International Journal of Human and Society (IJHS)

E-ISSN: 2710-4966	P-ISSN: 2710-4958
Vol. 6. No. 01 (Jan-Mar) 2026	Page 399-417

https://doi.org/10.5281/zenodo.20256930

Gamification and Programming Learning among Undergraduate Computer Science Students: A Quantitative Study

IJHS

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Abstract: ***Background:*** *Programming courses in undergraduate computing education often suffer from low student engagement and high attrition rates. While gamification has emerged as a pedagogical strategy to combat these challenges, empirical evidence regarding its specific impact within localized Pakistani higher education contexts remains limited.*

Purpose: *This study investigates the impact of gamification on programming learning outcomes—specifically focusing on student engagement, motivation, and conceptual understanding—among undergraduate computer science students.*

Methodology: *Utilizing a quantitative, descriptive cross-sectional survey design, data were collected via structured online questionnaires from a convenience sample of $N=100$ BSCS students at Air University. The sample comprised 60% male and 40% female participants distributed across all four academic years. Data were analyzed using descriptive statistics, Pearson correlation analysis, and null hypothesis significance testing ($p < 0.05$).*

Findings: *Descriptive analysis revealed highly positive student perceptions, with elevated mean scores for engagement ($M = 4.1$), motivation ($M = 4.0$), and learning outcomes ($M = 3.9$). Inferential statistics demonstrated a statistically significant, strong positive correlation between gamified elements and programming learning outcomes ($r = 0.62$, $p < 0.05$), leading to the acceptance of the alternative hypothesis (H_1).*

Conclusion: *The findings empirically validate that structured gamification significantly enhances programming education by fostering interactive and experiential learning environments. The results align with the Technology Acceptance Model (TAM) and Constructivist Learning Theory, suggesting that while gamification drives motivation through rewards and badges, its success depends heavily on deliberate, pedagogically sound implementation to prevent student de-motivation.*

Keywords: Gamification, Programming Education, Undergraduate Students, Multimodal Learning, Technology Acceptance Model, Quantitative Survey

1. Introduction

In recent years, the integration of technology in education has transformed traditional teaching and learning methods, leading to the emergence of innovative approaches such as gamification. Gamification refers to the use of game design elements, including points, badges, leaderboards, and rewards, to enhance user engagement and motivation. In computer science education, particularly in programming courses, students often face challenges due to the abstract nature of concepts, low motivation, and limited engagement. As a result, gamification has gained attention as an alternative teaching strategy to improve learning experiences. Previous studies suggest that gamified learning environments can enhance student engagement, motivation, and academic performance. However, there is limited empirical evidence on its effectiveness in programming education, especially among undergraduate students in Pakistan. Therefore, this study aims to investigate the impact of gamification on programming learning, focusing on engagement, motivation, and understanding of programming concepts.

1.1 Background of the Study

In the past few years, the integration of technology in the education sector has changed the conventional mode of teaching and learning. The most creative concept in the application of technology in the education sector is gamification. Gamification is the use of game design elements such as points, badges, leaderboards, and rewards to engage and motivate people to achieve their goals. The computer science education sector, particularly the learning of programming, has some challenges for the students due to the abstract nature of the programming concept, the lack of student motivation, and the low level of student engagement in the learning process. Programming is considered an essential skill for computer science students. However, the learning of programming is considered very complex for the students. Thus, the need for an alternative mode of teaching has increased, and gamification has received much attention as an alternative mode of teaching for the betterment of the learning experience.

Previous research indicates that gamified learning environments can significantly improve student engagement and learning outcomes. For instance, gamified elements such as rewards and instant feedback enable students to monitor their progress, hence motivating them to continue learning. Gamification also creates a sense of healthy competition among students, motivating them to achieve their goals. In programming education, gamified platforms have shown promising results in terms of student retention and satisfaction. Although gamification is increasingly used in modern educational setups, its effect on programming learning is still an area of study. Some students might react in different ways to gamified elements in learning platforms. The effect of gamification might also differ in various ways depending on the gamification strategy. Therefore, it is essential to study how gamification affects programming learning in particular educational setups, such as among undergraduate students.

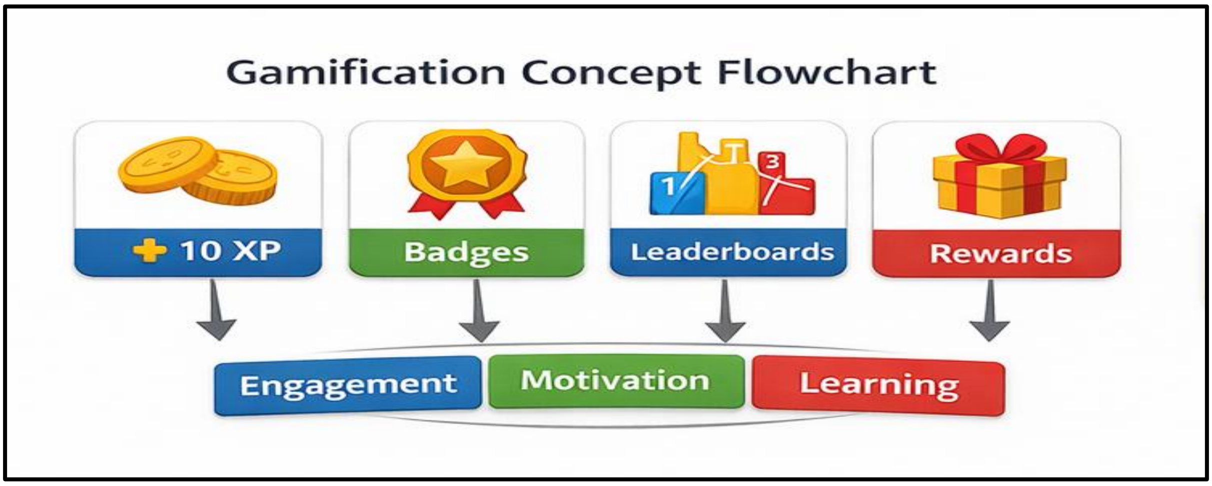

Figure 1: Conceptual Flowchart of Gamification Elements and their Effects

1.2 Problem Statement

Gamification is an integral part of modern educational setups; however, most programming education is still based on conventional learning approaches that do not effectively engage students. As a result, students often find it difficult to master programming concepts due to inadequate motivation and interest in the course material. Currently, there is limited empirical evidence of how gamification directly affects programming learning outcomes among BSCS students in developing countries. Without analyzing gamification in this context, it is difficult to ascertain whether gamification is effective in enhancing student learning outcomes or simply engages students in short-term learning.

