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DESIGN THINKING

IN SERIOUS GAMES AND THE SCIENCE OF INNOVATION IN COLOMBIA

EL PENSAMIENTO DE DISEÑO DE SERIOUS GAMES Y LA CIENCIA DE LA INNOVACIÓN EN COLOMBIA

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ABSTRACT

This paper explains a serious game based on the Design Thinking methodology as a tool for encouraging creativity and innovation. The activity is based on innovation science and aims to improve individuals' ability to produce creative and effective ideas in a structured and collaborative environment. Through an empathetic mindset, the activity empowers participants and allows them to experiment with real materials in a role-playing game that leads them to create feasible solutions to complex problems. These use the novel methodologies for teaching and learning concepts in adults. The four major action areas and process steps to be completed are as follows: 1) identify the learning objective, 2) develop the game mechanics, 3) design the interface between the learner and the game mechanic, and 4) assess the interfaces, interactions, and learning efficacy. The main outcome of this activity is an increased awareness that finding creative and effective solutions requires the combination of various perspectives, skills, and knowledge.Final del formulario

Keywords: Playful environments, design thinking, gamification, creativity, innovation, learning

RESUMEN

Este artículo explica los juegos serios basados en la metodología "Design Thinking" como herramienta para fomentar la creatividad y la innovación. La actividad se basa en la ciencia de la innovación y tiene como objetivo mejorar la capacidad de las personas para producir ideas creativas y efectivas en un entorno estructurado y colaborativo. A través de una mentalidad empática, la actividad empodera a los participantes y les permite experimentar con materiales reales en un juego de rol que los lleva a crear soluciones factibles a problemas complejos. Para ello utilizamos las novedosas metodologías de enseñanza y aprendizaje de conceptos en adultos. Las cuatro áreas de acción principales y los pasos del proceso que se deben completar son los siguientes: 1) identificar el objetivo de aprendizaje, 2) desarrollar la mecánica del juego, 3) diseñar la interfaz entre el alumno y la mecánica del juego, y 4) evaluar las interfaces e interacciones, y eficacia del aprendizaje. El principal resultado de esta actividad es una mayor conciencia de que encontrar soluciones creativas y efectivas requiere la combinación de varias perspectivas, habilidades y conocimientos.

Palabras clave: Entornos lúdicos, pensamiento de diseño, gamificación, creatividad, innovación, aprendizaje

INTRODUCTION

Playful activity is an essential component of successful education because it improves motivation, information retention, social and teamwork skills development, and the promotion of creativity and critical thinking. When designing a playful activity to teach the design thinking approach, activities that foster motivation, creativity, and divergent thinking, as well as allow for greater interaction and collaboration among participants, must be considered, so that the information shared through play is remembered more easily and remains in individuals over time. The academic activity presented in this paper is created using a serious game methodology, with the goal of teaching design thinking in a practical setting.

A group of individuals between the ages of 33 and 41, graduates of a Colombian public institution, were considered for the activity's design. To identify the user needs to be connected with learning these concepts, the design thinking methodology was used, and a first version prototype of playfulness was designed and tested with this group of students (Eslava et al., 2023).

The feedback received was used to redesign some aspects of playfulness, as well as the student and teacher guide (Ripoll, 2023), and to perfect the prototype for its formal debut, which took place with the assistance of the university's educational innovation laboratory. The designed serious game can be applied to groups of at least 8 individuals, either undergraduate or graduate students, in an average 2-hour space, depending on the total size of the group. The serious game requires the use of a set of materials and consists of three stages: one of basic theory, one of experimentation, and one of reflection.

The pedagogical role of fun in education

Playing as a child can have a positive effect on adult development in a variety of ways. For starters, play allows young people to practice and develop social skills such as cooperation, dialogue, and empathy (Springer, 2022) through unstructured and nonjudgmental interactions with peers (Whitton, 2022). This, in turn, can result in enhanced social adjustment and relationships in adulthood (Proyer et al., 2019). Second, play can be beneficial to emotional growth. Playful activities can help people express and regulate their emotions, deal with stress, and build resilience. In adulthood, this can contribute to increased emotional intelligence, more adaptive coping strategies, and improved emotional regulation skills (Jensen & Lykke, 2022). Playfulness can also be defined as a manner of approaching life with curiosity, openness, and social flexibility.

