

# Developing Prototype of Interactive and User-centric Web Learning using Gamification Approach

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## Abstract

Web-based learning systems have become an essential technology for supporting interactive learning experiences in primary education. However, many learning platforms are developed without systematically identifying user needs, resulting in limited user engagement and ineffective implementation of gamification features. Therefore, this study aims to identify user requirements for developing an interactive and user-centric learning information system through a requirement gathering process. A questionnaire-based approach was employed to collect user preferences regarding four gamification elements: points, rewards, achievement badges, and completion time. The respondents consisted of fifth-grade elementary school students, representing the primary users of the proposed system. The collected data were analyzed to produce functional requirements in the form of use cases and detailed system requirement specifications that serve as the foundation for subsequent system development. The findings indicate that the selected gamification elements were perceived as easy to understand and motivating by the respondents. In addition, the preliminary implementation of gamification activities showed a 26% increase in participant engagement, with an average point improvement of 43.31%, demonstrating the positive influence of gamification on learning motivation even before its integration into a complete web-based learning information system. The main contribution of this research is a user-centered requirements model for a gamified learning information system, providing a practical foundation for developing interactive educational platforms that better align with students' needs and learning preferences.

## Keywords:

Prototyping, Learning Website, Gamification, Students

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## 1. Introduction

The rapid advancement of digital technology has transformed how organizations deliver information, services, and communication through websites. Modern websites have evolved beyond static information portals into interactive platforms that support active user participation and real-time engagement. Industries increasingly rely on website technology to improve communication efficiency, service accessibility, and customer satisfaction. As digital transformation continues, organizations require websites that not only present information but also encourage users to interact, provide feedback, and participate in organizational activities. Consequently, website interactivity has become a critical factor in determining the effectiveness of digital services across various sectors, including education. Interactive web technologies therefore play an essential role in improving user experience while supporting organizational objectives in the digital era. [1][2][3][4][5]

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The quality of user interaction significantly influences the success of a website. Interactive features such as quizzes, animations, discussion forums, instant feedback, and dynamic interfaces encourage users to actively engage rather than passively consume information. Previous studies have shown that interactive websites improve user engagement, increase visit duration, strengthen customer loyalty, and enhance overall user satisfaction. These benefits occur because interactive systems provide immediate responses to user actions and create a personalized browsing experience. As a result, website developers increasingly prioritize user-centered interaction design to ensure that digital platforms remain attractive and competitive. This growing emphasis on engagement makes interactivity an important component in designing effective web-based learning environments. [6][7][8][9][10][11]

Education has experienced a major digital transformation as learning activities increasingly utilize online technologies. Educational institutions adopt web-based platforms to provide learning materials, facilitate communication, and support collaborative learning activities. Interactive learning environments enable students to access educational resources anytime and anywhere while participating in discussions, simulations, and various collaborative activities. Previous studies have demonstrated that technology-supported learning improves students' understanding, collaboration skills, creativity, and learning motivation. Consequently, educational institutions continue to seek innovative approaches that combine technology with effective instructional strategies to improve learning outcomes. Developing interactive educational websites therefore becomes an important strategy for creating engaging and flexible learning environments. [12][13][14][15][16][17][18][19]

Gamification has emerged as one of the most promising approaches for increasing engagement in digital learning environments. The concept integrates game elements such as points, badges, rewards, levels, challenges, leaderboards, and progress indicators into non-game applications to encourage user participation. Previous research has consistently reported that gamification improves learner motivation, increases participation, promotes repeated system usage, and enhances user satisfaction. Reward mechanisms provide immediate feedback that reinforces learning behavior, while progress tracking motivates students to complete learning activities. These characteristics make gamification highly suitable for interactive educational websites, particularly for elementary school students who naturally respond well to game-based learning experiences. [20][21][22][23]

Despite the proven effectiveness of gamification, many existing learning platforms still implement generic game elements without carefully analyzing user preferences. Developers frequently select popular gamification features based on previous implementations or personal assumptions rather than collecting requirements directly from target users. Such an approach may reduce user engagement because different learner groups have different motivational characteristics, cognitive abilities, and learning behaviors. Elementary school students, for example, may value rewards, avatars, or storytelling differently from older learners. Therefore, selecting gamification mechanisms without understanding user expectations can limit the educational effectiveness of the resulting system. This issue indicates the need for a more systematic requirements engineering process before implementing gamification features. [20][21][22][23]

