

Tech4Seniors: A Gamified Challenge-based Learning Experience Integrating Design Thinking and IoT

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Abstract: This paper presents Tech4Seniors, a short, intensive learning experience that engages engineering students in developing Internet of Things (IoT) solutions to real-world challenges faced by senior citizens. The activity combines Design Thinking and game-based learning principles within a structured, mission-based format, with students working in teams to progress through iterative stages of problem definition, ideation, prototyping, and evaluation. A key aspect of the experience is its focus on user-centred design. Before the in-class session, students interviewed older adults and worked with UX personas representing sensory, mobility, cognitive, or security-related challenges. These insights informed the development of functional prototypes using IoT components and rapid-prototyping materials. The activity was implemented with undergraduate students in a technology-oriented course and evaluated using a mixed-methods approach, including post-activity surveys (n = 52), expert assessment of final prototypes, and qualitative reflections. Two team-formation strategies—random assignment and leader-selected teams based on prior technical experience—were also examined. Results consistently show high levels of student engagement, perceived learning, collaboration, and the development of empathy. Students reported strong alignment between identified user needs and proposed solutions, and expert evaluations confirmed the prototypes' overall quality and feasibility. No meaningful differences were observed between the two team formation strategies. These findings suggest that short, structured, and game-oriented learning experiences can effectively support both technical and human-centred skills in engineering education, particularly when grounded in real-world user contexts. The paper offers a replicable model and practical insights for designing empathy-driven, game-based learning activities.

Keywords: Gamification, Challenge-based learning, Design thinking (DT), Internet of things (IoT), Educational innovation, Higher education

1. Introduction

In recent years, engineering and technology education has increasingly shifted toward active, student-centred learning approaches (Prince, 2004). Traditional lecture-based formats often fall short of developing the practical, collaborative, and human-centred skills needed to address complex, real-world problems (Prince, 2004; Razzouk and Shute, 2012). As a result, approaches such as Design Thinking, challenge-based learning, and game-based learning have gained attention for their ability to engage students in meaningful, applied learning experiences.

Game-based learning has been linked to greater student motivation, engagement, and persistence, particularly when learning activities are structured around clear goals, progression, and feedback (Gui et al., 2023; Wang et al., 2022; Hamari et al., 2014). However, in many higher education contexts, the integration of game elements remains superficial or limited to isolated mechanics, often failing to align with learning objectives or disciplinary practices fully (Deterding et al., 2011; Hamari et al., 2014).

At the same time, there is growing recognition of the importance of incorporating user-centred perspectives into engineering education (Razzouk and Shute, 2012; Liedtka, 2018). Designing technological solutions that are both functional and meaningful requires not only technical expertise but also empathy and an understanding of users' needs, particularly in socially relevant contexts such as ageing populations (Razzouk and Shute, 2012; Yu et al., 2024).

This study presents Tech4Seniors, a short, intensive learning experience that combines game-based learning principles, Design Thinking (DT) methodology, and Internet of Things (IoT) prototyping. The activity challenges students to design and develop technological solutions to everyday challenges faced by senior citizens, grounded in real user input and empathy-driven analysis.

The proposed approach is implemented as a mission-based, time-constrained experience in which students work in teams to move through structured stages aligned with the Design Thinking process. Iterative feedback, prototyping cycles, and a final competitive pitch create a game-like learning environment that promotes engagement, collaboration, and rapid problem-solving.

The study evaluates the approach through student perceptions, expert assessments, and qualitative reflections. In addition, two team-formation strategies are compared to assess their potential influence on collaboration and outcomes.

This paper makes three contributions. First, it presents a replicable model integrating game-based learning, Design Thinking, and IoT. Second, it provides empirical evidence on student engagement, learning outcomes, and prototype quality. Third, it offers practical insights for designing empathy-driven, game-oriented learning experiences in engineering education.

2. Literature Review

2.1 Game-based Learning in Higher Education

Game-based learning (GBL) has emerged as a widely studied approach to enhancing student engagement and supporting active learning in higher education. GBL uses game environments or game design elements to facilitate learning through interaction, challenge, and feedback. Unlike gamification, which typically introduces isolated elements such as points or badges, GBL integrates learning content into a cohesive, structured game experience.

Empirical evidence strongly supports the effectiveness of GBL in educational contexts. Meta-analytic studies in STEM education report moderate-to-large positive effects of digital game-based learning compared with traditional instructional approaches (Gui et al., 2023; Wang et al., 2022). These findings suggest that this approach not only enhances cognitive outcomes, such as knowledge acquisition, but also improves affective outcomes, including student motivation and engagement.

