Application of Transmedia Gamification to Motivate Scientific Writing in Engineering Students

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***Abstract*—This study reports on a pedagogical experience whose objective was to analyze the effect of transmedia gamification to motivate the initial development of scientific writing skills in engineering students. Various transmedia resources were employed, including the gamified platform 'Call for Papers for Engineers', Moodle platform, YouTube platform, Facebook social network, and various board games. The study is quantitative. The sample was intentionally selected, consisting of 80 engineering students from a Peruvian university. The analysis of the effect of the pedagogical experience on the motivation to publish a scientific article reveals a noticeable trend. It is concluded that the use of transmedia storytelling and gamified resources in teaching scientific writing has a positive impact on students.**

***Keywords*—gamification, transmedia storytelling, higher education, scientific writing, engineering**

I. Introduction

Scientific writing in Engineering is a critical aspect of the scientific process, especially when presenting results clearly and concisely. University studies offer many courses focused on research methodology, but there is an urgent and pressing need for more training in scientific writing [1]. Students often perceive this skill as challenging [2], requiring language skills [3], an understanding of research processes, and digital competencies.

Research on student writing places this genre within the category of scientific writing, emphasizing the ability to argue and propose future actions with a defined purpose, a detailed plan, and persuasive reasoning [4]. Academic papers, research projects, and final graduation projects, common in university education, aim to deepen understanding of this genre and its application in engineering education. This involves promoting the rhetorical and discursive organization of this type of writing within the framework of professional training [5]. A vital aspect of this training is integrating digital tools, which are essential in facilitating the development of writing skills in university students [6].

Scientific writing is a crucial cornerstone in the university setting and requires special attention from educational institutions [7]. Universities play a pivotal role in guiding students to develop the writing skills needed to produce scientific texts. This involves articulating ideas using specialized terminology and codes specific to each discipline [8, 9]. The need for academic literacy in writing is apparent, given that most university activities, such as writing reports, dissertations, and research papers, heavily depend on the ability to express oneself in writing [10]. The gravity of this task underscores the importance of scientific writing in the university setting.

Students must develop competence in scientific writing to complete their studies by producing research reports through theses or articles. Laplante [11] refers to five stages in the writing process: brainstorming, drafting, revising, editing, and publishing. The scientific writing process must be taught by established standards and the intended audience [12, 13].

Various pedagogical experiences have contributed to different approaches to developing scientific writing competence at the university level. These approaches range from using rubrics or model articles [14], incorporating scientific writing exercises as part of other courses [15, 16], implementing small research projects [17], using scientific posters [18, 19], to using gamified platforms that include various multimodal and multimedia resources [20].

Incorporating game elements into academic environments can help students learn better, primarily when implemented in Academic Skills Centers through specially designed platforms [21]. Gamification allows students to explore through experimentation and active discovery [22]. Generally, games guide players through mastery and keep them engaged with potentially challenging tasks [23].

Gamification has gained considerable attention and is considered a highly relevant methodological tool for implementation in the educational field [24]. In recent years, this term has seen a significant rise in interest in specialized journals, presenting it as an innovative method in educational and business environments [25].

This article reports on a pedagogical experience where transmedia resources and gamified strategies were employed in teaching scientific writing, which, according to Laplante [11], culminates in publication. Given the importance of scientific writing in university education, this research is based on a crucial question: Does the application of transmedia gamification promote the development of scientific writing skills in engineering students? The objective is to analyze the effect of transmedia gamification in motivating the initial development of scientific writing competencies in engineering students.

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II. Literature Review

A. Gamification

The most widely used definition of gamification is that proposed by Deterding *et al*. [26], which consists of using game design elements in non-game contexts. This definition highlights four semantic components: game, elements, design, and non-game contexts. Huotari and Hamari [27] present a different perspective, viewing gamification as a process aimed at improving service by incorporating gaming experiences to support the overall value creation for users. This perspective focuses on the experience rather than the methods of achieving it.

Gamification in educational processes is considered a vital resource today [28, 29]. One of the main benefits is its ability to facilitate intrinsic and extrinsic motivation [29]. Gamified learning interventions have a more significant impact on intrinsically motivated students [30]. Gamification can be used as a motivational tool through positive feedback, autonomy, and the satisfaction of basic needs. Additionally, it can be a crucial solution to address motivational issues in learning contexts, provided it is well-designed and based on well-established implementation models [31].