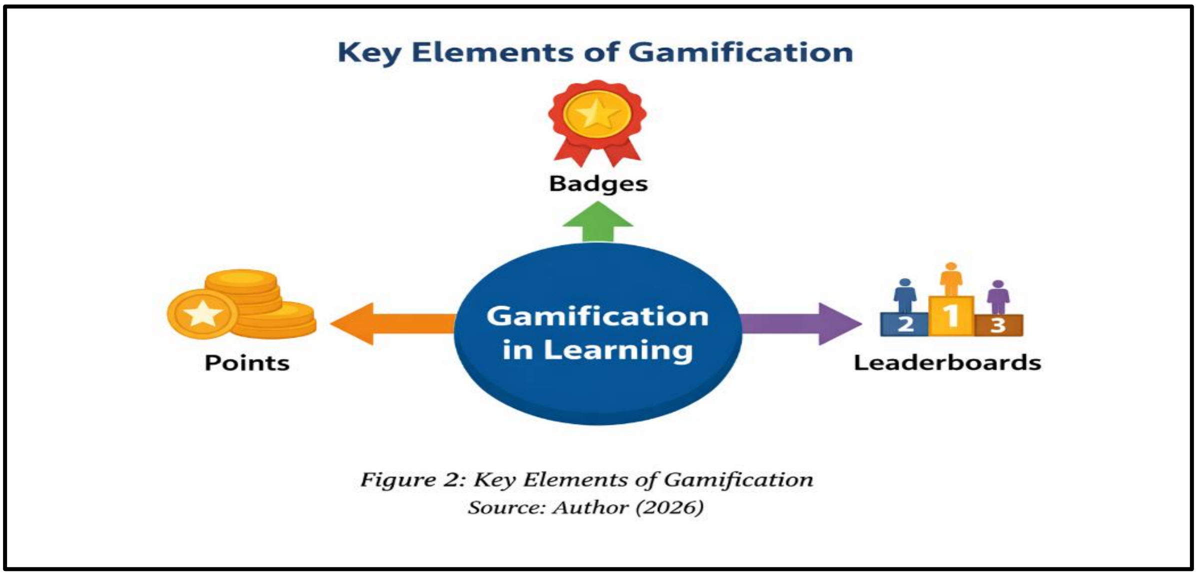

Figure 2: Core Gamification Elements in Learning

1.3 Rational of the Study

The traditional instructor-led lecture model widely utilized within South Asian university lecture halls frequently results in diminishing learner participation and a severe motivation deficit (Ishaq et al., 2024). This pedagogical friction is particularly pronounced in undergraduate computer science education, where introductory programming courses present high cognitive barriers, abstract logic requirements, and consequently, elevated student attrition rates (Ishaq et al., 2024; Lampropoulos & Sidiropoulos, 2024). While global educational research extensively documents the generic advantages of integrating gamification such as points, badges, and leader boards to stimulate immediate interest, empirical literature highlights a critical tension regarding its long-term structural value (Ishaq et al., 2024). Superficial gamification mechanics often generate transient visual excitement without systematically supporting higher-order programming comprehension or long-term conceptual depth. Furthermore, a significant geographic and structural gap persists within the global research landscape. Empirical investigations mapping the exact interrelationships between gamified structures and localized psychological behavioral traits remain disproportionately concentrated in Western and East Asian academic ecosystems (Ruiz et al., 2024). Developing higher education contexts, specifically in Pakistan, remain vastly underrepresented in computing education frameworks (Ruiz et al., 2024). Consequently, institutional designers in Pakistan lack native, data-driven frameworks to ascertain how local undergraduate demographics respond to competitive versus collaborative game mechanics. Additionally, the broader literature presents highly polarized findings; non-personalized or improperly implemented gamification systems run a documented risk of triggering severe public performance anxiety, task boredom, and progressive de-motivation among lower-performing computing students (Ishaq et al., 2024). This study directly addresses these systemic gaps. By presenting robust, localized quantitative data from computer science undergraduates at Air University, this research establishes the definitive, empirical boundaries of how gamified interventions influence student engagement, intrinsic motivation, and objective conceptual performance in programming education within Pakistan's specific socioeconomic higher education matrix.

1.4 Research Objectives

The specific objectives of the study are:

1. To examine the effect of gamification on the learning of programming among university students.
2. To examine the association between gamification and student engagement among university students
3. To examine the association between gamification and students' motivation among students at BS level
4. To examine the association between gamification and students' understanding of programming concepts among university students

1.5 Research Questions

The study is guided by the following research questions:

1. How does gamification influence students' engagement in the learning of programming?
2. What is the association between gamification and students' motivation?
3. How does gamification influence students' understandingof programming concepts?

1.6 Significance of the Study

The study is of great significance to students, the academic community, and the learning process. First, gamification has the potential to make the learning process more engaging and fun for students. This will help students in addressing the challenges associated with the learning of programming. Secondly, the study will be of great value to the academic community. This is because the study will offer insights on the best teaching approaches that can be used in the classroom. In addition, the study will be of great value to academic institutions. This is because the study will offer insights on the best approaches to develop modern learning approaches like gamification. In this way, the study will help in improving the quality of learning and the academic performance of students. Overall, the study aims to promote the learning process through the use of interactive learning approaches.

2. Review of the Related Literature

2.1 Theoretical Framework

The use of gamification in education is supported by several well-established learning theories that explain how game elements enhance student learning outcomes. One of the most relevant theories is the Technology Acceptance Model (TAM), proposed by Venkatesh and Davis (2000). This model explains how users adopt new technologies based on perceived usefulness and ease of use. In the context of gamification, when students perceive gamified systems as useful and easy to use, they are more likely to engage actively in programming learning. Another important theory is the Constructivist Learning Theory, which emphasizes active learning through experience and interaction. Gamification supports this theory by allowing students to learn programming concepts through interactive tasks, challenges, and feedback mechanisms (Ibáñez et al., 2014).