The success of GBL has been attributed to key game design elements, including clear objectives, immediate feedback, progression mechanics, and interactive challenges. These elements foster greater student persistence and active participation, creating learning environments that support problem-solving and decision-making skills (Priyaadharshini et al., 2020; Hamari et al., 2016, as discussed in Li et al., 2023).

However, challenges remain in ensuring that game mechanics closely align with learning objectives and in avoiding superficial implementations that fail to engage students meaningfully.

2.2 Game-based Learning in Engineering Education

In engineering education, GBL has been explored to address the limitations of traditional lecture-based instruction, particularly in developing practical skills and collaborative problem-solving. Engineering curricula often require integrating theoretical knowledge with hands-on application, making them well-suited to game- and challenge-based approaches.

Research indicates that GBL can enhance not only engagement but also higher-order thinking skills, including creativity and problem-solving. Structured game environments that incorporate challenges, iterative feedback, and progression have been linked to improved idea generation and deeper learning outcomes (Gui et al., 2023). Systematic reviews further highlight that game-based approaches in computing and engineering support motivation, active participation, and the development of transferable skills (Videnovik et al., 2023).

Despite these benefits, several limitations remain. Many existing implementations rely heavily on digital platforms or complex game development processes, limiting scalability and adoption in typical classroom settings. Additionally, research on short-duration, face-to-face interventions that combine GBL with hands-on prototyping and real-world problem contexts is limited.

2.3 Design Thinking and User-centred Learning

Design Thinking (DT) has gained significant traction as an educational methodology emphasising creativity, iterative problem-solving, and user-centred design. In engineering education, DT is particularly relevant because it bridges technical problem-solving with human-centred perspectives, fostering a holistic approach to innovation. Beyond its academic applications, DT has become a cornerstone methodology in the software development industry, especially in innovation-driven areas. Companies leverage DT to foster collaboration, generate creative solutions, and ensure that products and services align with real user needs. This industrial adoption highlights DT's relevance as both an educational and professional innovation tool.

Recent meta-analytic evidence indicates that DT has a substantial positive impact on student learning, particularly in creativity, innovation, and problem-solving skills (Yu, Yu, and Lin, 2024). A central component of

DT is the empathise stage, in which students engage with real users to understand their needs, constraints, and lived experiences. This process fosters empathy and solution relevance.

Integrating DT with prototyping further enhances experiential learning by enabling students to test and refine ideas through iterative cycles. However, implementing DT in can be challenging in time-constrained environments.

2.4 Integrating Game-based Learning and Design Thinking

Although GBL and DT have been extensively studied separately, their integration into a unified instructional design remains limited. Emerging research suggests that combining structured game elements with iterative, user-centred design processes can create highly engaging and effective learning experiences.

Game-based structures provide motivation, progression, and feedback, while DT ensures that solutions remain grounded in real user needs. This synergy is especially relevant in engineering education, where students must balance technical feasibility with usability and social impact.

Moreover, there is growing interest in embedding learning activities in authentic, socially meaningful contexts. Addressing real-world challenges—such as those related to ageing populations—can enhance student engagement and promote empathy and ethical awareness.

2.5 Research gap and Contribution

Despite the increasing interest in both GBL and DT, several gaps remain in the literature:

- There is limited empirical research on short-duration learning experiences that integrate game-based structures, such as progression, challenges, and competition, with user-centred DT processes. These experiences should also incorporate hands-on prototyping with technologies like IoT and insights from prior interviews with target users, both of which are essential for connecting learning to authentic contexts and fostering transferable skills in educational and professional environments.
- Few studies have examined the performance of such integrated approaches across varying team-formation strategies in higher education contexts.

The present work addresses these gaps by introducing and evaluating Tech4Seniors, a short, intensive, game-based learning experience that integrates DT, IoT prototyping, and real-world user engagement. The study offers empirical insights into student learning, engagement, and prototype quality, and provides practical guidance for designing scalable, socially relevant learning experiences in engineering education.

3. Methodology

3.1 Research Design

This study uses a mixed-methods approach to assess the effectiveness of the Tech4Seniors learning experience. The research design integrates quantitative data from student surveys and expert evaluations with qualitative data from open-ended student reflections. This combination aims to triangulate perceived learning outcomes, observed performance, and student experiences.