Gamification as a methodology involves integrating game mechanics into educational settings, providing a unique opportunity to address aspects such as motivation, effort, retention, and collaboration within the educational context. Gamified educational materials are designed to focus on the student's interactive experience, encouraging active participation and the ability to make autonomous decisions related to the study content [24]. By engaging the student in this way, gamification creates a stronger connection between the learner and the educational material, which can enhance understanding of concepts, strengthen specific skills, and reward individual progress. Ultimately, adopting gamification in the classroom represents an opportunity to revamp our educational practices and guide students toward more meaningful and engaged learning [32].

It is also essential to consider that there are different types of gamification. According to Pujolà [33], there is structural gamification and content gamification. The first gamifies the structure of activities without changing the content; the second adjusts the content to turn it into a game, for example, through a narrative. Other authors, such as Marczewski, cited by Pujolà [33], refer to superficial gamification, which promotes extrinsic motivation, and deep gamification, which develops intrinsic motivation. Both types of gamification can be used when designing educational activities.

It would be relevant to investigate the relationship between motivation for academic reading and discursive practice outcomes and the connection between reading comprehension and these outcomes, as explored in previous studies [34]. Gamified educational materials emphasize the interactive experience and active participation in knowledge construction, which can enhance student motivation and engagement in digital learning environments, especially in higher education.

B. Motivation in Education

Motivation in educational environments is a collaborative effort approached from various psychological theories. One corresponds to the self-determination theory of Deci & Ryan [35], which distinguishes between intrinsic and extrinsic motivation and is based on satisfying needs for autonomy, competence, and relatedness. Csikszentmihalyi [36] describes motivation as a complete immersion and enjoyment in challenging activities, driving intrinsic motivation. Likewise, Dweck's [37] achievement goal theory contrasts the growth mindset, which promotes personal improvement, with the fixed mindset, thus influencing motivation and academic performance.

According to Reeve [38], the need for achievement is "the desire to perform well in terms of a standard of excellence" (p. 130). This author summarizes the contribution of research on the characteristics of people with high needs compared to those with low needs: the first one chooses versions of an activity that range from moderately complex to difficult instead of easy versions; engage in achievement-related tasks quickly rather than procrastinating; they demonstrate more significant effort and better performance because pride motivates them; they persist in the face of difficulties and failure in tasks of moderate difficulty; and they take personal responsibility for their successes and failures rather than seeking help or advice from others.

The theories mentioned are abstract concepts and offer practical and effective approaches to fostering compelling motivation in educational contexts. These theories of motivation, which encompass components such as competence, goals, successes, and tasks that approximate the need for achievement, have been the fundamental theoretical approach to creating the questionnaire applied in this study. Gamification, as a motivational tool, has successfully applied these theories to provide positive feedback to students and promote their improvement in academic performance.

C. Transmedia Storytelling in Higher Education

The concept of transmedia storytelling, a narrative technique that tells a single story or story experience across multiple platforms and formats using digital technologies, was introduced by Jenkins [39], who asserts that media convergence has made it inevitable for content to flow through multiple channels in this new era. Jenkins also states that each medium has its strengths and that each franchise must be autonomous to allow users independent consumption. According to Scolari [40], transmedia storytelling encompasses different signification systems, including verbal, audiovisual, iconic, and interactive systems and various media such as cinema, comics, television, video games, and theater. Transmedia storytelling results from an integrated production that involves a network of characters, events, places, times, and media.

Transmedia storytelling, which originated in fiction, expands a story across various media and communication languages, creating a narrative universe where each element adds more details to the events being told [40, 41]. Additionally, these narratives require the active participation of users or fans, who contribute to the narrative world through their creations on different digital platforms. However, this can challenge engaging "produsers" in content production.

The research by Martínez and Rodríguez [42] emphasizes how transmedia storytelling fosters the development of communicative, digital, and narrative skills. It cultivates reading habits and technological competence, preparing students for future academic and professional careers. In line with this approach, Batrova *et al*. [43] highlight that creating book trailers is an effective tool for student training, as it promotes the development of communicative, cultural, interpersonal, and intercultural interaction skills. Together, these studies demonstrate that transmedia storytelling in education enriches the learning experience and strengthens the acquisition of essential skills for the contemporary world.