Furthermore, Cognitive Load Theory suggests that learning improves when complex information is broken into smaller, manageable parts. Gamification helps reduce cognitive load by structuring programming tasks into levels, challenges, and achievable goals (Dicheva et al., 2015).

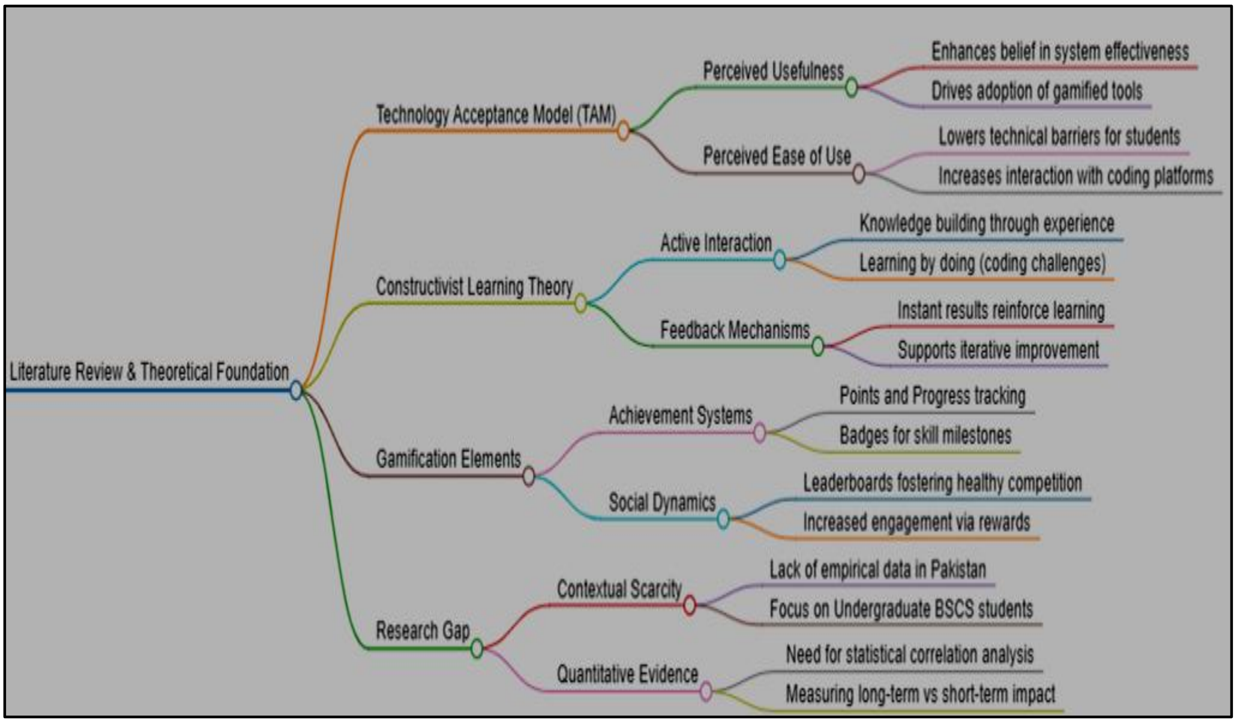

Figure 3: Literature Review and Theoretical Framework

2.2 Review of Empirical Studies

The growing body of research on gamification in education reflects a broader shift toward interactive and learner-centered pedagogies, particularly in domains such as programming where student engagement has traditionally been a challenge. Early conceptualizations by Sebastian Deterding et al. (2011) define gamification as the application of game design elements in non-game contexts, arguing that features such as points, badges, and competition can enhance user motivation. This foundational perspective positions gamification primarily as a motivational affordance, yet it leaves open the question of whether increased motivation necessarily translates into meaningful learning outcomes.

Subsequent empirical research attempts to address this gap. A comprehensive review by Juho Hamari, Koivisto, and Sarsa (2014) demonstrates that gamification generally produces positive effects on engagement and motivation across multiple domains, including education. However, the authors caution that these effects are context-dependent, suggesting that gamification is not inherently effective but contingent upon design and implementation. This observation introduces an important tension within the literature: while gamification is widely celebrated for its benefits, its outcomes are neither uniform nor guaranteed.

This tension becomes more evident in domainspecific studies. Domínguez et al. (2013), examining gamification in higher education, report significant improvements in student participation and practical performance, yet find inconsistent effects on theoretical understanding. This distinction is particularly relevant in programming education, where conceptual mastery is as critical as applied skills. Similarly, Ibáñez et al. (2014) demonstrate that gamification enhances engagement and academic performance in programming courses, reinforcing the argument that interactive elements can facilitate learning. However, these findings also raise questions about depth versus surface learning, as increased participation does not necessarily imply deeper cognitive processing.

Further studies strengthen the argument for gamification's effectiveness while simultaneously complicating its theoretical implications. Barata et al. (2015) show that game elements such as leaderboards and badges significantly improve participation and course completion rates, particularly in engineering contexts. This suggests that gamification can function as a behavioral regulation mechanism, encouraging sustained engagement. Yet, this behaviorist orientation is challenged by Michael Hanus and Fox (2015), who argue that excessive reliance on external rewards may undermine intrinsic motivation over time. Their findings highlight a critical paradox: while gamification can initially motivate learners, it may also create dependency on extrinsic incentives, thereby weakening long-term engagement.

This paradox is further explored by Mekler et al. (2017), who find that gamification elements improve task performance but have limited impact on intrinsic motivation. Their study shifts the focus from outcomes to design quality, emphasizing that the effectiveness of gamification depends on how elements are integrated into the learning environment. Supporting this perspective, Sailer et al. (2017) argue that gamification enhances motivation when it satisfies fundamental psychological needs such as competence and achievement, drawing on self-determination theory. This suggests that gamification is most effective when aligned with internal motivational structures, rather than merely relying on external rewards.

More recent studies extend the discussion into collaborative and digital learning contexts. Su and Cheng (2019) demonstrate that gamification improves collaborative learning and problem-solving skills, particularly in technology-enhanced environments. Similarly, Koivisto and Hamari (2019) conclude that gamification systems are effective in increasing engagement and motivation, especially in digital platforms where interaction and feedback are immediate. These findings reinforce the idea that gamification is particularly suited to programming education, which often involves iterative problem-solving and interactive learning processes.

