Journal of Theoretical and Applied Information Technology
30th April 2023. Vol.101. No 8

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

# THE IMPACT OF GAMIFICATION ON CREATIVE AND INNOVATIVE SKILLS OF GRADUATE STUDENTS

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## ABSTRACT

This study aimed to evaluate the effectiveness of a gamification design in enhancing creative and innovative thinking skills among graduate students. Five objectives were pursued: (1) to identify the factors of gamification that contribute to enhancing these skills, (2) to design learning outcomes for the gamification, (3) to develop the gamification for enhancing these skills, (4) to compare the pre-implementation and post-implementation results of graduate students' creative and innovative thinking skills, and (5) to investigate the correlations between these skills. The gamification design consisted of five elements: Exercise, Achievements, Reward Systems, Community Synchronization, and Result Transparency. Results of a factor analysis revealed that key factors that had an impact on creative and innovative thinking were Problem-Solving, Exploration, Risk-Taking, Brainstorming, Open-Ended Play, Diverse Perspectives, and Novelty, with a cumulative explanation of variance of 86.80%.Comparing the pre-implementation and post-implementation results of the graduate students showed a significant improvement ($p < 0.01$) in both their creative and innovative thinking skills. Correlations between the students' creative and innovative thinking skills were mostly significant ($p < 0.01$), indicating that the gamification design had a direct positive impact on their creative and innovative thinking abilities. In conclusion, this study provides evidence that a gamification design can enhance graduate students' creative and innovative thinking skills, and highlights key factors that contribute to this enhancement. These findings have implications for the design of effective gamification interventions in educational settings.

**Keywords:** *Gamification, Creative Thinking Skill, Innovative Thinking Skill, Graduate Student*

## 1. INTRODUCTION

The integration of technology has greatly impacted work performance and the ratio of human to mechanical labor. In 2019, the share of mechanical labor increased to 29% while human labor decreased to 71% [1]. This shift towards a higher reliance on technology has caused a significant impact on the development of individual skills, particularly in the areas of creative and critical thinking and negotiation abilities. To address this issue, instructional models in the 21st century need to be aligned with the demands of the market in order to be effective [1].

In Thailand, the establishment of the Ministry of Higher Education, Science, Research, and Innovations in 2019 reflects the country's commitment to monitoring and promoting higher education, science, research, and innovation for national and global development [2]. National education policies, such as the B.E. 2560-2579 National Educational Plan [3], the B.E. 2561-2580 long-term 20-year higher education plan [4], the 12th National Economic and Social Development Plan [5], and the higher education standards [6], all prioritize the development of learners' problem-solving and entrepreneurial skills, as well as innovation creation and research.

Gamification, the application of game design elements in non-game contexts, has become a popular instructional tool [7]. While it was initially used for entertainment, advancements in technology have expanded its use to different learning approaches and improving problem-solving skills. The development of gamification for enhancing creative and innovative thinking skills among university students is crucial in promoting their creative problem-solving abilities, imaginative innovation, critical thinking, and entrepreneurship.

One of the benefits of using gamification in education is its ability to engage learners in the learning process, thereby increasing their motivation and interest in the subject matter. Gamification can

also help learners develop their problem-solving skills, creativity, and critical thinking abilities. This is because gamification involves a highly interactive and immersive experience that can help learners understand complex concepts and develop their cognitive abilities [7].

Another benefit of gamification is that it allows learners to apply the skills they have learned in real-world situations. This is because gamification often involves the use of simulations, virtual environments, and other interactive learning tools that simulate real-world scenarios. This helps learners develop their ability to think creatively and critically about complex issues and problems, and to apply their knowledge and skills in real-world situations.

Gamification has emerged as a promising approach for enhancing learners' creative and innovative thinking skills in higher education. It often involves incorporating game-like elements, such as competition, rewards, and other motivational factors, into the learning process. Research has shown that gamification can positively impact learners' motivation, engagement, and performance, and can help them develop essential skills for success in today's rapidly changing world.

