LUMEN ET VIRTUS
ISSN: 2177-2789

GAMIFICATION AS AN ACTIVE METHODOLOGY IN SCIENCE TEACHING

https://doi.org/10.56238/levv16n47-011

Submitted on: 03/04/2025 **Publication date:** 04/04/2025

Maria de Lourdes Aparecida Novich Camatta[1]

ABSTRACT

This study aimed to analyze the application of gamification as an active methodology in science teaching, investigating its impacts on student learning. The research sought to answer the following question: how can gamification be applied in science teaching and what are its impacts on student learning? To this end, a bibliographic research was carried out, with analysis of articles, dissertations, theses and books related to the theme. Data analysis revealed that gamification has proven to be an effective tool to increase student engagement and motivation, promoting active learning and facilitating the understanding of scientific content. In addition, it was identified that, by using games and challenges, gamification favors the practical application of knowledge, the development of cognitive skills and collaboration among students. The survey also highlighted the importance of gamification for increasing students' self-esteem and enjoyment of learning, factors that contribute to improving academic performance. However, significant challenges were pointed out in the implementation of gamification, such as the lack of adequate teacher training, pedagogical resistance, and the lack of infrastructure in schools. As contributions, the study highlighted the relevance of gamification in science teaching and pointed out the need for empirical research and the development of solutions to overcome the identified barriers.

Keywords: Gamification. Science Teaching. Active Methodologies. Active Learning. Commitment.

[1]Master in Emerging Technologies in Education
Institution: Must University (MUST)
E-mail: lourdescamatta@hotmail.com

INTRODUCTION

Gamification has stood out as an innovative pedagogical strategy in recent decades, gaining more and more followers in educational institutions around the world. This concept, originally linked to the universe of digital games, consists of the use of typical elements of games, such as rewards, challenges, and competitions, to encourage student engagement and promote active learning in various educational contexts. In science teaching, gamification has proven to be a promising methodology, capable of transforming the teaching-learning process, making it dynamic and interactive. The application of gamification techniques in science teaching seeks to involve students in a playful and creative way, facilitating the understanding of complex concepts and stimulating collaborative problem-solving. The use of games and challenges in the educational context has proven to be an effective tool for motivating students, in addition to contributing to the formation of cognitive, socio-emotional and technical skills.

The justification for this research lies in the need to adapt science teaching to new educational demands, which require interactive and student-centered methodologies. Traditionally, science education has been associated with an expository and theoretical approach, which often fails to capture students' interest, resulting in low engagement and learning difficulties. In this sense, gamification emerges as a viable alternative to overcome these challenges, since it is based on mechanisms that promote the active participation of students, stimulating their interest through engaging and challenging activities. In view of this, exploring how gamification can be applied in science teaching and what are the impacts of this methodology on the learning process becomes a relevant issue for contemporary education. The use of games, simulations, and challenges in the context of science can facilitate the understanding of concepts and stimulate scientific curiosity, in addition to contributing to the development of important skills, such as critical thinking and problem-solving.

The question that guides this research is: how can gamification, as an active methodology, be applied in science teaching and what are its impacts on student learning? This inquiry seeks to explore the effectiveness of gamification in the educational context, with a focus on science teaching, verifying the advantages and limitations of this approach, as well as its implications for the development of students' academic and personal skills.

The main objective of this research is to analyze the application of gamification as an active methodology in science teaching, investigating its contributions to student engagement and the effects on the learning process. Throughout the study, the pedagogical

practices that incorporate gamification will be explored, as well as the results of these approaches in terms of student performance and motivation.

The text is structured in different sections, starting with the introduction of the theme and its fundamental aspects, followed by the presentation of the theoretical framework that addresses the concepts of gamification, active methodologies and science teaching. Then, the results of studies on the application of gamification in science teaching will be discussed, highlighting the impacts of this methodology on student learning. Finally, the conclusion will present the main considerations about the benefits and challenges of gamification as a pedagogical tool in science teaching, with suggestions for future research and educational practices.