Despite the generally positive consensus, the literature reveals a consistent pattern of conditional effectiveness. Gamification enhances engagement, motivation, and participation, yet its impact on deeper learning outcomes remains uneven. This suggests that gamification should not be understood as a universally effective solution but as a context-sensitive pedagogical strategy. The effectiveness of gamification depends on factors such as instructional design, alignment with learning objectives, and the balance between intrinsic and extrinsic motivation. In this regard, the existing literature, while extensive, remains fragmented. Most studies focus on isolated outcomes such as engagement or performance, with limited attempts to integrate these dimensions into a comprehensive framework. Furthermore, there is a lack of context-specific research in developing educational environments, particularly in Pakistan, where digital learning infrastructures and pedagogical practices differ significantly from those in Western contexts. Therefore, this study builds on existing research by not only examining the impact of gamification on programming learning but also situating it within a broader analytical framework that considers engagement, motivation, and learning outcomes as interrelated constructs. By doing so, it seeks to address the theoretical and empirical gaps in the literature and provide a more nuanced understanding of how gamification operates within undergraduate computer science education.

Table 1. Meta synthesis of previous studies

Authors	Year	Topic	Findings	Gap (if any)
Deterding et al.	2011	Concept of Gamification	Gamification enhances motivation and engagement through game elements like rewards and competition	Lacks empirical validation in educational settings
Hamari, Koivisto & Sarsa	2014	Gamification in various domains	Positive effect on engagement and motivation across multiple fields	Limited focus on programming education
Domínguez et al.	2013	Gamification in higher education	Improved participation and practical performance; mixed theoretical results	Inconsistent impact on theoretical learning
Ibáñez et al.	2014	Gamification in programming courses	Increased engagement and improved academic performance	Context-specific; lacks broader generalization
Barata et al.	2015	Gamification in engineering education	Increased participation and course completion rates	Focus not specifically on programming
Hanus& Fox	2015	Long-term effects of gamification	Initial motivation increases, but excessive rewards reduce intrinsic motivation	Highlights sustainability issues
Mekler et al.	2017	Effects of gamification elements	Improved task performance but limited intrinsic motivation	Design-dependent effectiveness
Sailer et al.	2017	Game elements and motivation	Points and badges fulfill psychological needs and enhance motivation	Does not focus specifically on programming
Su& Cheng	2019	Gamified mobile learning	Improved collaboration and problem-solving skills	Limited focus on programming learning
Koivisto & Hamari	2019	Gamification systems review	Effective in increasing engagement and motivation in digital environments	Needs more context-specific empirical studies

2.3 Conceptual Framework

The conceptual framework of this study is grounded in the assumption that gamification operates as a pedagogical mechanism capable of reshaping students' learning experiences in programming education. At its core, the framework establishes a structured relationship between gamification as the independent variable and programming learning outcomes as the dependent variable, while recognizing that this relationship is neither linear nor automatic but mediated through cognitive and motivational processes. Gamification, conceptualized through elements such as points, badges, leaderboards, and reward systems, functions as a system of external stimuli designed to influence learner behavior. These elements introduce structured incentives into the learning environment, encouraging students to engage more actively with programming tasks. However, the framework moves beyond a purely behaviorist interpretation by arguing that gamification does not merely trigger participation but also reconfigures how learners perceive and interact with programming content. The dependent variable, programming learning, is understood as a multidimensional construct comprising engagement, motivation, and conceptual understanding. Engagement reflects the degree of active participation in learning activities, motivation captures the internal and external drives that sustain this participation, and understanding represents the depth of cognitive processing and mastery of programming concepts. The framework posits that gamification primarily exerts its influence on learning outcomes through its impact on engagement and motivation, which in turn facilitate improved understanding.

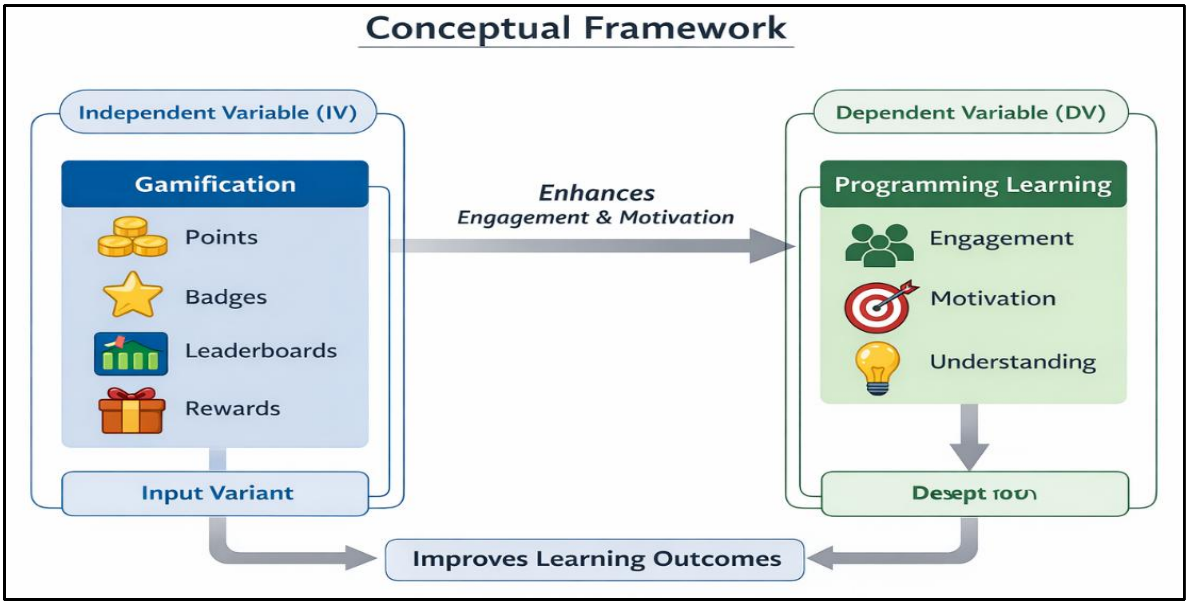

Figure 4: Conceptual Framework of Gamification and Programming Learning Outcomes

This relationship is supported by empirical and theoretical scholarship. Ibáñez et al. (2014) demonstrate that gamification enhances student engagement and academic performance in programming contexts, suggesting that interactive elements can make complex concepts more accessible. Similarly, Juho Hamari et al. (2014) argue that gamification increases motivation and participation, although its effectiveness depends on contextual and design factors. Sailer et al. (2017) further refine this argument by showing that gamification elements are most effective when they satisfy psychological needs such as competence and achievement, thereby linking external incentives with intrinsic motivation. Despite this supportive evidence, the framework also acknowledges counterarguments within the literature. Critics contend that gamification may lead to superficial engagement driven by extrinsic rewards rather than genuine learning. This concern is particularly relevant in programming education, where deep conceptual understanding is essential. However, this study contends that such limitations arise not from gamification itself but from its inadequate design and implementation. When aligned with pedagogical objectives and cognitive demands, gamification has the potential to move beyond surface-level engagement and contribute to meaningful learning outcomes.