It's crucial to recognize that the mere availability of a communication channel or the proposal of transmedia storytelling does not guarantee the user's transition to the prosumer role. Therefore, it's relevant to consider various transmedia storytelling that might not have had the desired impact. This could be due to various factors, including limited knowledge about the proposal, lack of interest, inadequate conceptual and technical skills for creating and disseminating content, or fear and embarrassment about expressing opinions on social and political issues. Acknowledging these limitations, we share the perspective of Jenkins *et al.* [44], who caution that focusing solely on DIY (do-it-yourself) content creation can undervalue other forms of participation, such as evaluation, critique, and redistribution of material. This recognition of limitations should inspire us to further explore and improve the field of transmedia storytelling.

Additionally, it is worth noting that transmedia and multimodal works in the field of engineering still lack sufficient research [45]. It is crucial to note that integrating gamification, transmedia storytelling elements in higher education is an emerging field with significant promise. However, more research is required to determine its effectiveness and applicability in academic contexts [40, 41].

III. Materials and Methods

A. Design

Regarding motivation, the study was designed as a pre-experiment with a single treatment group and a single measurement. The pre-experiment consists of working with a group to which the treatment is applied. A measurement criterion of one or more variables is applied to evaluate the level of the group [46]. In the present study, the treatment consisted of applying a pedagogical experience to train students in writing scientific articles. The evaluation was carried out at the end of the second semester of the 2023-2024 academic year. At the end of the pedagogical experience, the Motivation Scale was used to publish a scientific article and measure the results for Peruvian university students. In the pre-experimental design, there is no prior reference to the initial level of motivation; it is a limitation inherent to this type of design. In order to counterbalance this restriction, a knowledge questionnaire and two open questions about multimedia resources used in the pedagogical experience were additionally applied. In this case, to evaluate knowledge, a pre-and post-experiment design was used with one measure before starting the training and another measure after the training.

B. Participants

The sample for this study is purposive and consists of 80 students (79 males and one woman). All students are enrolled in the first year of the Mechanical Engineering program at a public university in Arequipa. The age range of the participants is between 16 and 22 years. Data were collected during the second semester of 2023/2024, with prior informed consent. In the knowledge assessment at the end of the semester, two students did not participate, so the sample for this part of the study consists of 78 participants.

C. Measurement

A scale was used to evaluate the motivation for publishing articles, while a questionnaire was designed to assess knowledge. Four categories of activity express motivation. Motivation must often be inferred from its expressions through the person's behavior, involvement, physiology, and self-reports. This study chose self-reporting, which is easy to administer, can be applied to many people simultaneously, and can focus on precise information [38]. However, a limitation is that people can distort it by giving socially desirable responses.

Motivation. The Scale for Motivation to Publish a Scientific Article among Peruvian University Students (MOPu-AC), developed by Mamani-Benito *et al.* [47], was used. The scale's internal structure consists of 9 items distributed in a single factor with factor loadings greater than 0.50. Each item is stated in an affirmative sense, with five response options on a Likert scale: Strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree. The design and validation of the scale were conducted with Peruvian university students with cultural characteristics similar to those of the participants in this study. The scale has high reliability, with a Cronbach's alpha coefficient of 0.86 in our sample.

Knowledges. A 10-question multiple-choice questionnaire was created to assess knowledge related to scientific writing. It mainly focuses on the structure of a scientific article, citation and referencing styles, use of connectors for each section of the article, and dissemination of the article. Additionally, students answered two open-ended questions on the use of the gamified platform and board games and video games.

D. Description of the Pedagogical Experience

The pedagogical experience followed this sequence:

Phase 1: Training in Scientific Article Writing. Students were trained by reading scientific articles, a practice that familiarized them with the field and made them feel knowledgeable and prepared. They were taught the structure and development of a scientific article, including the title, abstract, keywords, introduction, methodology, results, discussion and conclusions, and references. The gamified platform *Call for Papers for Engineers* was a supporting resource.

Phase 2: Collaborative work on the development of a literature review article. In this phase, the university's virtual classroom platform, Moodle, was used, along with board games, to reinforce teamwork.

Phase 3: Creation and social media promotion of a poster and video on the written article. Both the YouTube platform and the social network Facebook were used in this phase.

Phase 4: Application of the scale for motivation to publish a scientific article.

The outputs produced were literature review articles, posters, and videos. The students played a crucial role in this project, as they were given a series of missions to complete, along with points and levels to achieve, through the application of structural gamification at each phase. The student's sense of accomplishment was evident as they progressed through the project. Fig. 1 describes the gamification process.

Fig. 1. Gamification process.

