Gamification of design studio
in the context of a user-centered design workshop

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Abstract. In project studios and workshops, students from many design disciplines, such as architectural, interior, and industrial design, apply theory and practice. Design research, conceptualization, development, communication, and interactive teamwork are the fundamental factors that unify different disciplines in project studios. The project studio is a rich environment where design thinking methods are implemented and original, creative ideas and designs are generated. In this setting, the design studio instructors' approaches, frameworks, and applied design thinking exercises gain significance. This paper examines the contributions of gamification components to design thinking methodology and the design studio, using the User-Centered Design Workshop as a case study.

Keywords: Design Studio, Design Thinking, Gamification, Design Education, Design Process

1 Introduction

The overlapping element among design disciplines including architecture, interior architecture, and industrial design is that project studios are the foundation of the entire education paradigm. Project studios are important in the design education of different disciplines because they provide a hands-on learning experience that allows students to apply what they have learned in the other theoretical courses. Design studio courses are mostly constructed as a simulation of a real-world design problem, which is created as a framework by the instructor. In these courses, students are expected to use their creativity and critical thinking skills to develop design solutions.

In architecture, interior architecture, and industrial design programs, project studios typically focus on the design process, which involves researching, conceptualizing, developing, and communicating design ideas. Through this process, students learn how to identify and analyse design problems, generate, and evaluate design alternatives, and communicate their ideas effectively through visual and verbal presentations. Project studios also provide students with the opportunity to work in a collaborative environment, which is an important aspect of design practice. They learn how to work as part of a team, how to give and receive feedback, and how to manage their time and resources effectively. Overall, project studios are an essential part of design education because they provide students with the skills and experience, they need to succeed in their careers as architects, interior architects, or industrial designers [1, 2]. The establishment of a course framework based on current concepts and methods is crucial

for design education. In this context, allowing and providing students with the opportunity to explore multiple design studio frameworks through informal workshops has significant implications for both the student and the instructor. Their acquired knowledge contributes to the expansion of project studios in these disciplines.

The purpose of this study is to contribute to the development of project studios. Within the scope of a workshop based on the gamification technique for design processes, students are expected to obtain knowledge and experience regarding participatory design and user-centered design principles. This study tries to determine how gamification elements are integrated into the design process and their implications for the studio structure. In accordance with the goal of the study, the relationship between gamification elements and the design process is examined in the User-Centered Design Workshop, which is one of eight workshops held during the Gamification and Space Summer Workshop hosted by the Isik University Faculty of Art, Design, and Architecture [3, 4].

2 Theoretical Background

2.1 Design Thinking Techniques and User-Centered Design

In recent years, design problems have become increasingly complicated, and design thinking approaches have gained in importance as they offer designers the intellectual foundation necessary to make judgements that will assist them in solving multicriteria design problems. As a result, design students should learn to apply design thinking methodologies in various frameworks in design education, particularly in the studio environment. According to Buchanan [5], the twentieth century saw the evolution of design thinking from a production activity to a fragmented profession to a field of technical research and, finally, to what should now be recognised as a new liberal art of technological culture. Oxman [6] highlights the emergence of new design paradigms, such as cognitive-based design education systems in which design thinking is explicitly taught as a subject of competence.

The phases of a design process are determined by the needs and objectives of the project, as well as the preferences and methodologies of the design team. However, there are also numerous studies and frameworks regarding the design thinking phases. According to the Hasso Plattner Institute of Design at Stanford University (also known as the d.school) [7], design thinking can be divided into five separate phases: empathize, define, ideate, prototype, and test. Design thinking, as defined by IDEO [8], is a human-centered approach to innovation focused on customer knowledge, rapid prototyping, and idea generation that will change how products, services, processes, and organizations are developed. According to Brown [9], a design thinker possesses the following characteristics: empathy, integrative thinking, optimism, experimentalism, and collaboration. Besides, the researcher outlines design thinking using three spaces: inspiration, concept, and implementation.

