The integration of gamification in educational robotics as a tool to enhance discovery learning: teachers' perceptions

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ABSTRACT

The study examines the combined use of gamification and educational robotics as a means of enhancing the learning experience and fostering active student engagement. Through a literature review, the benefits of this approach are presented, including increased motivation, the development of creativity, the cultivation of collaboration, and problem-solving skills. A new educational methodology is proposed, based on the analysis, design, development, implementation, evaluation (ADDIE) model in combination with gamification techniques. The approach aims to create a more engaging, effective, and interactive learning environment. This methodology was evaluated through a usability study involving 302 educators from primary, secondary, and tertiary education institutions across Greece. Data were collected via an adapted software usability measurement inventory (SUMI) questionnaire and analyzed using non-parametric statistical tests including Mann-Whitney U and Kruskal-Wallis tests. The results indicate that participants generally evaluated the methodology favorably across all measured dimensions. The strongest influences on these perceptions derived from personal background variables such as age, educational level, and professional training. Specifically, perceptions related to learning and access to technology were more sensitive to these factors. Correlation analysis further confirms that concepts such as effectiveness, usefulness, and satisfaction are interconnected, reinforcing the notion that improving one aspect of the experience (e.g., training or support) can positively impact others. The analysis is comprehensive, appropriately executed, and provides actionable insights for tailoring future implementations of the methodology based on educators' demographic characteristics and training levels. The study concludes that the integrated gamification-robotics methodology demonstrates strong potential for implementation across diverse educational contexts, with professional development and information and communication technologies training identified as critical success factors.

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1. INTRODUCTION

The rise of gamification in education has been identified by Landers *et al.* [1] among early professionals. From the outset, they sought to incorporate game elements into more traditional educational settings, with many pioneering ways to achieve this. Initially, points, badges, and leaderboards were experimental tools used by educators and researchers searching for methods to increase student interest and engagement in their studies. The earliest known examples of gamified education date back to the 1980s, when software began to emerge for learning subjects such as mathematics, language arts, and science. It was at that time that the first generation of professionals in their respective fields recognized how game mechanics could advance education through games for education. They were the first to pursue this approach, thereby laying the groundwork for later development and expansion of game-based learning [1].

At the same time, educational robotics represents another innovative learning method, using robots to provide practical, hands-on training. With robotics integrated into education, teachers can create more dynamic learning environments. Their theoretical knowledge can be applied more seamlessly to real-world problems, benefiting both students and instructors in a more interactive learning approach. Students engage in collaborative activities, learning everything from programming robots to navigate mazes to establishing and operating enterprises that develop robotic prototypes. Educational robotics encompasses a broad range of activities and technologies, which—when combined with computer science—integrate multiple domains: science, technology, engineering, mathematics (STEM), and even art. Overall, educational robotics has developed a wide user base, serving STEM and science, technology, engineering, arts, mathematics (STEAM) education through complex tasks that reflect these subjects, allowing them to be meaningfully integrated both as standalone and interdisciplinary components. In this way, students not only acquire specific skills required in individual subjects but also develop a global readiness for future careers in STEM fields [2].

According to Ouyang and Xu [3], the integration of games and educational robotics has tremendous potential to transform learning experiences and equip students to succeed in the 21st century. By combining the motivational aspects of gamification with the hands-on learning of robotics, the result is genuinely engaging and immersive educational experiences capable of capturing students' interest and driving profound change and learning. Furthermore, integrating gamification and educational robotics supports broader educational objectives, such as fostering independent thinking, creativity, teamwork, and problem-solving skills. By engaging students in group robotics projects and gamified learning activities, educators can address these fundamental needs while simultaneously igniting a passion for learning and exploration [3].

