Enhancing Student Engagement in HCI Courses through Gamified Mobile Learning Interfaces in Higher Education

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***Abstract*—This research investigates the effects of gamification on designing mobile learning interfaces for Human-Computer Interaction (HCI) courses in higher education, aiming to generate interest and enhance learners' skills. The study involved 87 students who interacted with a gamified mobile learning platform designed specifically for HCI education. Three interface prototypes were developed and compared to identify the most effective design. This research uniquely addresses the application of gamification in HCI courses, an area previously underexplored in higher education, by integrating tailored gamified features. The evaluation process included usability testing, which measured key performance metrics such as task success rates and time efficiency. This research evaluated the results by measuring user satisfaction levels with the interface and analyzing heatmaps for the three prototypes. Alongside a Learning Outcome Assessment that compared pre-test and post-test scores to assess the educational impact of the gamified features. The results revealed that students favored Prototype I, receiving the highest engagement scores and positive feedback in terms of usability. This prototype also significantly improved students' comprehension and knowledge retention, as indicated by the Learning Outcome Assessment. In contrast to prior studies, this research employs a comparative analysis of three distinct prototypes to identify optimal design strategies tailored to HCI-specific learning environments. The findings highlight the effectiveness of incorporating gamification into mobile learning platforms, particularly in enhancing user experience and educational outcomes in HCI courses.**

***Keywords*—gamification, mobile learning, user interface design, User Experience (UX), User Interface (UI)**

I. Introduction

In the digital age, technology plays a crucial role in transforming teaching and learning methods, and mobile learning platforms have rapidly increased in popularity. Mobile learning enables students to access content and resources anytime and anywhere. However, technology use can affect the attention span of children and adolescents [1, 2]. Additionally, university students today often face challenges in maintaining focus due to distractions from technology and the digital world, such as social media or other engaging applications. In an era where online learning plays a major role [3–5], students may feel that the interactive engagement of traditional classrooms is missing, which can reduce participation and communication with peers or instructors. Gamification, a popular approach with evidence supporting its effectiveness, can increase student engagement and motivation by making learning more enjoyable and challenging. Therefore, applying gamification to mobile learning interfaces in Human-Computer Interaction (HCI) courses may encourage greater student engagement.

Furthermore, effective interface design is a critical factor in enhancing the user experience [6]. However, challenges such as a lack of interest and engagement in the learning process can arise when the interface design fails to be appealing or does not encourage user participation.As an approach to addressing this issue, gamification has been introduced into the design of learning interfaces to increase attractiveness and user engagement. Gamification is the process of incorporating game-like elements into systems to enhance engagement and challenge users. In educational contexts, the incorporation of game design elements can help make learning more engaging and improve educational outcomes for students. Despite the growing interest and extensive research on the use of gamification in education in recent years, there is still a lack of in-depth studies on the impact of game elements on mobile learning interface design, particularly within the context of HCI courses. HCI is a critical field that requires effective interface design to facilitate learning. In an era where digital technology is not just a tool but has become an inseparable part of daily life, technology has reshaped the structure of various activities in society, such as commerce, services, financial transactions, entertainment, and education [7].

The advancement of technology has made every aspect of life more convenient. In education, technology plays a significant role in promoting learning, developing skills, altering learner behavior, and supporting higher learning outcomes. The current trend has introduced many educational innovations, one of which is gamification—the implementation of game mechanics in non-gaming contexts. Without gaming [8], Gamification emerged in educational practices after World War II as a tool to enhance learner motivation and participation, particularly in areas like military training and industrial skill development. Over the years, it transitioned into a popular technique across multiple sectors, integrating game-like features and interactive designs to boost user engagement and improve educational and operational outcomes [9]. However, by 2010, gamification became widely known and popular, achieving significant success in both business and education. Additionally, the current trend includes numerous educational innovations, one of which is gamification. Gamification began to gain recognition and popularity around 2010 and has been successfully implemented in both business and education sectors [10]. Initially, gamification was used in marketing activities, but it has since expanded into teaching and learning activities. This approach has transformed learning into an activity characterized by competition, collaboration, and problem-solving, focusing on

creating an enjoyable and challenging learning experience where students aim to achieve and earn rewards based on the game's structure [11].

