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Using a Serious Game to Teach User-Centered Design

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ABSTRACT

The development of products with a good user experience requires a thorough understanding of the prospective users' behaviors, preferences, and needs. One of the design approaches that places emphasis on the needs of users is the user-centered design process. However, there is a general resistance in organizations to incorporate user-centered design practices in product development. One influencing factor is that user-centered design is multidisciplinary. Hence, creates challenges to get a mutual understanding and collaboration across different stakeholders throughout the development. In this paper we present the results of a serious game prototype that was created to describe user-centered design across stakeholders. Results of the prototype evaluation reveal that it has potential to impart knowledge on concepts related to user-centered design. Additionally, we propose further development of the game by personalizing game elements to increase the effectiveness of learning and player experience.

CCS CONCEPTS

• **Applied computing** → *Computer games*; • **Human-centered computing** → *User models*.

KEYWORDS

Serious games; User-centered design; Personalization

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1 INTRODUCTION

Traditional product development has been focusing mainly on the technical specifications of their products. However, especially with the advancement of technologies, we may have reached a point for the average consumer that the perceived advantages of better specifications (e.g., more computational power) is not significantly noticeable anymore. For example, the advancement of semiconductors has already surpassed Moore's law [1] predictions in 2016 [42].

[1]Starting from the 1960's, Moore's law predicted a yearly doubling of the number of transistors producible on a microchip, causing an exponential growth over the years. The number of transistors is closely connected to the improvement of the chip's performance.

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In conjunction with the increased possibilities of current technologies, product development is starting to shift from a specification perspective to a more consumer perspective in which the focus is on creating intelligent systems that can adapt to and serve the preferences and needs of its user.

User experience design (UX) as a discipline is concerned with all the elements that affect a user's perception with a company's product or service [36]. The International Organization for Standardization (ISO) has defined UX as a person's perceptions and responses that result from the use and/or anticipated use of a product [1]. A product with a good UX has shown to be fundamental to its success [26], and has shown to contribute to increase a company's competitiveness [2]. Products with a poor UX can easily cause a user to seek alternative options [32]. However, the majority of the organizations still focus on the technical specifications of their products instead [2].

In order to design a good UX the process needs to be human-centered, which means that a product should suit the user rather than making the user suit the product [6]. The human-centered development approach is called user-centered design (UCD) [19]. UCD is an iterative process during the design and development that focuses on understanding users and their context to achieve a good UX [36] by enhancing factors such as usability and usefulness [32].

Despite the importance of UX, the integration of the UCD process in the product development is not as widespread as it should be. One of the core principles of UCD is the close cooperation between different stakeholders. This means a shift from a traditional linear-sequential life cycle (e.g., waterfall method) to involvement of all stakeholders during all stages of the development (i.e., UCD). One of the challenges to face is the diverse nature of the stakeholder's backgrounds, goals and standpoints, which may not always benefit the user [26]. For example, for some stakeholders a complete shift in perspective is needed to create awareness of the importance to understand the users (e.g., programmers are traditionally more inclined to focus on code rather than users). Hence, incorporating UCD is challenging because the degree of understanding and adoption of the UCD process is often uneven among stakeholders [32]. Moreover, it is important that stakeholders take action to maintain and improve their knowledge about UCD skills, knowledge, and culture [41]. To achieve this, there is a need for stakeholders to learn about UCD and the value it brings to product development.

There has been an increased interest in game-based learning. Games that have an educational or training goal aside of mere entertainment are known as serious games [33]. With the wide variety of education and training needs, there has been an increased interest in using serious games in the workplace [34]. Prior studies indicate

that gaming during learning improves efficiency and positively stimulates achievement of the intended learning outcome [7]. As a result, games are increasingly used in various learning environments. For example, learning coding through solving puzzles [27, 29]. Hence, a serious game solution may be able to effectively educate about the UCD process as well.

To test the potential of using a serious game to educate about the UCD process, we conducted a preliminary study with a prototype of a serious game. The prototype consisted of a card game that describes the UCD process and roles of relevant stakeholders in the UCD process. The goal of the card game was to create awareness of UCD practices among various stakeholders, enabling them to experience the process of product development from the perspectives of the different roles involved.

Our preliminary results indicated that the participants gained new knowledge relating to UCD through the card game. The knowledge areas were divided into categories, which include the UCD design process, UX techniques and the purpose of the organization roles (i.e., stakeholders) involved. Additionally, this paper proposes further development of the prototype by creating a *personalized* serious game in which game elements can be adjusted based on organizational and player characteristics to improve learning and the player experience.