This study aims to explore the convergence of gamification and educational robotics in schools and to propose a new educational methodology. This methodology is evaluated in terms of efficiency, satisfaction, usefulness, ease of use, and ease of learning, as perceived by the educators who will be called upon to implement it. A literature review indicates that combining gamification with educational robotics is a promising approach for increasing student engagement, motivation, and learning effectiveness in schools. The study seeks to demonstrate the potential benefits of this combination through case studies, vivid examples, and practical activities. Ultimately, this article aims to provide teachers interested in introducing gamification and educational robotics into their classrooms with an overview of the available tools and ideas.

The novelty of this study lies in the development and evaluation of an integrated educational methodology that systematically combines gamification principles with educational robotics within the established analysis, design, development, implementation, evaluation (ADDIE) instructional design framework. While previous research has examined gamification and educational robotics separately, this study uniquely bridges both domains by proposing a structured, replicable methodology assessed through rigorous usability evaluation from educators' perspectives. The research questions guiding this study are:

- Is the proposed methodology efficient for educators to implement?
- Does the methodology provide user satisfaction?
- Is the methodology perceived as useful for educational purposes?
- Is the methodology easy to learn and use by educators with varying levels of technological competence?

2. STATE OF THE ART

Educational robotics is an innovative approach to learning that leverages the strengths of robots to promote practical and interactive educational activities. This approach is inherently engaging. In an era when the educational system increasingly expects students to extend their learning beyond the confines of the classroom—and with numerous electronic games available in everyday life [4], educational robotics has, in recent years, entered classrooms worldwide. It provides a vibrant stage on which students can enact stories and create immersive learning experiences for themselves. Students may even maintain the perception that they are serving the teachers' goals while learning through robotics. With educational robotics at the core, teachers can harness the power of robotics technology to facilitate compelling learning experiences [3], [5].

Moreover, educators can create learning environments where students apply abstract knowledge to real-world problems. In such initiatives, educational robots can perform tasks and interact with humans or other robots. Whether solving real-world challenges, programming robots to navigate mazes, playing chess with humans, or collaborating to execute group tasks, students gain valuable hands-on experiences that enhance their understanding of STEM concepts and develop their creativity and innovation skills [6], [7].

The primary advantage of educational robotics lies in its promotion of active learning. Unlike traditional classroom instruction, which often relies on passive learning methods, educational robotics encourages students to take a more proactive role in their education [3]–[7]. By interacting with robots, students experiment, solve problems, and collaborate with peers to achieve shared objectives. This active engagement stimulates curiosity, deepens interest in their studies, and fosters a personal investment in their performance. In addition, educational robotics promotes the development of both critical thinking and problem-solving skills. The evolution of educational robotics is closely linked to the emergence of robotics as a teaching and learning tool in educational settings. Early proponents of educational robotics focused on exposing school-aged children to the fundamentals of programming and problem-solving skills through robot-based activities [8], [9]. According to Pandey [11], technological advancements have been vital to the progress of educational robots, enabling the creation of more advanced and versatile robotic systems. Today, educational robots incorporate sensors, actuators, and artificial intelligence algorithms, allowing them to perform a wide variety of tasks and interact more complexly with their environment [10], [11].

In parallel, Madariaga *et al.* [12] state that gamification can be understood as the strategic integration of game elements and mechanics into non-game contexts, and it has emerged as a powerful tool in education to enhance student engagement and improve learning outcomes. By emphasizing the motivational aspects of games, teachers can design interactive learning scenarios that effectively capture students' attention, encourage active participation, and foster deeper understanding of the subject matter [12]. Gamification essentially involves applying game design principles to educational activities, transforming traditional learning experiences into interactive, game-like environments. Game elements may include points, badges, leaderboards, levels, challenges, rewards, or narratives, all strategically designed to promote desired behaviors. Appealing to intrinsic motivators, such as the reward-and-punishment theory and the emotional [13] impact of challenge, games can encourage students to work through material, persist in the face of obstacles, and pursue their ultimate goal of lifelong improvement in their chosen fields, as in Figure 1 [14].