Moreover, gamification has been found to be particularly effective in developing learners' entrepreneurial mindset and abilities. As gamification encourages learners to take risks, innovate, and collaborate, it can help them develop the skills and abilities that are crucial for success in today's business environment.

In Thailand, the government has demonstrated a strong commitment to higher education and innovation, making it crucial for educational institutions to adopt and integrate gamification into their instructional models. This study aims to evaluate the effectiveness of a gamification design in enhancing creative and innovative thinking skills among graduate students, with the goal of informing the development and implementation of gamification interventions in higher education.

## 2. REVIEW OF THE LITERATURE

### 4.1 Creative thinking skills

The importance of creative thinking skills in both education and business is widely recognized in today's rapidly changing world. In education, creative thinking is essential for students to develop the ability to solve complex problems, think critically, and make well-informed decisions. Research has shown that incorporating creative thinking exercises into the curriculum can have a positive impact on students' cognitive development and overall learning experience.

Gamification is emerging as a promising approach to promoting creative thinking skills in education. The incorporation of game elements into educational activities has been shown to increase student engagement, motivation, and creativity. In the business world, creativity is viewed as a key driver of organizational growth and value creation. A study by [8] found that creativity is a critical component of innovation and that companies that foster a creative work environment are more likely to be successful. Similarly, a study by [9] showed that individuals who engage in creative activities on a regular basis are more likely to generate innovative ideas and solve problems effectively.

Overall, creative thinking skills are an important aspect of educational management and career development in the 21st century. They are critical indicators of preparedness for global career opportunities and economic competitiveness, and are seen as essential for promoting organizational growth and adding value to businesses. [10]

### 4.2 Innovative thinking skills

The significance of innovative thinking skills in the current dynamic global scenario cannot be overstated. These skills are deemed essential for personal and professional growth, as well as for generating new and inventive products and ideas. Consequently, there is a growing interest in finding ways to enhance and cultivate these skills, particularly in organizational settings.

Gamification presents a promising solution for developing innovative thinking skills as it offers individuals the chance to participate in creative problem-solving, try out new ideas and perspectives, and take calculated risks in a supportive and low-risk environment. Additionally, gamification promotes collaboration and group brainstorming, which have been proven to foster innovative thinking. The acquisition of innovative thinking skills is vital for the success of an organization, as it enables the creation of new concepts and innovative products that provide added value to customers. Organizations should prioritize the enhancement of innovative thinking skills across all departments for their self-development. [11]

### 4.3 Gamification

Gamification, a concept that applies game design elements to non-game contexts, has been widely adopted in the field of education for the purpose of improving instructional management in the 21st century. The concept involves designing simulation-

based learning activities to foster learning enjoyment, motivation, and participation. The integration of gamification with game-based learning can also provide a platform for learners to simulate real-life scenarios and solve complex problems through interactive game elements [12].

One of the advantages of using gamification in online instructional management is the incorporation of goal planning and reward systems, which can help learners achieve specific goals and receive recognition for their efforts. A well-designed gamification approach can also promote cognitive development by combining game dynamics with instructional management. However, it is important to keep in mind the psychological and technological influences of gamification and to consider different approaches to learning gamification, score presentation, and communication tools [13].

Studies have shown that the implementation of gamification can have a positive impact on learners' motivation, behavior, and achievement, as well as instructors' evaluations and educational institutions' overall management [13]. A literature integration of gamification and motivation theory was presented in [14] to explore the challenges and insights from research on gamification. The study emphasized the importance of considering social aspects when incorporating gamification in the workplace, as these elements can lead to a more satisfying and engaging experience compared to single-player components [15][16].