2 RELATED WORK

2.1 Serious Games

Serious games are games in which education rather than entertainment is the main goal [34]. Although serious games are often intended for learning, their application extends to other goals such as acquisition of specific skills [11]. Serious games are categorized depending on their characterizing goal, that is the additional goal (e.g., learning, training health) apart from entertainment [11]. Hence, serious games have been applied in various domains such as health, military, corporate and education [8].

The use of game-based learning and training in organizations is not new, games have been used to teach concepts and processes such as marketing, project management and risk management [8]. In corporate environments, serious games motivate communication and collaboration, and are used to get people more involved and interactive in work related situations [5]. An investigation on the use of serious games in organizations revealed that employees prefer playing games as a means of learning because they enjoy the engagement [3]. The increased engagement allows serious games to quickly produce learning results, are cost effective, and can target multiple people at once [39].

One example of a serious game used for corporate training is named "COSIGA." The game simulates the collaborative process of product development among engineers in which the players have to work together to make the final product [21]. COSIGA enables the players to experience the process of new product development from the perspectives of the different disciplines involved in the design process and the interactions between these disciplines [21]. Another example of a serious game is "ERPsim." ERPsim is a game used to teach enterprise recourse planning concepts and ideas. The main goal of the game was to develop a hands-on understanding of the concepts underlying enterprise systems [30].

2.2 Adaptation & Personalization

Tailoring system environments to a user's behavior, preferences, and needs are a common practice in fields as recommender systems. These tailoring strategies usually adhere to a data-driven approach (e.g., using historical data to predict future behaviors [25]). The disadvantage of a data-driven approach is that it dependents on historical data. Hence, fails to facilitate a tailored experience when lacking historical user data (e.g., for new users). Theory-driven approaches (e.g., using psychological theory to create user models) provide opportunities to counteract on the lack of historical data by using questionnaires or infer user models from external data sources (e.g., [12, 13]). By doing so, theory-driven approaches are able to facilitate a tailored experience from the start of use.

Especially for gaming purposes, tailoring experiences from the start of use can have a significant impact on players as the first impression can play an important role in whether players continue playing the game. Furthermore, individual players within a player group often exhibit varying attributes such as skills, knowledge and backgrounds. Hence, tailoring can also contribute to an increased player acceptance, engagement, and motivation among heterogeneous player groups [40].

Games in which entertainment is the main purpose rely on player attributes to tailor the game experience [4]. Player attributes that are often adhered to are "gamer types" to indicate the type of player a user is (see for an overview of gamer type models [35]). Gamer types can then be used to adjust the gameplay of the game accordingly. For example, Orji et al. [37] increased the efficacy of persuasive messages of a game by adapting them to different gamer types.

Serious games on the other hand have the main purpose of learning and/or training instead of mere entertainment. Hence, the underlying intention of serious games is to support personal development instead of gameplay. Therefore, tailoring the gameplay on gamer types may forgo the intended effect. As the effectiveness of a serious game is indicated by reaching its learning and/or training goals [9], adjusting the game elements based on personal characteristics instead of player attributes may be more effective for learning and training purposes. For example, Lee & Ferwerda [28] proposed to personalize online educational tools by using personality types.

2.3 Challenges of Adapting the UCD process

Because stakeholders may have different goals with a product, there is a general resistance to incorporate UCD practices. There are several challenges underlying this resistance. UCD practices require regular communication and collaboration among stakeholders. The collaboration between different stakeholders is a challenge due to factors as: difference in training, responsibilities, and motivation in the work place [23]. For example, one of the challenges is the developer mindset. This refers to that some developers are too focused on the code and thereby loosing sight of other aspects of the product (e.g., the user's perspective) [2]. One way to alleviate this problem is by educating developers on the value of UCD.

Another challenge is the lack of knowledge and awareness of the available research methods that could be employed to extract requirements from end users [2]. The lack of knowledge and awareness of available research methods diminishes the effects on the importance of incorporating UCD.

To increase the willingness to incorporate UCD in the development process, it is important that the stakeholders understand the UCD process and be aware of the impact that it can have on the success of the product [26]. To overcome the above stated challenges, we designed a prototype of a serious game to assess the possible effects it can have in raising awareness of UCD and the effects of it when incorporating it in the development process.