By embracing a playful mindset, individuals can adopt a more positive and lighthearted approach to everyday challenges and opportunities (Álvarez, 2023). This can lead to greater resilience, adaptability, and a more positive outlook on life. Finally, play can also support cognitive development in youth. Playful activities can stimulate the brain and promote cognitive flexibility, creativity, problem-solving, and decision-making skills. These cognitive skills can be useful in a variety of adult contexts, such as work, education, and everyday problem-solving (Estroff, 2020). Overall, the evidence suggests that engaging in play can contribute to improved cognitive skills in adulthood. Serious games, game-based learning, playful and simulation environments can motivate imparting knowledge, skills and competencies, and raising awareness of specific phenomena (Din & Gibson, 2019).

Serious Games

The primary goal of serious games is education, rather than entertainment. While they do not necessarily have to be digital, serious games are commonly used in the medical field to convey knowledge about diseases, promote physical activity, and enhance cognitive control in the elderly (Zhao et al., 2021). Serious games have also been found to be effective in improving school and university teaching, even in traditionally dry subjects like computer programming and mathematical logic, as well as engineering education (Despande & Huang, 2023).

The use of this games for knowledge or skill transfer provides several advantages. By coupling activities that are readily performed with those that are not, serious games can increase the duration and intensity of an otherwise uninteresting activity. Serious games build on the constructivist learning theory, which emphasizes active engagement with the learning material as a process for creating meaning, knowledge, and experience (Despande & Huang, 2023). Learners can experiment with ideas and strategies using simulations without fear of real-world repercussions. This can help learners create mental models that are more realistic and help them make better decisions at work. Serious games can also help students explore complex theoretical concepts in a secure environment, allowing them to avoid potentially costly errors in the real world. According to research, serious games have a greater cognitive impact on the learning process than enhanced motivation alone (Gurbuz & Celik, 2022).

Serious games must be distinguished from gamification, which employs traditional media and reinforcements such as points, badges, or leaderboards to increase engagement. While gamification is used in industrial settings to

enhance process quality or performance, serious games concentrate on education and skill transfer [8].

Creativity in adult life and its relationship with design thinking

Gifted education has a long history of introducing novel teaching practices to foster students' creative thinking skills (Shively et al., 2018). Given the critical importance of creative thinking in developing global problem solvers and achieving gifted education objectives, it is critical that classroom evaluations are designed to support students' development of these process skills (Lo & Porath, 2017). Specifically, the promotion of creativity has numerous benefits, including fostering healthy psychological functioning (Rasulzada & Dackert, 2009), bolstering student intrinsic motivation and creative self-efficacy, facilitating learning and long-term knowledge retention, and preparing students to make meaningful contributions to society.

Given the significance of creative thinking, various educational models have emerged, one of which is the design thinking model (DTM). DTM is a process model that clearly incorporates both creative and critical thinking abilities (Shively et al., 2018). Its evolution has spanned several decades, beginning with seven stages when Nobel Laureate Herbert Simon presented one of the first formal models in 1969 (Dam & Siang, 2017). This model has been adapted and applied in a variety of areas over time. DTM is a systemic, nonlinear process in design and education that consists of five stages: empathize, describe the issue, ideate, prototype, and test. These stages need not occur in a predetermined sequence and may be revisited and repeated iteratively, as illustrated in Figure 1.

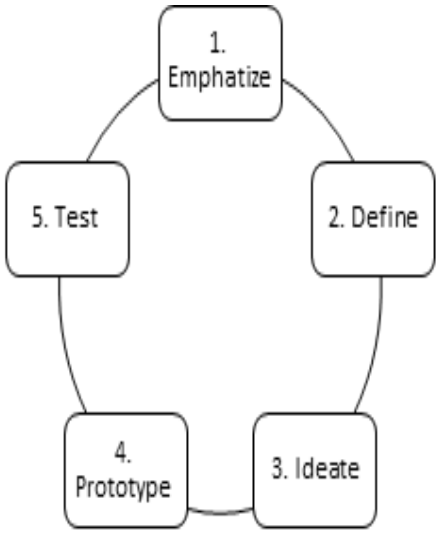


Figure 1. The design thinking process modeling. DTM.

Source: Self Elaboration.

