). For that reason, the holistic case study design approach was used for this research.

The first step in the project was creating an online version of the game. An important consideration was to use online tools that are free for students of the THWS, so they are available for all students. Limited to only using free tools created a challenge as the game required the essential parts of collaboration and discussion. For example, the perfect solution for this problem would be to use a board game simulator or create a website that would combine all the needed functions. Those options require investments and often are not free. Therefore, it was decided to use a combination of different software: one to conduct the game online with the possibility of verbal communication, and another that would have all the game elements. The overview of the chosen options can be found in Table 1.

Table 1: Chosen tools

Tool Name	Purpose	Version	Source
Skype	Telecommunication computer software	8.81.0.268	www.skype.com
Zoom	Telecommunication computer software	5.10.1 (4420)	www.zoom.ua
Concept Board	Online whiteboard		www.conceptboard.com
Miro Board	Online whiteboard		www.miro.com

To choose the best variant, several rounds of workshops of 20 students of the THWS were conducted. At first, the game was played offline, so everybody could learn how to play it and what the game is about. After that, the games were conducted online, with different combinations: Zoom + Miro Board, Zoom + Concept Board, Skype + Miro Board, Skype + Concept Board, and just Zoom, using a special Miro Board function.

For evaluation of the different variants, the following evaluation criteria were used:

– Free access.

– Technical complexity.

– Easy to play.

– Element of uncertainty.

– Reusability.

– Similarity to the physical game.

After the first round of the online games, all participants were asked to complete a short questionnaire:

1. Did you have free access to the game? (Corresponds to the "Free to access" criteria)

2. Did you have technical issues during the game? (Corresponds to the "Technical complexity" criteria.)

3. Was it easy for you to play the game online? (Corresponds to the "Easy to play complexity" criteria.)

4. Did you feel a lot of difference in the gaming process between offline and online game sessions? (Corresponds to the "Similarity to the physical game" criteria.)

Aside from those questions, there were two additional factors that were evaluated by the research team: "Element of uncertainty" and "Reusability". As in the original game, uncertainty is an important part of the process (for example initial product prices and events) as it represents the real market's uncertainty. It was important to keep this in the online version. However, participants would not know which elements were changed or adapted, therefore evaluation was performed by the research team. "Reusability" stands for effort needed to conduct the next game (for example, how difficult is it to restack the cards or clear the board).

Each of those criteria was evaluated on a scale from 1 to 5, where 1 is the lowest or a negative grade and 5 is the highest or a positive grade. However, they do not have the same value. For example, participants cannot rate how easy it is to play the game if they do not have access to the game. Therefore, the research team came up with the weighing factors for each criterion, which are shown in Table 2.

Table 2: Weighting factors for evaluation criteria

Easy to access	28.57 %
Technical complexity	23.8 %
Easy to play	19.06 %
Element of uncertainty	14.29 %
Reusability	4.76 %
Similarity to the physical game	9.52 %

These percentages came from the direct comparison of each evaluation criterion, where the most important one got a 1, and the least important 0. For example, the criterion "Easy to access" is more important than any other criterion. Therefore, in comparison, it always receives a 1. With this method, the values were placed in a table, then all the numbers were added together, and according to the sum, the percentages were calculated.

In Table 3, which can be seen below, the average grades for variants are shown, using Zoom as the main software for online communication. In Table 4 the final evaluation of each of the variants is shown.

Table 3 Evaluation Round 1

Evaluation						
Variant	**Technical Issues**	**Easy to play**	**Differences**	**Free to access**	**Uncertainty**	**Reusability**
Miro +Zoom	4.2	4.05	3.85	5	3	4
Zoom	3.8	4.15	3.95	5	3	4
Concept board + Zoom	2.1	2.95	2.65	5	3	3

Table 4 Final Evaluation Round 1

Evaluation	
Miro +Zoom	4.1857
Zoom	4.1190
Concept board	3.3143

According to the participant's evaluation, Skype and Concept Board were eliminated from the list of options due to their instability. Specifically, Skype requires too much RAM, which led to lags and other problems for many participants. Concept

Board is not developed enough to be able to include all the game elements and handle five people online at the same time. However, the results for other variants were still lower than expected, and the deviance was very little.

Another part of the of evaluation is that after each game, the research team asked each participant about what they found good and what they would change in the game to make it better and more enjoyable. Some of the suggestions were implemented for the next round, such as:

– The currency system changed from bars and a bank to calculations of game master alone and post-its on service cards.

– To make bank calculations easier, an Excel sheet was integrated into the board.

– Initial rules were added to make a board more understandable and provide hints throughout the game to decrease the number of misunderstandings.

– Playing phase time was increased to 20 minutes and the number of phases was decreased from 6 to 4.

After the second round of the online game, the results written in Table 5 were obtained. Unfortunately, even if only using one software (Zoom) and its possibilities to integrate Miro without all the players going into Miro itself, it created connection problems because of the overload.

Table 5 Final Evaluation Round 2

Evaluation	
Miro +Zoom	4.3595
Zoom	3.7524

According to the obtained results from the evaluations, the most suitable variant for creating a digital version of EDIPS[2] was a combination of Zoom and Miro Board with implemented changes.