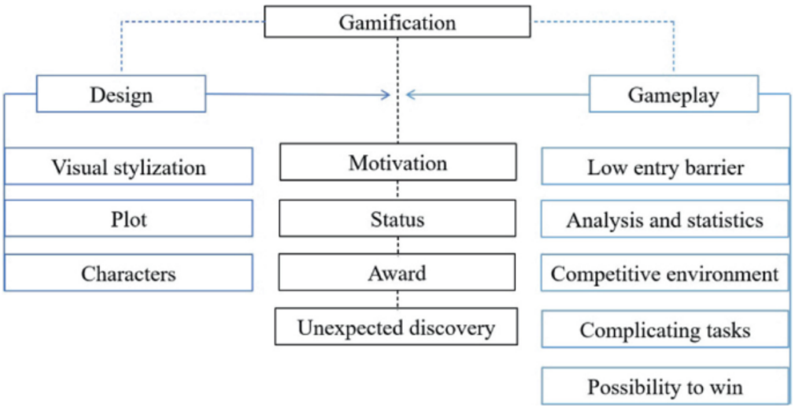

Figure 1. Gamification, design, and gameplay [7]–[14]

The principles of gamification and educational robotics are interdependent within this model. It simultaneously serves as a framework for designing immersive experiences, utilizing robots and game mechanics to achieve improved instructional outcomes. Furthermore, by employing gamification as a reference framework, the model incorporates principles of motivation and reward. Different styles of visual representation for writing, character creation, and plot development contribute to the formation of an engaging and immersive format that can draw users into the experience [15]. Providing tangible rewards and small surprises—such as prizes and unpredictable events that also act as motivators—further enhances engagement [12].

A recent study by Zhan *et al.* [16] found that one of the most significant benefits of gamification in education is the increased engagement of students. Games are inherently fun and exciting; they offer immediate feedback, clear goals, and a sense of progress, all of which contribute to focused attention and sustained motivation. By incorporating game elements into their activities, educators can transform learning into a more immersive, interactive, and enjoyable experience, thereby achieving higher levels of student engagement [16], [17]. According to Nascimento *et al.* [18], gamified education promotes active learning by prompting students to take an active role in the learning process. Rather than passively receiving information, students engage in problem-solving, decision-making, and reflecting on the consequences of their actions. This approach involves hands-on experience and active participation, fostering better comprehension and retention [18]. The key advantage of gamification in education lies in enhancing students' motivation and engagement. Beyond this, many students tend to disengage in traditional classroom settings. Gamified learning experiences leverage elements such as points, badges, leaderboards, and challenges to create stimuli that encourage active learning rather than passive response. Competition and progression in gamification align with intrinsic drives for mastery, achievement, and autonomy. Students begin to set goals and strive to overcome any obstacles along their path [19], [20].

While gamification offers numerous advantages, it also presents challenges. According to Madariaga *et al.* [12], "one of the greatest challenges is designing gamified experiences that align with learning objectives and outcomes." Engagement and motivation are benefits of game elements, but these must be integrated carefully into the curriculum to support and enhance desired learning goals. Otherwise, these strengths may become hollow. "We must find a balance between creating enjoyable learning and ensuring that students master essential concepts and skills," according to Chen *et al*. [6]. Educators can employ collaborative challenges, group projects, and team competitions to foster cooperation among students in gamified activities. By working toward shared goals, students develop essential teamwork and communication skills while deepening their understanding of course content [6].

Nascimento *et al.* [18] further note that gamification promises to teach students through the motivational and competitive aspects of games. By blending game components and virtual items—known as "mechanics"—that help define how individuals behave, educators can make learning activities more dynamic. Incorporating game elements into education allows educators to create learning environments that are more engaging and attractive to students. Through a blended approach combining flipped learning and gamified learning, strategic implementation aims to create a pedagogical framework that evolves with student participation, motivation, and learning outcomes. Flipped learning is an alternative instructional model. Implementing this strategy begins with careful planning and preparation, encompassing materials, course design, game systems, and the identification of learning objectives. Employing a combination of flipped learning and gamification in undergraduate foundational programming courses highlights an innovative educational approach that adds significant value [21].