The DTM has a significant benefit in that it focuses on solutions. Students are encouraged to create solutions to positively framed queries using phrases like "how might we...?" This method promotes creative fluency and flexibility by encouraging students to think about options rather than obstacles (Shively et al., 2018). Furthermore, because the DTM is a process-based model, evaluating the solution is not enough; the process of developing the solution is equally essential. By reflecting on and assessing their work, designers can revisit different stages of the DTM when encountering roadblocks.

This structured approach may enhance creativity, as constraints have been shown to be beneficial for the creative process (Haught-Tromp, 2017). Additionally, the DTM demonstrates the non-linear and recursive nature of design, reflecting the real-world design process and emphasizing the potential need for incubation time. Incubation time is crucial for promoting critical and creative thinking, and by documenting the process, teachers and students can recognize the value of time spent (Shively et al., 2018).

MATERIALS AND METHODS

A framework plan for designing a serious game

This section elaborates on design thinking factors for our serious game. This could also be true for future areas of action requiring novel methodologies for teaching and learning concepts in adults. This methodology was adapted from that proposed by Gurbuz & Celik (2022). The four major action areas and process steps to be completed are as follows: 1) identify the learning objective, 2) develop the game mechanics, 3) design the interface between the learner and the game mechanic, and 4) assess the interfaces, interactions, and learning efficacy. This four-step process model, depicted in Figure 2, should be repeated iteratively, beginning with simple prototypes and progressing to the complete game. Throughout this iterative process, the learning objectives, mechanics, and interface can be refined continuously to address any issues that arise during user testing, with the aim of enhancing the overall learning experience.

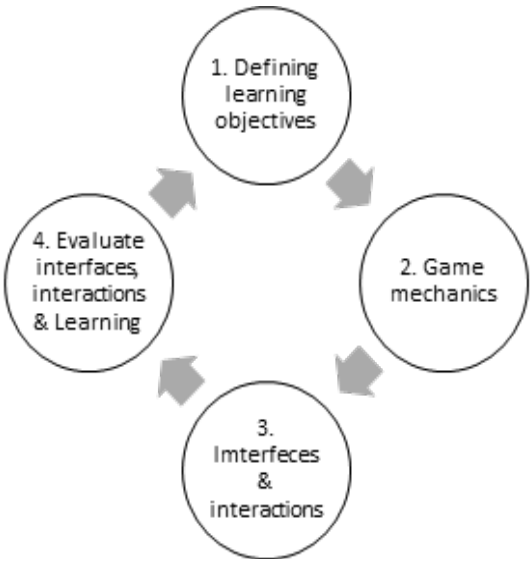


Figure. 2. Process model for designing a serious game.

Source: Self Elaboration.

Step 1: The most important stage in the serious game development process is defining the learning objectives. The target context and overall goals must first be identified, which may include knowledge transfer, raising awareness on specific topics, experiencing the interrelationship of different concepts, increasing resilience, or improving the ability to quickly select and process information to make effective decisions.

Step 2: The basics of the game. The methodology outlines six components that can be used to create serious games. The first part, "system," alludes to a collection of entities, their attributes, their surroundings, as well as their interactions and relationships. This can be modeled in a corporate setting to include employees or roles, machines, and so on. The second component, "rules," specifies the formal framework of actions that players can take. For example, the maximum number of raw materials to be used or the maximum amount of time to be spent on each task.

The third element, "artificial," refers to the use of simplified representations of life and behavior in games. This enables players to experiment with cause-and-effect relationships and different actions without fear of real-world consequences. The fourth ingredient, "conflict," is a critical component of a game in which one or more participants face challenges by competing against each other, simulated customers, or markets. The fifth element, "players," can be a single person or a group of players competing against the simulated environment or against one another.

Finally, the sixth aspect, "quantifiable outcome," symbolizes the objective function that players usually strive to maximize through skillful action. This can include metrics like the speed or quality of a task, as well as the sales and profits of an entire department or business. To measure learning outcomes and the effects of personality on decision-making and evaluation, player performance can be linked to experimentally manipulated game conditions, psychometric scales, personality traits, questionnaires, and learning analytics.

