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ORIGINAL

Gamification and Formative Feedback with Kahoot! in Programming Fundamentals: A TAM-SDT-UCD Approach with Mechatronics Engineering Students

Gamificación y retroalimentación formativa con Kahoot! en Fundamentos de Programación: Enfoque TAM-TAD-DCU en estudiantes de Ingeniería Mecatrónica

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ABSTRACT

Immediate and meaningful feedback is a key element in improving academic performance in computational foundational disciplines. This study aimed to evaluate the impact of gamified strategies in the feedback process of the Programming Fundamentals course. The intervention was conducted with a population of 31 first-level students from the Mechatronics Engineering program at Universidad Técnica del Norte, of which 15 students voluntarily participated from the same course. Activities were designed using the Kahoot! platform, focused on reinforcing theoretical and practical content related to the course syllabus and the programming languages Java and Python. The adopted methodology was applied in nature, with a descriptive approach and exploratory scope. The results showed increased active participation, improved retention of key concepts, and a more positive attitude towards programming learning. In addition, recurring error patterns were identified, which served as input for tailored feedback. The use of playful dynamics fostered a collaborative learning environment, contributing to the development of cognitive and metacognitive skills. It was concluded that the integration of educational technologies with gamification elements enhances the effectiveness of feedback processes, increases students' intrinsic motivation, and enables timely identification of knowledge gaps. This approach is especially valuable in programming education, where active engagement and continuous practice are critical to academic success.

Keywords: Gamification; Formative Feedback; Programming; Kahoot!; Mechatronics Engineering Education.

RESUMEN

La retroalimentación inmediata y significativa representa un elemento clave para la mejora del rendimiento académico en disciplinas de base computacional. Esta investigación tuvo como objetivo evaluar el impacto del uso de estrategias gamificadas en el proceso de retroalimentación en la asignatura Fundamentos de Programación. La intervención se llevó a cabo con una población de 31 estudiantes de primer nivel de la carrera de Ingeniería en Mecatrónica de la Universidad Técnica del Norte y una muestra de 15 estudiantes voluntarios del mismo curso. Se diseñaron actividades basadas en la plataforma Kahoot!, orientadas a reforzar contenidos teóricos y prácticos vinculados al contenido de la asignatura y a los lenguajes de programación Java y Python. La metodología adoptada fue de tipo aplicada, con enfoque descriptivo y carácter exploratorio. Los resultados evidenciaron un aumento en la participación activa, mayor retención de conceptos clave y mejora en la actitud frente al aprendizaje de la programación. Asimismo, se identificaron patrones de error frecuentes que sirvieron como insumo para retroalimentaciones adaptadas. El uso de dinámicas lúdicas promovió un entorno de aprendizaje colaborativo, contribuyendo al desarrollo de competencias cognitivas y metacognitivas. Se concluye que la integración de tecnologías educativas con elementos de gamificación favorece procesos de retroalimentación más eficaces, incrementa la motivación intrínseca del estudiantado y permite una identificación oportuna de brechas de conocimiento. Este enfoque resulta especialmente valioso en el contexto de la enseñanza de la programación, donde el compromiso activo y la práctica constante son determinantes para el éxito académico.

Palabras clave: Gamificación; Retroalimentación Formativa; Programación; Kahoot!; Educación en Ingeniería Mecatrónica.

INTRODUCTION

Context and relevance of educational technologies

Currently, the use of educational technologies in the university classroom has become particularly relevant as a strategy to strengthen student participation and optimize teaching and learning processes, as well as to foster a more dynamic integration in the school. Among these strategies, gamification has established itself as an innovative approach in education. Gamification is the application of game design dynamics in non-game contexts to strengthen learning, stimulate motivation, and promote the development of positive skills, attitudes, and behaviors in students.[1,2] It is also an emerging trend that encourages learning by incorporating elements that promote active participation and meaningful knowledge construction.[3] Furthermore, gamification adapts to changes in the thinking and learning styles of new generations, responding to their interests and needs. Its primary purpose is to engage students in the learning process through a clear, attractive presentation of content, thereby strengthening effort, sustained motivation, and cooperation in the academic sphere and promoting more participatory, meaningful learning.

Theoretical dimensions of gamification analysis

To gain a deeper understanding of its impact on higher education, it is helpful to link it to theoretical frameworks that explain technology acceptance, intrinsic motivation, and the usability of digital tools. These include the Technology Acceptance Model (TAM), Self-Determination Theory (SDT), and User-Centered Design (UCD), which provide complementary dimensions for analyzing both students' willingness to adopt educational technologies and the motivational and design factors that influence the learning experience.

The Technology Acceptance Model (TAM) was proposed by Fred Davis in 1989 as an adaptation of Fishbein and Ajzen's reasoned action model. This model seeks to explain and predict users' intention to use a technology based on two fundamental components: perceived usefulness, understood as the degree to which a person believes that the use of a technology improves their performance in a given task, and perceived ease of use, which refers to the level at which an individual considers that the use of that technology will be free of physical and mental effort.[4] Both factors directly influence the user's attitude toward the technology, as well as their intention to use it, which affects its adoption and acceptance.