According to Gündüz and Akkoyunlu [22], gamification is designed to encourage and motivate students in learning by introducing game design principles and mechanics into their educational experience. Through the integration of points, badges, scores, and various rewards, gamification transforms studying into an interactive and enjoyable journey. In this way, students can actively monitor their successes or failures, are encouraged to track their progress, and may compete or collaborate with one another—thus fostering a sense of achievement and enjoyment in their academic pursuits [22].

The implementation of a blended strategy initially requires thorough planning and preparation. Educators develop comprehensive learning resources for the flipped learning and gamification components, ensuring they align with the course's learning objectives. Additionally, teachers identify key learning behaviors and goals—such as completing assignments before class, actively participating in discussions, and mastering course content—that will support the game system throughout the course [23].

3. PROPOSED METHODOLOGY

Traditional instructional design follows the methodology outlined by the ADDIE model. In this methodology proposal, the ADDIE instructional systems design (ISD) framework is combined with gamification techniques to create a more engaging and effective teaching approach for learners. According to the proposed methodology, the design of the educational program adheres to the principles of gamification. Gamification is defined as the use of game mechanics and elements in non-game contexts [24]. It refers to the strategic application of game elements to achieve a goal—in this case, an educational one. Zichermann and Cunningham [25] describe gamification as the application of game thinking and dynamics with the aim of solving problems and increasing audience engagement. Consequently, a process that might otherwise be perceived as tedious by learners can, through gamification, become more appealing. The growing popularity of creating and using digital games has significantly contributed to the adoption of gamification across numerous fields, including healthcare, the economy, and education. Koivisto and Hamari [26] emphasize that gamification has been proposed as a solution for engaging people in individual and social behaviors such as exercise, consumption, and learning. In essence, gamification aims to increase learner commitment and to promote specific beneficial behaviors [26].

The proposed methodology in Figure 2, incorporates a two-phase instructional model that combines systematic design with gamification techniques, aiming to increase learner participation, motivation, and learning effectiveness.

- Phase 1: analysis, design, and development

In the first phase, the instructor meticulously designs the lesson plan, taking into account the needs and composition of the learner group. General and specific learning objectives are set, a scenario–project aligned with the educational goals is developed, and all necessary materials, conditions, and resources are prepared to ensure full readiness for instruction.

– Phase 2: implementation and evaluation

In the second phase, the instructor implements the planned lesson, applying a personalized methodology enriched with gamification techniques. This process includes four stages:

i) B.1 challenges and trials – presentation: the instructor presents the content and transforms the objectives into learning incentives. Sequential challenges with increasing difficulty are announced, rules are explained, and clear instructions are provided to enhance understanding and engagement;
ii) B.2 narrator-hero – demonstration: a "hero" is selected to take on the role of narrator and protagonist of the story, strengthening emotional involvement and activating learners' intrinsic motivation;
iii) B.3 progress – development – practice: the practical application begins, divided into guided and independent practice. In the guided practice, the first, simpler task is carried out under the instructor's supervision with continuous feedback. In independent practice, learners work autonomously while receiving real-time updates on their progress, thereby reducing anxiety and boosting self-confidence. Proper time allocation for each challenge is essential;
iv) B.4 reward points – evaluation: learners earn points, rewards, and levels, as in a game, to enhance extrinsic motivation. Rewards may include coins, medals, trophies, or experience points. Time constraints are introduced to influence the acquisition of rewards, promoting responsible time management. Successful or unsuccessful completion of challenges serves as an evaluation for both the learner and the instructor.

Overall, this model combines rigorous planning with interactive and game-like elements, transforming learning into a more engaging, structured, and effective process.