The complexity of the design process has been modelled by numerous theorists who have utilised approaches that are similar but with minor changes. Aburamadan and Trillo [10] note that research methodologies for architectural design lack a discipline-specific conceptual framework, in contrast to social and positivist sciences. According

to the authors' viewpoint, a user-centered design outcome may be achieved and confirmed with the aid of design science, that is reasoning, which recasts the numerous stages of architectural design as iterative evaluations.

Buchanan [5] observes that there is an academic push to understand more about design as an integrative field. Researchers from various design fields agree that design should be implemented, yet there are several ways to describe design and design methodologies. An abundance of studies [2, 11, 12] are being conducted in the context of design studio in a variety of design disciplines, including architecture, interior design, industrial design, and visual communication design, to assess the viability of establishing a framework for design studio courses using design thinking approaches. Designers apply different concepts and methodologies as strategies or frameworks to direct and organise the design process. Although the names of these procedures vary, the first stage in the design process is always to empathise [13]. During this stage, a comprehensive understanding of the user's requirements is incorporated. Goldschmidt and Rodgers [14] remark that there is no universally accepted definition of design thinking; however, the priority of the user and, for others, empathy for the human condition are the strongest common denominators.

In an architectural design studio course, students may learn about a variety of design methodologies and how to apply them to the design of spaces and structures. In addition, the process of architectural design begins with the acquisition of knowledge regarding the needs, aspirations, and behaviors of the people who will use the designed space or structure. This may entail performing research and collecting data via activities such as user interviews, focus groups, observations, and user testing. This phase aims to create a comprehensive grasp of the user's perspective and uncover chances for designing an environment that fits their demands and enhances their experience. Architects may also address the broader context in which the building or space will be utilized, such as cultural, social, economic, and environmental elements that may influence the design. This can help them produce designs that are considerate of the demands of the users and the larger community, as well as the specific peculiarities of the site and location. Overall, this is a crucial aspect of the architectural design process because it enables architects to develop truly user-centered structures and spaces that enhance the user's experience of the environment. By taking the time to comprehend the user's perspective and requirements, architects can produce designs that are more likely to be successful and meet the requirements of the intended users.

The empathy phase of design thinking approaches is defined by a series of guiding concepts and procedures in the context of different design disciplines in a studio environment. User-centered design (UCD) [15] is an iterative design process in which each phase of the process focuses on the users and their needs. Using a variety of research and design techniques, UCD design teams engage users throughout the design process to create highly usable and accessible products for them. User-centered design is frequently used interchangeably with human-centered design, but there is a distinction: user-centered design is a subset of human-centered design. Consequently, user-centered design necessitates a more in-depth analysis of the target audience. It is not only about the general characteristics of a person; it is also about the specific habits and preferences of target users to develop appropriate solutions for problems [16].

2.2 Gamification in Design Education

The concept of "gamification" is not new, but the term is. Utilizing game elements, such as point and reward systems, to increase participation in tasks, gamification transforms a tedious activity into a game-like experience, making it more engaging for users. Gamification increases engagement and productivity among educators, managers, and others. Besides, it is also used to motivate individuals to complete personal challenges such as weight loss and language acquisition [17].

Understanding the advantages and disadvantages of gamification in the classroom is of utmost importance for educators, as research [18] has indicated a significant interest in gamification to motivate students. Gamification entails employing game elements to enhance classroom participation, engagement, loyalty, and competition. Nevertheless, effectively integrating game elements into various educational challenges presents a formidable challenge [19]. Various gamification approaches are currently being utilized to facilitate learning in diverse educational settings. However, the implementation of gamified learning has surpassed researchers' comprehension of its mechanisms and methodologies.