Prior studies have demonstrated its effectiveness in fields such as general education and business training, where integrating game-like elements improved learner participation and outcomes [6–8]. However, its specific application to HCI courses, which demand interactive and user-centered design skills, remains underexplored. This gap presents an opportunity to investigate how gamification can be tailored to optimize learning in this context. For this reason, the researcher has conducted a study on the appropriate user interface design for education by applying the concept of gamification to HCI courses. This research addresses the gap in understanding how gamified mobile learning interfaces can specifically enhance student engagement and motivation in HCI courses, an area that remains underexplored in higher education. By introducing three prototypes and evaluating their effectiveness, this study provides novel insights into the optimal design strategies for gamification in HCI learning environments, bridging the gap between User Experience (UX) principles and educational outcomes. The objective to explore and understand the impact of gamification on the design of mobile learning interfaces for teaching HCI courses in higher education. Additionally, this study seeks to increase learner interest and engagement, helping students feel more motivated to learn.

In addition, This study aims to understand the effects of incorporating gamification on user experience and learning outcomes. Additionally, the research seeks to identify methods that can motivate students to engage more in their learning, using gamification as a tool to enhance learning motivation. Gamification can help students develop skills in interacting with modern technology and contribute to more effective, long-term retention of course content. The study involves comparing three different graphic designs of user interfaces based on varying gamification activities to determine the most suitable design for IT students. This will serve as a prototype for designing user interfaces for mobile learning in HCI courses that align with the needs and usage behaviors of undergraduate students.

II. Literature Review

This section is divided into two parts: the first part discusses the background of gamification in education, and the second part examines related research on user interface design in educational settings.

A. Gamification in Education

Gamification involves designing systems, services, organizations, and activities that mimic the experiences and motivations found in gaming, but with the added aim of influencing user behavior towards achieving educational goals [12]. It is recognized as a promising educational model that has the potential to enhance student learning outcomes [13]. Numerous studies have applied gamification within universities and various academic contexts [14], across a wide range of subjects [15, 16] including information technology [17] and mathematics [18]. Many researchers are using gamification to enhance educational engagement. Shaban and Xiao [19] incorporated gamification within social networks to boost collaboration among computer science students. Shabadurai *et al*. [20] proposed a dynamic framework that adapts to user needs in online training, increasing engagement. Rincon-Flores *et al*. [21] explored gamified telepresence for calculus learning, emphasizing real-time engagement, while Borras-Gene *et al.* [22] integrated gamification in engineering MOOCs to maintain motivation. Bovermann *et al.* [23] examined online readiness and attitudes, finding mixed results on gaming impact in education. Mystakidis [24] used social virtual reality gamification to foster engagement in distance learning. Oe *et al.* [25] assessed gamification's influence on learning outcomes, especially during the COVID-19 era, and Aristana and Ardiana [26] designed a gamified solution for students with unstable internet, highlighting accessibility challenges.

Moreover, Khaldi *et al.* [27] conducted a systematic literature review on e-learning gamification in higher education, highlighting that targeted gamification significantly enhances student engagement and motivation in digital learning environments by aligning game elements with course objectives. Oliveira *et al.* [28] explored tailored gamification, finding that adapting game mechanics to individual learning styles improves educational outcomes and provides a pathway for more effective and satisfying learning experiences. Some researchers investigate how integrating gamification with instructional design can improve the usability and effectiveness of online learning platforms in higher education [29].

B. User Interface Design in Education

In the context of mobile learning, researchers have highlighted the importance of maximizing usability by ensuring that the application is tailored to meet learners' functional requirements, thereby providing an effective learning experience. An interface that is not user-friendly can lead to frustration and discomfort during learning sessions [30]. Moreover, some researchers emphasize that the user interface plays a critical role in the development of mobile learning applications, as it impacts various aspects of the learning process [31].