Fig. 2 illustrates the transmedia resources used in this experience, including the gamified platform *Call for Papers for Engineers*, the Moodle platform, the YouTube platform, and the social network Facebook.

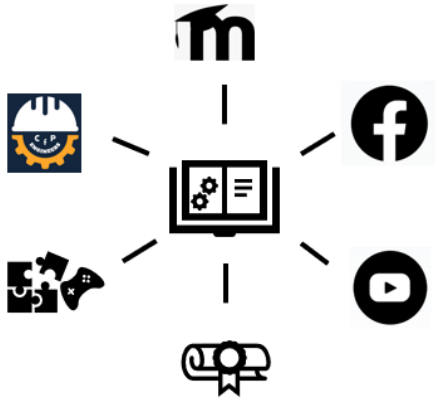

Fig. 2. Transmedia resources used in the pedagogical experience.

E. Data Analysis

Descriptive analysis was performed for the motivation scale, including mean and standard deviation. To analyze the knowledge questionnaire, Student's t-test and Cohen's *d* effect size were applied. The data were analyzed using the Statistical Package for the Social Sciences (SPSS) 26.0 software. Afterward, the responses to the two open-ended questions were examined for insights and common themes.

IV. Results

A. Knowledges

Training in scientific article writing was conducted in the first phase. As shown in Table 1, the training was effective and had a significant impact on the development of scientific articles, with a Cohen's *d* effect size of -0.82. The training covered central topics such as scientific writing, the structure and process of creating scientific articles, as well as their publication and dissemination. The results indicate that the post-training test had a higher mean (M = 15.99) compared to the pre-training test (M = 12.85). These results pertain to the knowledge assessment; the following sections will cover the final products, such as posters and videos created by the students.

Table 1. Comparison of the knowledge test before and after the training

Knowledge	Mean	Standard deviation	*t*(77)	P	*Cohen's d*
Before	12.85	2.67	42.445	.000	0.82
After	15.99	2.74	51.491	.000	

B. Motivation Scale

Table 2 shows the analysis of the effect of the learning experience on the motivation to write and publish a scientific article. It can be observed that the items with the highest average scores (above 3.5) are those related to article publication (1, 2, 3, 9), indicating that the respondents recognize the importance of completing research with publication. The highest score (3.71) corresponds to the first item, which considers publication as a contribution to the community. As students, it is the teacher's role to positively reinforce their motivation to participate in and contribute towards society; this approach likely helps sustain their motivation over time.

In the second group there are items with scores above 3.0 (5, 6, 7, 8). Items 5 and 6 pertain to authorship. According to Gálvez *et al*. [48], authorship in scientific articles and documents is an essential and complex process, requiring an understanding of responsibilities and ethical issues. Item 4 has the lowest average score (2.58), likely because these students are in their first year and have not yet had the opportunity to observe or participate in a research project.

Table 2. Mean and standard deviation of the scale for motivation to publish a scientific article

	Mean	Standard deviation
1. I want to contribute to the scientific community by publishing a scientific article.	3.71	1.01
2. I am determined to publish my research in a scientific journal.	3.53	1.11
3. The research process should end with the publication of a scientific article.	3.55	1.35
4. I am currently collaborating on a research project	2.58	1.36
5. I am eager to become the author of a scientific article.	3.38	1.13
6. When I review scientific articles, I imagine one of them being authored by me	3.01	1.17
7. I do my best to make my research topic publishable.	3.15	1.15
8. When I undertake a research project, I have in mind to publish the results in a scientific journal	3.24	1.09
9. Despite my limitations, I won't give up until I publish a scientific article.	3.59	1.15

C. Open-Ended Question

The first open-ended question was: "Do you think the gamified platform *Call for Papers for Engineers* can help improve scientific writing?" The participants (P) responded positively, mainly indicating that the gamified platform is interactive, motivating, and educational. Some of their responses were:

P13: Yes, because it uses an interactive method that allows me to learn and receive feedback with each exercise.

P15: Yes, because through the game, it helps us understand more about references, the parts that an article should have, etc.

P22: Yes, because being gamified, it offers an interactive and motivating experience, which increases user participation. Additionally, it provides immediate feedback, making it easier to identify and correct mistakes. This combination of elements creates an environment conducive to collaborative learning and continuously improving engineers' scientific writing skills.

P28: Yes, because it makes learning engaging, and you can repeat it several times, which helps to memorize and distinguish fundamental parts for scientific writing.