TAM has proven to be an effective tool for understanding the psychological and behavioral determinants that explain why an individual decides to use or not use a technology. Among its main advantages are its flexibility in adapting to different collaborative technologies and its low application requirements, as it does not require prior user experience. In turn, it allows identification of critical factors influencing its acceptance, such as compatibility with tasks and resistance to change, which can be addressed through planned educational activities aimed at facilitating technological appropriation and reducing cognitive barriers.[5]

Stover, et al.[6] argue that Self-Determination Theory (TAD) (Self-Determination Theory, SDT) seeks to understand human behaviors from a universal perspective, that is, those that can be generalized in different contexts in which individuals operate. This theory, developed by Deci and Ryan, focuses on intrinsic motivation and the satisfaction of three basic needs: autonomy, competence, and relatedness, as necessary elements for personal well-being and optimal development.[7]

Intrinsic motivation refers to performing an activity for the interest, pleasure, or satisfaction it provides, without the need for external rewards, and is associated with greater commitment and active participation. This type of motivation is related to the satisfaction of three basic psychological needs: competence, which involves feeling effective when interacting with the environment and overcoming challenges; autonomy, understood as the ability to be an agent and protagonist of one's own behavior; and relatedness, linked to the need for feelings of connection and care from others, an aspect that is particularly important in teamwork contexts.[6] Satisfying these needs not only promotes well-being and performance, but also encourages self-awareness, understanding, and self-acceptance, becoming a mechanism for action aimed at achieving personal and collective goals.[8,9]

In learning contexts, Self-Determination Theory seeks to facilitate cognitive and non-cognitive processes by providing students with an environment that promotes intrinsic motivation and active engagement. According to Kadir et al.[10], this theory suggests a structured curriculum that makes complex learning more manageable, provided that the environment promotes autonomy, competence, and social connection. In this way, not only is academic performance enhanced, but the student's personal and emotional development is also enhanced.

In relation to User-Centered Design (DCU) (UCD), this approach places the needs, preferences, and capabilities of users at the center of the design process to develop products, systems, or services that are usable, effective, and tailored to the target audience, ensuring that technological solutions are intuitive, functional, and aligned with the specific needs of users.[11,12] DCU/UCD is based on a deep understanding of the context of use and user participation throughout all stages of design.

DCU/UCD involves considering usability as an attribute that determines how easy and efficient a product is for the end user, based on the established objectives and the relationship between use and effort required.[12] Usability is a key criterion for evaluating the efficiency of a technological tool, especially in educational contexts where the aim is to facilitate the development of activities and tasks intuitively. In this sense, the interest lies in determining how people interact with technological tools to promote meaningful learning that directly impacts their motivation, understanding, and academic performance.

Gamification in pedagogical innovation

Within the teaching-learning process, the use of digital tools that incorporate playful dynamics and interactive resources opens up new possibilities for fostering active student engagement, strengthening self-regulation of learning, and promoting meaningful feedback. This approach aligns with contemporary trends in pedagogical innovation, where student leadership, content adaptability, and the personalization of the learning experience are considered essential factors for developing skills in highly complex cognitive contexts. In this sense, gamification, supported by educational technologies, integrates elements such as rewards, levels, badges, and immediate feedback to guide academic progress, maintain motivation, and stimulate continuous participation throughout the learning process.

Gamification should not be understood solely as a mechanism for completing a task, but rather as a strategy to engage students and promote meaningful learning.[13] Therefore, it is essential to analyze how gamification can contribute to overcoming various barriers by incorporating motivational dynamics that strengthen student autonomy, promote self-regulation of learning, and enhance classroom interaction. This approach, articulated with the Technology Acceptance Model (TAM), Self-Determination Theory (SDT), and User-Centered Design (UCD), allows us to examine its impact on technology acceptance, intrinsic motivation, and the usability of digital tools.

Kahoot! as a gamification tool

The selection of Kahoot! as a gamification tool in this study is based on both technical and pedagogical criteria that make it an ideal solution compared to other digital learning platforms. At the technological level, Kahoot! Offers a cloud-based architecture that enables immediate integration into different devices, ensuring multi-platform accessibility (computers, tablets, and smartphones) without the need for additional installations or complex configurations. It also facilitates the automatic generation of real-time reports, with individual and group metrics that enable statistical analysis and immediate feedback, a critical aspect for formative assessment. Its design also accounts for compatibility with low-bandwidth environments, allowing the prior download of questionnaires and ensuring the continuity of the teaching process even in contexts with limited technical resources.[14]

From a pedagogical and empirical perspective, multiple engineering studies in university settings demonstrate the effectiveness of Kahoot! in improving academic performance and student participation. According to Chernov, its use in introductory engineering courses significantly increases active participation and correlates positively with final exam results.[15] Meanwhile, research by Liang et al.[16] shows that the sustained incorporation of Kahoot! in engineering subjects promotes concentration, understanding of technical content, and enjoyment of learning through the use of quizzes in this tool. Similarly, Navarro-Castillo et al. confirm that, when using Kahoot! as a gamification tool for engineering students, this platform strengthened intrinsic motivation and contributed to more effective learning, enhancing their education and participation in real time, "improving the assimilation of complex concepts."[17] In civil engineering, Bienvenido-Huertas et al. showed a reduction in the academic failure rate and improvements in the assimilation of theoretical content when Kahoot! was used as a self-assessment tool in architecture and building engineering.[18] Finally, in computer engineering, there is evidence that, when compared to Mentimeter, Kahoot! Proved to be more effective in classes with a large number of students, due to its intuitive interface, greater dynamism, and better management of the transition between questions.[19]

These findings, coupled with the possibility that students not only participate as end users but also learn to configure and manage questionnaires, reinforce the relevance of Kahoot! as a technological and educational

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resource. Consequently, its selection in this research is justified by its technical robustness, methodological consistency, and accumulated empirical evidence in engineering, making it a tool aligned with the objectives of meaningful learning and formative assessment.