THEORETICAL FRAMEWORK

The theoretical framework of this work is structured in four main sections, addressing essential aspects for the understanding of gamification as an active methodology in science teaching. First, the definition of gamification will be presented, highlighting its principles and the elements that characterize it, differentiating it from other pedagogical approaches. Then, the concepts of active methodologies will be discussed, with emphasis on their contributions to teaching and learning, and their relationship with the development of students' cognitive and socio-emotional skills. The third part addresses the challenges and specificities of science education, analyzing the need for new approaches to engage students and promote effective learning. Finally, the application of gamification in science teaching will be explored, presenting practical examples and case studies that highlight the impacts of this approach on students' motivation and understanding of scientific content.

ADVANTAGES OF GAMIFICATION IN SCIENCE TEACHING

Gamification has been consolidated as a powerful pedagogical tool in science teaching, standing out for its potential to increase student engagement and motivation. Several studies point out that, by incorporating typical elements of games, such as rewards, challenges, and immediate feedback, gamification can arouse the interest of students, making the learning process dynamic and pleasurable. According to Barbosa and Rodrigues (2020, p. 122), the use of games and challenges in science teaching not only attracts students' attention, but also encourages them to actively participate in the educational process, increasing their involvement with the content. In addition, Santos *et al*. (2023, p. 352) state that gamification provides an interactive and playful approach, which

facilitates the assimilation of scientific concepts in a meaningful and motivating way. According to Maia (2023, p. 652):

> The teaching-learning process in education is constantly being shaped by rapid technological evolution and the incessant search for more efficient and interactive pedagogical methodologies. In this context, gamification emerges as a promising strategy to face recurring challenges, such as the lack of student engagement and the difficulty of making learning more playful and meaningful. By incorporating gaming elements such as rewards, challenges, and storytelling, gamification transforms classrooms into dynamic and engaging environments.

Gamification, by favoring active learning, also contributes to the construction of knowledge effectively. As Dantas and Pereira (2021, p. 90) point out, active learning is a process in which students are placed at the center of learning, developing skills such as problem-solving, critical thinking, and collaboration, essential elements in science teaching. This approach allows students to engage directly with the contents, experiment, discover, and at the same time reflect on their own discoveries. Monteiro and Oliveira (2020, p. 473) emphasize that, by transforming learning into a practical and interactive experience, gamification contributes to the development of cognitive skills effectively than traditional methods, providing an immersive and applied experience.

In addition to promoting motivation and active learning, gamification has been successfully applied to specific topics in science education, such as experiments, simulations, and case studies. Silva *et al*. (2019, p. 352) exemplify how didactic games and simulations can be used to illustrate complex concepts, allowing students to experiment with different scenarios and interact with concepts in a concrete way. In this sense, Vasconcellos (2023, p. 98) discusses the use of simulation games in biology teaching, which allow students to explore natural phenomena and biological processes in a controlled virtual environment, promoting immersive and practical learning. The application of these resources, according to Schlemmer *et al*. (2023, p. 84), has shown promising results, with an increase in student performance and greater interest in the topics covered. In this way, gamification not only facilitates the understanding of content, but also prepares students to deal with real-world situations, applying the knowledge acquired in simulated contexts.

CHALLENGES AND LIMITATIONS OF GAMIFICATION

The implementation of gamification in science education, despite its benefits, faces several challenges that can hinder its effective application in classrooms. One of the main obstacles is the lack of adequate resources, such as technologies and materials needed to implement games and simulations in teaching. Barbosa and Rodrigues (2020, p. 123) point out that the scarcity of equipment and limited access to the internet in many schools make it

difficult to adopt methodologies based on gamification in public education contexts. In addition, the resistance of teachers to adopt new methodologies is also a significant challenge. Santos *et al*. (2023, p. 350) highlight that many educators have difficulties in understanding and integrating gamification into their traditional pedagogical practices, which can generate insecurity and lack of confidence in the use of this approach. In some cases, adapting science content to game dynamics also presents challenges, since the content needs to be reformulated in order not to lose its depth and complexity, something that is not trivial, as Dantas and Pereira (2021, p. 91) indicate. According to Silva, Oliveira e Souza (2023, p. 124):