Beyond just usability, the development of mobile learning tools for students must also consider other UX elements, such as the inclusion of useful content, accessibility, credibility, attractive visuals, enjoyment, and user acceptance [32]. Some researchers integrate the gamification mechanism into the teaching process, focusing on designing activities and evaluating the effectiveness of UX design to identify the most appropriate interface for learners. The authors developed a user interface design for a digital testing platform based on the Sengkedan concept. The research focuses on enhancing the usability and effectiveness of the digital test system in educational settings [33]. While previous studies have explored gamification in education, their application to HCI courses remains underexplored. This research addresses this gap by introducing user interface designs tailored to information technology curricula, incorporating gamification elements such as dynamic feedback, personalized rewards, and intuitive navigation. These prototypes aim to enhance student engagement and learning outcomes in the unique context of HCI education.

III. Research Method

The part of research method of mobile learning interface design for human computer interaction courses of higher education by using gamification mechanisms are decides in five parts, Fig. 1 show the process of the framework.

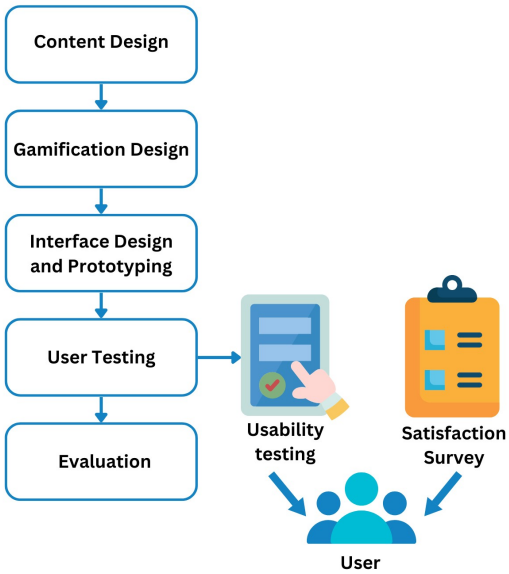


Fig. 1. Research methodology framework.

A. Content Design

In the content design process, the user involved is the course instructor. The course content is aligned with the information technology course plan. During the design phase, content is defined to identify the concepts, theories, and principles that will structure and model the teaching. The learning outcomes were defined to ensure that learners understand the basic principles of HCI, can apply this knowledge to develop UX and UI design, and are able to analyze problems related to usability design. The Active Learning curriculum in this research for the HCI course, shown in Table 1, covers essential topics to build foundational knowledge and skills. It begins with understanding HCI concepts, followed by exploring tools and processes for UX/UI design, understanding color schemes, and practicing screen and layout design on mobile devices. Each topic is structured to deepen students' comprehension and application in HCI design.

Table 1. Active learning for HCI course

No	Active learning Topic	period	Objective
1	Learning for HCI	2	Students understand the HCI.
2	Implementation of the UX/UI design process and the basics of interaction design.	2	Students know the Tool and steps for UX/UI design.
3	Understand the importance of color in the design of interaction systems.	2	Students understand the color scheme for UX/UI design.
4	Designing screens and layouts via mobile devices	4	Students can practice designing screens through mobile devices.

Additionally, Gamification was employed to increase interest and stimulate learner participation. The learning activities were designed to align with these learning outcomes, including reading content, taking quizzes, assigning projects, and incorporating various game mechanisms. Subsequently, the learning outcomes assessment method was defined using quizzes, project evaluations, and observing learner behavior to ensure that learners could achieve the stated goals. The sample group for this research consisted of 87 students from the information technology program in the faculty of science at Suan Sunandha Rajabhat University, who were enrolled in the Human Computer Interaction course.