Subject of study

In the Fundamentals of Programming course, taught in the Mechatronics Engineering program, teaching is carried out through theoretical-practical classes in the programming laboratory, following a progressive process that begins with data flow diagrams (DFDs), continues with the use of PSeInt and programming in Python, and culminates with the autonomous approach to Java under the guidance of the teacher. On this basis, an innovative strategy was implemented experimentally, incorporating a playful, gamified dynamic through Kahoot! Platform, applied specifically before the development of topics considered relevant to the course, to verify understanding of the content and provide immediate feedback. The questionnaires were proposed and designed by student groups as part of a planned activity that encouraged ownership of learning, promoted collaborative learning, and strengthened student engagement in developing the subject. This proposal does not replace the usual methodology, but rather complements it by creating an initial space for diagnosis and motivation that allows the teacher to identify conceptual gaps and for students to reflect on their understanding of the subject matter and the skills they need to participate successfully in the game.

The experience showed positive effects not only in cognitive dimensions, but also in motivational, behavioral, and socio-affective dimensions. These include increased intrinsic motivation, improved punctuality, the promotion of collaborative interaction, and the strengthening of a favorable socio-emotional climate among students, accompanied by higher levels of focused attention during question solving. The research problem focuses on the lack of empirical evidence on the impact of gamified strategies as early feedback mechanisms in introductory programming courses, underscoring the need to analyze their effects on motivation, participation, and learning consolidation in engineering training contexts.

METHOD

To ensure the study's replicability, specific materials were designed on Kahoot! Platform, consisting of multiple-choice questionnaires aligned with the course content and proposed by groups of students as part of a planned activity. The number of questions was adjusted to the complexity of each topic, incorporating different response times based on difficulty, double-scored questions to reinforce key concepts, and intentional distractors to identify recurring errors. These dynamics not only enabled verification of understanding of the content but also increased motivation, encouraged punctual class attendance, and strengthened active participation in the theoretical-practical sessions.

Methodologically, this research adopts a quantitative, descriptive, and cross-sectional design. The population consists of 31 students enrolled in the first year of the Mechatronics Engineering program at the Technical University of Northern Ecuador (Técnica del Norte) during the academic period from October 2024 to March 2025. From this population, an intentional, voluntary sample of 15 students was selected to participate in the survey, which served as a data collection tool.

Instrument and validation

The data collection instrument is a structured questionnaire designed to assess students' perceptions of using Kahoot! Tool as a formative feedback strategy. The questionnaire was aligned with the TAM, TAD/SDT, and DCU/UCD theoretical frameworks and organized into sections ranging from general data to assessments of usability, motivation, and impact on learning. To ensure content validity, the instrument underwent expert-judgment validation by a professional with training in education and experience in mechatronics, which ensured the relevance and clarity of the items in relation to the study objectives.

Reliability analysis using Cronbach's alpha indicated excellent internal consistency across all theoretical dimensions (table 1). These values exceed the threshold of 0,70 recommended in the literature, which supports the robustness of the instrument applied.[20]

Table 1. Study reliability: Cronbach's alpha applied to study dimensions

Theoretical dimension	Cronbach's alpha (α)
Technology Acceptance Model (TAM)	0,897
Self-Determination Theory (SDT)	0,894
User-Centered Design (UCD)	0,894

Questionnaire structure

The questionnaire consists of 28 closed questions, organized into five thematic sections:

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The formulation of the items is based on three complementary theoretical frameworks:

- The Technology Acceptance Model (TAM), to assess perceived usefulness and ease of use.
- Self-Determination Theory (SDT), aimed at assessing intrinsic motivation, autonomy, and active participation.
- The User-Centered Design (UCD) approach, applied to the analysis of the tool's usability, clarity of feedback, and accessibility of the interface.
- The response scales used are 5-point Likert scales, with the categories: Strongly agree, Agree, Neutral, Disagree, and Strongly disagree.(21) In addition to providing an intermediate option that reduces the risk of forced or artificially polarized responses, this scale reduces ambiguities and more accurately captures students' perceptions of the gamified strategy, in line with the research objectives. Dichotomous questions are also included to investigate specific aspects of previous experience and use of complementary resources. The consistency between the items and the theoretical constructs is carefully reviewed, ensuring the semantic validity of each item.

The questionnaire is organized into five thematic sections that allow for a comprehensive exploration of student perceptions of the use of the Kahoot! tool as a formative feedback strategy. This grouping responds both to criteria of methodological consistency and to the logic of user experience progression, from contextual variables to assessments focused on the technological interface.

The closed questionnaire is divided into the following sections:

- Section 1: general information (5 questions).
- Section 2: experience with Kahoot! (5 questions).
- Section 3: impact on learning (5 questions).
- Section 4: satisfaction and overall assessment (5 questions).
- Section 5: user-centered design – Kahoot! interface (8 questions).