Additionally, the study explores whether different team-formation strategies may influence collaboration, perceived learning, and project outcomes. Team composition is a recurring practical concern in engineering education, as instructors frequently debate whether teams should be assigned randomly or formed around students with prior technical experience. Although the present study was not designed as a controlled experiment, the use of two team-formation approaches provided an opportunity to examine potential trends and generate insights for future research.

3.2 Context and Participants

The study was conducted in a higher education setting within a technology-oriented undergraduate course. Participants included 52 students with diverse academic backgrounds and varying levels of prior experience in electronics, circuits, and robotics.

Students were organised into two groups, each with six teams of five members, for a total of 12 teams. Two team-formation strategies were implemented:

- Group A (Random teams): Students were randomly assigned to teams

- Group B (Leader-selected teams): Team leaders were identified based on prior technical experience and then selected their team members

Both groups participated in the same activity under identical conditions, including the learning objectives, resources, time constraints, and evaluation criteria.

3.3 Description of the Learning Experience

The Tech4Seniors activity was designed as a short, intensive, challenge-based learning experience that integrates principles of game-based learning, Design Thinking, and IoT prototyping.

The session followed a mission-based structure, with teams progressing through stages aligned with the DT process: empathise, define, ideate, prototype, and test. Each stage was time-constrained and tied to specific deliverables, introducing elements of progression and challenge characteristic of game-based learning environments.

A key feature of the activity was its emphasis on user-centred design. Before the session, each team selected a UX Persona representing a senior citizen facing specific challenges (sensory, mobility, cognitive, or security-related). This selection was especially meaningful because many students had personal connections—such as grandparents or elderly relatives—who fit these profiles and faced similar challenges. Students interviewed real individuals who matched these profiles, grounding their design decisions in authentic user needs and fostering empathy with the problem-solving process.

During the four-hour in-class session, teams developed functional IoT prototypes using individual electronic kits (sensors and actuators) alongside shared physical prototyping materials. The activity included two iterative feedback cycles with expert coaches who were upper-semester students. As can be seen in Figure 1, this "peer coaching" dynamic fostered a more collaborative environment, as students were more receptive to peers' suggestions and feedback at a similar academic level. This approach enhanced iterative refinement and encouraged a sense of trust and mutual learning.



Figure 1: All teams received peer coaching by upper-semester students

The experience concluded with a five-minute pitch per team, evaluated by a panel of experts who were not directly involved in the course. Their external perspective strengthened the evaluation. A competitive element was introduced through scoring and the awarding of a prize to the highest-rated solution, further motivating teams to deliver their best work.

3.4 Data Collection Instruments

Data were collected from three complementary sources:

3.4.1 Student survey

A post-activity survey was administered to all participants ($n = 52$). The survey included 12 Likert-scale items (5-point scale) and 2 open-ended questions. It measured six dimensions:

- Empathy and user understanding
- Problem–solution alignment
- Creativity and technical integration
- Usability and safety

- Teamwork and collaboration
- Overall learning satisfaction

Open-ended questions elicited students' perceptions of meaningful learning moments and potential areas for improvement.

3.4.2 Expert evaluation

The evaluation panel consisted of two faculty members with extensive experience in software and hardware development, as well as teaching and supervising engineering design projects. Both experts regularly participate in the assessment of student technology projects and have professional and academic experience in the development of digital and embedded systems. Their expertise was considered particularly relevant for evaluating the technical feasibility, innovation, usability, and alignment of the proposed IoT solutions with user needs.

As it can be seen in Figure 2, a panel of expert judges reviewed the final prototypes. Each team presented their solution in a five-minute pitch, followed by a Q&A session, during which its work was evaluated on a numerical scale from 1 to 100.



Figure 2: Each team had to present their solution to a panel of experts

Evaluation criteria included:

- Technical functionality and feasibility
- Alignment with user needs
- Innovation and originality
- Usability and safety considerations
- Clarity of presentation

3.4.3 Qualitative reflections

Student responses to open-ended questions were collected and analysed to identify recurring themes across learning experiences, challenges, and suggestions for improvement.

3.5 Data Analysis

Quantitative data from survey responses and expert evaluations were analysed using descriptive statistics, including means and standard deviations. Results were examined at the overall level and compared across the two team-formation strategies.

Due to the exploratory nature of the study and the sample size, the analysis prioritised qualitative interpretation over inferential statistical tests. Instead, observed differences between groups were interpreted cautiously, focusing on general trends rather than statistical significance.

Qualitative data were analysed using a thematic approach, complemented by word-frequency analysis to identify recurring patterns in student responses. These insights enriched and contextualised the quantitative findings, providing a more comprehensive understanding of the results.