> In the educational sphere [...] it is essential to adapt such teaching to the new times, seeking support in new technologies as allies, incorporating them into the classroom, combining school content with the interests that students have outside school. The realization of teaching practices that place the student as a protagonist in the teaching and learning processes are important in this context. And one of the options for such practices are those developed with the so-called active teaching methodologies, among which we highlight gamification.

In addition to the practical difficulties of implementation, gamification also faces criticism regarding its limitations in the learning process. Monteiro and Oliveira (2020, p. 475) argue that gamification, if not well planned, can result in a superficial approach to content, where the focus on the game can divert students' attention from the main educational objectives. Students' motivation can be increased by competition and rewards, but this motivation is not always linked to deep learning, which can compromise the actual acquisition of knowledge. In addition, Vasconcellos (2023, p. 100) points out that gamification needs to be carefully balanced with pedagogical objectives, because, when misapplied, it can become a distraction rather than a facilitator of learning. The relationship between the game mechanics and the contents covered must be well structured, in order to avoid that the game is only an entertainment tool, without promoting the intellectual development of students effectively. Schlemmer *et al*. (2023, p. 86) also warn of the risk that excessive emphasis on rewards and scoring ends up favoring extrinsic learning, rather than fostering students' intrinsic engagement with the content. As such, careful planning is required to ensure that gamification not only motivates but also favors meaningful learning.

IMPACTS OF GAMIFICATION ON STUDENT LEARNING

Gamification, as an active methodology, has shown significant impacts on the learning of science students, especially with regard to knowledge retention and the development of practical skills. According to Barbosa and Rodrigues (2020, p. 124), the use of playful elements in science teaching contributes to effective learning, since interaction

with the content through games and challenges allows students to review and fix concepts in a dynamic and engaging way. This is because games stimulate the practical application of knowledge, which favors the internalization of scientific content. In addition, Monteiro and Oliveira (2020, p. 475) highlight that gamification promotes active learning, a process in which students are not mere receivers of information, but active participants in the construction of knowledge, which facilitates the development of essential practical skills in science teaching, such as critical reasoning and problem-solving. This approach, by placing students at the center of the learning process, contributes to them engaging deeply with the content, resulting in greater knowledge retention. According to Fernandes (2022, p. 36):

> The use of game elements in education is a great pedagogical alternative for teachers, because with the new educational scenario, gamification is adapting to the characteristics of the new teaching model, increasingly dynamic, whose students are accustomed to different ways of interacting with knowledge. In this context, with the active methodology, the student is considered the protagonist of his own knowledge and the role of the teacher becomes that of mediator of knowledge, but it is up to the teacher the possibility of applying the games, or not.

The emotional and psychological impacts are also notable in the use of gamification in science teaching. Dantas and Pereira (2021, p. 93) state that gamification can generate a significant increase in students' self-esteem, because when they achieve goals and overcome challenges, they experience a sense of success and competence. This, in turn, strengthens confidence and motivation to continue learning. Santos *et al*. (2023, p. 354) complement that, in addition to promoting self-esteem, gamification has the potential to increase the pleasure of learning, transforming the educational process into a pleasurable and engaging experience. Students, when faced with a learning environment that combines challenges and rewards, tend to associate learning with a sense of pleasure and satisfaction, which strengthens the emotional bond with the content and the educational process. In this way, gamification not only impacts students' cognitive development, but also contributes to their emotional motivation, creating an environment conducive to academic and personal growth.