5   Development Contribution

The first part of the development of the game was the creation of the online version. Hence, Figure 3 is a screenshot of the Miro Board with the developed EDIPS[2] Online, including markings on the different game elements.
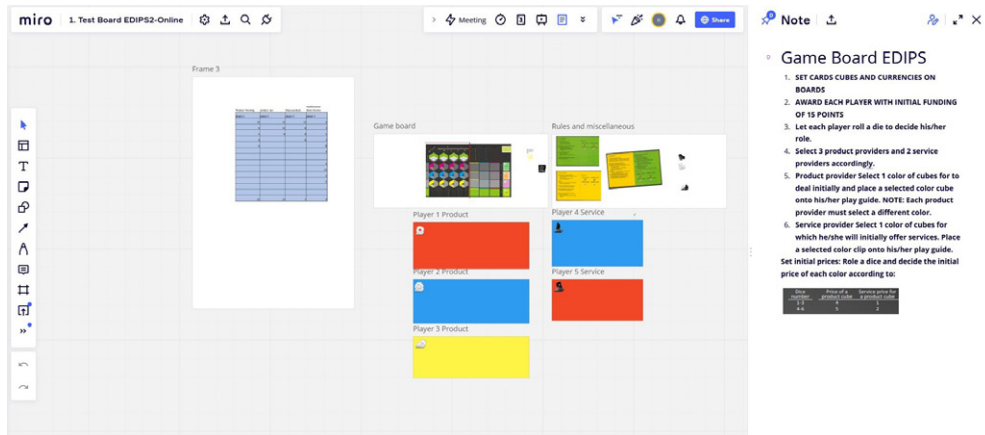

Figure 3: Playing board of EDIPS[2] Online

1   The first element on the playing board are the initial rules, which are always pinned. This allowed people to take a quick look at the rules of where to start and what to do, in case they forget the rules, or if they are playing for the first time.

2   Frame 2 shows the board itself, with all the cards and cubes that players must move.

3   Frame 3 shows all the rules for the different players: Product Providers, Service Providers, and PSS Providers. Therefore, any player can check all the rules at any time.

4   Under element 4 there are players' frames, where they can store their money, or use this space for their needs in general.

5 Frame number 5 is the Excel table, which is not visible to the players during the game. The Master writes down all the points that players gain/spend, to keep track of the gaming process and to ensure there is no cheating.

Another important contribution to the game development is not only showing that an online version can be created for free and with little to no cost but also changing and adapting to the new reality user guidelines for EDIPS[2] online. Original instructions, for EDIPS, are provided by Shimomura Laboratory, 2013. These are the changes to the rules, in comparison to the original guidelines:

– As already mentioned in Chapter 4, the duration of the playing phases was increased from 15 minutes to 20 minutes.

– The number of playing phases decreased from 6 to 4.

– A master of the game should not be playing the game, unlike in the original game.

– The game master should keep track of the calculation of points of all the players.

– Price change between the playing phases are now as follows:

• Decrease the price of the largest number of cubes (by 1 point instead of 2)

• Increase the price of the smallest number of cubes (by 1 point instead of 2)

• Do not change the price of the cubes that are not the largest, or the smallest amount.

– PSS providers pay for the recycling, the same as Product Providers in Alliance (1 point).

It is important to note that the online version of EDIPS[2] allows for tracking of the decision-making process of players. This may be an important change for future research in the field of decision-making processes, especially from the business perspective. This could result in a better understanding of how people make business decisions and their effectiveness.

6 Discussion and Summary

6.1 Discussion

There is a possibility for the further development of this variant and consideration of using or developing another software, which was not available in the scope of this project. There are a few reasons for that. Firstly, because of the complex setup, some computers may not be able to process the information flow, therefore technical issues may arise. Secondly, because of the load of work to conduct one game, it cannot be played more than twice a day. Therefore, it did not receive a great deal of exposure. An important distinction here is that a game master is absolutely needed to conduct a game, unlike the board game itself.

This research project had time and financial limitations, therefore there is room for the continuation of this research. Considering the points above, the recommendations for further developments are:

- Create software or application with the help of programming or use available software for board game simulators. This should eliminate the problems of dependency on the game master. Therefore, the game can be distributed to more people, and as a result, used for further research and studies.

- Further investigation into the possibilities of upgrading or changing the rules to make the game more efficient.

- Further investigation into game development to make it more widely known and can also help with following research and studies.

- This game and its online implementation can be used for lecturing, studies, training, brand development, and brand training inside companies.

One of the biggest limitations of this research was the requirement of no monetary investments and free and open software use. Because of that many possible variants were eliminated, for example, board game simulators.

6.2 Summary

In this research paper the possibilities of transferring a serious board game to the online environment were researched. The main task was to choose the best and the most suitable variant, which would satisfy all the requirements, such as free software and free accessibility for students.

For this development, firstly, suitable software was chosen, including communication software and online whiteboards. In different variations, they were tested with 20 participants, who gave their feedback after each of the game sessions. The feedback was a combination of the questionnaire and open questions. From the questionnaire, quantitative results were obtained and measured, and open questions provided information about which changes are needed to make the game experience better.

It is important to mention that there were two rounds of evaluation. After the first one, two choices of software were eliminated as not sufficient, and the other two were adjusted accordingly to complaints gathered from the players directly after the game sessions. After the implementation of the changes, new game sessions were conducted, and evaluations were gathered.

As a result, the Miro Board and Zoom combination was chosen as the best-fitting variant. Both applications are free of charge and readily available for students, who are the primary users of the resulting product.

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