Comparing oneself to others in a relevant context [17] has been found to be more motivating, as it satisfies relationship needs and provides a more accurate self-assessment. Collaborative gamification has been found to be more effective than competitive gamification, as the latter may lead to poor user experiences and decreased motivation for some players [14]. When competition is limited to teamwork, players tend to cooperate against a common opponent, leading to creative competition and social connections between work groups, resulting in higher motivation and engagement in the workplace [14]. People generally do not like to be perceived as weak in their work environment, and this type of gamification enables employees to be more competitive and engaged in their work.

Additionally, gamification can also enhance creativity, critical thinking, and problem-solving skills. The application of game design elements in educational contexts can provide a platform for learners to engage in hands-on, interactive learning activities that simulate real-life scenarios and promote cognitive development [12]. Furthermore, the integration of gamification with game-based learning can facilitate the development of new knowledge and skills through hands-on experience and exploration [12].

The use of gamification in educational contexts has received considerable attention due to its potential to enhance the overall quality of instruction and improve learners' motivation, behavior, and achievement. However, in order to effectively integrate gamification into educational settings, it is crucial to understand why this approach is necessary and what problem it seeks to address.

In particular, the psychological and technological influences of gamification should be carefully considered, along with the importance of adopting a well-designed approach that prioritizes social aspects and collaboration. Furthermore, the integration of gamification with game-based learning can offer a valuable opportunity to facilitate hands-on learning activities that promote cognitive development and the acquisition of new knowledge and skills. Overall, a strong conceptual basis is essential for understanding the potential benefits and challenges of gamification in educational settings and developing effective interventions that address the specific needs of learners.

## 3. RESEARCH OBJECTIVE

The objectives of this research were:

To investigate the factors of gamification designed to enhance creative and innovative thinking skills among graduate students;

To design learning outcome of gamification designed for designed for enhancing creative and innovative thinking skills;

To develop gamification designed for designed for enhancing creative and innovative thinking skills;

To compare the graduate students' pre-implementation of their creative and innovation skills through gamification with their post-implementation;

To investigate the correlations of the graduate students' creative skills and innovative thinking skills.

## 4. SCOPE OF STUDY

### 4.1 Population and Sample

The sample consisted of 24 graduate students enrolled in Digital Technology for Technical Education. Department of Educational Technology and Information Science Faculty of Technical Studies King Mongkut's University of Technology North Bangkok. In the first semester of the academic year 2022.

### 4.2 Variable Used for the Study

The research variables comprised:

#### 4.2.1 Independent Variable

Gamification designed for enhancing creative and innovative thinking skills

#### 4.2.1 Dependent Variables

1. The effectiveness of gamification designed for enhancing creative and innovative thinking skills
2. Creative thinking results
3. Innovative thinking skills
4. Correlations of creative skills and innovative thinking skills

### 4.3 Time

The 1st semester of the 2022 academic year were all conducted in this study.

### 4.4 Data Analysis

Validity of the questionnaire was tested through Cronbach's Alpha coefficient, which ranges from 0 to 1. A high reliability score of close to 1 indicates that the questionnaire is highly reliable, a score approaching 0.5 indicates moderate reliability, and a score close to 0 suggests low reliability. In this study, a high alpha coefficient was used, with a minimum threshold of 0.7, as it is considered an acceptable criterion for basic research.

Factor Analysis was utilized to examine the groupings of the correlated variables. If any incorrect grouping was identified, the researcher would revise the question and perform the analysis again. Principal component analysis was employed in the study with Varimax Rotation to group the variables in accordance with the research objectives. The grouped variables were required to have a factor loading of greater than 0.5 as per the established scale criteria. If any question had a factor loading below 0.5, it would be excluded from the analysis. If a question did not align with the other questions in the same factor and was incompatible with the questions in other factors, it would also be removed. Statistical descriptions used for analyzing the results of evaluating the appropriateness of developed gamification included percentage, mean, and standard deviation.

In order to analyze the pre-implementation of the university students' creative and innovative thinking skills compared with their post-implementation, as well as to investigate the correlations of the pre-implementation of the university students' creative and innovative thinking skills through using the Pearson's correlation coefficient, referential statistical descriptions used for testifying research hypotheses included t-test dependent samples.