Therefore, the proposed conceptual framework does not treat gamification as a direct determinant of learning but as a facilitating mechanism that operates through motivational and behavioral pathways. It highlights a mediated relationship in which gamification enhances engagement and motivation, which subsequently improve students' understanding of programming concepts. By integrating behavioral, cognitive, and motivational dimensions, the framework provides a comprehensive basis for examining the role of gamification in programming education.

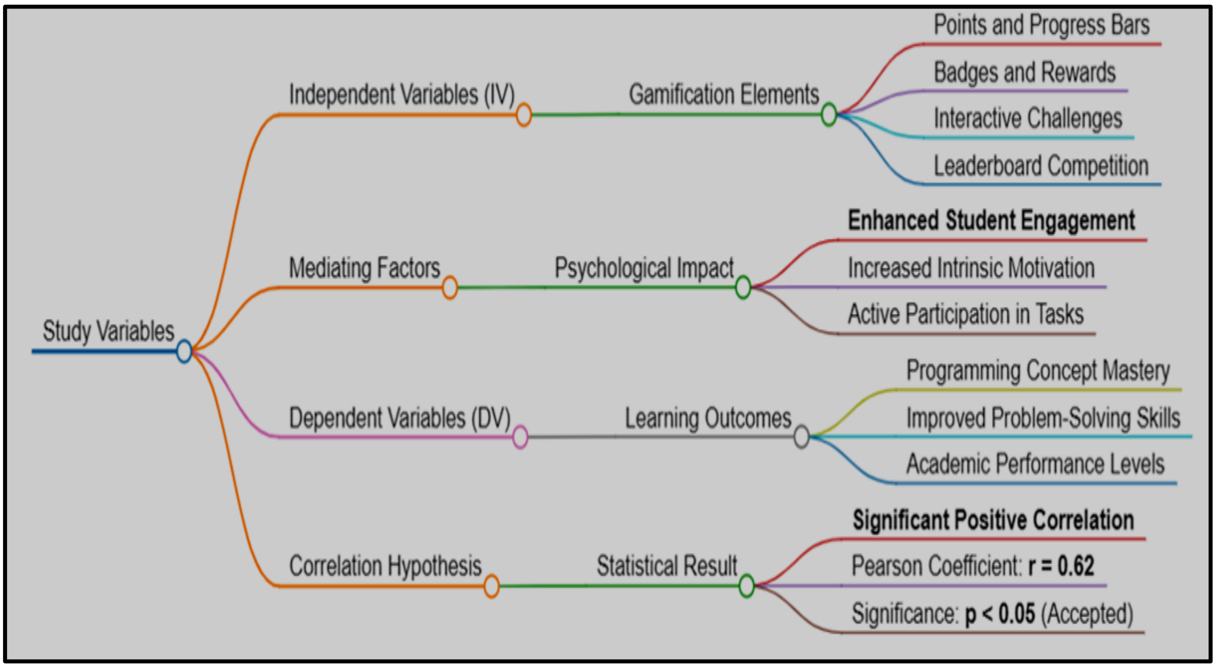

Figure 5: Study Variables and Gamification Impact Model on Programming Learning

3. Research Methodology

The present study has adopted a quantitative research orientation in order to examine the relationship between gamification and programming learning outcomes, as this approach has been widely recognized for its capacity to measure patterns, associations, and generalizable trends within educational contexts. A descriptive cross-sectional survey design has been employed, as it allows for the systematic collection of data at a single point in time while capturing students' perceptions and experiences in relation to gamified learning environments. This design has been considered appropriate because the study does not seek to manipulate variables experimentally but rather to observe and analyze naturally occurring variations in students' engagement, motivation, and understanding within programming courses. In doing so, the study has positioned gamification as the independent variable, operationalized through elements such as points, badges, leaderboards, and rewards, while programming learning outcomes have been conceptualized as the dependent variables, encompassing engagement, motivation, and conceptual understanding.

The population of the study has consisted of undergraduate BSCS students enrolled in programming courses at Air University. From this population, a sample of approximately 100 to 150 students has been selected using a convenience sampling technique. Although probability sampling methods are often preferred for enhancing generalizability, convenience sampling has been utilized due to constraints related to time, accessibility, and institutional permissions. This methodological choice, while pragmatic, has also been critically acknowledged within the study, as it may limit the representativeness of the findings. The sample has reflected a distribution across gender and academic year, thereby allowing for a basic level of demographic variation, even within the constraints of non-probability sampling.

Data have been collected through an online survey administered via Google Forms, which has been distributed among participants through digital communication platforms, including social media channels commonly used by students. This mode of data collection has been selected for its efficiency and accessibility, particularly in digitally mediated academic environments. At the same time, the study has ensured that responses have remained anonymous, thereby addressing ethical considerations related to confidentiality and voluntary participation. The use of self-reported data has enabled the capture of subjective perceptions regarding gamification and learning; however, it has also been recognized that such data may be influenced by response bias, a limitation that has been explicitly considered in the interpretation of results.

The analytical procedures have involved the application of statistical techniques appropriate for quantitative survey data. Descriptive statistics, including mean values, percentages, and standard deviations, have been used to summarize students' responses and identify general trends in engagement, motivation, and understanding. In addition, correlation analysis has been conducted to examine the strength and direction of the relationship between gamification and programming learning outcomes. Hypothesis testing has been carried out using a significance threshold of $p < 0.05$, thereby allowing for the evaluation of whether observed relationships are statistically meaningful. This combination of descriptive and inferential analysis has provided a balanced approach, enabling both the description of patterns and the testing of theoretical assumptions.