Requirements engineering has become a fundamental phase in software development because it determines whether the resulting system satisfies user needs. Software engineering literature emphasizes that inaccurate or incomplete requirements often become the primary cause of project failure and user dissatisfaction. A user-centered requirements engineering process allows developers to understand stakeholder expectations before designing functional components. In educational systems, this approach becomes even more important because learning effectiveness depends heavily on user experience and usability. Collecting user preferences during the early development stage enables developers to translate educational needs into functional requirements, use cases, and interaction models that better support learning objectives. Therefore,

requirements gathering should precede the implementation of gamification rather than follow it. [6][7][19][20][21]

Another important issue concerns the limited integration between user-centered design and gamification-based educational website development. Many previous studies have evaluated the effectiveness of completed gamified systems after implementation, while relatively few studies have investigated how user preferences influence the initial system design process. This creates a research gap because successful gamification depends not only on selecting attractive game elements but also on ensuring that these elements align with learners' expectations and learning behaviors. Without a structured mechanism for identifying preferred gamification features, developers risk producing educational websites that are technically functional but less engaging for their intended users. Addressing this gap requires a systematic approach that combines user requirement analysis with gamification design before software development begins. [7][19][20][21][22][23]

This study addresses the identified gap by proposing a user-centered requirements gathering approach for developing an interactive web-based learning system using gamification. Rather than directly implementing predefined game mechanics, this study first investigates elementary school students' preferences through structured questionnaires to identify the most suitable gamification elements. The collected requirements are analyzed and transformed into functional requirements, use cases, and gamification specifications that guide the prototype development process. This approach ensures that the proposed learning platform reflects actual user expectations instead of developer assumptions. The resulting framework contributes to requirements engineering for educational information systems by integrating user-centered design principles with gamification, thereby providing a stronger foundation for developing engaging, interactive, and learner-oriented web applications. [6][7][19][20][21][22][23].

## 2. Methodology

The primary objective of this study is to identify user-centered gamification requirements for an interactive web-based learning information system that will be developed in the subsequent research phase. We apply a quantitative survey approach using a structured questionnaire to investigate students' preferences for various gamification elements, including point systems, rewards, punishments, and achievement badges. The questionnaire measures users' perceptions of the motivational value of each gamification component, including preferred point mechanisms, suitable reward and punishment types, badge criteria, and the overall influence of these elements on learning engagement. The collected data serve as the basis for selecting the most appropriate gamification features before the system design stage.

This study adopts a descriptive survey design involving 45 fifth-grade elementary school students who actively use digital learning media to prepare for their sixth-grade examinations. The participants represent the target users of the proposed learning platform and provide direct input regarding their expectations for gamified learning environments. Data are collected through structured questionnaires consisting of open-ended questions and voting-based responses to capture both qualitative opinions and quantitative preferences. The identified requirements are subsequently analyzed and translated into functional requirements and gamification specifications that guide the design of the interactive learning information system.

The questionnaire was designed to identify students' preferences toward the proposed gamification features in the learning information system. It consisted of several sections covering key gamification aspects, including point systems, rewards, punishments, achievement badges, and their perceived motivational impact. The collected responses were used to determine the most suitable gamification elements for the subsequent system design and development.

## 1. Point System Preference.

There are three-point systems offered, as seen in Table 1.

Table 1. Point System Preference

| No. | Correct Points | Incorrect Points | No Answer Points |
|-----|----------------|------------------|------------------|
| 1   | +1             | 0                | 0                |
| 2   | +1             | -1               | 0                |
| 3   | +3             | -1               | 1                |

## 2. Reward and Punishment Preference

The rewards and punishments in this study are represented by a graphical representation of temporary point acquisition. Several models of temporary point acquisition graphs are offered in Figure 1, including bar graphs (horizontal, vertical) and line graphs.

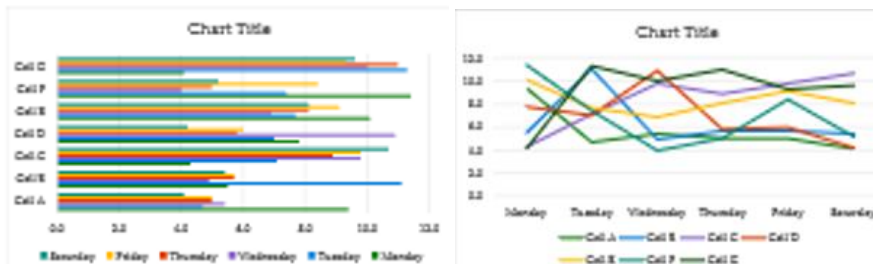


Fig. 1 Example of the offered graph

## 3. Winning Badge Preference

The badge selection task was to assign students to determine the badge they desired most based on Fig. 2. The options, from the far left, were numbered 1, 2, and 3. Students were asked to choose based on that number.