There are different studies in which gamification is being utilised in design education through the incorporation of game elements and mechanics in design studio courses, to engage and motivate learners as they acquire knowledge and skills in their design discipline. Oneistox [20] is a learning platform for architects, designers, and engineers that incorporates gamification methodologies, specifically "white hat" gamification with positive reinforcement. The main goal of the EDUGAME4CITY [21] project is to determine whether the use of virtual gamified strategies in urban design can improve public participation by providing a more dynamic, realistic, and agile collaborative environment using augmented and immersive visual technologies. A secondary hypothesis is that gamified strategies can improve the spatial comprehension skills of non-experts, students, and professionals and increase their motivation and satisfaction. Another study [22] on the gamification of the design studio conducted with interior architecture students reveals that 92% of students found it simpler to adapt to the course due to gamification, and 75% said they were able to generate more original problem situations. In addition, all study participants agreed that gamification facilitated the design process and the identification of problem situations. In addition to this information, the study demonstrates that gamification assisted students in memorising concept maps and function schemes utilised in the design process. The use of gamification and rule-based design techniques in architectural education within a design studio to facilitate knowledge development and deep learning is the subject of another study. It proposes a gamified design platform for urban mass housing that incorporates numerous stakeholders and enables players to generate design suggestions using a gamified online platform. Using gamification as a design studio approach enables everyone to collaborate and understand each other's demands and needs before stating their own, with the designer addressing any potential biases [23]. GaoDe is also a framework that emphasises a new student-centered, game-based learning method for architecture education and employs a 3D CAD environment that enables students to design and self-evaluate legendary buildings. Students are able to comprehend the

complexities of architectural design while self-assessing without fear of being judged, as demonstrated by the findings of the research [24].

Gamification has been widely used as a methodology in experimental studies in design studios across various disciplines, particularly in the field of education. These studies provide valuable insights into the potential and implications of gamification for design studios. As a result, design educators can benefit from the lessons learned through these studies. In line with this, the online workshop titled "Gamification and Space" serves as a case study for evaluating the applicability of gamification to design education. The workshop's observations over the course of five days provide a basis for this evaluation. The relevance of gamification in design education can be assessed through an examination of the insights and observations gleaned from this workshop. Based on the way they incorporated gamification into their studio work, the researchers classified the 11 workshop processes into three categories: those that used gamification to enhance the design process, those that used gamification to enhance the learning process, and those that used the concept of gamification as a design theme [25]. The User-Centered Design workshop, which was one of the 11 workshops studied, was classified under the category of using gamification to inform the design process. This categorization reflects the workshop's focus on using gamification as a framework for the design process.

3 Integrating Game Elements in the Design Process: User-Centered Design Workshop

The User-Centered Design Workshop is founded upon the crucial relationship between the user, a fundamental factor in the design process, and the designer, who interprets and mediates the users' physical, spiritual, and social demands to integrate them seamlessly into the creative flow of the design process. Seven students specializing in architecture, interior architecture, and industrial design, hailing from different universities, actively participated in this workshop.

The workshop program (Fig. 1) encompassed two distinct parts: firstly, the students were assigned the task of designing a game, after which they were given the opportunity to play the game they had created. During the game-design phase, the students engaged in fruitful discussions regarding their ideas and subsequently collaborated to devise a playable game. The chosen game genre for the "design game" was role-playing, which necessitated the development of individual gamification aspects associated with role-playing games. These aspects typically include a rule system, a setting, characters, and the story or adventure that players experience. The participants dedicated the first and second days of the workshop to designing all these elements.

The subsequent step, guided by the workshop coordinator, involved the participants playing the design game they had collectively crafted. The participants formed teams and generated designs for fictional residents within a recreational area. Subsequently, the collaboratively created designs were evaluated and deliberated upon, with badges and points being awarded as recognition. On the final day of the workshop, the coordinators and participants engaged in discussions to analyze the effectiveness and potential dysfunctions of various game aspects in gamifying the design process.
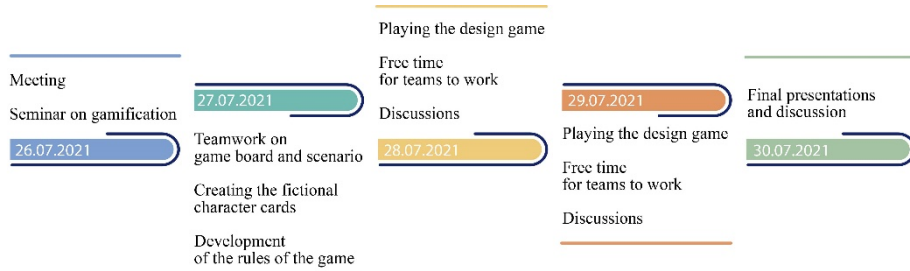
Fig. 1. The program of the User-Centered Design Workshop.