4. Results

4.1 Student Survey Results

A total of 52 students completed the post-activity survey on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Across all six dimensions, responses were consistently positive, with mean scores above 4.0 in each category.

The highest rating was for Overall Learning Satisfaction ($M = 4.62$, $SD = 0.60$), indicating that students perceived the experience as highly valuable for learning. Similarly strong results were observed for Empathy and User Understanding ($M = 4.51$, $SD = 0.71$), suggesting that the use of UX personas and real-user interviews effectively supported a user-centred perspective.

High scores were also reported for Teamwork and Collaboration ($M = 4.48$, $SD = 0.93$) and for Usability and Safety ($M = 4.40$, $SD = 0.81$). These results indicate that students not only worked effectively in teams but also considered practical aspects such as comfort, accessibility, and security when designing their solutions.

Slightly lower—though still positive—scores were observed for Problem–Solution Alignment ($M = 4.19$, $SD = 0.89$) and Creativity and Technical Integration ($M = 4.04$, $SD = 1.00$). The greater variability in these dimensions suggests differences in students’ confidence in the originality and technical robustness of their prototypes, likely influenced by time constraints and prior experience.

Table 1: Post-activity survey results (n = 52)

Dimension	Mean (M)	Standard Deviation (SD)
Overall learning satisfaction	4.62	0.60
Empathy and user understanding	4.51	0.71
Teamwork and collaboration	4.48	0.93
Usability and safety	4.40	0.81
Problem-solution alignment	4.19	0.89
Creativity and technical integration	4.04	1.00

Note. Responses measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree)

Overall, the survey results indicate a consistently positive perception of the activity, particularly in collaboration, empathy, and the practical application of IoT technologies.

4.2 Comparison by Team Formation Strategy

An exploratory comparison was conducted between Group A (randomly assigned teams) and Group B (leader-selected teams) to assess whether team composition influenced perceived learning outcomes.

Table 2: Comparison of survey results by team formation strategy

Dimension	Group A (Random)	Group B (Self-selected)
Overall learning satisfaction	4.60	4.63
Empathy and user understanding	4.46	4.56
Teamwork and collaboration	4.42	4.54
Usability and safety	4.40	4.40
Problem-solution alignment	4.30	4.09
Creativity and technical integration	3.93	4.14

Note. Responses measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree)

Across all six dimensions, both groups reported similarly high scores, with only minor variation. In Empathy and User Understanding, Group B had a slightly higher mean (4.56) than Group A (4.46). By contrast, Group A reported a marginally higher score in Problem–Solution Alignment (4.30 vs 4.09).

Differences in Creativity and Technical Integration were also limited, with Group B reporting a slightly higher mean (4.14) than Group A (3.93). For Teamwork and Collaboration, both groups again showed strong

agreement (Group A: 4.42; Group B: 4.54), indicating that collaboration was perceived positively regardless of the team formation method.

Overall Learning Satisfaction remained consistently high across both groups (Group A: 4.60; Group B: 4.63), with minimal variation.

Taken together, these results suggest that the learning experience produced comparable outcomes across both team-formation strategies. The absence of notable differences suggests that the activity's effectiveness may not depend strongly on team composition.

4.3 Expert Evaluation Prototypes

Each team presented its prototype in a concise five-minute pitch, followed by a question-and-answer session addressing specific aspects of the solution. The evaluation was conducted by two expert judges with extensive experience in hardware and software development.

For Group A (random teams), scores ranged from 74 to 94, averaging 86. For Group B (leader-selected teams), scores ranged from 78 to 97, averaging 90.

Although Group B achieved a slightly higher mean score, both groups showed strong overall performance, with several teams in each group scoring above 90. As shown in Figure 3, both groups exhibit overlapping score distributions, with a slightly higher median observed for self-selected teams.

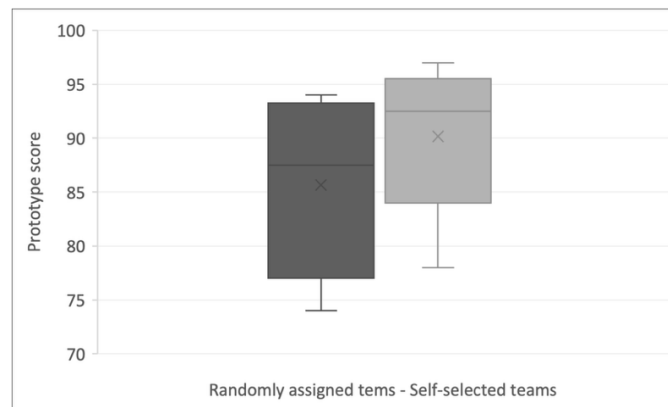


Figure 3: Expert evaluation scores by team formation strategy

Note. Boxplots show the distribution of total prototype scores for randomly assigned and self-selected teams. The central line represents the median, the box indicates the interquartile range, and whiskers denote the minimum and maximum values.