The first section, General Data, collects relevant sociodemographic and academic information to contextualize the findings and establish relationships between personal variables and subsequent responses. The second section, Experience with Kahoot!, focuses on the immediate perception of the tool's use during class, allowing the identification of factors related to acceptance, interest, and willingness to use it. The third section, Impact on Learning, delves into students' self-perception of the strategy's effects on comprehension, reflection, and content assimilation, which constitutes the core of the analysis. The fourth section, Satisfaction and Overall Assessment, collects overall impressions of the strategy applied and suggestions for future applicability, providing input for pedagogical decision-making. Finally, the fifth section, User-Centered Design – Kahoot! Interface incorporates criteria derived from the DCU/UCD approach, enabling the evaluation of the digital environment's usability, accessibility, and aesthetics from a pedagogical perspective.

This segmentation facilitates a systematic and differentiated analysis, consistent with the objectives of the study and aligned with recognized theoretical frameworks, such as the Technology Acceptance Model (TAM), Self-Determination Theory (SDT), and the principles of User-Centered Design (UCD).

The questions asked in this study are detailed below:

Section 1: General Data

Q1. Did you take the Fundamentals of Programming course with the instructor (instructor's name)?
Q2. Age when you took the Fundamentals of Programming course
Q3. Gender
Q4. Student ID number
Q5. Had you used Kahoot! before this Programming Fundamentals class?

Section 2: Experience with Kahoot! in Class

Q6. Was it easy to access and use Kahoot! during class?
Q7. Using Kahoot! increased my interest in programming.
Q8. I felt motivated to actively participate during the Kahoot activity.
Q9. The Kahoot! activities created a collaborative learning environment.
Q10. I felt comfortable using Kahoot! as an educational tool.

Section 3: Impact on Learning

Q11. Kahoot! helped me to better remember the concepts covered in class.
Q12. During the Kahoot! game, I identified concepts that I had not fully understood.
Q13. Kahoot! facilitated my understanding of programming concepts.
Q14. The Kahoot! questions made me reflect on how I was applying the concepts I had learned.

Q15. I felt more confident about the programming topics covered after the activity.

Section 4: Satisfaction and Suggestions

Q16. I am satisfied with the use of Kahoot! in this subject.
Q17. Would you recommend this type of activity in other subjects?
Q18. During the game, I was able to identify mistakes that I had not noticed in previous classes.
Q19. I found the structure of the game to be appropriate in terms of time, difficulty, and feedback.
Q20. I would like to see more similar games implemented in future classes.

Section 5: User-centered design (Kahoot! tool)

Q21. The Kahoot! interface was clear and easy to understand.
Q22. I was able to read the questions and answer options without difficulty.
Q23. I found the game design attractive and appropriate for the educational environment.
Q24. The time allotted for answering was sufficient to read and think about the answer.
Q25. I had no technical problems accessing or using Kahoot! during class.
Q26. The podium feature (scores and winners) motivated me to participate actively.
Q27. Seeing my position in the ranking encouraged me to pay more attention during the game.
Q28. I liked being able to select my avatar and enter my name in Kahoot!.

The structure of the questionnaire does not follow a purely thematic logic but is aligned with the theoretical frameworks that guide this study. Each section groups together questions that explore specific dimensions of the student's experience with Kahoot!, based on well-defined constructs. In this way, a theoretical-methodological traceability is established, facilitating both the interpretation and discussion of the findings.

Table 2. Correspondence between questions, construct, and theoretical dimension

Theoretical dimension	Question number	Associated construct
General data	Q1	Academic context
	Q2	Sociodemographic variable
	Q3	Sociodemographic variable
	Q4	Academic variable
	Q5	Previous experience
Technology Acceptance Model (TAM)	Q6	Perceived ease of use
	Q10	Perceived ease of use
	Q16	Attitude toward use
	Q19	Perceived usefulness/attitude
Self-Determination Theory (SDT)	Q7	Intrinsic motivation
	Q8	Intrinsic motivation
	Q9	Social relationship/interaction
	Q11	Competence
	Q12	Competence/awareness of mistakes
	Q13	Competence
	Q14	Autonomy/self-regulation
	Q15	Competence
	Q18	Competence / metacognition
	Q20	Intention to use in the future
User-Centered Design (UCD)	Q21	Usability
	Q22	Accessibility
	Q23	Aesthetics / user experience
	Q24	Usability / efficiency
	Q25	Technical accessibility
	Q26	Immediate feedback / motivation
	Q27	Commitment / attention
	Q28	Personalization / user experience

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The table summarizes this correspondence between the questions, the sections of the questionnaire, and the theoretical frameworks that support them (table 2).

RESULTS AND DISCUSSION

The high reliability values obtained reinforce the validity of the findings. In this sense, the high internal consistency of the items in each theoretical dimension suggests that the questionnaire applied is methodologically sound for assessing technological acceptance, intrinsic motivation, and user experience in gamified environments. These results are consistent with the literature, which considers α values above 0,90 to be excellent indicators of reliability, adding further robustness to the study's conclusions.

The application of the structured questionnaire to 15 first-year Mechatronics Engineering students at the Technical University of the North enables us to identify key perceptions regarding the use of Kahoot! as a formative feedback tool in the Fundamentals of Programming course.