Step 3: Interactions and interfaces. To successfully design a serious game, a thorough understanding of the system's intended users - in this instance, the learners - as well as their tasks and future goals is required. To accomplish this, several methods can be used both before and during the development process to obtain a thorough understanding of the target group and their specific needs (Capecchi et al., 2022). The game can be optimized for optimum impact and efficacy by aligning the design with the intended audience's prior knowledge, experience, and technical abilities, as well as their norms and values

Step 4: Examine displays, relationships, and learning effectiveness. The primary challenge in creating a serious game is striking a balance between intricacy and simplicity while keeping the game entertaining. Achieving this sensitive equilibrium necessitates a comprehensive analysis and continuous improvement of the learning goals, game features, and interface design, similar to how commercial games are developed. Empirical evaluations are performed throughout the development process to obtain feedback on various aspects of the game, such as the players' enjoyment, whether the game's difficulty matches the players' skills (Plata-Gómez et al., 2022), whether the learning objectives are met, the comprehensibility of the interface, and the effectiveness of the interactions. Based on this input, the serious game and its underlying mechanics should be continually refined until they satisfy the specified quality standards.

RESULTS AND DISCUTION

This section showcases the process model and its constituent process steps by employing a game-based approach to design thinking. Using this game, we delve into the various insights gained from the development iterations.

Learning objectives of the game

To define the objectives, we analyzed the literature existing regarding serious games on design thinking for graduated and postgraduate students (Despande & Huang, 2023), and we also considered the information existing in the university's educational innovation laboratory, we then conceptualized a game that integrates this three learning objectives: 1) Developing the ability to identify and empathize with the end-users and stakeholders to gain a deep understanding of their needs, goals, and challenges. 2) Cultivating the skill to generate and evaluate multiple solutions to a complex problem using ideation and prototyping techniques, and selecting the most viable solution that aligns with the users' needs. 3) Enhancing the ability to iterate and refine a solution by actively seeking and incorporating feedback from end-users and stakeholders in the development process, to ensure the solution's effectiveness and usability.

Mechanics of the game

At the beginning of the game, the group is divided into teams of at least 2 participants each, and a maximum of 4. Each team represents a company. A monitor or teacher

will act as the "consumer". The teams give themselves a "company name" and will compete to create the most innovative product using the Design Thinking methodology. The exercise will have 5 phases, according to the phases of Design Thinking: a) Empathize b) Define c) Ideate d) Prototype and d) Implement. Phases are implemented as follows.

a) Empathize: At the beginning of the exercise, the teams listen to the description of the activity (see Table 1), and then to the "consumer", who has a series of demands related to "why they did not purchase a certain product again". These demands are recorded in the CONSUMER MANIFESTO (see Table 2).

Table 1. Description of the Serious Game: COMADI´s Wallet.

The digital era community of leather goods makers, COMADI, is facing an important dilemma: their wallet sales have drastically dropped in the last three years, and therefore they are considering whether to stop producing wallets or propose a new design that meets the user's needs.
To do so, COMADI hires expert advisors with the purpose of presenting a wallet prototype that fits the current design and expectations of potential customers.
Your company has been hired for this purpose, and proposes to COMADI to follow the Design Thinking methodology to deliver a product that is derived from the understanding of customer needs, and that surpasses the functionality and design issues that have notably decreased sales.

Source: own elaboration

Table 2. Consumer Manifesto for the COMADI´s Wallet case.

On behalf of the group of consumers consulted for the COMADI wallet challenge, I want to read you this manifesto: We want to declare that the colors that COMADI has been using for wallets seem boring and old-fashioned to us. We have had many problems with the sizes of the wallets. They don't fit the needs of men or women. Men only need to carry a few things and women want to carry everything. None of us can find a wallet that has enough space to carry all the things a person needs. We have felt for years that wallets are always the same. Nothing has changed for years. The materials used to make them are either too cheap and quickly fall apart or are made in an old-fashioned way that makes them last forever. "We want to renew our wallets every year," but we can't if they fall apart so quickly! Finally, we declare that if our demands are not met, we will be forced to stop buying wallets forever! Sincerely, Group of consumers.

Source: own elaboration

b) Ideate: In this phase, participants must generate user insights using an empathy map with the template shown in Figure 3