The user-centered design workshop implemented gamification as a crucial aspect of the design process, encompassing two essential components: game scenario development and gameplay. Throughout the workshop, participants effectively utilized the online platform Miro, which facilitated interactive and visually collaborative experiences, enabling the creation of the game board and various gamification components. The workshop focused on a role-playing game scenario that revolved around addressing the specific needs of the residents residing in the Kriton Curi Recreation Area, located in Istanbul's Kozyatağı neighborhood. The primary objective of the game was to design urban furniture that not only catered to the residents' requirements but also preserved the area's natural texture and historical significance. To achieve this objective, a game scenario board was created to represent the recreation area, along with a diverse set of game character cards. These fictional character cards embodied various neighborhood association members who actively participate in the region.

3.1 Game Scenario and Its Components

In order to develop the game scenario and its components, the participants conducted a comprehensive analysis of the recreation area collectively. They delved into the intricacies of the design work, examining the underlying concepts and constraints, which laid the foundation for the creation of the design game. The initial research findings regarding the recreation area were meticulously gathered and organized on the Miro Board, as illustrated in Fig. 2. The park map played a pivotal role in constructing a board game, drawing from extensive research conducted on the design region. During an insightful brainstorming session, participants freely expressed their ideas, leading to the development of a well-defined classification framework encompassing the demands and limitations pertaining to the study topic. This classification framework served as a valuable reference point, enabling participants to navigate the complexities of the design process effectively. By collectively exploring and organizing their ideas, the participants gained a deeper understanding of the key aspects that needed to be addressed in the design game.

Fig. 2. The initial analysis for the design scenario and its components.

Moreover, as part of the workshop's analytical process, a systematic classification of the demands and limitations associated with the study topic was developed. This classification framework served as a valuable tool, enabling the participants to identify and address the specific requirements and constraints inherent in designing urban furniture for the recreation area. By meticulously analyzing the demands and limitations, the participants were able to develop solutions that accounted for the diverse needs of the users while adhering to the predefined limitations. Using the design requirements, limitations, and a comprehensive rating system, gamification components such as badges and points were carefully established. These components played a crucial role in evaluating the designers' work for the selected user. By integrating badges and points into the design game, the participants could assess and recognize the effectiveness of the designs based on predefined criteria. The integration of gamification components and the comprehensive classification of demands and limitations added structure and purpose to the design process, enhancing the overall effectiveness of the workshop in addressing the unique challenges of designing for the recreation area.

These classifications were then transformed into badges that could be utilised for evaluating future designs. As a consequence of the participants' efforts, the basic rules, grading criteria, and badges of the "design game" for the park were revealed. As illustrated in Fig. 3, the participants generated badges to evaluate and award the best designs in categories such as joyful, non-human centered, grass head, sustainable, inclusive, most-evolving, creativity, and aesthetics.

Fig. 3. Some badges created by students for the design game based on the Kriton Curi Recreation Area (Joyfull, Inclusive, Sustainable, Most Evolving, Grass Head, Aesthetics, Creativity, Non-Human-Oriented).