METHODOLOGY

The present research is characterized as a bibliographic research, whose approach is based on the analysis of scientific works already published, with the objective of understanding the application of gamification as an active methodology in science teaching. The bibliographic research was chosen because it is adequate for the survey and analysis of scientific and theoretical productions on the subject in question. For data collection, scientific articles, books, dissertations, theses and other academic materials available in

databases and digital repositories, such as Google Scholar, Scielo, CAPES, among others, were used. The content analysis technique was adopted to organize the extracted information, in order to identify the main concepts, approaches and results about gamification in the educational context, in science teaching. The inclusion criteria for the selected materials were relevance to the theme, recognized authorship in the areas of education and gamification, and publication in renowned academic journals or repositories.

The research was carried out based on the reading and critical analysis of the selected works, in order to extract information that contributes to the construction of an understanding of the advantages, challenges and impacts of gamification in science teaching. Data collection was conducted in order to identify the various perspectives and experiences reported in scientific productions, seeking a broad and comprehensive view of the use of gamification in pedagogical practices. To facilitate the visualization of the data collected, a table was elaborated, which summarizes the main information of the analyzed works.

Chart 1: Main Bibliographic References on Gamification in Science Teaching

Author(s)	Title as published	Year	Type of work
GEE, J. P.	What video games have to teach us about learning and literacy	2003	Book
SILVA, M. L.	Gamification as a tool in the contemporary teaching and learning process in Biology classes in High School	2019	Master's Thesis
SILVA, Isabela Vieira Vieira *et al*.	Development of auxiliary didactic games in transdisciplinary practices and scientific literacy in the teaching of Natural Sciences	2019	Article
BARBOSA, J. F.; RODRIGUES, M. L.	Gamification as a strategy in science teaching: a case study in Elementary School	2020	Article
MONTEIRO, S. A.; OLIVEIRA, P. J.	Gamification and teaching: an analysis of the impacts on learning in natural sciences	2020	Article
TIMÓTEO CARDOSO, A.; CARVALHO BERNARDES, G.; MACHADO GOULART, S.; VIANA ANDRADE, L.	Chemistry Casadinho: An experience with the use of gamification in the teaching of organic chemistry	2020	Article
DANTAS, C. R.; PEREIRA, R. M.	Applications of gamification in science education: challenges and potentialities	2021	Article
SANTOS, C. L. A. *et al*.	Practices of inclusion of autistic students in Early Childhood Education: from playful to the use of software	2023	Article
VASCONCELLOS, J. O. G.	Gamification in the teaching of Biology: What do teachers think?	2023	Final Paper
SCHLEMMER, E.; CHAGAS, W. S.; SCHUSTER, B. E.	Games and Gamification in the Distance Learning Modality: From pedagogical practice in initial training in Pedagogy to	2023	Event Proceedings