## 5. RESEARCH METHODOLOGY

The research design used in this study is a mixed-methods design that involves both quantitative and qualitative data collection methods. The study is divided into three phases, each with its specific aims and research tools.

Phase 1: Gathering Data and Designing Gamification

In this phase, primary data were collected from 156 graduate students through questionnaires and secondary data were obtained through interviews with 12 professors and experts, books, textbooks, and previous research studies. The collected data were analyzed using factor analysis to examine the impact of gaming on creative and innovative skills. The questionnaires and interview forms were the research tools used in this phase.

Phase 2: Gamification Development and Assessment

In this phase, gameplay was developed to foster creative and innovative skills among graduate students. The effectiveness of the gamification approach was evaluated by 9 experts in the field using the expert assessment form.

Phase 3: Exploring Gamification Performance

In this phase, a one-way experimental group design was used to compare the pre-application and post-application creative thinking skills of graduate students. To assess the effectiveness of gamification, various research tools were used such as lesson plans, worksheets, contents designed for each learning unit, objectives, learning resources, playing methods, and game play learning assessment methods. A creativity skills test was used to assess students' creative thinking skills in four key areas: initiative, fluid thinking, flexible thinking, and detailed thinking. Additionally, an innovation thinking skills aptitude test was administered to assess learners' abilities gained from developed innovations, consisting of six key skills: contextual analysis, conceptualization, collaboration, reflection, presentation, and assessment.

Developing research tools is a crucial aspect of the research process. The research tools used in this study were questionnaires, interview forms, expert assessment forms, lesson plans, worksheets, contents, objectives, learning resources, playing methods, and assessment methods, as well as a creative skills test and an innovative thinking skills aptitude test. These tools were designed to ensure that the data collected is accurate, reliable, and relevant to the research question.

A questionnaire was administered online to collect primary data from 156 graduate students. The questionnaire was constructed with a combination of

closed-ended and open-ended questions to gather both quantitative and qualitative data. The validity of the questionnaire was established through an analysis of the Item Objective Congruence Index (IOC) to ensure that the questions aligned with the research objectives.

The reliability of the questionnaire was assessed by calculating its confidence value. Experts consider a high confidence value to indicate a high level of reliability, which can be measured using Cronbach's alpha.

Secondary data was gathered through interviews with 12 professors and experts in the field. The interview form was created to ensure that the questions asked were consistent and relevant to the research question, thus ensuring the accuracy and reliability of the data collected.

The expert assessment form was used to evaluate the effectiveness of gamification in promoting creative and innovative skills. The form was designed to gather information about the experts' perceptions of gamification's performance, and their assessments were based on their expertise and experience in the field.

Lesson plans, worksheets, contents, objectives, learning resources, and playing methods were developed to ensure that the gamification activities were structured and relevant to the research question. The assessment method was created to evaluate the impact of gamification on the creative and innovative skills of graduate students.

The creative skills test was designed to assess students' creative abilities in four key areas: initiative, fluid thinking, flexible thinking, and detailed thinking. The innovative thinking skills aptitude test was developed to evaluate students' competencies in six key skills: contextual analysis, conceptualization, collaboration, reflection, presentation, and assessment. These tests were constructed to ensure that the data collected is accurate and relevant to the research question.

In conclusion, the development of research tools is a significant aspect of the research process, and the tools were designed to guarantee that the collected data is accurate, reliable, and relevant to the research question. The creation of these tools plays a crucial role in determining the impact of gamification on creative and innovative skills.

## 6. SUMMARY

The current study investigates the influence of gamification on improving creative and innovative thinking skills. To gain a deeper understanding of the key elements that contribute to creative and innovative thinking within the context of gamification, a factor analysis was conducted. The results of this analysis are displayed in Table 1, which lists the components along with their eigenvalues, the percentage of variance explained, and the cumulative percentage. The factor analysis provides valuable insights into the critical aspects of creative and innovative thinking that are present in gamification and can be used to inform future research in this area. The results of the factor analysis are a crucial step towards understanding the impact of gamification on the development of creative and innovative thinking skills.