Table 2. Mechanics and dynamics in gamification design and development

Type	Regular
Game Mechanics and Dynamics	Description
Fast Feedback	Players will receive immediate feedback, which allows them to know the results of their actions quickly and adjust their strategies accordingly.
Challenge	Players will face various challenges, motivating them to improve their skills or knowledge.
Badge	Scoring format and presentation using symbols

B. Gamification Design

Gamification design is carried out after each lesson objective has been defined. There is important to adapt the tutorials to the mechanics of the game and to the objectives of each teaching activity. The design of gamification for teaching the HCI course aims to enhance student interest and engagement by incorporating game mechanics that effectively promote learning. The elements of gamification used in this course include providing immediate feedback, allowing students to receive real-time information on their learning outcomes. Rewards are also employed in this study to motivate learning by awarding badges when students achieve specific goals, fostering a sense of accomplishment and encouraging greater commitment to learning. Challenges are created by designing gamification that matches the students' skill levels, with the difficulty gradually increasing to help develop their skills and knowledge. Overcoming these challenges motivates students to solve problems and continuously improve their abilities. Additionally, continuous engagement is promoted by maintaining student interest and participation throughout the learning process. This is achieved by designing quests or missions in the form of games, giving the learning experience a structured and goal oriented approach. The details of gamification design are shown in Table 2.

C. Interface Design and Prototyping

For the process of interface design and prototyping, a preliminary design of a use case diagram was created to make the interface design consistent with the system development.

The usecase diagram in Fig. 2 provides a detailed overview of the interactions within a Learning Management System (LMS) that incorporates gamification elements. The system caters to three primary user roles: Students, Lecturers (Instructors), and Administrators (Admins). Each role interacts with the system through distinct use cases tailored to their specific functions and responsibilities. The use cases depicted in the diagram encompass the core functionalities of the LMS. The system includes key functions such as Register, which allows students to create an account and access resources. Login provides secure access to personalized dashboards for all users, and Lesson where students interact with course content and lecturers manage educational

materials. Additionally, gamification enhances student engagement by integrating game elements into the learning process, while Score and Profile management allows students and administrators to monitor and manage performance metrics and personal information.

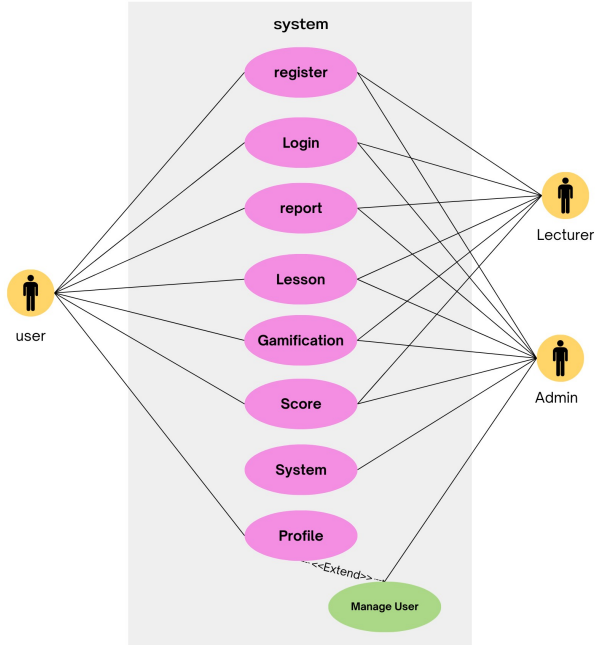


Fig. 2. Use case diagram.

The researchers designed three prototypes show in Fig. 3 with the following details:

- **Prototype I** uses cartoons and bright colors to present lesson content and activities, attracting learners' attention and making learning friendly and fun. The lessons are divided and easy to use, allowing learners to immediately select the lesson topics they are interested in. Gamification is used in the design, with rankings and color games that help foster positive participation and competition among learners.
- **Prototype II** is designed for progress tracking and motivation. Gamification promotes and emphasizes tracking learners' progress through accumulating points and unlocking new learning content based on their scores. The ranking is done in a graph, allowing learners to see an overall picture of their progress and compare it with their classmates.
- **Prototype III** is structured to prioritize assessment and feedback by incorporating gamification elements such as quizzes and point-based scoring to evaluate learning outcomes. This design emphasizes organized lesson structures, enabling learners to choose specific lessons and tests and fostering a motivating and goal-oriented learning experience.

Table 3 provides a comparative analysis of the design features and gamification elements of the three prototypes developed for this study. Each prototype adopts a distinct approach to navigation, progress tracking, gamified elements, learning structure, and visual appeal to enhance student engagement and learning outcomes in HCI courses. The table highlights the unique characteristics of each prototype and how their gamification strategies differ to cater to diverse learner preferences and objectives.