3 PROTOTYPE DESCRIPTION

A prototype was created to assess the possible effects of a serious game for learning UCD in a development process.[2] The prototype consist of a serious card game. The serious card game is a three-player collaborative game which requires the participants to work together to finish a software product development project while following the UCD process. The card game consists of a total of 97 cards (example of the cards can be found in Figure 1):

- 4 "project" cards that are describing the type of project the team will be solving
- 3 "role" cards that are describing the roles of the players
- 4 "phase" cards that are representing the different phases in a UCD process
- 28 "technique" cards that are representing the different methods that the players can apply to complete a UCD phase
- 20 "modifier" cards that are describing the actions the players need to take during the game
- 30 "capital" cards that provide players buying power to purchase techniques
- 8 "drawback" cards to add engagement to the game by warning players of potential failures of the project

3.1 Game Overview

The prototype game consists of three common roles in an organization's product team: a UX designer, programmer, and business officer. Through the project cards the team needs to complete the given project. In order to complete the project, the team must follow and complete a UCD process, which is made up of four phases: research, design, prototyping, and testing. A phase can be completed by applying the appropriate techniques such as interviews, surveys, and/or card sorting.

The team needs to minimally reach 10 points in order to complete the phase by collecting a corresponding number of technique points. Techniques are collected by using capital cards. Capital cards are assigned to each player at the beginning of the game. The players can use this capital to purchase techniques. The players play in consecutive order. Hence, only one player can finish a phase at once. To mimic UCD iterations, the team can encounter modifier cards during the game. These cards require players to take particular actions that can change the state of the game. For example, a modifier can require a player to trade resources with another player. Modifiers are used once and immediately when picked up.

The games is designed to allow the players to collaborate and utilize each other's abilities. Hence, winning is achieved as a team and not as individual players. To win, the team needs to complete all the phases of the UCD process, which indicates that they have successfully completed their project. The team can loose after encountering a total of eight drawback cards which can be drawn at random during the game.

3.2 Game Play

Each player selects a role upon the start. The team then randomly selects a project card and places it face up so that it is visible to all players. Under the project card, the four phase cards are also placed face up. Each player gets ten capital cards to make a personal deck. On the table there will be two other decks placed (shuffled and faced down): 1) technique and 2) modifier (+drawback) cards.

Five technique cards are placed up to start the game. The team decides which player goes first. Five cards from a personal deck is drawn on a player's turn to make a hand. The player then draws a card from the top from the modifier deck and fulfills the instructed action. Finally, the player uses the capital cards on their hand to acquire techniques from the table; each picked up technique needs to be replaced with a new one from the deck to ensure there are always five technique cards on the table. The acquired new cards then add up to a player's personal deck. If on a player's turn their hand contains techniques that are applicable to the current phase, then they have to be placed faced up in front of the player. This will enable the team to form a playing strategy, such as trading cards to complete the phase.

3.3 Results of the Card Game Assessment

In order to evaluate the educational goal of the game, three types of tests were conducted: 1) assessment of the content validity of the card game to determine whether the constructs represented are representative for UCD, 2) playtest to assess the functionality of the game, and 3) subjective player assessment on the educational goal of the game.

The content validity assessment was conducted by presenting the game and administering an open-ended questionnaire to a practitioner of UCD. The questionnaire contained four open questions relating to four card types: role, project, phase, and technique cards. These cards were presented for assessment because they contain UCD and UX concepts that players are intended to learn during gameplay. The results showed that the cards contain valid information relating the UCD process, UX techniques, roles involved, and types of projects.

The functionality assessment was conducted through a playtest, which involved a total of six participants divided in two groups. All participants indicated that they had no prior knowledge and awareness of the UCD process. The participants were observed while playing the game in order to capture the game experience. The results of the functionality assessment gave indication that the game objective was well understood by the players. Players showed to form strategies and engaged in communication and collaboration to complete the game.

The learning outcome assessment was conducted by providing an open-ended questionnaire to the participants at the end of game. The result of the questionnaire showed that participants gained new knowledge and awareness about UCD process. One of the knowledge areas identified was learning the design process; players indicated having a better idea of the phases needed to develop a new

[2]See for a more detailed description of the prototype [24].