*Table 1: Factor Analysis of Creative and Innovative Thinking in Gamification*

| Component | Eigenvalue | %Variance Explained | Cumulative % |
|---|---|---|---|
| Problem-Solving | 5.67 | 22.68 | 22.68 |
| Exploration | 4.56 | 18.24 | 40.92 |
| Risk-Taking | 3.45 | 13.80 | 54.72 |
| Brainstorming | 2.89 | 11.56 | 66.28 |
| Open-Ended Play | 2.23 | 8.92 | 75.20 |
| Diverse Perspectives | 1.67 | 6.68 | 81.88 |
| Novelty | 1.23 | 4.92 | 86.80 |

The results of the factor analysis conducted to identify the creative and innovative thinking elements from gamification are shown in Table 1. The table displays 7 components, including Problem-Solving, Exploration, Risk-Taking, Brainstorming, Open-Ended Play, Diverse Perspectives, and Novelty. Each component is represented by an eigenvalue that indicates the amount of variance explained by the component, as well as a cumulative percentage that shows the total variance explained by all the components up to that point. The highest eigenvalue and the largest percentage of variance explained is for the Problem-Solving component (5.67, 22.68%), followed by Exploration (4.56, 18.24%) and Risk-Taking (3.45, 13.80%). The cumulative percentage reaches 86.80% with the inclusion of all 7 components, which suggests that these 7 components capture a significant amount of variance in the creative and innovative thinking elements from gamification.

To identify the creative and innovative thinking elements from gamification, a factor analysis was conducted and the results are presented in Table 1. To obtain these elements, a questionnaire was administered to the participants and the following questions were asked to assess each component:

The development of gamification designed for enhancing creative and innovative thinking skills was divided into 5 major components:

Exercise: The exercise component of the gamification design involves incorporating challenges, tasks, and activities that encourage the development of creative and innovative thinking skills. These exercises should be designed to be engaging and relevant to the students' learning objectives.

Achievements: The achievements component focuses on recognizing and rewarding students for their efforts and progress in developing their creative and innovative thinking skills. This can include awarding badges, certificates, or other types of recognition for completing tasks, challenges, or demonstrating exceptional creativity or innovation.

Reward Systems: The reward systems component of the gamification design is designed to incentivize students to engage in the exercises and activities that promote creative and innovative thinking. This can include tangible rewards such as points, rewards, or virtual currency, as well as intangible rewards such as recognition and status within the learning community.

Synchronizing with the Community: The synchronizing with the community component of the gamification design aims to foster collaboration and peer-to-peer learning among students. This can be achieved by creating opportunities for students to share their ideas, collaborate on projects, and provide feedback to each other.

Result Transparency: The result transparency component of the gamification design is designed to provide students with clear and meaningful feedback on their performance and progress in developing their creative and innovative thinking skills. This can include regular assessments, progress tracking, and visual representations of students' performance, such as graphs or charts.

The gamification design aimed at enhancing creative and innovative thinking skills is composed of five major components, as shown in figure 1.


*Figure 1: Learning components of gamification designed for enhancing creative and innovative thinking skills*

The figure 1 in the study depicts the learning components of gamification designed for enhancing creative and innovative thinking skills. The figure is divided into three parts, each representing a critical aspect of the gamification design.

Part 1: User Management, Content Management, and Gamification Support

This part of the figure highlights the fundamental components that are necessary for successful implementation of gamification. User management involves creating user profiles, tracking progress, and providing personalized feedback to the students. Content management involves organizing the learning materials and making them accessible to the students. Gamification support involves providing technical assistance and ensuring the overall smooth functioning of the gamification system.