Table 3. Comparison of prototype design and gamification element

Aspect	Prototype I	Prototype II	Prototype III
Navigation Design	Simple and direct with clear icons for quick access	Interactive map-based navigation	List-based navigation with lesson labels
Progress Tracking	Game levels with progress tracking	Unlockable stages on a map	Sequential unlocking of lessons
Gamified Elements	Ranking system, social interaction	Score indicator, map exploration	Quiz access, achievement-oriented steps
Learning Structure	Structured by game levels	Progression through stages in a sequential order	Step-by-step lesson progression
Visual Appeal Aspect	Minimalist and functional design Prototype I	Highly visual with an adventure theme Prototype II	Clean and systematic layout Prototype III

This approach aims to enhance learner motivation and encourage higher scores through interactive assessment. Fig. 4 demonstrates different gamified interface designs across three prototypes, each developed to address specific aspects of user engagement and learning outcomes.

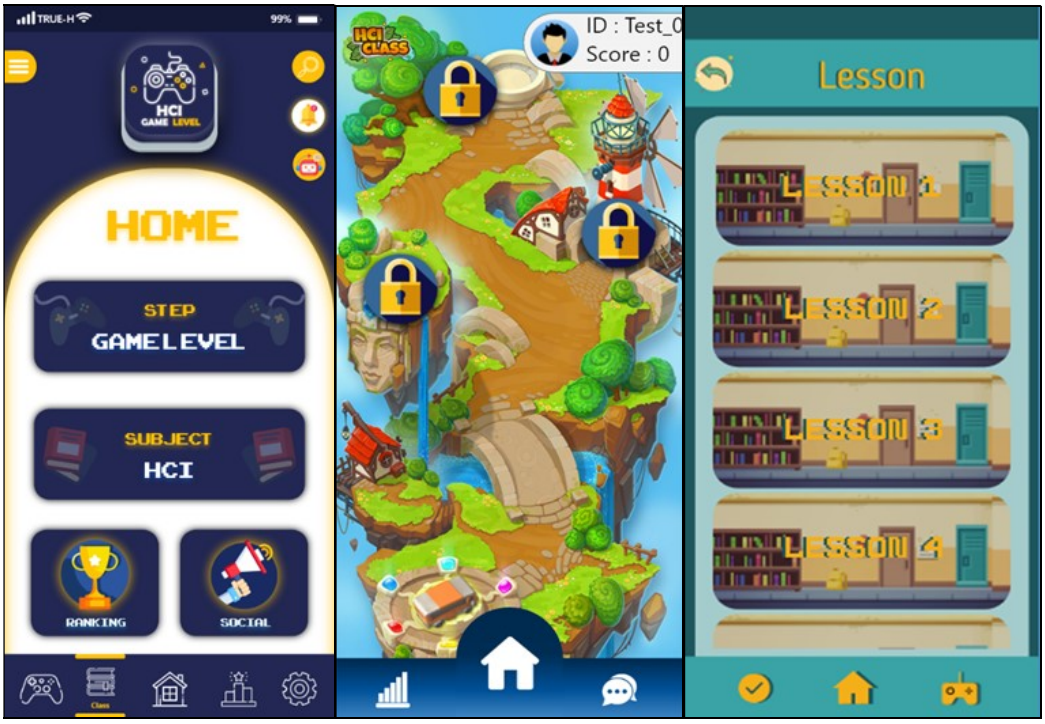
- **Prototype I** leverages user personalization as a strategy to enhance engagement, allowing users to customize the interface, such as selecting smartwatch wallpapers. This design aims to foster a sense of ownership and connection with the interface.
- **Prototype II** incorporates decision-based tasks accompanied by immediate feedback, aligning with principles of active learning and reinforcing user interaction. This approach encourages critical thinking and promotes a dynamic learning experience.
- **Prototype III** focuses on assessment-driven interactive learning, where learners progress through levels and earn points for completing quizzes. This design emphasizes achievement and goal setting, motivating users to sustain their engagement while tracking their progress.