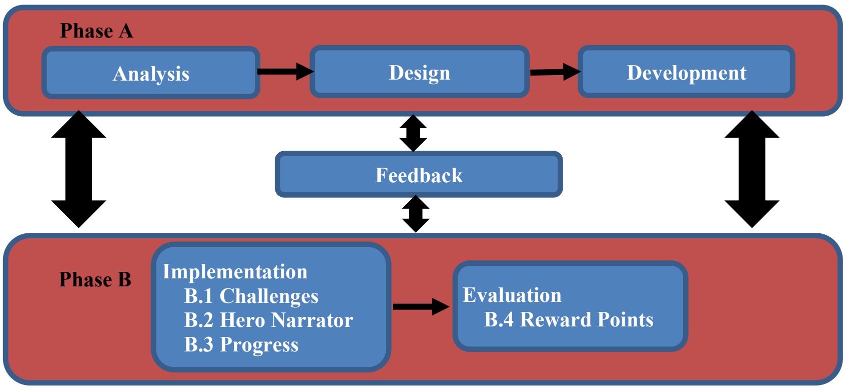

Figure 2. Proposed methodology

4. RESEARCH METHOD

An extensive and targeted literature review was initially conducted to identify the most appropriate method for evaluating usability. This process resulted in the selection of a questionnaire as the primary research tool, specifically the adoption of the software usability measurement inventory (SUMI) questionnaire, which was deemed the most suitable for the study's needs. The instrument was piloted, leading to minor but meaningful refinements. A convenience sampling method was employed to recruit participants for this study. The sample consisted of educators actively engaged in teaching robotics and new technologies to primary and secondary school students across various regions of Greece. Sample selection criteria included: i) current employment as an educator in formal educational institutions (primary, secondary, or tertiary level); ii) involvement in teaching robotics, new technologies, or STEM-related subjects; iii) willingness to participate in a five-hour training session on the proposed methodology; and iv) ability to complete the evaluation questionnaire. Exclusion criteria included educators without direct teaching responsibilities and those unable to attend the full training session. The final sample comprised 302 educators who met all inclusion criteria and voluntarily agreed to participate in the study.

The questionnaire consisted of two main parts. The first part included nine independent variables: gender, age, specialty, type of educational institution served, region of employment, teaching experience, type of degree held, pedagogical training, and training in information and communication technologies (ICT). The second part comprised five groups of questions corresponding to the five dependent variables: efficiency, satisfaction, usefulness, ease of use, and ease of learning.

4.1. Data collection procedure

Subsequently, five-hour meetings were held with participants, during which the educational methodology was presented in detail and any questions were addressed. This was followed by the implementation of methodology-based scenarios, after which participants were invited to complete the questionnaire in electronic form (Google Forms). The collected data were analyzed using SPSS to confirm or reject the research hypotheses. The research questions posed prior to the study were:

- Is the methodology efficient for users?
- Is the methodology useful?
- Is the methodology easy to learn and use?
- Does the methodology provide user satisfaction?

As part of the study, the opinions of robotics and new technologies instructors—teaching primarily to primary and secondary school students in various regions—were recorded. The instructors completed the questionnaire online. The results were analyzed and visualized using statistical tools (SPSS) to support the research findings. Participation was voluntary and anonymous, fully adhering to research ethics principles and data protection regulations. A total of 302 educators participated in the evaluation of the innovative teaching methodology for courses incorporating educational robotics and new technologies with gamification elements. Regarding gender distribution, the sample showed a notable imbalance, with female participants representing the majority at 72.2% (n=218), while male participants accounted for 27.8% (n=84) of the total sample, as shown in Table 1.

Table 1. Demographic characteristics of participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	84	27.8
	Female	218	72.2
Age	21-30	89	29.5
	31-40	104	34.4
	41-50	86	28.5
	51-60	21	7.0
	>61	2	0.7
Specialization	Humanities	180	59.6
	Technological studies	76	25.2
	Sciences	46	15.2
Educational level	Primary education	146	48.3
	Secondary–gymnasium	20	6.6
	Secondary–general lyceum	41	13.6
	Secondary–vocational lyceum	50	16.6
	Tertiary education	45	14.9
Work area	Urban	177	58.6
	Semi-urban	67	22.2
	Rural	33	10.9
	Island	24	7.9
	Border area	1	0.3
Years of experience	1-10	215	71.2
	11-20	54	17.9
	21-30	31	10.3
	>30	2	0.7
Degree held	University degree	134	44.4
	Master's degree	165	54.6
	Ph.D.	3	1.0
Pedagogical training	None	27	8.9
	Based on appointment degree	204	67.5
	SELETE/ASPETE	71	23.5
ICT training	None	26	8.6
	Level A	9	3.0
	Level B	36	11.9
	Based on degree	87	28.8
	Private certificate	144	47.7