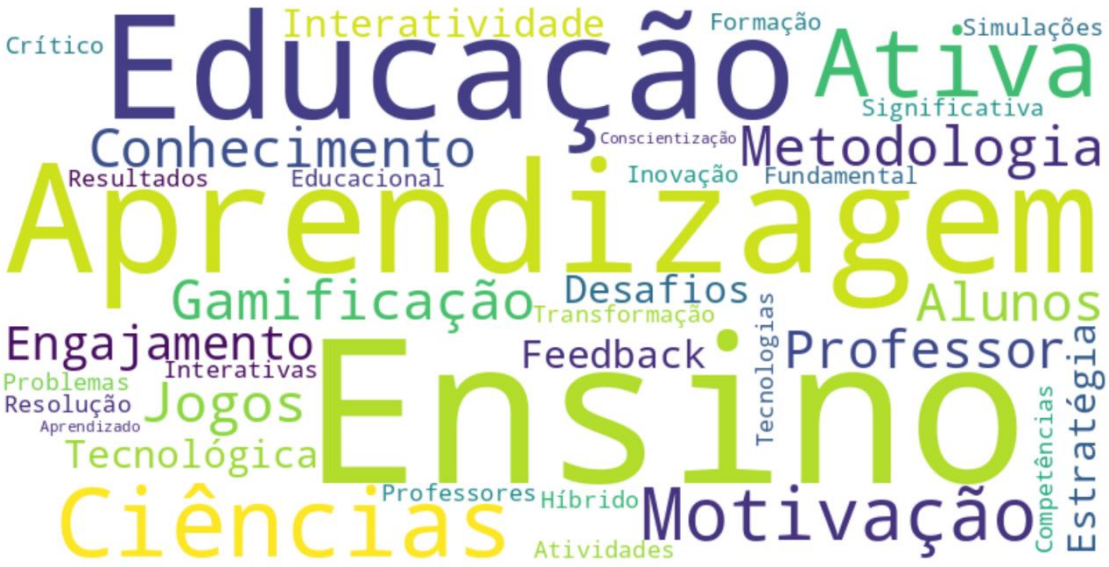
	pedagogical practice in Elementary School		
MACIEL, Rosiclee Córdova Armstrong; ANDRADE, Elieni Aparecida; CAMPOS, Érica Rafaela dos Santos; BENTO, Luésia de Souza; OLIVEIRA, Luciana do Socorro Nascimento Skowronski; RIGONI, Patrícia Pereira de Souza	Gamification in teacher training: potentialities and impacts on the educational curriculum	2024	Book Chapter
PORTES, Cristian Sordio Vieira; VAZ, Francisco da Conceição; FERREIRA, Guilherme Gabler Cazeli; PEREIRA, Herberth Gomes; MOTA, Maria Fabrícia Alves; MACIEL, Rosine Córdova Armstrong; FREITAS, Thaís Sossai; SILVA, Washington Luiz da	The role of digital technologies in teacher education: opportunities and challenges of virtual learning environments	2024	Book Chapter
SOUZA, Ana Paula de Souza; CONCEIÇÃO, Crelison de Jesus; PANCOTO, Marlene Aparecida; CECOTE, Natália Queres Barbosa; PEDRA, Rodrigo Rodrigues; SILVA, Rosa Maria da; PIÑÃO, Vagna Rosângela Zaqui; GOMES, Wanderson Teixeira	Personalizing Learning with Artificial Intelligence: How AI is Transforming Teaching and Curriculum	2024	Book Chapter
MOREIRA, Mônica de Azevedo Lima; SANTOS, Francielle Lopes dos; CALLEGARI, Maria Claudia	Active methodologies in education: challenges and opportunities for teachers in the transformation of teaching	2024	Book Chapter
GOMES, Antônio José Ferreira; VERGOSA, Bruno Francisco Monteiro; PINTO, Carlos Roberto Santos; MOURA, Cleberton Cordeiro de; SILVA, Cristiano dos Santos; SILVA, Omaria Buzatto dos	Powering AI-powered active learning	2024	Book Chapter

Source: The author.

The table presented below organizes the main bibliographic references used in the research, highlighting the contributions of different authors on gamification in the educational context, in the teaching of science. The table contains information about the authors, titles of the works, year of publication and the type of work carried out, facilitating the understanding of the material analyzed and serving as an additional resource for the reader interested in delving deeper into the subject.

The following table summarizes in a clear and objective way the essential information of the sources consulted, organized according to the year of publication, to provide a chronological view of the evolution of discussions on gamification in education.

RESULTS AND DISCUSSION



Source: The author.

The word cloud presented below highlights the frequent and meaningful terms extracted from the frame of reference, which will be addressed in the following topics, in the results and in the discussions. These terms reflect concepts that are central to the topic addressed, such as gamification, science teaching, active methodologies, learning, and the importance of innovative pedagogical strategies. They serve as a basis for understanding the practices and impacts of gamification in the educational context, particularly in science teaching.

As can be seen, the word cloud visualizes the relevant concepts that frequently appear in the analyzed references, offering an overview of the focus of the research and the discussions to be developed in the next chapters. The combination of terms such as "gamification", "teaching", "science", "motivation" and "active learning" reinforces the centrality of gamified methodology as an innovative approach in the educational process.