D. User Testing

In the user testing process to test the gamification of the mobile learning design, From the registration in the HCI course, there were 87 students in a class. Students were randomly divided into three groups with an equal number of students (approximately 29 students per group). Each group was assigned to use one of three different prototypes. Participants were selected based on the following criteria: 1) enrollment in an HCI course, 2) familiarity with mobile learning platforms but no prior experience with gamified interfaces, and 3) willingness to participate in the study. These criteria ensured that the sample group possessed a uniform baseline understanding. For the experimental setup, researchers ensured that all participants tested the prototypes in a controlled laboratory environment to maintain consistent conditions, such as lighting, sound levels, and the duration of prototype use. Researchers provided all participants with identical instructions and guidance before the experiment to minimize bias and ensure consistency across groups. Each session was standardized to a duration of 30 minutes for all participants.

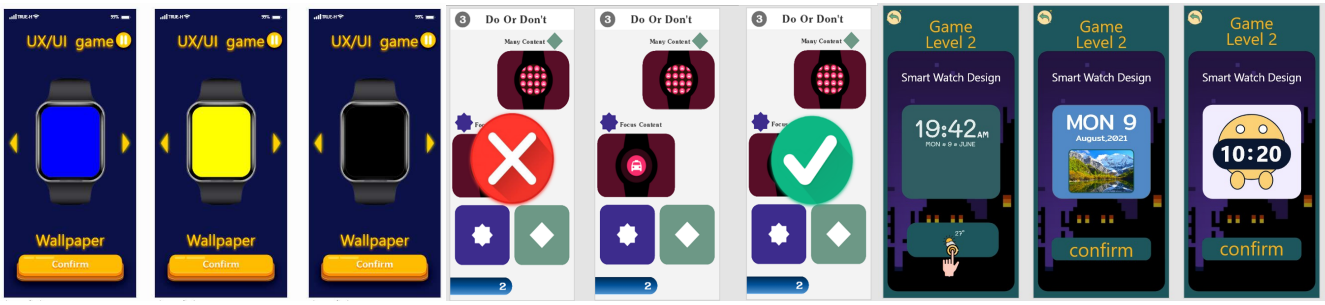
Usability testing by using heat map tool was used to record user clicks, scrolling, time spent on individual features, and interactions with each prototype. A satisfaction survey was also conducted via a satisfaction questionnaire. Multiple

comparisons were used to test the difference between the mean satisfaction scores of the three user groups and to analyze which interface design had a significantly higher score.



(a) Prototype I (b) Prototype II (c) Prototype III

Fig. 3. Examples of interface design for all 3 types of prototyping.



(a) Prototype I (b) Prototype II (c) Prototype III

Fig. 4. Examples of interface design for gamification.

Fig. 5. Example of Heat map evaluation results.

IV. Experimental Result

The results of the learners' initial learning and usage were given to each group to try out the assigned UI for the same amount of time, with a 30-minute trial period, to learn how to use it and explore the various functions. Then, task-based testing was set up, which consisted of searching for information, filling out forms, and trying out gamification. During the testing, user interaction data was recorded using a heat map, and users were asked to answer a satisfaction questionnaire. An example of the heat map result is shown in Fig. 5.

From Table 4, Prototype I consistently outperform the other two prototypes on various user experience criteria, with an average satisfaction score of 4.58, indicating that users generally find Prototype I easier to use, has a more aesthetically pleasing interface, and is more responsive, particularly in areas such as clarity of use, ease of navigation, and game experience. In contrast, Prototype II and Prototype III have lower and more similar average satisfaction scores (3.87 and 3.81, respectively), indicating that their user experiences are comparable.