4.2. Statistical analysis

For the analysis of participant responses, composite mean scores were calculated for the five core constructs derived from the questionnaire: efficiency, satisfaction, usefulness, ease of use, and ease of learning. Initial descriptive statistics provided an overview of central tendencies across these dimensions. Internal consistency was assessed using Cronbach's alpha to evaluate the reliability of grouped items. Normality tests (Kolmogorov-Smirnov and Shapiro-Wilk) indicated that none of the composite variables met the assumption of normality, leading to the use of non-parametric tests for group comparisons. These included the Mann-Whitney U test for gender comparisons and the Kruskal-Wallis tests for other demographic categories. Additionally, Pearson correlation coefficients were calculated to examine the relationships among the five dependent variables. Internal consistency was found to be acceptable to good for most scales, with Cronbach's alpha values ranging from 0.708 (efficiency) to 0.773 (satisfaction), indicating that the grouped items consistently measured the same underlying construct. The only exception was the usefulness scale, which yielded an alpha of 0.688—slightly below the commonly accepted threshold of 0.70.

5. RESULTS AND DISCUSSION

The descriptive results revealed that participants generally evaluated the teaching methodology positively. The highest mean score was for satisfaction (M=3.65), followed by efficiency (M=3.59), usefulness (M=3.43), ease of use (M=3.50), and ease of learning (M=3.48), all scoring above the neutral midpoint, reflecting overall positive experiences. This aligns with findings from previous studies on gamification in education, which demonstrate that incorporating game elements significantly enhances user satisfaction and engagement [12], [17].

Correlation analyses indicated strong and statistically significant relationships among several constructs. The strongest correlation was observed between satisfaction and usefulness ($r=0.662$, $p<0.01$), suggesting that the more emotionally satisfying participants found the methodology, the more useful they perceived it to be. These findings are consistent with research by Sailer *et al.* [15], who demonstrated that gamification elements that satisfy psychological needs are perceived as more useful and engaging. Efficiency was also positively correlated with both satisfaction ($r=0.528$, $p<0.01$) and usefulness ($r=0.400$, $p<0.01$), indicating that when the methodology was perceived as efficient, it was also regarded as useful and enjoyable. This interconnection between efficiency and satisfaction has been documented in studies of educational robotics implementation [5], [6]. Ease of learning was moderately correlated with ease of use ($r=0.449$), implying that those who found the methodology easy to use also found it easier to learn. Similar patterns have been observed in studies examining the usability of educational technologies and gamified learning environments [13], [22]. Overall, the correlation matrix reflects an internally coherent system in which constructs reinforce one another in predictable ways.

Gender differences were examined using the Mann–Whitney U test. Results showed that satisfaction was the only construct with a statistically significant difference between male and female participants ($p=0.041$), with women reporting higher satisfaction levels. For all other variables (efficiency, usefulness, ease of use, and ease of learning), no significant gender differences were found, indicating broadly consistent perceptions across genders, though emotional engagement with the methodology may be slightly higher among female respondents. This finding diverges from some earlier technology adoption studies but aligns with recent research showing diminishing gender gaps in educational technology acceptance [26].