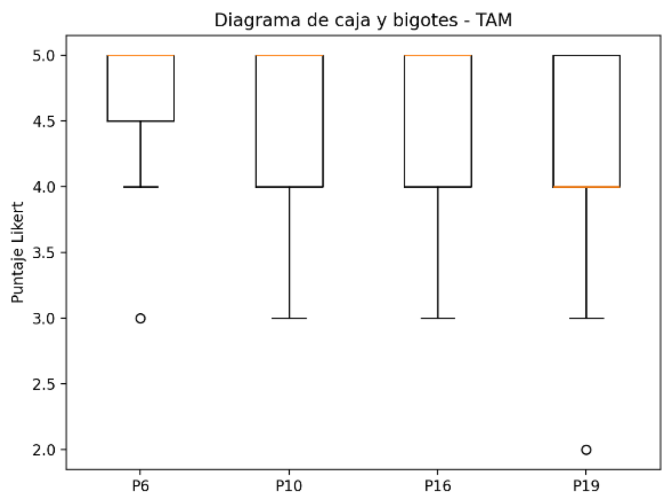
Dimension analysis with Kahoot! for the Fundamentals of Programming course:

Technology Acceptance Model (TAM)

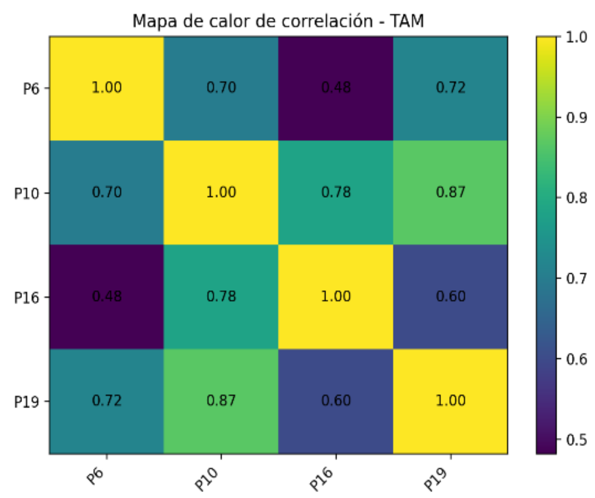
The average scores are in the high range (≈4,1-4,7/5). P6 (Kahoot! was easy to access and use) stands out as the highest value (~4,7), followed by P16 (satisfaction, ~4,5) and P10 (ease of use, ~4,4). P19 (suitability of structure: time/difficulty/feedback) is the lowest (~4,1), although it remains in positive territory. This pattern indicates high perceived ease and a favorable attitude toward the tool; the perceived usefulness associated with the activity's design (P19) is good, but it is the area with the most room for improvement (calibrating time, difficulty, and feedback).

The medians are 4–5, and the IQR is narrow, indicating consensus in the assessment of acceptance. Isolated outliers are observed in P6 (≈3) and P19 (≈2), consistent with specific episodes such as access/connectivity and lengthy texts. The high central tendency and low dispersion support the conclusion that the user experience was consistent (figure 1 (a)).

In figure 1 (b) The associations are high between P10–P19 (r≈0,87) and P10–P16 (r≈0,78), and moderate-high between P6–P10 (r≈0,70) and P6–P19 (r≈0,72); P16–P19 is moderate (r≈0,60), while P6–P16 is the lowest (r≈0,48). In terms of the Technology Acceptance Model (TAM), the results suggest that ease of use (P10) acts as a bridge between perceived ease (P6) and judgments of satisfaction (P16) and adequacy or "usefulness" of the structure (P19). This implies that, to increase satisfaction, it is more effective to optimize the direct experience (clarity of interaction, feedback) than to focus solely on initial access.



(a)



(b)

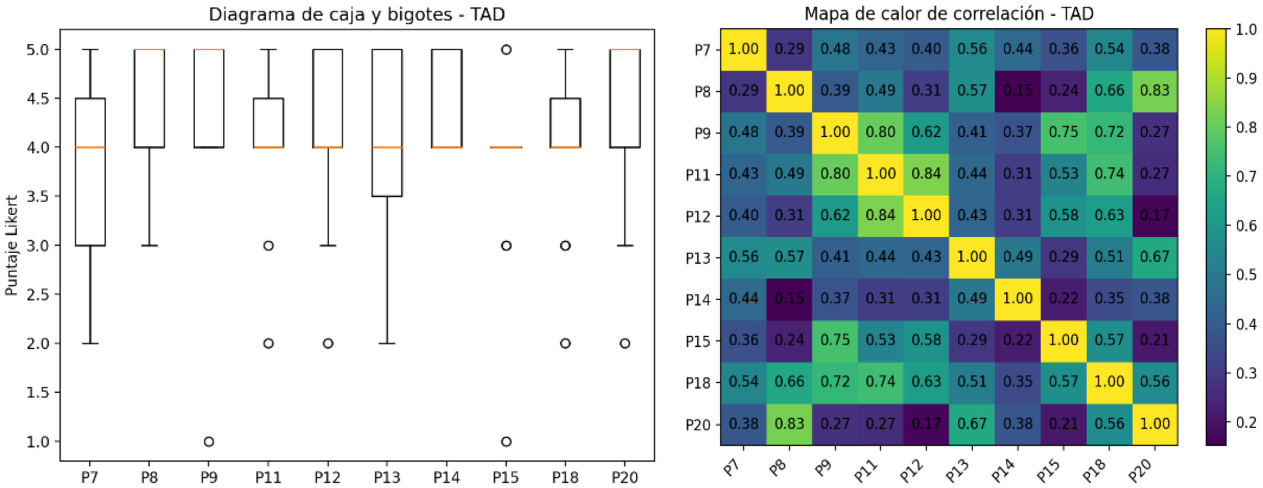
Figure 1. Technology Acceptance Model (TAM): (a) Box and whisker plots by item (P6, P10, P16, P19) - Likert scale 1–5. (b) Heat map of correlations (Pearson) between items (P6, P10, P16, P19)

Self-determination/Motivation (TAD/SDT)

The mean profile is generally high (≈4,0–4,5/5), with peaks in P8 and P9 (motivation/participation) and also high values in P14 (reflection) and P20 (intention to continue). P7 (initial interest) and P15 (self-efficacy after the activity) are in the medium-high range (~3,7), suggesting that the active dynamics increase motivation and participation at the time. Still, it is advisable to reinforce the motivational "start" (before the game) and consolidate the feeling of competence at the end, upon completion of the activity.