Table 4. Mean satisfaction scores for each prototype based on user experience

List	Average		
	Prototype I	Prototype II	Prototype III
Clarity of use	4.5	3.8	3.9
Ease of navigation	4.7	4.0	4.1
Consistency of design	4.6	3.9	3.8
System responsiveness	4.4	3.7	3.6
Aesthetics and appeal	4.8	4.1	4.0
Gamification experience	4.7	3.9	3.7
Device compatibility	4.5	3.8	3.7
Help and information availability	4.6	3.7	3.8
Customization and control	4.4	3.8	3.6
Suitability for educational purposes	4.7	3.9	3.8
Clarity of content presentation	4.5	4.0	3.9
Average	**4.58**	**3.87**	**3.81**

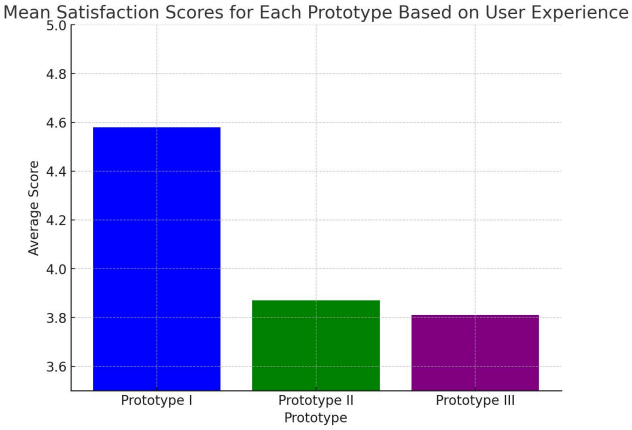


Fig. 6. Comparison mean satisfaction scores of three prototypes.

Fig. 6 shows the average satisfaction score of each prototype based on user experience. Prototype I received the highest average score of 4.58, indicating high user satisfaction. Prototype II and Prototype III had lower scores, with average scores of 3.87 and 3.81, respectively, suggesting that most users preferred Prototype I.

Moreover, this research used one-way ANOVA to test whether there were any differences between the prototypes from the three mobile learning interface design approaches. The ANOVA analysis demonstrates in Table 5 that there is a statistically significant difference in user satisfaction scores among the three prototypes. This means that the variation in satisfaction scores is unlikely to have occurred by chance, as evidenced by the F-value of 15.25 and a *p*-value of less than 0.001. These results confirm that at least one prototype stands out significantly in terms of user satisfaction when compared to the others. As shown in Table 6, with a significance level of $\alpha = 0.05$, the results indicated significant differences in satisfaction scores between Prototype I and Prototype II, as well as between Prototype I and Prototype III. However, no significant difference was observed in user satisfaction scores between Prototype II and Prototype III. The significant differences between the two prototypes, as confirmed by ANOVA, indicate that users have a clear preference for Prototype I, especially for educational purposes in HCI courses. These findings emphasize that Prototype I is the most effective design for increasing user engagement and satisfaction.

Table 5. ANOVA results for satisfaction scores across prototypes

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	23.50	2	11.75	15.25	0.01
Within Groups	65.00	84	0.77		
Total	88.50	86			

Table 6. Multiple comparisons of user satisfaction scores

Indexing		Mean Difference (I-J)	Std. Error	sig (2-tail)	Conclusion
(I)	(J)				
Prototype I	Prototype II	0.70	0.15	0.002	Significant
Prototype I	Prototype III	0.68	0.17	0.017	Significant
Prototype II	Prototype III	0.02	0.14	0.419	No Significant

Table 7 shows the comparison of Pre-Test and Post-Test scores for Prototype I, which assesses users' understanding and experience in various aspects related to the use of gamification to help design the interface, showing an increase in the overall Post-Test score. The table also shows that after using Prototype I, scores in each topic significantly increased, especially in the knowledge of starting a quiz or activity and understanding of the role of game elements categories, indicating that Prototype I increased users' learning and understanding of the content.