3.2 Characters

Following the establishment of the game board and scenario, character creation was the second step in the production of the design game. Character cards, similar to those used in board games, were created as illustrated in Fig. 4. In addition to personal features and interests, the cards included information about the user's park usage and needs. In the preceding phase, the participatory design students did geographical and spatial analyses of the region as well as extensive social research on the recreation areas' frequent users. Through additional social media research, participants constructed characters based on the flow and social structure of daily life in the recreation area. As a result of this research, although the user cards are fictional, they were developed based on genuine profiles. One participant wanted to add a turtle, one of the park's residents, among the characters. This character's features resembled those of cartoons or fairy tales.
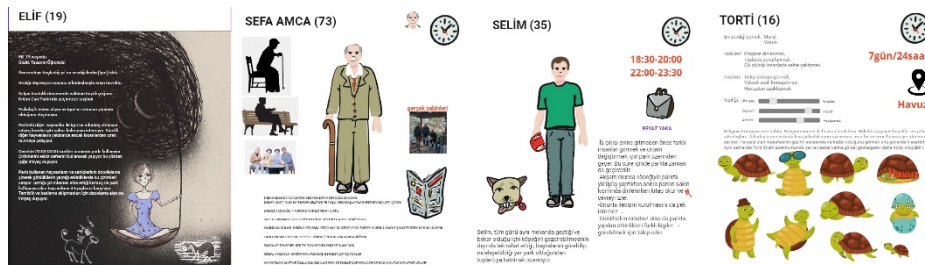

Fig. 4. Some character cards including detailed information about the fictional user created by the students.

Due to time limits, the participants were given templates to use on the Miro board to design characters by assembling them like puzzle pieces. When the designed photos were assembled like a puzzle, a card describing a distinct character was formed. Participants were also informed that they may develop their own characters if the supplied pictures do not appropriately represent their scenario.

Character design was the final task of the first phase of the workshop, which was the creation of the design game. Participants were not informed that their individually designed characters would be added to a player pool and then assigned at random. This was done so that the designers wouldn't start thinking about the designs before the game started, when they were making the characters.

3.3 The Design Game

The design game was launched in the second phase of the workshop, following the conception of the game and the random assignment of teams and characters. Seven individuals were separated into two doubles and one trio. During the scoring, the varying number of designers on each team was also considered. Participants in the teams would represent the character allotted to them by lot during game meetings and serve as the designer of the urban furniture (Fig. 5) that meets the wants of their teammates' fictional characters.

Fig. 5. The final urban furniture designs for Torti (left) and Eylül (right)

The newly formed teams were given time to work on the design after choosing a symbol color and being labelled as the yellow, green, and blue teams, respectively. Following the formation of the teams, two meetings were conducted to debate the designs. In accordance with the scenario of these meetings, the neighborhood association arranged some participation meetings to discuss the urban furniture to be constructed in the recreation area and to discuss designs. As depicted in Figure 6, the designers presented their user-centered urban furniture to all attendees at these meetings. In these discussions, each participant played the role of a recreation area user and awarded the designs with points and badges. The designers were informed that they will be judged based on the criteria, game rules, and badges they developed at the creation phase of the design game. Throughout this exercise, each park resident assigned a secret score to each design based on the evaluation criteria developed by the participants and shared it with the instructor. The team score was determined by

averaging the scores of each individual design. As illustrated in Figure 6, Miro was used to generate a leaderboard for this purpose.

Scoreboard	Points		Badges
Teams	1st meeting	2nd meeting	
Yellow Team: *Recep, Elif*	70,5	82	Joyfull
Green Team: *Selim, Kemal*	67,5	57,2	Non-human oriented, inclusive
Blue Team: *Eylül, Sefa, Torti*	63	73,6	Usability, grass head, inclusive

Fig. 6. The scoreboard of the design game

3.4 Evaluation of Design Thinking Phases and Gamification Components

On the final day of a 5-day workshop, the participants presented and discussed the findings of the design game, which was conducted through role-playing and gamification of the design process. This conversation elicited the opinions of design students and professors regarding which gamification components are valuable in a user-centered design process and which are ineffective. The comparison in Table 1 is based on the notes that were taken during the whole process and the information that was gathered at the end meeting. We will use IDEO's phases of design thinking [5] to compare these two things.