Regarding the second open-ended question: Did reading articles about the use of board games and video games in class for creating a scientific poster prove motivating? Why? Some responses were:

P12: Yes. These readings gave me a new perspective on how video games and board games can be valuable tools in academia. I discovered how these forms of entertainment can be fun and effective in promoting learning and creativity in the educational setting.

P16: It is both motivating and interesting because board and video games allow us to improve our skills and reason better, as most of them are strategic games.

P44: Absolutely. I have a computer at home, and I play on it almost daily, but now I am not limited to computer games; I also play board games. Thanks to the games we played in class, I became very interested in that new experience, and now I even look for "exotic" board games. However, it is not just about playing and having fun. Thanks to this, I understood the article, and combined with my previous ideas, it is not about the outcome but the process. This process involves learning, abstraction skills, comprehension, retention, and a myriad of mental processes that, with the right guidance, can make learning through fun possible. I have been thinking about it for a long time, and seeing that someone else came to the same conclusion is very satisfying.

P59: Yes, it's incredible to see how the human brain learns faster and easier when it's doing something enjoyable, like playing board games. Without even realizing it, learning becomes dynamic, moving away from traditional methods, and in many cases, proving to be more effective. Additionally, it helps improve communication skills, teamwork, and logical structuring of ideas.

D. Creation and Dissemination of the Poster and Video on Social Media

In line with McClelland and Aktinson's achievement motivation, the theory on which the instrument applied in this study is based, a person with a strong achievement motivation seeks to succeed in tasks that present a challenge [38]. In this study, the academic task was to create and disseminate posters and videos about the prepared article on social media. Beyond the knowledge of article development, students acquired skills to create an academic poster and a promotional video for the article's dissemination on social media. On the other hand, social media provides a platform for communication and information exchange among peers or users with similar interests. Fig. 3 shows an example of a poster collaboratively created by students.

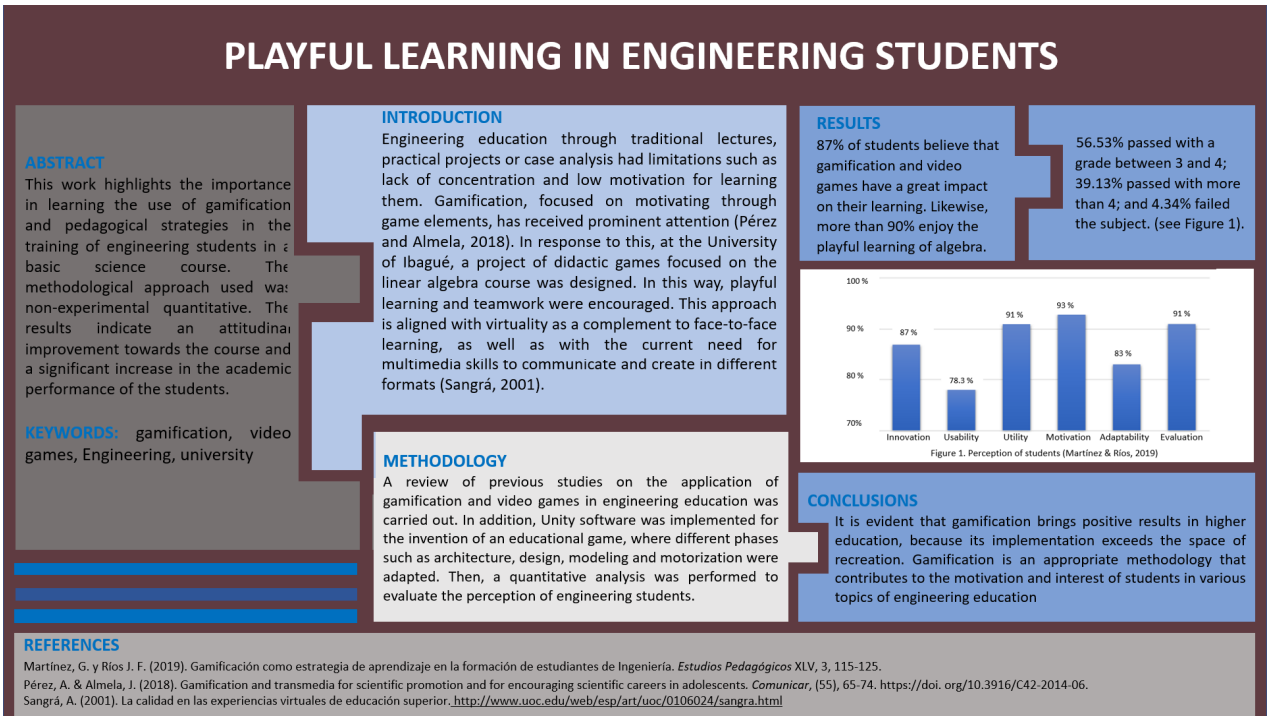

Fig. 3. Example of a poster elaborated by the students.