Table 7. Comparison of pre-test and post-test scores for prototype I

List	Pre-Test Score	Post-Test Score
Understanding of basic navigation feature	2.8	4.2
Expectation on gamification impact	3.5	4
Knowledge of starting a quiz or activity	3	4.5
Motivation to learn through gamification	3.3	4.3
Recall steps to access key content	2.9	4.1
Understanding of gamification's role	3.2	4.4
Confidence in learning with the interface	3	4.2
Average	**3.10**	**4.24**

V. Conclusion and Discussion

The heatmap and user satisfaction score analysis provided a comprehensive understanding of the effectiveness of the three prototypes designed for a HCI course. The experimental results showed that Prototype I was the most effective for this specific student sample in HCI courses, as demonstrated by user satisfaction assessments. The heatmap analysis indicated that users interacted with Prototype I more frequently and more effectively, especially in areas with core functions such as navigation and gamification elements, indicating that the Prototype I design was more user-friendly and more in line with learners' expectations and learning needs. In addition, the user satisfaction survey results supported these findings, with Prototype I which receiving the highest average score (4.58) compared to Prototype II (3.87) and Prototype III (3.81). These results indicated a clear preference for Prototype I, which was also reflected in the multiple Comparisons results. The results showed a significant increase in satisfaction scores between the prototypes confirming that the difference in user preferences was statistically significant. Prototype I was significantly more popular than both Prototype II and Prototype III. At the same time, there was no significant difference in user satisfaction between Prototype II and Prototype III. In addition, the higher Post-Test scores compared to Pre-Test scores in the areas of knowledge of starting a quiz or activity

and understanding of gamification's role indicate an increased user understanding of fundamental features and a recognition of gamification's value in the HCI learning process. This improvement suggests that Prototype I is an effective interface, suitable for enhancing HCI course delivery and supporting the development of instructional systems in this field. This study demonstrated the impact of gamification on user engagement and learning outcomes in HCI courses. By evaluating three prototypes, it identified Prototype I as the most effective design due to its user-friendly interface and well-integrated gamification elements, which align with the needs of modern learners. These findings contribute valuable insights into the design of gamified educational tools, enhancing usability and fostering deeper learning engagement. This study can be extended to explore the impact of other gamification elements, such as team-based competition or the development of more sophisticated virtual rewards.

The results of this research are consistent with previous research on the impact of user-friendly interface design and the effective use of gamification elements in educational environments. Studies have shown that user-friendly, aesthetically pleasing interfaces that incorporate engaging elements, such as gamification, tend to increase user satisfaction and learning outcomes [8, 9]. The results of this study support these conclusions, indicating that the design elements used in Prototype I, navigation, responsive systems, and engaging gamification features are effective in promoting positive user experiences and increasing learning engagement. The lower effectiveness of Prototype II and III may be attributed to specific design limitations. Prototype II included interactive elements but lacked the seamless flow of usability compared to Prototype I, resulting in lower engagement. Meanwhile, Prototype III focused solely on testing and assessment, which may have limited its overall appeal and user interaction. Furthermore, Prototype I is consistent with literature that emphasizes the importance of usability design in educational tools [9–12]. In discussing the research findings, Prototype I demonstrated the highest interface effectiveness, evaluated through interaction frequency and user satisfaction scores in critical areas, such as navigation and gamification elements. These results align with the study by Khaldi *et al.* [27], which found that gamification tailored to educational content significantly enhances learning effectiveness, particularly when emphasizing quality engagement and interaction. The findings also support Oliveira *et al.*'s [28] perspective that personalized gamification, adapted to learners' specific needs, promotes more effective learning, especially when the interface design aligns with practical usability and student learning behaviors.

Furthermore, the observation that Prototype I achieved the most interactions and highest satisfaction scores corresponds with Mystakidis's research, which demonstrated that gamification in virtual learning environments stimulates engagement and encourages students to use learning functions actively [24]. However, these findings contrast with Bovermann *et al*. [23], who noted that some learner groups may hold varied attitudes towards gamification, potentially hindering consistent engagement, especially among those less comfortable with game-based learning.

The higher satisfaction scores and heatmap data for Prototype I underscore its effectiveness in providing a user-friendly environment that supports self-directed learning and promotes ongoing interaction. The results suggest that when designing educational interfaces, particularly in the HCI context, developers should focus on creating user-friendly, engaging, and visually appealing designs that reflect user expectations and enhance the learning experience.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

PJ is the principal researcher of this study and wrote the initial manuscript; DP and KP collected data from the research experiment and reviewed and finalized the manuscript; all authors had approved the final version.

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