The medians are concentrated at 4-5, with moderate to narrow IQRs, indicating general agreement on the motivational effect of the activity. Low outliers (1-2) appear in specific items (e.g., P9, P11-P13, P15, P18, P20), consistent with individual experiences of greater difficulty, fatigue, or a preference for non-competitive dynamics (figure 2(a)). The central tendency remains high, so these cases do not alter the main pattern. Meanwhile, in the correlation, strong and moderate associations are observed that form three clusters (figure 2 (b)):

- Activation and competition: dense network between P9-P11-P12-P15-P18 (P9-P11 r≈0,80; P11-P12 r≈0,84; P9-P15 r≈0,75; P11-P18 r≈0,74), suggesting that participation is linked to understanding/diagnosis and self-efficacy.
- Social connection and intention: P8 is associated with P18 and P20 (r≈0,66 and r≈0,83), indicating that motivation/participation translates into continuity and error detection (self-regulated learning).
- Differentiated metacognition: P14 maintains low correlations with several items (P8 r≈0,15), suggesting a metacognitive component that is partially independent of affective activation.

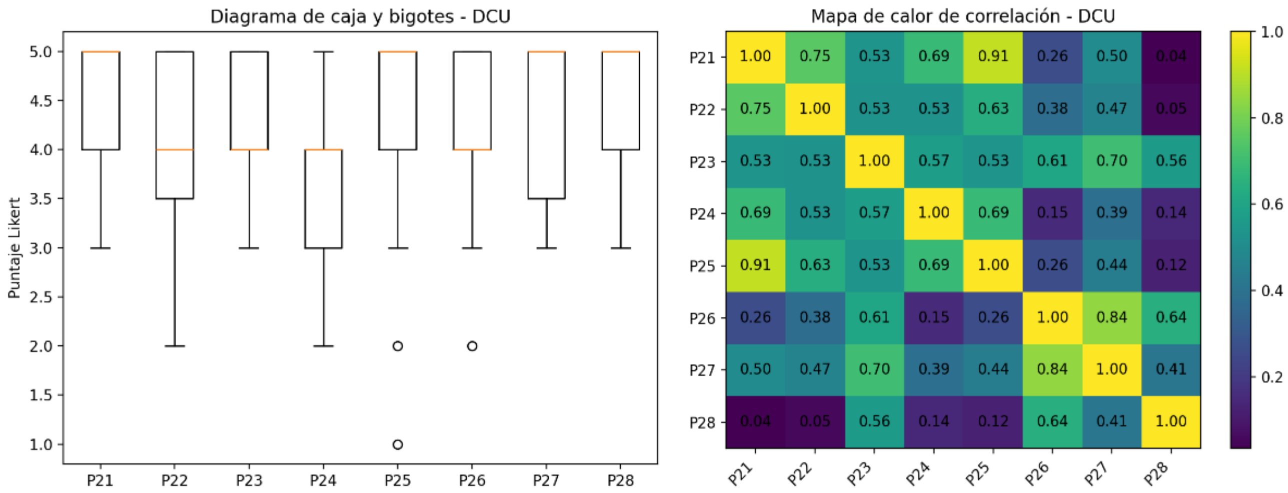


(a) (b)

Figure 2. (a) Self-determination/Motivation (TAD/SDT): Box plots and whiskers by item (P7-P15, P18, P20). Likert scale 1-5. (a) Motivation (TAD/SDT): Heat map of correlations (Pearson) between items (P7-P15, P18, P20)

User-centered design (UCD)

The usability dimension received a high, stable rating. The means per item ranged mainly from ~4,1 to ~4,7, with maximums in P21 (interface clarity) and P28 (personalization/identity). Items such as P23, P25, P26, and P27 (Engagement) and P27 maintained high values, while P24 (response time) recorded the lowest mean, indicating a point of friction associated with time management or reading load (figure 3 (a)).



(a) (b)

Figure 3. (a) Usability (DCU/UCD): Box plots and whiskers by item (P21-P28) - Likert scale 1-5. (b) Usability (DCU/UCD): Heat map of correlations (Pearson) between items (P21-P28)

The matrix reveals functional clusters: (i) fluidity/operational efficiency with high correlations between P21–P25, and (ii) attention/follow-up motivating mechanics with high correlations between P nd P26–P27. P24 is moderately related to the fluidity block (time as a sensitive link in the flow), while P28 has low correlations with P21–P22, contributing a non-redundant hedonic/personalization dimension. Overall, usability coexists with efficiency, situational motivation, and enjoyment/identity. Implication: optimization must be.