Part 2: Exercise, Achievements, Reward Systems, Synchronizing with the Community, and Result Transparency

This part of the figure showcases the interactive and engaging elements of gamification that are crucial in enhancing creative and innovative thinking skills. Exercise involves providing students with hands-on tasks and activities that challenge their thinking and problem-solving skills. Achievements provide recognition for the students' progress, encouraging them to continue their learning journey. Reward systems provide incentives for students to strive for excellence in their creative and innovative thinking skills. Synchronizing with the community involves encouraging students to collaborate with their peers and share their learning experiences. Result transparency involves providing students with insights into their learning progress, helping them track their performance and make improvements.

Part 3: Evaluation of Creative and Innovative Thinking Skills

This part of the figure focuses on evaluating the effectiveness of gamification in enhancing creative and innovative thinking skills. It involves assessment tools, such as questionnaires, aptitude tests, and checklists, that are used to measure the students' progress and improvement in creative and innovative thinking skills. The results of the evaluations are used to inform the design and development of gamification in the future.

Table 2 provides a breakdown of the specific content, learning outcomes, and assessment through gamification for enhancing creative and innovative thinking skills. Each of the content areas listed in the table has a corresponding learning outcome and assessment method, which can be used to evaluate the effectiveness of gamification for improving these

skills. The areas listed include problem-solving, exploration, risk-taking, brainstorming, open-ended play, diverse perspectives, and novelty. By incorporating these content areas and assessment methods into gamification designs, organizations can effectively enhance the innovative thinking skills of their employees and contribute to their overall success and development.

*Table 2: Learning Outcome of Creative and Innovative Thinking Skills through Gamification*

| Learning Outcome | Assessment through Gamification |
|---|---|
| Develop creative problem-solving skills | Observe improvement in problem-solving abilities in game-based scenarios |
| Encourage exploration of new ideas and perspectives | Measure increased willingness to try new things and consider diverse perspectives in a game environment |
| Enhance confidence in taking calculated risks | Observe improvement in risk-taking behaviors and attitudes in game-based scenarios |
| Foster collaboration and group brainstorming | Evaluate effectiveness of group problem-solving and idea generation in game-based scenarios |
| Encourage free-form and open-ended thinking | Measure increased creativity and innovation in game-based scenarios that lack specific goals or objectives |
| Promote diverse perspectives and broaden outlook | Evaluate increased appreciation and consideration of diverse perspectives in game-based scenarios |
| Encourage a willingness to try new and unique things | Measure increased interest and engagement in new and unique game mechanics and experiences |

Thus, evaluating the effectiveness of gamification designed for enhancing creative and innovative thinking skills was approved by 9 major gamification-oriented experts specializing in the application of gamification used for educational purposes together with learning management processes, creativity, and innovative thinking skills. In terms of evaluating the appropriateness of gamification learning, it showed that those gamification-oriented experts' opinions toward the appropriate applications of gamification were mostly found as illustrated in Table 3.

*Table 3: Results of Evaluating the Appropriateness of Gamification*

| Evaluated Contents | M | S.D. |
|---|---|---|
| **Gamification Screen Design** | | |
| Well-organized gamification components | 4.56 | 0.50 |
| Its readable, cleared, and colorful alphabetical letters | 4.33 | 0.44 |
| Balanced and appropriate color selection | 4.78 | 0.53 |
| Interpretation with gamification contents | 4.44 | 0.50 |
| Cleared, interpretative, and proper gamification buttons | 4.56 | 0.44 |
| Appropriate graphic designs and pictures | 4.78 | 0.53 |
| **Gamification Design** | 4.56 | 0.53 |
| Well-planned aims of gamification | 4.78 | 0.44 |
| Appropriate, and cleared regulations for learners | 4.56 | 0.53 |
| Better learning imagination in cope with its contents | 4.67 | 0.50 |
| Interesting, and attractive presentation | | |
| Better interaction with learners | 5.00 | 0.00 |
| Appropriate, and concise recommendations | 4.67 | 0.50 |
| Components of Gamification | 4.67 | 0.50 |
| **Gamification's Situations** | | |
| Interesting and attractive thematic situations | 4.44 | 0.53 |
| Appropriate length of time used for playing gamification | 4.78 | 0.44 |
| Easy-to-understand expressions used for such a different situation | 4.67 | 0.50 |
| Learning activities emphasizing on learner-centered learning management | 4.44 | 0.73 |
| Enhancing learners' creativity | | |
| Engaging in learners' innovative thinking skills | 4.78 | 0.44 |
| | 4.44 | 0.53 |
| **Total** | 4.63 | 0.50 |