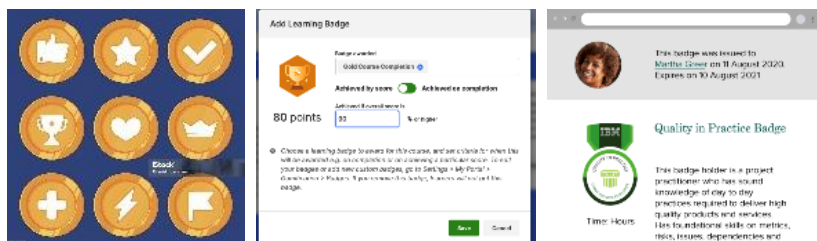


Fig. 2 Example of the offered badge

## 4. Time Preference

Time was measured by students answering questions posed in class. The average time required during the question-and-answer process will be used as a time limit for completing the questions on the elementary school student learning information system platform.

The mathematical equations used to calculate the maximum and average scores are as follows:

$$M = \max(x_1, x_2, x_3, \dots, x_n) \quad (1)$$

$$Average = \frac{x_1 + x_2 + x_3 + \dots + x_n}{n} \quad (2)$$

Equation (1) will be used to calculate the preference for points, awards, and badges. The value x will be filled in by the sum of the participants' questionnaire scores. Equation (2) will be used to calculate the time preference, where the value x will contain the average time to complete the questions in each session.

We collected data incrementally throughout multiple classroom learning sessions to observe students' preferences after they experienced different gamification elements. The research team distributed a structured questionnaire at the end of each session and conducted class voting to identify the most preferred gamification mechanisms. After the first lesson, students selected their preferred point allocation system, and we applied the selected mechanism during the following session. After the second lesson, students evaluated several reward and punishment alternatives, and the selected options were implemented in subsequent activities. In the final stage, each student selected a preferred achievement badge from several design alternatives. We also recorded the completion time for learning activities and questionnaire responses to evaluate students' participation and engagement.

This study analyzed the collected data using descriptive statistics to identify the most preferred gamification features. We summarized the voting results to determine students' preferences for point systems, rewards, punishments, and achievement badges, while the average completion time represented students' participation during classroom activities. The researchers translated these findings into functional requirements and gamification specifications that guide the development of the proposed interactive learning website. The final product provides a user-centered gamification design consisting of point mechanisms, time management rules, reward and punishment strategies, and achievement badges that will serve as the foundation for the next system development phase.

### 3. Results and Discussion

This section will explain the results of each data collection based on preference categories. The final design based on these preferences will then be presented. The data was obtained through the indirect implementation of gamification through quizzes and questions in class.

#### 3.1 Point System

The voting results in classes A and B, as shown in Table 2, indicate that the system will implement point model number 3, labeled green. This is based on the highest number of votes in the needs questionnaire regarding the point system to be developed for the learning system. Number 1 was in second place, with points awarded to correct answers, while incorrect answers and no points were deducted. Numerically, classes A and B differed in that option number 3 was won by class B and option 2 by class A. However, the final results, as seen in this questionnaire, indicate number 3 was the most voted for.

Table 2. Point System Results

| No.         | Point System                          | Vote | Class A | Class B |
|-------------|---------------------------------------|------|---------|---------|
| 1           | Correct +1, Incorrect 0, No Answer 0  | 13   | 7       | 5       |
| 2           | Correct +1, Incorrect -1, No Answer 0 | 10   | 5       | 6       |
| 3           | Correct +3, Incorrect -1, No Answer 1 | 22   | 10      | 12      |
| Total Votes |                                       | 45   | 22      | 23      |

The voting results indicate that Point System 3 ("Correct +3, Incorrect -1, No Answer +1") received the highest number of votes, accounting for 22 out of 45 respondents (48.9%). This preference demonstrates that elementary school students tend to favor a scoring mechanism that provides greater rewards for correct answers while still maintaining moderate penalties for incorrect responses. Interestingly, respondents also preferred receiving a small reward for unanswered questions, suggesting that they perceive participation itself as worthy of appreciation. This finding indicates that students prefer a balanced reward mechanism rather than a purely punitive system. Consequently, the selected point model was adopted as the default scoring strategy in the proposed learning

system. Compared with the other two alternatives, Point System 3 provides stronger motivational feedback by emphasizing achievement while maintaining fairness during the learning process. This result is consistent with previous studies reporting that point-based reward systems are among the most effective gamification elements for encouraging student participation and learning motivation.