To further examine these outcomes, a criterion-level analysis was conducted using the expert evaluation rubric. A more detailed analysis of the expert evaluation rubric (Table 3) revealed consistently strong performance across all five criteria in both groups. The highest scores were observed in user and problem understanding and inclusion and usability, indicating that teams effectively addressed user needs and practical considerations in their designs.

Table 3: Expert evaluation by rubric dimension and team formation strategy

Dimension	Weight	Group A (Random)	Group B (Self-selected)
User and problem understanding	25%	2.29	2.33
Creativity and innovation	20%	1.67	1.69
Technical functionality	20%	1.77	1.75
Inclusion and usability	20%	1.78	1.83
Communication and teamwork	15%	1.23	1.42

Note. Values represent mean weighted scores per criterion based on expert evaluation

Differences between groups were generally small. Group B (self-selected teams) showed slightly higher scores in communication and teamwork, as well as inclusion and usability, while both groups performed similarly in creativity and innovation and technical functionality.

These findings are broadly consistent with the student survey results, where high levels of perceived collaboration, usability and user-centred thinking were also reported. Overall, the expert evaluations support the conclusion that both team formation strategies led to the development of coherent and functional IoT prototypes.

4.4 Qualitative Findings

Qualitative analysis of the open-ended responses offers further insight into students' experiences of the activity. Two main areas were examined: meaningful learning moments and suggested improvements.

4.4.1 Meaningful learning experiences

Students frequently highlighted hands-on prototyping as the most impactful aspect of the activity. Many described building and testing circuits, integrating sensors and actuators, and seeing their ideas take functional form within a limited time frame.

Teamwork and collaborative ideation also emerged as a central theme. Students described brainstorming sessions, task distribution, and the integration of diverse perspectives as key elements of their learning experience.

The user-centred aspect of the activity was another recurring theme. Several students emphasised that designing for a real person—rather than a hypothetical user—changed how they approached the problem, particularly in terms of usability and relevance.

Time pressure was often cited as both a challenge and a driver of learning. While some students found the limited duration restrictive, others noted that it encouraged faster decision-making and experimentation.

Finally, feedback from peers and coaches was frequently regarded as valuable, particularly for helping teams refine their ideas during the iterative stages.

4.4.2 Suggested improvements

The most common suggestion was the need for more time, with students indicating that longer sessions would allow for more iterations and more refined prototypes.

Students also highlighted limitations in materials and technical resources, including component availability and compatibility issues. Several responses noted the potential integration of software components, such as databases or user interfaces, as an area for improvement.

Another recurring theme concerned the structure of coaching support. While feedback from senior students serving as mentors was appreciated, some participants suggested greater continuity—such as assigning a single mentor per team—to provide more consistent and focused guidance.

Finally, some students reflected on the need for improved initial planning and task organisation, particularly in defining realistic project scopes within the available time.

Despite these suggestions, overall feedback remained strongly positive, with several students indicating they would repeat the experience without major changes.

5. Discussion and Contributions

The findings suggest that the Tech4Seniors activity offers an effective way to integrate game-based learning, Design Thinking, and IoT prototyping within a short, intensive format. Rather than treating these elements as separate pedagogical strategies, the results indicate that combining them creates a learning environment that supports both technical development and user-centred thinking.

A central outcome of the study is the strong emphasis on empathy-driven design. High scores in user understanding, together with qualitative reflections, indicate that engaging with real users before the activity had a clear impact on how students approached problem-solving. This reinforces previous work on DT in engineering education, which highlights the importance of grounding technical solutions in real user contexts.

rather than in abstract problem definitions. The empathise stage directly informed subsequent design decisions.

At the same time, the results highlight the role of hands-on prototyping as a learning mechanism. Students consistently identified building and testing functional solutions as one of the most meaningful aspects of the experience. This aligns with experiential learning approaches, in which knowledge is constructed through action and iteration. Expert evaluations confirmed that students produced working prototypes aligned with user needs.