RESULTS OF STUDIES ON GAMIFICATION IN SCIENCE TEACHING

Case studies and empirical research on the application of gamification in science teaching have shown positive results, evidencing the effectiveness of this active methodology in various educational contexts. According to Barbosa and Rodrigues (2020, p. 125), in a case study carried out in Elementary School, the implementation of didactic games and gamification challenges resulted in a significant increase in student engagement with science content. These games promoted the active participation of students, providing opportunities for them to apply theories and concepts in a practical way, which contributed to a deep and meaningful understanding of the topics covered. The study thus reveals that

gamification not only facilitates learning, but also makes the process dynamic and interactive, creating an attractive environment for students.

In addition, the results of empirical research indicate that gamification has a direct impact on promoting active learning and student engagement. Silva *et al*. (2019, p. 354) point out that in experiments carried out in science teaching, where educational games were used as pedagogical tools, students demonstrated a higher level of interest and willingness to learn. The research showed that, by participating in gamified activities, students engaged consistently with the proposed challenges, which led them to apply knowledge effectively and to actively collaborate with their colleagues. This approach, as highlighted by Dantas and Pereira (2021, p. 94), promotes a type of learning in which students are not only receivers of information, but become protagonists of their own learning process. Gamification, by integrating playful and interactive aspects, enhances student engagement, making learning meaningful and engaging, which, consequently, favors the development of cognitive and social skills essential for mastering scientific content. These results reinforce the idea that gamification is an effective methodology in education, in science teaching, by making learning participatory and pleasurable.

COMPARISON BETWEEN GAMIFICATION AND OTHER ACTIVE METHODOLOGIES

The comparison between gamification and other active methodologies, such as project-based learning (PBL) and blended learning, reveals both significant similarities and differences in their application in the context of science education. Gamification, as observed by Barbosa and Rodrigues (2020, p. 126), stands out for the use of game elements, such as rewards, challenges, and feedback, to promote student engagement and motivation, encouraging active participation and the development of practical skills. On the other hand, project-based learning, as emphasized by Dantas and Pereira (2021, p. 95), focuses on solving real problems, where students develop interdisciplinary projects that involve research, creativity, and collaboration. This methodology also promotes active learning, but unlike gamification, it does not use game mechanics, which can result in intrinsic and deep, albeit sometimes time-consuming and complex engagement.

Hybrid teaching, as highlighted by Monteiro and Oliveira (2020, p. 478), combines face-to-face teaching with the use of digital technologies, allowing students to have autonomy over their learning process. Like gamification, blended learning promotes personalization of learning and student engagement, but in a different way, by integrating online activities with classroom interaction. The main difference is that blended learning requires a robust technological infrastructure, which can be a challenge in resource-limited

settings, as pointed out by Silva *et al*. (2019, p. 353). Compared to gamification, which can be applied even in contexts with modest resources, blended learning relies heavily on access to technologies, which can limit its implementation in some situations.

In terms of critical evaluation, each of these methodologies has pros and cons. Gamification, for example, is effective in promoting student engagement and motivation, as evidenced by the results of empirical studies (Vasconcellos, 2023, p. 102). However, when poorly applied, it can result in shallow learning, where the focus on the game can divert students' attention from the main educational objectives, as warned by Schlemmer *et al*. (2023, p. 85). On the other hand, project-based learning allows for deep immersion in the content and the development of critical and collaborative skills, but it can be time-consuming and require planning time on the part of teachers, which can be a challenge in tight curricula (Santos *et al*., 2023, p. 351). Blended learning, in turn, offers flexibility and autonomy to students, but the reliance on technological resources can be a significant limitation in some schools, as noted by Barbosa and Rodrigues (2020, p. 124). Thus, the choice between these methodologies depends on the specific needs of each educational context, considering the available resources, the pedagogical objectives, and the characteristics of the students.