Fig. 4 shows the dissemination of the work products created by students on Facebook and YouTube platforms. These platforms are widely used by university students, who leverage their computing strategies to upload and share material on them.

Fig. 4. Example of a poster created by the students and dissemination of the work on Youtube and Facebook platforms. https://www.facebook.com/profile.php?id=100092848086244

V. Discussion

Transmedia gamification emerges as an innovative strategy to encourage scientific writing among engineering students. This approach combines game elements and narratives across multiple digital platforms to engage and motivate students in the academic writing process. The results demonstrate a positive impact on students' motivation and commitment to scientific writing and the publication of their work on social media while promoting effective communication skills and critical thinking within the academic sphere.

Analyzing the pedagogical experience's effect on motivation to publish a scientific article indicates a notable trend. The items with the highest means, particularly those related to the importance of publishing the article and its contribution to the scientific community, suggest that students have a significant perception of the relevance of this process. This observation aligns with motivational theories [32, 34], emphasizing the importance of achievement and social contribution as motivational drivers.

On the other hand, the items related to authorship and collaboration in research projects show a slightly lower perception among students. This opinion could be due to their initial academic level and lack of practical research experience, as Gálvez *et al*. suggested [48]. However, these areas also represent significant opportunities for students' academic and professional development, highlighting the importance of integrating activities and experiences that promote active participation in research projects from the early stages of university education.

The student's responses to the open-ended questions about the gamified platform and reading articles on the use of board games and video games reinforce the idea that these methodologies are perceived as motivating and effective for improving scientific writing skills. These findings align with the definitions and perspectives on gamification [26, 27, 49] and research on gamification in educational processes [28, 29].

Moreover, creating and disseminating posters and videos about written articles on social media demonstrate students' commitment and collaboration in academic tasks, supporting the idea that gamification can effectively improve motivation and academic performance. This finding is consistent with literature highlighting the benefits of gamification in increasing student engagement and participation, especially among intrinsically motivated [30], and its capacity to address different motivational aspects such as autonomy and need satisfaction [31].

Other experiences in different educational settings and levels also suggest that using gamified transmedia resources

offers satisfactory results when aiming to motivate students to venture into the scientific field [50]. This is the case in the study by Pérez-Manzano *et al*. [51], where participants achieved high levels of motivation to solidify their scientific vocation through the gamified project Antarctica. Similarly, [2] incorporated storytelling into the teaching of scientific writing, leading to greater motivation among students. However, the lack of comparative studies on integrating transmedia storytelling, gamification, and other innovations underscores the urgency of understanding how different pedagogical approaches impact the motivation and learning of engineering students [3, 6, 9]. Although transmedia gamification shows promise in the educational field, it is crucial to address these challenges to optimize its effectiveness and widespread applicability in academic settings, thereby highlighting its potential.

VI. Conclusions

The novelty of this work consists of integrating gamification with various transmedia resources, such as the gamified platform Call for Papers for Engineers, the Moodle Platform, the YouTube Platform, and the social network Facebook, to motivate students to enter scientific writing, as detailed in the description of the pedagogical experience of this study. The results suggest that applying transmedia gamification strategies to scientific writing can highly motivate students and enhance their engagement with the research and academic publication process. These findings support the need for further investigation into the relationship between motivation and academic performance in gamified educational contexts and the integration of these methodologies into higher education to improve the learning experience for students. Additionally, this work leads to the development of new didactic strategies that cultivate intrinsic motivation in students, encouraging more significant involvement in scientific research.

A limitation of this study is that this pedagogical experience was only conducted with first-year engineering students during one semester, as the timing had to be adjusted to the university's academic period. Future research will extend the experience to a larger sample and incorporate artificial intelligence in gamified scientific writing instruction for engineering students.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, R.N.-P.; methodology, R.N.-P. and A.B.-P.; investigation, O.T.-G.; formal analysis, A.B.-P.; writing—original draft preparation, E.V. and O.T.-G.; writing—review and editing, E.C.-G.; all authors had approved the final version.

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