3.2 Rewards/Penalties

The image number and title are centered in the column (center alignment). The image number is written sequentially using Arabic numerals. The image title is written below the image in title case, except for conjunctions, conjunctions, and prepositions. The image title uses 8-point font. Images must not exceed the margins of each column. If the image is large enough to fit in one column, it may span two columns. The reward system chosen, based on the references in chapter 2, is number 1/bar graph. Bar graphs are more comfortable to view because they clearly show the value boundaries between participants. The results of the selected graphical vote collection can be seen in Table 3. For the award voting, several Class B participants did not vote.

Table 3. Award/Punishment Results

| No. | Award System (Score Dashboard) | Vote | Class A | Class B |
|-----|--------------------------------|------|---------|---------|
| 1   | Bar Graph                      | 21   | 14      | 7       |
| 2   | Line Graph                     | 13   | 8       | 5       |
|     | Total Votes                    | 34   | 22      | 12      |

Based on the questionnaire results, the respondents clearly preferred the bar graph visualization, which obtained 21 of the 34 recorded votes (61.8%). This result indicates that students prefer a straightforward graphical representation of their learning progress rather than a continuous line graph. A bar graph enables students to compare their scores with classmates more easily because each student's achievement is represented individually, making progress easier to interpret. Although several participants in Class B did not submit responses, the voting distribution still shows a strong preference for the bar graph. Therefore, this visualization was selected as the score dashboard in the proposed learning information system. The result suggests that a simple and intuitive visual representation is more suitable for elementary school students, supporting the objective of developing a user-centered learning platform.

3.3 Victory Badges

This study offers three models of victory badges, as shown in Fig. 2. The results indicate that badge number 1 will be used in the learning system to be developed. This result was obtained by collecting votes, as shown in Table 4, and using equation (1).

Table 4. Victory Badge Election Results

| No. | Badge Choices | Vote | Class A | Class B |
|-----|---------------|------|---------|---------|
| 1   | Badge 1       | 20   | 8       | 12      |
| 2   | Badge 2       | 14   | 5       | 9       |
| 3   | Badge 3       | 11   | 9       | 2       |
|     | Total Votes   | 45   | 22      | 23      |

The badge selection results show that Badge Model 1 received the highest preference, with 20 of the 45 respondents selecting this design. Although the difference between Badge Model 1 and Badge Model 2 is relatively small, the voting outcome indicates that students favor badge designs that are visually simple, recognizable, and easy to associate with achievement. This finding reinforces the importance of selecting gamification assets based on user preferences rather than developer assumptions. Consequently, Badge Model 1 was chosen as the achievement indicator within the proposed learning system. Integrating badges that align with users' preferences is expected to strengthen students' intrinsic motivation by providing visible recognition of their learning accomplishments.

### 3.4 Time

The average time is calculated based on the average number of quizzes completed in class. Table 5 shows the average number of students completing each calculation given in class during the teaching and learning process. The calculation uses equation (2).

Table 5. Average Time to Complete Questions

| No. | Average Time to Complete<br>(Class A) | Average Time to Complete<br>(Class B) |
|-----|---------------------------------------|---------------------------------------|
| 1   | 00:04:10                              | 00:20:48                              |
| 2   | 00:37:33                              | 00:57:43                              |
| 3   | 00:14:54                              | 00:59:53                              |
| 4   | 00:16:42                              | 00:19:05                              |
| 5   | 00:02:29                              | 00:05:46                              |
| 6   | 00:09:16                              | 00:19:15                              |
| 7   | 00:02:13                              | 00:04:03                              |
|     | <b>Average</b>                        | <b>00:19:34</b>                       |

The average completion time analysis revealed that students required approximately 19 minutes and 34 seconds to complete the classroom exercises. However, substantial variation was observed between Class A and Class B, indicating differences in students' learning pace and problem-solving abilities. Rather than directly adopting this average as the system timer, the researchers translated these findings into a practical requirement by recommending a 30-second time limit for each question.

The gamification integration process will focus on four use cases: the Class Dashboard, Working on Questions, Managing Questions and Answers, and Viewing Badges. A more detailed process can be seen in the use case descriptions in Tables 6 to 9.