Analysis by sections of interest

The findings are presented below, organized into five sections: (1) General data; (2) Experience with Kahoot! in the classroom; (3) Impact on learning; (4) Satisfaction and suggestions; and (5) Usability (DCU/UCD)

Section 1: General Data

93,3 % of respondents identify as male and 6,7 % as female, all of whom are taking the course for the first time. 60 % had used Kahoot! Before, 40 % were experiencing it for the first time in this course. It should be noted that the entire group consists of first-time students.

Additionally, the students taking the *Fundamentals of Programming* course are mostly 18 years old, with 9 participants, or 60 % of the sample. Next, at a lower frequency, there are two 19-year-olds (13,3 %), two 20-year-olds (13,3 %), and one 21-year-old and one 22-year-old, each at 6,7 %. This distribution reflects a relatively homogeneous age distribution, consistent with the expected profile of first-level students. This homogeneity is favorable for analysis, as it minimizes potential biases arising from differences in educational trajectories or prior levels of technological exposure.

Section 2: Experience with Kahoot! in the Classroom

1. Kahoot! was easy to access and use during class: regarding the accessibility and ease of use of the tool during the session, 73,3 % (11 out of 15 students) strongly agree with the ease of access and use of Kahoot! in the classroom environment. An additional 20 % (3 students) agreed, while only one student (6,7 %) took a neutral stance. This confirms the high usability perceived by students, which validates the relevance of the tool as a feedback resource applicable to the Fundamentals of Programming course.
2. The use of Kahoot! increased my interest in programming: 66,7 % of students (10 out of 15) indicate that using Kahoot! increased their interest in programming. 20 % (3 students) disagreed, and 13,3 % (2 students) remained neutral. These data show that gamification can promote motivation towards complex content, although its impact is not uniform across the cohort.
3. I felt motivated to participate actively during the Kahoot! Activity: 93,3 % of students (14 out of 15) reported feeling motivated to participate actively during the Kahoot! Activity, with responses distributed between “strongly agree” (53,3 %) and “agree” (40 %). Only one student (6,7 %) expressed a neutral stance. This demonstrates the potential of gamified dynamics to encourage active participation in programming teaching contexts.
4. The activities with Kahoot! created a collaborative learning environment: 93,3 % of students believe that the use of Kahoot! Contributes to creating a collaborative learning environment, with 66,7 % stating that they “strongly agree” and 26,7 % “agree” with this statement. Only one student (6,7 %) expressed a contrary opinion. This result shows that integrating playful dynamics into the classroom not only encourages individual participation but also stimulates peer interaction, a key element in the development of skills in engineering training contexts.
5. I felt comfortable using Kahoot! as an educational tool: 60 % of students selected “strongly agree,” and 20 % selected “agree.” Twenty percent adopted a neutral position. These results show that the platform’s interface is accessible and user-friendly, which promotes an environment conducive to active participation.

Section 3: Impact on Learning

1. Kahoot! helped me to better remember the concepts covered in class: 86,7 % of students confirm that using Kahoot! makes it easier to remember the concepts covered in the programming fundamentals class (including code), with 60 % agreeing and 26,7 % strongly agreeing. Only 6,7 % disagree, and an additional 6,7 % are neutral. These results suggest that the use of gamified tools such as Kahoot! promotes learning consolidation by activating short- and medium-term memory through immediate reinforcement of key content.
2. While playing Kahoot!, I identified concepts that I had not fully understood: eighty percent of students say that during the Kahoot! activity, they were able to identify concepts they had not understood correctly: 46,7 % “strongly agree” and 33,3 % “agree.” This perception highlights the tool’s potential to activate metacognitive processes, facilitating awareness of one’s own knowledge gaps. The remaining 13,4 % remain neutral or disagree, which invites consideration of the diversity of learning styles present

in the classroom.

3. Kahoot! facilitated the understanding of programming concepts: 73,3 % of students reported that Kahoot! facilitated understanding of programming concepts, with 46,7 % "strongly agreeing" and 26,6 % "agreeing." Twenty percent remain neutral, while only 6,7 % disagree. This result shows that incorporating playful tools in the classroom can help reinforce the assimilation of technical content, especially in subjects that traditionally present a higher level of abstraction, such as Programming Fundamentals.

4. The Kahoot! questions made me think about how I was applying the concepts I had learned: 100 % of students believe that the questions asked in Kahoot! lead them to reflect on how they are applying the concepts learned, with 66,7 % agreeing and 33,3 % strongly agreeing. This evidence reinforces the value of formative feedback mediated by interactive tools, as it promotes not only the retrieval of information, but also metacognition and critical judgment about the learning process itself.

5. I felt more confident about the programming topics covered after the activity: 73,3 % of participants say they feel more confident about programming topics after the Kahoot! Activity, while 13,3 % adopt a neutral position. Only one student disagreed with this statement. These results suggest that using the tool strengthens self-confidence in the knowledge acquired, a key aspect of the self-regulated learning process in engineering education contexts.

Section 4: Satisfaction and Suggestions

1. I am satisfied with the use of Kahoot! in this course: overall satisfaction with the use of Kahoot! in the course is high: 93,3 % of students express agreement, divided between those who "agree" (33,3 %) and "strongly agree" (60 %). Only one student takes a neutral stance. This trend reinforces the positive perception of the integration of playful digital tools as a teaching strategy and supports their applicability in learning the subject under study, as they generate more dynamic and motivating learning experiences.