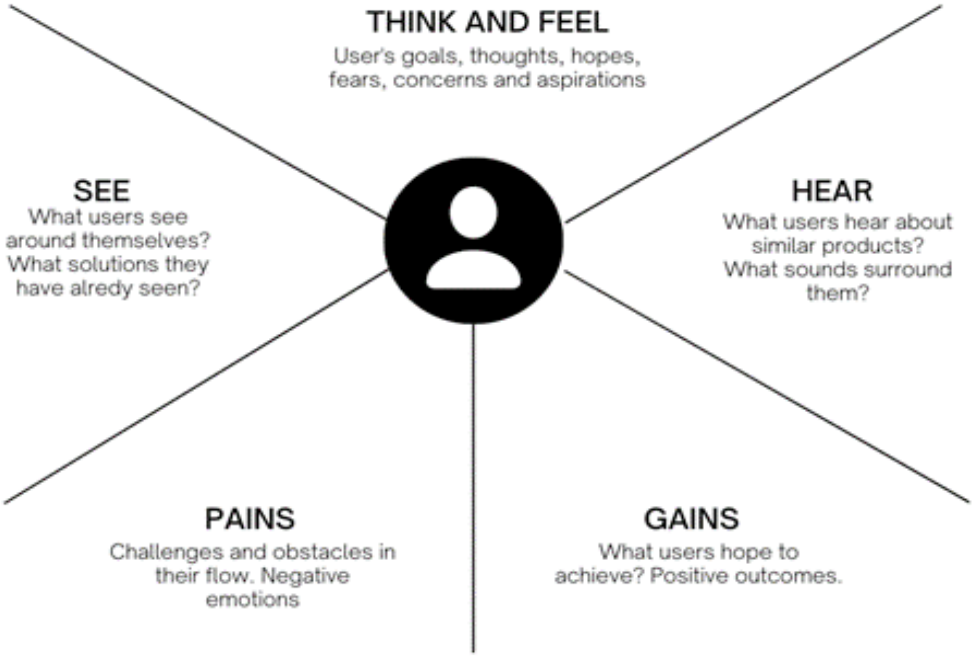


Figure 3: Empathy map for the design thinking game

Source: own elaboration

c) Define: During this phase and based on the user insights generated in the previous stage, each team will fill out a brainstorming map for the creative solution they would give to the problem (see map in Figure 4)

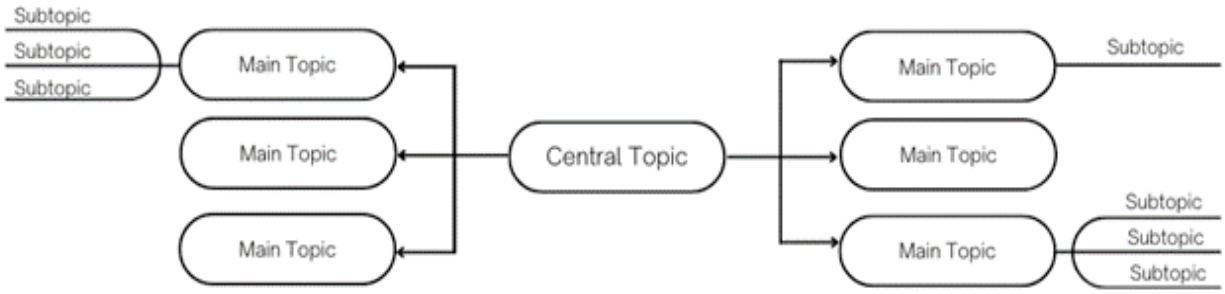


Figure.4: Brainstorming tool.

Source: own elaboration

d) d) Prototyping: Based on the user insights generated in the previous phase and in the brainstorming, each team will build a prototype with the set of materials they receive on their worktables (a list of commonly used materials for this exercise is sown in table 3).