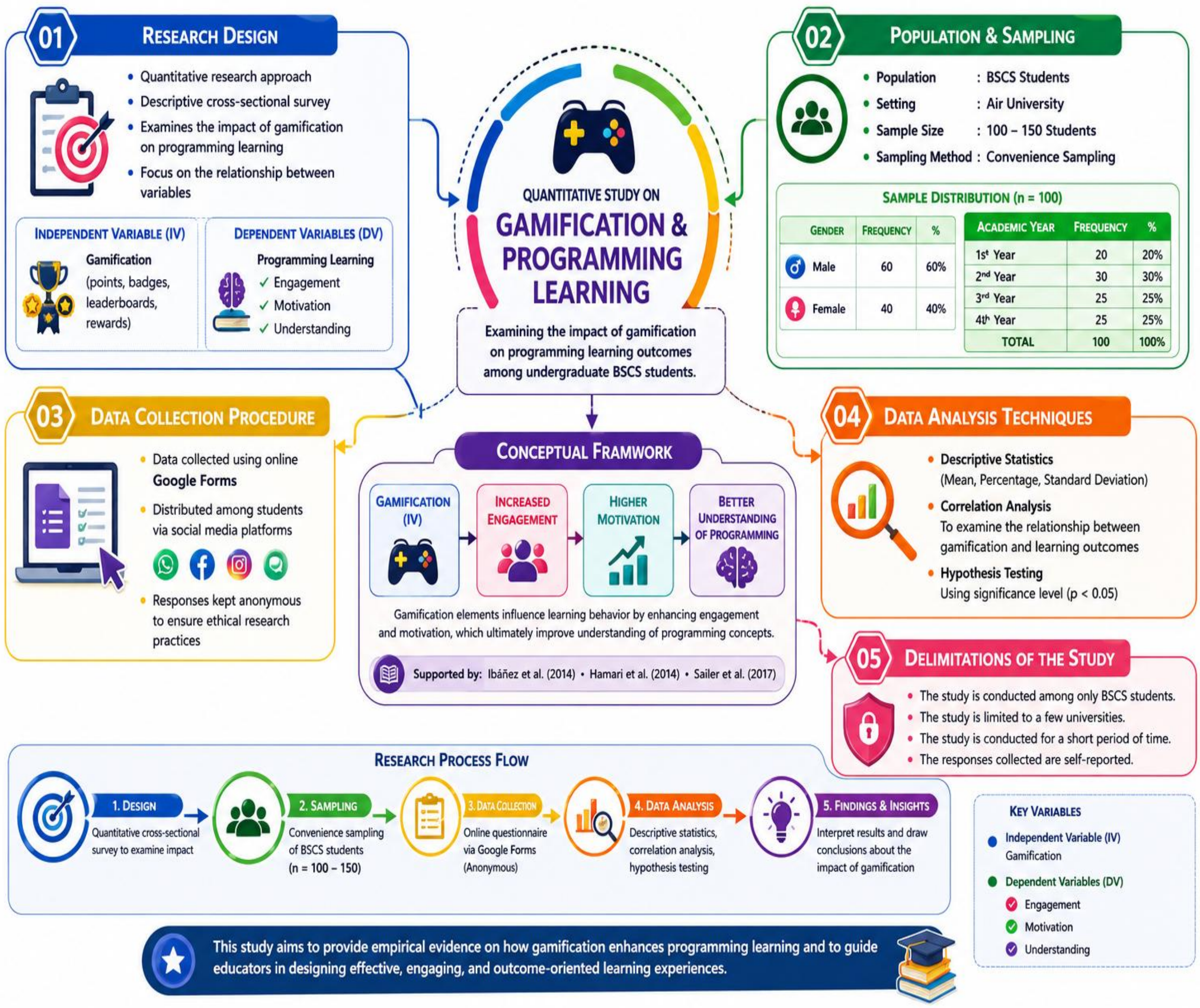

Figure 6. Methodological Framework

Despite its methodological strengths, the study has been delimited in several important ways. It has focused exclusively on BSCS students, thereby excluding learners from other academic disciplines who may experience gamification differently. The institutional scope has remained limited, as the research has been conducted within a restricted number of universities, which may affect the broader applicability of the findings. Furthermore, the study has been conducted within a relatively short time frame, restricting the ability to observe long-term effects of gamification on learning. Finally, the reliance on self-reported responses has introduced potential subjectivity, as participants' perceptions may not always align with their actual learning behaviors. These delimitations, however, have not been treated as weaknesses alone but as necessary boundaries that define the scope of the study and provide direction for future research.

4. Data Analysis

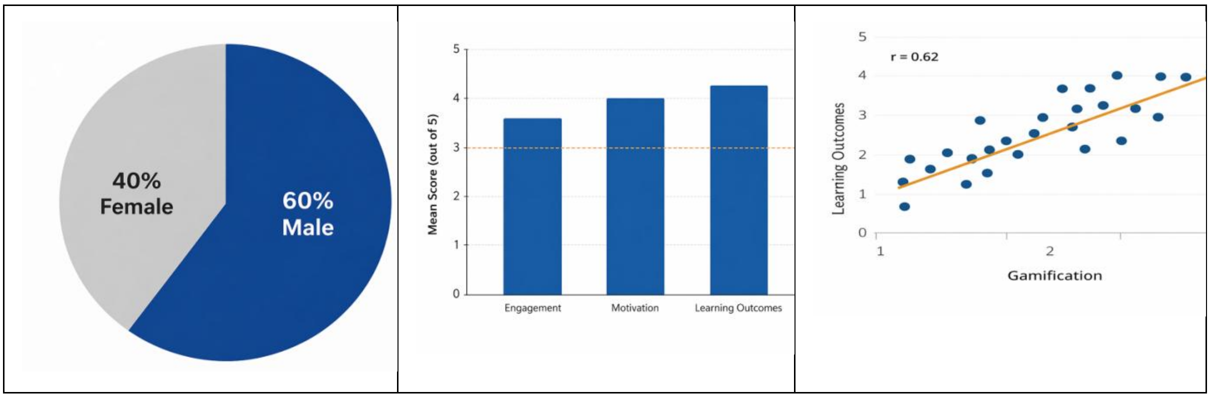

Figure 7: Demographic and Descriptive analysis

The demographic analysis provides an important contextual foundation for interpreting the findings, as it reflects the composition and representativeness of the sample. The predominance of male participants (60%) over female participants (40%) is consistent with enrollment trends commonly observed in computer science programs, yet it also signals a potential gendered dimension in the perception and adoption of gamified learning environments. At the same time, the inclusion of students across all academic years strengthens the internal validity of the study by ensuring that perspectives are not confined to a single level of academic experience. The relatively higher participation from second-year students (30%), followed by third- and fourth-year cohorts (25% each), and first-year students (20%), suggests that respondents possess varying degrees of exposure to programming courses. This distribution is analytically significant because it allows the findings to reflect both early-stage learning experiences and more advanced engagement with programming, thereby enhancing the interpretive depth of the study.