Table 3: Results of Evaluating the Appropriateness of Gamification presents the evaluation results of various aspects of gamification. The table includes three evaluated contents, namely Gamification Screen Design, Gamification Design, and Gamification's Situations. Each of the evaluated contents has several sub-items, with corresponding scores (M) and standard deviations (S.D.).

The results indicate that the gamification components were well-organized and readable, with a balanced color selection and clear interpretation of the contents. The aims of the gamification were well-planned, with appropriate and clear regulations for learners. The presentation was interesting and attractive, and there was better interaction with learners. The gamification situations were interesting and attractive, with appropriate length of time for playing and easy-to-understand expressions. Overall, the results show a high average score of 4.63, with a low standard deviation of 0.50, indicating a high level of consistency in the evaluations. The results suggest that the gamification design used in the study was appropriate and effective in enhancing learners' creativity and innovative thinking skills.

A comparison of the creative thinking skills of 24 sampled graduate students before and after implementation was evaluated using the Test for Creative Thinking-Drawing Production. The test consisted of 11 major indicators to assess the students' creative abilities. The results of the test are displayed in Table 4.

*Table 4: Graduate Students' Creative Thinking Skills: Pre- vs. Post-Implementation Average Scores Comparison*

| | Paired Differences | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|
| | Mean | Std. Deviation | | | |
| Pre - Post | -50.292 | 3.653 | -67.441 | 23 | .000* |

*p<.01

The results of the creative thinking skills test of 24 graduate students before and after implementation of gamification are presented in Table 2. The test, which evaluated the students' abilities through 11 indicators, showed that the post-implementation scores were higher than the pre-implementation scores, with a significant difference of 0.01.

Table 4 displays the results of the graduate students' innovative thinking skills before and after implementation, which were obtained through a questionnaire assessing their abilities in 6 sub-skills: contextual interpretation, conceptualization, collaboration, reflection, presentation, and evaluation.

*Table 5: Graduate Students' Innovative Thinking Skills: Pre- vs. Post-Implementation Average Scores Comparison*

| | Paired Differences | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|
| | Mean | Std. Deviation | | | |
| Pre - Posttest | -51 | 4.872 | -51.279 | 23 | .000* |

*p<.01

Table 5 demonstrates that the graduate students' scores on their innovative thinking skills after the implementation, with a significant difference of 0.01, were higher than those before the implementation.

The correlation between the graduate students' creative and innovative thinking skills acquired through gamification-based implementation was evaluated using Pearson's Correlation Coefficient, as depicted in Table 6.

*Table 6: Correlation Results of Creative ana Innovative Thinking Skills*

| | | Creative Thinking Skills | Innovative Thinking Skills |
|---|---|---|---|
| Creative Thinking Skills | Pearson Correlation | 1 | .782** |
| | Sig. (2-tailed) | | .000 |
| | N | 24 | 24 |
| Innovative Thinking Skills | Pearson Correlation | .782** | 1 |
| | Sig.(2-tailed) | .000 | |
| | N | 11 | 11 |

**. Correlation is significant at the 0.01 level (2-tailed).

Table 6 presents the results of the correlation analysis between the scores of Creative Thinking Skills and Innovative Thinking Skills for the 24 sampled graduate students. The Pearson Correlation is a measure of the strength and direction of the linear relationship between two variables.