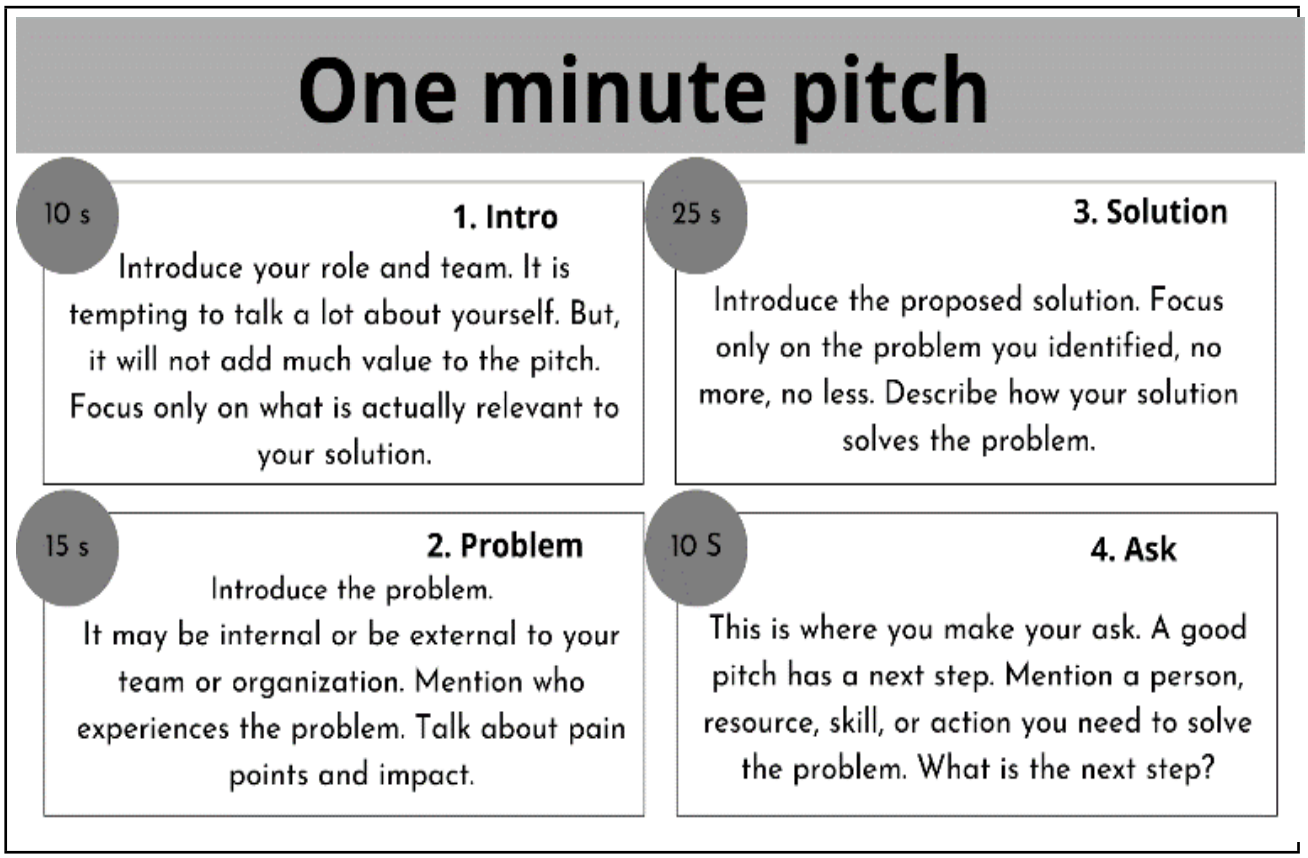
Table 3. List of used materials per team.

4 pieces of foam in different colors • Scissors • Scalpel • Hot glue • Cold glue • Colorful buttons • Glitter • Fine-tip markers • Sequins • Pieces of fabric in different colors.

Source: own elaboration

e) Implementation: This phase will be simulated through a one-minute pitch, in which each team will present its solution. For the pitch, participants can use the template in Table 4.

Table 4. Pattern to be used for the one-minute pitch.



Source. own elaboration

Interfaces and interactions.

The game can be improved to reach the highest degree of influence and effectiveness by considering the user's requirements, norms, and beliefs. Our educational innovation laboratory calculated the time it would take each squad to finish each assignment. The criteria used included whether the task was completed separately or in groups, the number of people in each group, whether materials were needed for completion, and whether templates or other tools were available for use. Maximum times were given for each task based on prior experience, as shown in Table 5. Other game regulations include working in teams without interacting with the teams of other players.

Table 5. Timing per step of the serious game designed.

Empathize stage.	15 min
Ideate Stage.	20 min
Define.	15 min
Prototype stage.	30 min
Implementation stage.	10 min
TOTAL estimated time	90 min

Source: own elaboration

Evaluation of interfaces, interactions, and learning efficacy.

This study identified three aspects to assess in the serious game before its full implementation: accomplishment of the learning goal, comprehensibility of the interface, and engagement efficacy. In this study, a pilot group of 8 serious game testers were chosen and subjected to it for 90 minutes of gaming while following all of the directions outlined in the previous parts. The participants were adults who had finished a work job and were pursuing postgraduate education. Their ages varied from 25 to 40. The squad consisted of six males and two women. We divided the company into two teams of four people each, with one woman on each squad.