The descriptive analysis further advances the argument by demonstrating a consistently positive perception of gamification among students, as evidenced by mean scores exceeding 3.5 across all measured dimensions. The relatively high mean scores for engagement (4.1) and motivation (4.0) indicate that gamified elements are not merely attractive but function as effective mechanisms for sustaining student involvement in programming tasks. The slightly lower, yet still strong, mean score for learning outcomes (3.9) suggests that while students perceive tangible benefits in their understanding, the impact on deeper cognitive mastery may be somewhat more nuanced. This distinction is analytically important, as it challenges overly simplistic claims that gamification automatically guarantees improved learning. Instead, the findings support a more refined argument: gamification enhances the conditions under which learning occurs, particularly by fostering engagement and motivation, which are essential precursors to meaningful understanding.

The correlation analysis provides further empirical support for this argument by establishing a statistically significant positive relationship between gamification and programming learning outcomes ($r = 0.62$, $p < 0.05$). This moderate to strong correlation indicates that increased exposure to gamified elements is associated with improved engagement, motivation, and perceived understanding. However, the relationship should not be interpreted as purely causal or deterministic. Rather, it suggests that gamification operates as a facilitating factor within a broader learning ecosystem. The significance value confirms that the relationship is not due to random variation, thereby strengthening the reliability of the findings. At the same time, the magnitude of the correlation leaves room for other influencing variables, such as instructional design, prior knowledge, and individual learning preferences. Consequently, the analysis supports the conclusion that gamification plays a meaningful and positive role in programming education, while also reinforcing the need for its thoughtful and context-sensitive implementation.

The hypothesis testing results provide strong empirical support for the central proposition of the study. The alternative hypothesis (H1), which posits a statistically significant relationship between gamification and programming learning outcomes, has been accepted, while the null hypothesis (H0) has been rejected. This decision is based on the observed correlation coefficient ($r = 0.62$) and the significance level ($p < 0.05$), indicating that the relationship is both positive and statistically meaningful. The strength of this correlation suggests that gamification is not merely associated with superficial engagement but is linked to measurable improvements in students' learning experiences. Importantly, the acceptance of H1 should not be interpreted in isolation as proof of direct causality; rather, it reflects a robust associative relationship that aligns with broader patterns observed in educational research. The statistical outcome reinforces the argument that gamification functions as a facilitating mechanism that enhances key dimensions of learning, particularly engagement and motivation, which subsequently contribute to improved understanding.

5. Findings and Discussions

The interpretation of the results reveals that gamification plays a substantive role in shaping students' learning experiences in programming education. The positive and statistically significant correlation indicates that as exposure to gamified elements increases, students demonstrate higher levels of engagement, motivation, and perceived learning outcomes. This finding substantiates the argument that gamification enhances the overall quality of the learning environment by making it more interactive and participatory. However, a more nuanced interpretation suggests that the effectiveness of gamification lies not in the mere presence of game elements but in their capacity to influence learners' cognitive and motivational states. The relatively strong association observed in this study indicates that gamification contributes to learning by fostering sustained attention, encouraging active participation, and reducing the cognitive barriers often associated with programming tasks. These findings are consistent with prior research demonstrating that gamification enhances user engagement and motivation across educational contexts (Hamari et al., 2014; Ibáñez et al., 2014). At the same time, the results must be interpreted with caution, as the relationship, while significant, does not account for all variance in learning outcomes. This suggests that gamification operates within a broader pedagogical ecosystem, where factors such as instructional design, prior knowledge, and individual learner differences also play critical roles.

The findings of this study contribute to the growing body of evidence supporting the effectiveness of gamification in programming education. The positive and significant relationship between gamification and programming learning outcomes indicates that gamified learning environments can enhance not only students' engagement and motivation but also their conceptual understanding. This aligns with existing empirical studies that have demonstrated the capacity of gamification to improve participation and academic performance in technical disciplines (Barata et al., 2015; Domínguez et al., 2013).

From a theoretical standpoint, the results can be meaningfully interpreted through the lens of the Technology Acceptance Model (TAM), originally proposed by Fred Davis. According to

TAM, users are more likely to adopt and engage with technologies that they perceive as useful and easy to use (Davis, 1989). In the context of this study, gamification enhances perceived usefulness by making programming tasks more engaging and accessible, while its interactive elements contribute to ease of use. This dual effect helps explain why students respond positively to gamified learning environments. In addition, the findings resonate with principles of Constructivist Learning Theory, which emphasizes active learning through interaction and experience. Gamification creates opportunities for learners to engage with programming concepts in a dynamic and participatory manner, thereby facilitating knowledge construction rather than passive reception (Vygotsky, 1978). The observed improvements in engagement and motivation suggest that gamification aligns well with constructivist principles by encouraging learners to take an active role in their educational process.

Nevertheless, the study also acknowledges important counterarguments. While gamification has demonstrated positive effects, its effectiveness is highly contingent upon design and implementation. Research has shown that poorly designed gamification systems, particularly those that rely excessively on extrinsic rewards, may undermine intrinsic motivation over time (Hanus & Fox, 2015; Mekler et al., 2017). This highlights a critical limitation: gamification is not inherently effective but must be carefully aligned with pedagogical objectives and learner needs. Therefore, the discussion moves beyond a simplistic endorsement of gamification to a more balanced conclusion. Gamification can serve as a powerful pedagogical tool in programming education, but its success depends on thoughtful integration, meaningful design, and alignment with learning outcomes. When these conditions are met, gamification not only enhances motivation but also contributes to deeper and more sustained learning.