The results of the analysis show a strong positive correlation between the scores of Creative Thinking Skills and Innovative Thinking Skills with a correlation coefficient of .782. This indicates that as the scores of Creative Thinking Skills increase, the scores of Innovative Thinking Skills also tend to increase. The significance value (Sig. (2-tailed)) is .000, which is less than 0.01, meaning the correlation is statistically significant at the 0.01 level (2-tailed).

## 7. FINDINGS AND CONCLUSION

According to recent research [18], incorporating gamification into education can positively impact students' learning outcomes. Gamification is the process of applying game mechanics and design to non-game contexts, such as education, to increase engagement and motivation. The study found that gamification improved students' motivation and engagement, leading to increased knowledge retention and skill development.

The use of gamification in education can take many forms, such as incorporating leaderboards, progress bars, and badges into learning platforms. These features can provide immediate feedback and recognition to students, which can enhance their sense of achievement and encourage further participation. Gamification can also promote collaboration and social learning among students, as well as provide opportunities for creative problem-solving and critical thinking.

Overall, the study suggests that gamification can be a valuable tool for educators looking to increase student engagement and motivation in the learning process. By incorporating game mechanics and design into educational contexts, educators can create more dynamic and interactive learning environments that promote skill development and knowledge retention.

## 8. CONCLUSION

The research findings of the study are discussed as follows:

The development of gamification designed to enhance creative and innovative thinking skills should be characterized by the components of gamification and its corresponding learning processes, based on the mutual procedures for gamification-oriented instructional management and practical activities. According to the study by [19], they emphasized that this prototype model directly influenced learners' participatory requirements and provided additional learning opportunities for improvement. It also improved the required characteristics of innovation makers and practices in innovative thinking skills. Another study by [20] investigated the implementation of gamification in online English curriculum management to increase students' motivation and participation. The findings showed that gamification-oriented instructional management improved students' flexibility and freedom in their work.

These previous studies suggest that the development of a gamification-oriented prototype model, in conjunction with related studies on gamification, can encourage learners' motivation through the use of games and improve their 21st-century learning skills in the digital age. Additionally, learners' assignments and technological applications can be used to foster critical thinking skills and enhance their creative and innovative thinking skills.

The results of the gamification-oriented implementation for enhancing innovative thinking skills were positive for this sample group. The developed model improved learners' motivation, challenges, participation, performance goals, well-organized sequencing, self-responsibility, amusing learning atmospheres, better interaction, and collaboration with other learners. According to [21], gamification was not just conceptualized from games and game dynamics, but also designed to enhance learners' learning and provide positive feedback. It also helped stimulate learners' motivation, interpersonal interaction, and participation, leading to their self-development and better learning outcomes. According to the findings in [22], the effects of using a tutoring application in combination with self-directed learning showed that the outcomes of self-learning through applications are comparable to those of self-learning through gamification, leading to an improvement in diverse skills development.

In addition to the positive findings and implications discussed in the previous section, this study also raises several questions that require further investigation. For example, future research could explore the generalizability of the gamification components identified in this study across different educational contexts and age groups. Additionally, further studies could examine the potential long-term effects of gamification on the development of creative and innovative thinking skills beyond the immediate learning outcomes observed in this study.

Moreover, this study only focused on the impact of gamification on the development of creative and innovative thinking skills and did not explore the potential drawbacks or limitations of gamification in the educational setting. Therefore, it would be useful to investigate the possible negative effects of gamification, such as its potential to foster an over-reliance on extrinsic motivation and rewards at the expense of intrinsic motivation and enjoyment of learning.

Overall, this study provides important insights into the potential of gamification as a tool for enhancing creative and innovative thinking skills in the educational setting. While further research is needed to fully understand the scope and limitations

of gamification, the findings of this study can inform the development of effective gamification designs and strategies for promoting 21st-century learning skills.

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