Participants developed an empathy scenario for the design game during the workshop. By modelling various user scenarios and views, users are exposed to varied points of view and can empathise with the demands and pain points of various users. Through role-playing and narrative, users are able to place themselves in the shoes of other users and comprehend their experiences. In addition, during the inspiration phase, observation and field research expanded the empathy maps in order to discover and comprehend the various emotions, ideas, and behaviours of various people. Personas, user feedback, and game meetings also enable designers to comprehend and empathise with the unique characteristics, wants, and issues of a variety of users. Gamification elements can be used to simplify complex tasks, promote collaboration and teamwork, create a sense of challenge, and provide personalised experiences. During the User-Centered Design Workshop, the storytelling element of gamification enabled participants to comprehend the challenge from the end-user perspective. Collaboration and teamwork are also reflected by the co-creation tools throughout the process. The participants concurred that the framework developed during the workshop will improve their relationships with the user in future design processes. In conclusion, gamification aspects enhance the inspiration phase of design thinking through the creation of empathy scenarios, role-playing and storytelling, observation and field research, personas, user feedback and interviews, and the creation of a user-centered environment.

Gamification features can be utilised to facilitate the process of transforming ideas and solutions into a coherent concept during the concept phase of design. Moreover, using a playful and entertaining approach, the participants worked in an open and casual environment, which helps design students think creatively and without the pressure of

a formal setting. In the ideation phase, the creativity prompts on the character cards inspired students to think creatively and generate new ideas. Challenges and contests, prizes, teamwork, and co-creation components of games also influenced the ideation phase by motivating participants to come up with novel and inventive concepts. Participants underlined that they understood the significance of following specific rules during the design process, which can also be viewed as the resolution of complicated problems.

Table 1. The comparison of design thinking phases and gamification components

Design Thinking Phase	Gamification Components	Participant Opinions
Inspiration	Empathy scenarios Role-playing and storytelling Observation and field research Personas Rules and Limitations Co-creation	*"I concentrated on establishing the connection between the user and the space. In the research procedures of my future projects, the user profile will always serve as a benchmark during the development of the project, allowing me to maintain control over the procedure."*
Concept	Personas Co-creation Rules and Limitations Role-playing and storytelling Game scenario	*"Thanks to the rules developed for the design game and the requirement to respect these rules, we now have a checklist for the criteria we should evaluate during the initial phase of the project but subsequently disregard."*
Implementation	Personas Rules and Limitations Role-playing and storytelling Game scenario Points Scoreboards Badges	*"I had difficulty assigning numerical values to the designs during evaluation, but I was able to make a decision with ease when awarding badges. Badges were awarded for the quality of the design, and perhaps due to the nature of the design, it is more appropriate to evaluate the quality by explaining it than by assigning a numerical score."*

Gamification components such as role-playing and narrative, prizes, badges, rules, and feedback enabled participants to track their progress and assess their proximity to attaining their objectives. The game meetings fostered an open-minded environment in which everyone freely discussed and critiqued the designs. The challenges and game discussions encouraged participants to think critically and imaginatively, so that during the implementation phase, they were also more receptive to iteratively improving their

designs. At the stage of presenting and reviewing the design, the participants felt that the badges were a more functional evaluation tool and discussion starter.

4 Discussion & Conclusion

The User-Centered Design Workshop, which integrates the characteristics of the design process with gaming elements, has demonstrated the potential of gamification in project studios across diverse design disciplines. By blending the characteristics of the design process with gaming elements, the workshop technique has effectively integrated the user factor into the studio, playing an active and crucial role from the initial stages of design through to the evaluation of the final product. However, to ensure the success of similar workshops or studies, it is imperative to begin with a comprehensive review of related literature and existing research on gamification in design education. This step is crucial as it establishes a solid foundation, prevents duplication of efforts, and facilitates a deep understanding of the current state of knowledge in the field.