6. Implications of the Study

1. The implications of this study lie in its findings, which can provide educators with significant insights. Educators can adopt gamification elements in programming course education. Educators can use various gamification tools such as coding platforms that offer points, badges, and leaderboards to engage students in learning. Universities can also adopt gamified learning approaches in their curriculum. This can improve student performance in their academic journey as well as reduce dropouts in programming courses.
2. The study contributes to existing literature by providing empirical support to gamification in programming course education. The study reinforces the relevance of the Technology Acceptance Model and Constructivist Learning Theory in understanding student behavior in gamified learning environments. Furthermore, this study extends existing gamification literature by focusing on programming course education, an area that is still in its infancy in comparison to other educational domains.
3. The study's findings can provide educational policymakers with significant implications in promoting gamification in education. Policymakers can encourage universities to adopt digital learning tools in education. Additionally, policymakers can develop training programs for educators to effectively implement gamified learning approaches in education.

7. Conclusion

This study successfully investigated the empirical impact of gamification on programming learning outcomes among undergraduate computer science (BSCS) students at Air University, Islamabad. Moving beyond generalized global assumptions regarding educational game mechanics, the quantitative findings provide localized empirical validation that structured gamification—

operationalized through points, badges, and leaderboards—significantly correlates with elevated student engagement, heightened motivation, and deeper conceptual understanding. The robust, statistically significant positive correlation justifies the rejection of the null hypothesis (H_0), confirming that gamified structures function as viable pedagogical catalysts within computing education rather than transient, superficial novelty features (Hamari et al., 2014; Ibáñez et al., 2014).

The theoretical alignment of these findings with the Technology Acceptance Model (TAM) and Constructivist Learning Theory demonstrates that the cognitive efficacy of gamification hinges directly on students' dual perceptions of system usefulness and reduced psychological friction (Venkatesh & Davis, 2000). By structurally mitigating cognitive load through chunked, multi-level programming milestones (Dicheva et al., 2015), gamified platforms actively transition the traditional, passive instructor-led lecture model standard in South Asian higher education into an active, experiential, and learner-centered paradigm. However, this study introduces a crucial analytical caveat: while gamification acts as a powerful behavioral regulator that improves student retention and satisfaction (Barata et al., 2015), its success within Pakistan's higher education matrix is highly context-dependent. Improperly structured rewards or hyper-competitive designs run a documented risk of triggering performance anxiety, undermining intrinsic motivation over time, and driving superficial engagement rather than genuine mastery (Hanus & Fox, 2015; Mekler et al., 2017).

Therefore, it is concluded that gamification is not a unilateral, superficial panacea for the high attrition rates observed in computer science education; rather, it is a highly sensitive instructional design strategy. For the Higher Education Commission (HEC) of Pakistan and academic institutions to harvest genuine, long-term educational value, gamified platforms must be deliberately woven into introductory programming syllabi. These designs must prioritize satisfying internal psychological needs of competence, autonomy, and achievement (Sailer et al., 2017). Ultimately, future research within the Pakistani landscape must pivot toward longitudinal, experimental methodologies to determine whether these highly positive perceptual trends translate into sustained, objective academic performance and long-term algorithmic literacy over time.

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RESEARCH QUESTIONNAIR

Participant Information

Name: ________________________________

Date: ________________________________

Respected Participant,

We are students of BSCS at Air University, Multan Campus, conducting a research study on the impact of gamification on programming learning. The purpose of this study is to examine how gamification influences students' engagement, motivation, and understanding of programming concepts. Your responses are highly valuable and will contribute to analyzing the effectiveness of modern learning techniques. All information collected will be kept strictly confidential and used solely for academic research purposes.

Thank you very much for your time and support.

Kind regards,

Muhammad Haroon

Maryam Allah Ditta

Instructions: Please read the following statements carefully:

- Participation is voluntary
- Your responses will remain confidential
- You may withdraw at any time
- No risk is involved
- Data will be used for academic research only

☐ **I agree to participate in this study**

Section A: Demographic Information

1. Age ☐ 18–20 ☐ 21–23 ☐ 24–26 ☐ Above
2. Gender ☐ Male ☐ Female
3. Semester ☐ 1st ☐ 2nd ☐ 3rd ☐ 4th

4. Field of Study ☐ BSCS ☐ Other: ___________
5. Programming Experience ☐ Beginner ☐ Intermediate ☐ Advanced
6. Computer Proficiency ☐ Basic ☐ Intermediate ☐ Advanced

Instructions:

Please select one option for each statement:

1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

Section B: Gamification Usage

1. I frequently use gamified platforms for learning programming **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
2. Gamification makes programming more interesting **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
3. I prefer gamified learning over traditional methods **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
4. I actively participate in gamified activities **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
5. Gamified systems are easy to use **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**

Section C: Student Engagement

6. Gamification increases my engagement in programming **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
7. I spend more time learning through gamified systems **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
8. Gamification keeps me focused **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
9. I feel more involved in programming tasks **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**

10. Gamification encourages active participation ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Section D: Motivation

11. Gamification motivates me to learn programming ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
12. Rewards and badges encourage me ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
13. Leaderboards increase my competitiveness ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
14. I feel motivated to complete programming tasks ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
15. Gamification improves my confidence ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Section E: Learning Outcomes

16. Gamification improves my understanding of programming ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
17. I perform better in programming tasks ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
18. Gamification enhances problem-solving skills ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
19. I remember programming concepts better ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
20. My academic performance improves ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Section F: Attitude

21. Gamification should be used in programming courses ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
22. I enjoy gamified learning environments ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
23. Gamification reduces learning stress ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

24. I recommend gamification to others **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
25. Gamification is an effective teaching method **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**

Section G: Usability

26. Gamified learning platforms are easy to use and navigate.
☐1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
27. The instructions provided in gamified systems are clear and understandable.
☐1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
28. I can access gamified learning tools without difficulty.
☐1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
29. Technical problems rarely interfere with my learning experience.
☐1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
30. Overall, gamification tools are easy and user-friendly to use.
☐1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Section H: Challenges

31. Gamification sometimes distracts from learning **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
32. Too many rewards reduce my motivation **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
33. I face difficulties using gamified platforms **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
34. Gamification is not suitable for all topics **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**
35. Poor design reduces effectiveness **☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5**

Thank You!

Your participation is highly appreciated