We used a combination of two methods to assess learning outcomes: (1) we observed players' behavior while they played to assess their understanding of the material and their ability to apply it, (2) we collected game data such as the time it took players to complete each level and analyzed their understanding and progress in the game. (2) We questioned participants to learn more about their gameplay experiences and how they helped them learn.

We learned from watching both teams that a team size of four players is optimal because their strategies and decision-making processes were evenly spread among the team members. The information was straightforward and simple to grasp. As they played the game, the players verbalized their ideas. The time spent on each step was near to the times set during the serious game planning (see table 6).

The materials used were adequate; however, a larger variation could be given as their use promoted one of the game's most inventive phases. Furthermore, team members can be identified with a unique emblem or even with an element linked with a particular position within their team, such as a general manager, marketing manager, etc.

Table 6: Time (in minutes) for each team to complete the levels.

Team A		Team B
Empathize.	13	17
Ideate.	15	20
Define.	12	14
Prototype.	37	35
Implementation.	10	8
TOTAL time	87	94

Source: own elaboration

On the other hand, when interviewing the participants after the serious game had ended, they expressed that they were positively surprised by the effectiveness of the interactions that arose during the game. Within each team, there were profiles of different professions, and interacting with each other was something very valuable.

They also added that they found in this exercise a real way to apply a methodology like design thinking since, although this methodology is well-documented in the literature, participating in a serious game based on it enhances their understanding and ability to apply it in their day-to-day work. Finally, they expressed that participating in this exercise has shown them that innovation processes can also be a science, as effective results can be achieved by following a series of ordered steps.

Play is frequently associated with physical activities such as sports, games, or outdoor recreation. However, play can take many other forms that go beyond physical interaction and can be integrated into everyday activities, social interactions, and thoughts. Indeed, a specific type of game known as serious games, also known as educational games, are designed with the primary purpose of teaching, or training, a specific concept or skill. This article describes a structured exercise in which a game is created to engage and encourage learners to learn about design thinking while offering an engaging and dynamic learning experience.

The subject was chosen because many young executives, including new graduates, are continually challenged to innovate in their employment (Scholten & Granic, 2019). This does not appear to be a simple job, given that innovation is regarded a formal discipline that necessitates extensive formal efforts. On the other hand, design thinking has been shown to assist people and groups in innovating by creating creative and effective solutions to complex issues. This problem-solving strategy employs innovative and human-centered methods to find and handle complex issues.

With the help of the university's Educational Innovation laboratory, a serious game was created with the educational goal of: 1) developing in participants the ability to identify and understand user needs, 2) cultivating their ability to propose multiple solutions to a given problem and choose the most viable one, and 3) increasing their ability to iterate a possible solution by incorporating feedback from end-users. For the serious game design, a version of Akkaya & Akpinar (2022) approach was used, which suggests four design phases: 1) establish learning goals, 2) establish game dynamics, 3) establish interfaces and interactions, and 4) assess interfaces and interactions.

CONCLUSIONS

After the design was finished, a prototype test of the serious game was performed with a group of 8 graduate students as part of the "evaluation of the game's interfaces and interactions." The findings show an adequate design that permits accomplishing the objectives of each step of the design thinking process within the design's expected time frame. Similarly, the materials used, the cards, patterns, and tools recommended for each stage of the design process, and the explanations provided by the teaching aides were all suitable.

The comments from the players demonstrates that this game achieves the educational goal for which it was created. This is proof for the work team that play can take the shape of fanciful and creative activities that enable people to explore their own ideas and ingenuity and can be especially essential for nurturing invention and problem-solving skills that can be achieved through serious games. Finally, from a pedagogical standpoint, play, games, and particularly meaningful games, can be incorporated into the teaching and learning process with the goal of incorporating them into our ideas and attitudes. Approaching challenges and issues with interest, ingenuity, and a readiness to take chances and attempt new things can all contribute to a playful mentality. This mentality can aid in the development of a growth mindset, which is the belief that one's skills and intellect can be developed and improved.

The implementation of the serious game is the next step, according to the work structure. To accomplish this, each working team that wants to execute the serious game must have the infrastructure, materials, and tools outlined in this piece. Teachers and teaching assistants must be given specific duties and obligations. Future work will include trying the game with various kinds of students to find mistakes or fails in gaming and game functionality, which will be done via frequent assessments. Another course of action is to measure the achievement of learning goals, because variables linked with generated knowledge were not addressed in the assessment shown in this article.

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