Table 6. Use Case Description: Class Dashboard

| Name              | Class Dashboard                                                                                                                                                                                                                                                 |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Actor             | Student and Teacher                                                                                                                                                                                                                                             |
| Description       | Use case that occurs when students or teachers want to view their grades and rankings in the class                                                                                                                                                              |
| Initial Condition | Students and teachers must be logged in and registered through this system                                                                                                                                                                                      |
| Flow of Events    | <ol style="list-style-type: none"> <li>1. Students and teachers select the Home menu</li> <li>2. The system displays the class dashboard on the home page</li> <li>3. The dashboard page displays the points earned during the class's active period</li> </ol> |
| Post Condition    | Students and teachers can view their points earned and the score dashboard for the class. For students, their names will be bolded so they can easily find their position on the dashboard                                                                      |

Table 7. Use Case Description: Working on Questions

| Name              | Working on Questions                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Actor             | Student                                                                                                                                                                                                                                                                                                                                                                                                             |
| Description       | Use case that occurs when students work on questions previously determined by the teacher                                                                                                                                                                                                                                                                                                                           |
| Initial Condition | The student has logged in and registered through this system. The questions have been created by the teacher and activated in the class                                                                                                                                                                                                                                                                             |
| Flow of Events    | <ol style="list-style-type: none"> <li>1. The student selects the Questions menu</li> <li>2. The system displays the questions activated by the teacher</li> <li>3. The question will impose a time limit on the students working on the questions using the time limit based on the questionnaire results, which is 30 seconds, a time not too far from the average value of 19 seconds 34 milliseconds</li> </ol> |
| Post Condition    | The student will work on the questions activated by the teacher, with the time limit per question determined by the system and the teacher                                                                                                                                                                                                                                                                          |

Table 8. Use Case Description: Managing Questions and Answers

| Name              | Managing Questions and Answers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Actor             | Teacher                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Description       | Use case that occurs when the teacher manages questions (adds, changes, deletes, or searches)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Initial Condition | The teacher has logged in and registered through this system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Flow of Events    | <ol style="list-style-type: none"> <li>1. The teacher selects the Manage Questions menu.</li> <li>2. The system displays the collection of questions held by the school.</li> <li>3. There is a menu for adding, editing, deleting, or searching for questions.</li> <li>4. For each question detail, the teacher is required to provide an answer and a deadline.</li> <li>5. The system will provide a suggested time, similar to the questionnaire results, but this can be changed and determined by the teacher based on the difficulty level of the questions.</li> </ol> |
| Post Condition    | The teacher has a collection of questions in this system that have been added, edited, or deleted                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Table 9. Use Case Description: Viewing Owned Badges

| Name              | Viewing Owned Badges                                                                                                                                                                                                                                                                                        |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Actor             | Student                                                                                                                                                                                                                                                                                                     |
| Description       | Use case that occurs when a student wants to view the badges they have earned during the school term.                                                                                                                                                                                                       |
| Initial Condition | The student has logged in and registered through this system. Students have also completed the questions, allowing the system to calculate points.                                                                                                                                                          |
| Flow of Events    | <ol style="list-style-type: none"> <li>1. Students select the View Badges menu.</li> <li>2. The system displays the collection of badges they have earned during their studies at the school.</li> <li>3. Each badge detail contains a description of the badge (day, date, time, and question).</li> </ol> |
| Post-Condition    | Students can view their collection of badges, complete with descriptions when further selected.                                                                                                                                                                                                             |

Meanwhile, researchers also observed the manually calculated points. Based on the data summarized in Table 10, gamification has an impact on the teaching and learning process. Gamification increased student points by 43.31% using equation (2).

Table 10. Average Point Increase Results

| Start Point | End Point | Point Increase |
|-------------|-----------|----------------|
| 0           | 6         | 600            |
| -2          | -2        | 0              |
| 0           | 0         | 0              |
| 14          | 17        | 21.42857       |
| 3           | 3         | 0              |
| 0           | 0         | 0              |
| 0           | 0         | 0              |
| 3           | 3         | 0              |
| 11          | 11        | 0              |
| 11          | 17        | 54.54545       |
| 0           | 0         | 0              |
| -1          | -1        | 0              |
| 0           | 0         | 0              |
| 0           | 0         | 0              |
| 3           | 3         | 0              |
| -1          | -1        | 0              |
| 0           | 0         | 0              |
| 0           | 0         | 0              |
| 6           | 12        | 100            |



increase of 43.31%, while 26% of participants improved their scores during the learning sessions. Although the gamification elements were implemented manually rather than through a web-based platform, the results indicate that they effectively encourage active participation and improve learning outcomes.

This paper concludes that identifying user preferences at the early requirements stage can support the development of a more effective gamified learning system. We utilize these findings as the basis for the next phase of research, which will implement the identified gamification features in an interactive web-based learning information system. We expect that integrating these user-centered requirements into the final platform will further enhance student engagement, motivation, and learning performance.

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