2. Would you recommend this type of activity in other subjects?: 100 % of students say they would recommend the use of activities such as Kahoot! in other subjects. This result reflects not only a positive assessment of the experience, but also a perception of the applicability and transferability of the resource to various educational contexts. The unanimity of the responses suggests that the tool not only fulfills a specific function in this subject, but is also perceived as a replicable strategy capable of enriching teaching-learning processes in other areas of the curriculum.

3. During the game, I was able to identify errors that I had not noticed in previous classes: eighty percent of the students (adding "agree" and "strongly agree") stated that while using Kahoot!, they were able to identify errors that had previously gone unnoticed in previous classes. This finding highlights the tool's potential as a formative feedback mechanism, as it promotes self-assessment and awareness of conceptual gaps.

4. I found the structure of the game to be adequate in terms of time, difficulty, and feedback: 80 % of participants consider the structure of the game to be adequate in terms of the time allocated, the level of difficulty, and the feedback received. This level of acceptance indicates that the design of the activity manages to balance these three key factors, promoting an effective and fluid learning experience.

5. I would like to see more similar games implemented in future classes: 86,7 % of students agreed with implementing more similar games in future classes, which shows a high acceptance of Kahoot! as an educational tool. This result supports its perceived usefulness and intention for future use, in line with the principles of the Technology Acceptance Model (TAM).

Section 5: User-Centered Design (Kahoot! Tool)

1. The Kahoot! interface was clear and easy to understand: 93,3 % of participants agreed that the Kahoot! interface was clear and easy to understand, demonstrating a high perception of usability. This finding supports the suitability of the tool from a User-Centered Design (UCD) perspective.

2. I was able to read the questions and answer options without difficulty: 73,3 % of students indicated that they could read the questions and answer options without difficulty, reinforcing the perception of visual accessibility of the tool and aligning with the principles of clarity of the UCD approach.

3. I found the game design attractive and appropriate for the educational environment: 86,7 % of students consider the game design to be attractive and appropriate for the educational environment, which shows a positive perception of the tool's aesthetics and functional suitability, in line with the principles of User-Centered Design.

4. The time allocated for responding was sufficient to read and think about the answer: sixty percent of students consider the time allocated for responding to be sufficient to read and think about their answers, while 33,3 % adopt a neutral stance and 6,7 % express disagreement. These data suggest that, although the majority perceive adequate time management, there is room for improvement in the configuration of timers to ensure an inclusive and reflective experience for all participants.

5. I had no technical problems accessing or using Kahoot! during class: 80 % of students report having no technical issues accessing or using Kahoot! during class, indicating a largely smooth technological experience. However, 13,3 % express neutral or unfavorable opinions, highlighting the importance of ensuring stable connectivity and compatible devices for all participants.

6. The podium feature (scores and winners) was motivating for active participation: the Kahoot! podium feature, which displays scores and winners at the end of the activity, motivates most students: 80 % agree or strongly agree that it has a positive effect on active participation. This gamification dynamic seems to encourage engagement, although a small percentage (20 %) express neutrality or disagreement, suggesting that not all students respond in the same way to competitive elements.

7. Seeing my position in the ranking encouraged me to pay more attention during the game: the visibility of the ranking during the game has a positive influence on students' attention: 73,3 % say that seeing their position motivates them to concentrate more, while 26,7 % remain neutral. This result reinforces the idea that competitive elements, when managed properly, can be allies in promoting focus and active participation.

8. I liked being able to select my avatar and enter my name in Kahoot! The ability to personalize the experience by selecting an avatar and name is positive for 93,3 % of students, suggesting that these elements contribute to emotional involvement and a sense of belonging in the activity. Only 6,7 % remain neutral, without expressing opposition.

CONCLUSIONS

The results of this study confirm that the use of gamified strategies, specifically through Kahoot! The tool is established as a practical methodology for formative feedback in the context of teaching Programming Fundamentals. There is strong student acceptance of the platform's usability, accessibility, and aesthetics, which reinforces the relevance of the User-Centered Design (UCD) approach.

From the perspective of the Technology Acceptance Model (TAM), both perceived usefulness and ease of use positively influence the willingness to actively participate in gamified activities. Self-Determination Theory (SDT), meanwhile, is reflected in high levels of intrinsic motivation, autonomy, and participation, aspects that directly influence the consolidation of learning.

Likewise, gamification enables timely identification of conceptual gaps and frequent errors, thereby strengthening metacognitive processes and promoting self-regulated learning. All students recommend implementing these dynamics in other subjects, suggesting the potential for the strategy's transferability and scalability across various educational settings.

Overall, the results show a coherent circuit between the three dimensions: usability (UCD) is high and stable—with a straightforward interface, fluidity, and practical motivational elements—and only one recurring point of friction in response time; technological acceptance (TAM) is solid, driven by ease and comfort of use, with high satisfaction and a positive but perfectible structure; and motivation (TAD/SDT) is activated during the activity (participation, enjoyment, intention to continue), although it is advisable to increase the motivational start and close with achievement feedback to consolidate self-efficacy. In operational terms, adjusting timing/readability, shielding the technical experience, and maintaining personalization and the podium/ranking with a non-punitive option should translate into greater intention to use and more robust learning.

The integration of educational technologies with playful dynamics promotes collaborative learning environments, enhances the user experience, increases motivation, and deepens understanding of technical content. This strategy is presented as an effective teaching tool to optimize programming instruction in engineering degrees, particularly at the initial levels where active engagement is critical to academic success.

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