During the workshop, the analysis phase, which is essential in every project studio, was effectively synthesized to create the game's scenario. This scenario provided a framework for designers to assess their performance at each stage of the design process. Additionally, it is essential to clearly define the objectives and goals of the workshop or study to ensure clarity and effectiveness. In this case study, the objective was to explore the potential of gamification in the user-centered design process. By explicitly articulating the objectives, the workshop's design can be guided to ensure that the outcomes align with the intended purpose.

Throughout the design process, it is crucial to continuously reflect on and explore the dynamic relationship between users and designers. The case study emphasized the significance of integrating the user factor into the design process and fostering empathy and understanding. Participants should be encouraged to consistently consider the needs and perspectives of users throughout the entire design journey. By maintaining a focus on the user-designer relationship, the workshop or study can effectively cultivate a user-centered approach and enhance the overall quality of the design outcomes. Assigning "fictitious" characters based on roles revealed by park research to participants not only increased motivation and excitement but also created an environment conducive to profound discourse, particularly when participants disagreed with the designer's decisions. This approach stimulated meaningful discussions and provided opportunities for participants to delve deeper into the user-designer relationship.

When incorporating competitive elements of gamification, it is crucial to strike a balance between competition and cooperation. While competition can provide motivation and excitement, it is equally important to emphasize the value of compromise and cooperation. Creating an inclusive environment where participants feel comfortable freely discussing and critiquing designs fosters meaningful and constructive discourse. Incorporating the gamification technique into a user-oriented design process involves a combination of competitive and cooperative gaming elements, such as leaderboards, scoring teams, and scoreboards. However, it is essential to prioritize components that encourage compromise and cooperation over pure competition. In the workshop, participants expressed a preference for evaluating

designs based on badges, in addition to scoring and ranking, as a more effective approach to assess design quality. As a result, the distribution of badges has gained prominence as a means of evaluating design quality in the gamification of the design process.

To assess design quality, it is recommended to consider the use of badges and feedback alongside numerical scoring. The case study revealed that badges provide a more comprehensive and suitable means of evaluating design quality, as they allow for detailed explanations and discussions. To implement this approach, it is crucial to develop a set of meaningful badges that align with the objectives of the workshop or study. Furthermore, encouraging participants to provide feedback and insights alongside badge assignments will contribute to a more holistic evaluation process.

The utilization of role-playing techniques during the discussion sessions highlighted the iterative nature of the design process and encouraged participants to continuously enhance their designs through feedback and evaluation. It is highly recommended to offer participants ample opportunities for reflection on their work, identification of areas for improvement, and iterative development of their designs within the studio environment. This iterative approach cultivates a growth mindset among participants, fostering their resilience and adaptability in the field of design practice.

The workshop method employed in this study has served as a valuable pilot study for a studio approach that can be further developed to enhance the relationship between designers and users in educational settings. By integrating diverse game elements, role-playing, and board game components, the workshop method has demonstrated its potential to facilitate students' understanding and engagement with the subject matter. Within the studio environment, where various creative artifacts of varying qualities are produced, the implementation of the "role-playing" method and the use of category badges have proven to be more effective than traditional scoring and leaderboards.

The designers involved in the workshop experienced significant improvements in their work through the valuable feedback received from fictional park residents during two consecutive meetings. These findings align with observations from applied project classes, where the incorporation of gamification elements has consistently fostered a constructive atmosphere and provided a structured framework for enhancing student engagement and facilitating meaningful interactions between users and designers.

In conclusion, this study has shed light on the potential of gamification in design education through a specific workshop format. However, it is important to acknowledge the limitations of the study. The small sample size and the contextual nature of the use case may restrict the generalizability of the findings. Nonetheless, the insights gained from this study can serve as a valuable foundation for future research. It is recommended that future studies explore different methodologies and approaches to further investigate the effects of gamification in design education. By employing larger and more diverse participant samples, utilizing varied workshop formats, and extending the study duration, researchers can build upon the experiments and findings of this limited case study and contribute to a more comprehensive understanding of the role of gamification in design education.

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