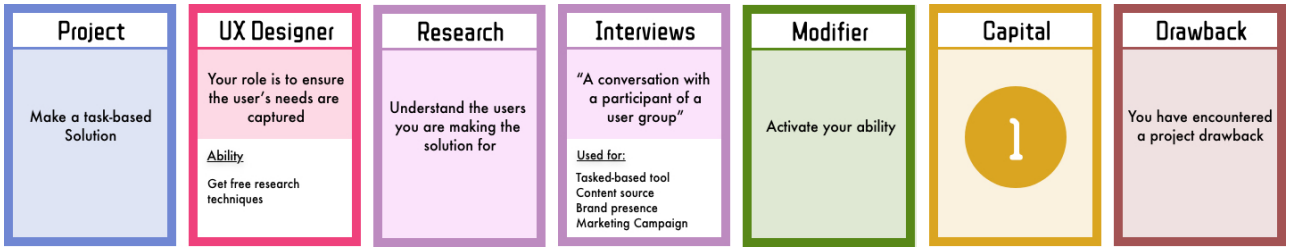

Figure 1: Example of project, roles, phase, technique, modifier, capital and drawback cards respectively

product, and learned about UX techniques that could be applied during product development. Finally players specified that they had a new perspective on the roles involved in UCD.

4 CONCLUSION

The results reveal that the game is functional and a good representation of the UCD process. Players indicated that they were able to acquire new knowledge and became more aware about the UCD process. Hence, results indicate that the goal of the serious game is fulfilled. However, the results presented are only preliminary. Further research can be carried out with participants from organizations to assess the impact and learning potential. This would provide more insight on how the card game performs from a practitioners' perspective. Furthermore, during evaluation the participants only played the game once, it would be interesting to see whether playing the game over an extended period of time helps the participants learn and retain more/different information.

Although the prototype reached its goal, it in general lacks aesthetic appeal. Aesthetic appeal can play an important role for games. Hence, the graphical elements of the cards could be improved to add components such as images which would further improve player immersion and engagement. In the following section we propose means of personalization and adaptation to further improve the gameplay, player experience, and learning outcomes.

5 PROPOSAL

5.1 Adaptation & Personalization Dimensions

Adaptation and personalization of different game elements can have an influence on the effectiveness of the game. Since the game is intended for use by different organizations, it is important that the game can adapt to different organizational structures. By being able to adapt the game to different organizational structures, the game is able to increase awareness through the direct applicability of the respective organization, and thereby also lowering the threshold of ultimately adapting the UCD process in the organization. Furthermore, the current prototype supports only three basic roles. The game can be expanded to include more roles that are involved in the UCD process (depending on the organizational context). On a player-level, mapping the positions that players have in the organization to the roles within the game can have positive effects on the gameplay as well. Research has shown that self-representation (i.e., the ability for a player to identify themselves to the context of the game) is important to engage and encourage players to continue playing [8]. Self-representation can consequently lead to increased attention and learning of the concepts during the game [31].

The game is not only intended to educate its players about the UCD process itself, but also to train players on what their position entails if such a UCD process would be adapted by the organization. Hence, the game's intention is also provide opportunities for players to work on personal development within their roles. Prior studies have often used personality types to characterize an individual and to model their behaviors, preferences, and needs (e.g., [17, 18]). Hence, personality can conversely also indicate undesirable characteristics for certain position within the UCD process. The game can adapt certain gameplay elements to improve on these characteristics. For example, when a player is shown to be introvert by nature and the position that they are in requires to be more outspoken, the game can adapt the gameplay in such a way that more emphasis will be put on training the player to speak out more. Personality can also be used to adapt the strategy to teach. For example, Chen et al. [10] analyzed usage data of online learning environments and found relationships between users' personality traits and different strategies users adopt for learning.

The acquisition of personality traits can be done in several ways: explicitly and implicitly. Explicitly is done through the use of questionnaires. For example, a commonly used questionnaire is the 44-item Big Five Inventory (BFI; [22]) or the Ten Item Personality Inventory (TIPI; [20]). However, obtrusiveness is a common problem for explicit acquisition methods by requiring time from the user to fill in the questionnaire and thereby interrupting the interaction between the user and the system. Alternatively, the implicit method can be exploited by using data from external source (e.g., through the connectedness with social networking services, such as single sign-on mechanisms). For example, research has shown to be able infer personality from platforms as Facebook [14], Twitter [38], and Instagram [15, 16]. The main disadvantage of using the implicit acquisition method is that it may lack prediction accuracy.

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