Age significantly influenced perceptions of ease of learning ($p=0.003$), with younger participants (particularly those aged 21–30) reporting greater ease in learning compared to older respondents. This age-related difference in technology adoption is well-documented in the literature, with younger educators typically demonstrating higher comfort levels with novel educational technologies and gamification approaches [18], [21]. Educational level also had a significant association with ease of learning ($p=0.016$), with participants holding higher academic qualifications finding the methodology easier to learn. Higher educational attainment has been linked to greater adaptability to innovative teaching methodologies and technological integration in classroom settings [4], [8]. Degree type had a significant effect on both accessibility to digital resources ($p=0.024$) and satisfaction ($p=0.037$), with Ph.D. holders reporting the highest scores in both categories. Teaching experience did not yield statistically significant effects on any dependent variables, although there were observable trends suggesting that more experienced participants tended to report lower ease of learning.

Participants with formal pedagogical training (e.g., SELETE/ASPETE) and those with higher ICT training levels (e.g., Level B or degree-based certification) reported significantly higher satisfaction scores (both $p=0.000$). This indicates a strong link between professional development and confidence or infrastructure availability for technology use. The critical role of professional training in successful technology integration has been emphasized in multiple studies on educational robotics and gamification implementation [3], [9], [23]. Workplace location (urban, semi-urban, rural, island, and border) also influenced satisfaction scores ($p=0.046$), with participants from more remote areas (e.g., islands and border regions) reporting better access—possibly due to targeted technology investments. However, no significant workplace effects were found for the other constructs. This unexpected finding may reflect recent policy initiatives aimed at bridging the digital divide in remote educational settings [10].

Specialization (humanities, technological studies, and sciences) had no statistically significant effect on any dependent variable. While mean rankings varied slightly across groups, none reached statistical significance. This finding suggests that the methodology was well-received across disciplines, supporting its flexibility and broad applicability in diverse educational contexts. The cross-disciplinary applicability of gamified educational robotics has been noted as a key advantage in promoting STEM and STEAM education across different subject areas [2], [7], [19].

6. CONCLUSION

This study evaluated an innovative educational methodology integrating gamification with educational robotics within the ADDIE instructional design framework. The evaluation involving 302 Greek educators yielded predominantly positive findings. Participants rated the methodology favorably across all measured dimensions, with satisfaction achieving the highest mean score (M=3.65). Strong positive correlations among constructs—particularly between satisfaction and usefulness (r=0.662)—demonstrate internal coherence of the methodology. These findings confirm that the proposed approach successfully addresses all four research questions, demonstrating efficiency, satisfaction, usefulness, and ease of use/learning.

Key determinants of positive perceptions included age (younger educators reported greater ease of learning), educational level (higher qualifications associated with better adaptation), and professional training (formal pedagogical and ICT training strongly predicted satisfaction). Notably, academic specialization did not significantly affect perceptions, supporting the methodology’s cross-disciplinary applicability. These findings carry important implications for educational practice. The critical role of professional development suggests that successful implementation requires comprehensive training programs addressing both technical and pedagogical dimensions. The methodology’s broad disciplinary applicability positions it as a promising framework for integrated STEM/STEAM education initiatives.

However, several limitations constrain interpretation. The convenience sampling method may have introduced selection bias. The cross-sectional design captures only immediate post-training perceptions not sustained implementation. Geographic focus on Greece limits generalizability. Most significantly, this study assessed educator perceptions rather than student learning outcomes—the ultimate measure of educational effectiveness.

Future research should address these limitations through longitudinal studies examining sustained implementation, experimental designs assessing student learning outcomes, cross-cultural replications enhancing generalizability, and mixed-methods approaches providing deeper implementation insights. Additionally, investigating integration with emerging technologies such as artificial intelligence and augmented reality represents a promising direction for advancing gamified educational robotics. The combined application of gamification and educational robotics constitutes an interdisciplinary and innovative pedagogical approach that can effectively address the demands of contemporary education and enhance the quality of the learning process. With appropriate professional development support, this methodology holds substantial potential for creating more engaging, effective, and learner-centered educational practices across diverse educational contexts.

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Apostolos Tsagaris		✓	✓			✓				✓		✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [AT], upon reasonable request.

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