These findings align with prior research on active and game-based learning in engineering education (Prince, 2004; Dai et al., 2025), which can enhance engagement and problem-solving.

One notable insight from the findings is the impact of time constraints. Although limited time is often perceived as a challenge in DT activities, students in this study frequently highlighted it as a catalyst for heightened focus and swift decision-making. This mirrors a key dynamic in game-based experiences, particularly in video games, where time is often a central element driving engagement. Gamers tend to view time limits not as stressors but as motivating factors that amplify urgency and excitement. Jane McGonigal refers to this phenomenon as "urgent optimism"—a mindset in which the combination of challenge and time pressure inspires individuals to tackle problems with energy and determination (McGonigal, 2010). Similarly, the time-bound structure in this study appears to have reinforced these principles, enhancing elements such as challenge, urgency, and progression through stages. These findings suggest that well-structured, short-duration formats can leverage this "urgent optimism" to foster meaningful and impactful learning experiences.

The activity also demonstrated strong outcomes in collaboration and peer learning. High ratings for teamwork, together with qualitative feedback, indicate that students were able to organise effectively, distribute tasks, and integrate diverse perspectives. Iterative feedback from advanced-semester students (couches) further supported reflection and improvement, although students' suggestions regarding mentor continuity point to an area for refinement in future implementations.

One of the study's initial motivations was to examine whether team-formation strategies would affect learning outcomes. The results show no substantial differences between randomly assigned and leader-selected teams, in either student perceptions or expert evaluations. Rather than suggesting that team composition is irrelevant, this finding points to the robustness of the instructional design. The activity's structure—particularly the combination of clear goals, iterative feedback, and shared constraints—appears to support consistent outcomes across different team configurations.

From a game-based learning perspective, the results offer insight into how game elements can be meaningfully integrated into engineering education without relying on fully developed digital games. In Tech4Seniors, game-like dynamics emerged from the combination of mission-based progression, time constraints, iterative challenges, and a final competitive pitch. These elements sustained engagement while remaining closely aligned with the learning objectives, addressing a common limitation in GBL implementations: the superficial addition of game mechanics.

5.1 Contributions

This study makes three main contributions to the field of game-based learning and engineering education.

5.1.1 Development of an innovative instructional model

The study introduces a replicable instructional framework that seamlessly integrates game-based learning, Design Thinking, and IoT prototyping within a condensed, short-duration format. Unlike traditional approaches that often rely on extended project timelines or digital platforms, this model demonstrates that impactful, hands-on, and user-centred learning experiences can be achieved in a single session, provided the activity is meticulously structured.

5.1.2 Empirical validation of the approach

By combining student perceptions, expert evaluations, and qualitative reflections, the study provides robust empirical evidence for the effectiveness of the proposed instructional model. Triangulating these diverse data sources enhances the credibility of the findings and underscores the value of using mixed-methods evaluation in similar educational contexts.

5.1.3 Practical design insights for education

The findings offer actionable recommendations for educators, highlighting the critical role of empathy-building activities, the benefits of time-constrained challenges, and the flexibility of team-formation strategies. These insights are particularly valuable for instructors seeking to design game-based learning experiences that foster social relevance and meaningful engagement in engineering and technology education.

5.2 Limitations

While this study provides valuable insights, several limitations must be acknowledged to contextualise its findings. First, the relatively small sample size, confined to a single institutional setting, may limit the generalisability of the results. Second, reliance on self-reported data introduces potential biases arising from students' perceptions and response tendencies. Third, the short duration of the activity limits the ability to assess long-term learning outcomes and skill retention.

5.3 Future Directions

To build on these findings, future research should prioritise larger, more diverse samples to improve representativeness and applicability across contexts. Longitudinal studies are also essential for assessing the durability of technical and user-centred competencies over time. By addressing these gaps, subsequent investigations can deepen our understanding of how game-based and socially impactful learning strategies shape engineering and technology education, fostering innovation and adaptability in an evolving academic landscape.

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Ethics Declaration: Formal ethical clearance was not required for this study. Students were invited to complete an open survey voluntarily, and it was clearly stated that their responses could be used for research purposes. Participation was entirely optional, and no identifiable personal data was collected.

AI Declaration: Grammarly, an AI-powered writing assistant, was used during the preparation of this paper. The tool supported the revision process by identifying grammar, spelling, and punctuation errors and suggesting improvements to enhance clarity and conciseness. All suggestions provided by the tool were carefully reviewed and selectively applied by the author to preserve the intended meaning and academic tone of the paper.

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