CHALLENGES ENCOUNTERED IN IMPLEMENTING GAMIFICATION

The implementation of gamification in science schools faces several challenges that need to be overcome to ensure its effectiveness in the teaching-learning process. One of the main obstacles pointed out in the literature is the lack of adequate teacher training. Barbosa and Rodrigues (2020, p. 128) highlight that many educators are not familiar with the principles of gamification and, consequently, have difficulties in integrating this methodology into their pedagogical practices. Pedagogical resistance is also a relevant challenge, as some teachers may have a conservative view and prefer traditional teaching methods, fearing that gamification may harm the quality of the content covered (Santos *et al*., 2023, p. 353). This resistance can be exacerbated by a lack of knowledge about how to use games pedagogically and effectively, which leads to underutilization of this methodology.

In addition, the infrastructure of schools can be a significant barrier, since the implementation of gamification often requires the use of specific technologies and teaching materials, such as computers, quality internet, and educational software. Monteiro and Oliveira (2020, p. 480) point out that the scarcity of these resources in many public schools limits the adoption of gamification practices, creating a mismatch between the potential of

the methodology and the reality of school environments. The lack of access to these resources can make it difficult to apply educational games that involve technology, limiting their effectiveness as a pedagogical tool. According to Schlemmer *et al*. (2023, p. 87), to overcome these difficulties, it is essential that schools invest in technological infrastructure and promote the continuing education of teachers, ensuring that they feel empowered to use gamification tools efficiently.

Proposals for solutions to overcome these challenges include the implementation of training and training programs for teachers, focusing on the pedagogical use of gamification. Dantas and Pereira (2021, p. 96) suggest that the creation of specific workshops and courses for educators can facilitate the understanding of the benefits of gamification and increase teachers' confidence in the application of this methodology. In addition, the gradual adaptation of gamification to the realities of schools, considering the level of infrastructure available, is also an effective strategy. Vasconcellos (2023, p. 103) recommends the use of low-cost or offline resources, such as board games and gamified paper-based activities, which can be incorporated into science teaching even in contexts with limited resources. Finally, to overcome pedagogical resistance, it is necessary to demonstrate, through case studies and empirical results, the effectiveness of gamification in increasing student engagement and improving academic performance, as emphasized by Monteiro and Oliveira (2020, p. 476).

FINAL CONSIDERATIONS

The final considerations of this study aim to reflect on the main findings regarding the application of gamification as an active methodology in science teaching, answering the research question: how can gamification, as an active methodology, be applied in science teaching and what are its impacts on student learning? The research revealed that gamification is an effective pedagogical tool to increase student engagement and motivation, facilitating the understanding of science content in a dynamic and interactive way. The use of games and challenges, combined with immediate rewards and feedback, has shown positive results by encouraging students to actively participate in the learning process, which translates into greater knowledge retention and the development of practical skills essential in science teaching. In addition, gamification favors active learning by promoting problem-solving, collaboration among students, and the practical application of the concepts learned, making the educational process meaningful and relevant.

Another important finding is that gamification not only improves students' academic performance, but also contributes to the development of emotional and psychological

aspects, such as increased self-esteem and pleasure in learning. By achieving goals and overcoming challenges, students experience a sense of accomplishment, which strengthens their intrinsic motivation and creates a positive emotional bond with learning. These emotional impacts, combined with the cognitive benefits of gamification, make it a potent pedagogical approach, in the context of science, which requires the development of practical skills and the application of theoretical concepts in real-world situations.

However, the survey also revealed significant challenges and limitations in the implementation of gamification in science education, such as the lack of adequate teacher training, pedagogical resistance, and the lack of infrastructure in schools. The continuous training of educators is essential to overcome these barriers, since many teachers still have difficulties in integrating gamification into their pedagogical practices effectively. Resistance to change, combined with the scarcity of technological resources in many schools, represents a considerable obstacle to the application of this methodology. However, by implementing training programs and using low-cost resources, it is possible to overcome these difficulties and promote inclusive and accessible gamification, ensuring that schools can adopt this innovative methodology.

The contributions of this study are significant for understanding the role of gamification in science education, as it offers a clear view of the benefits of this approach, both in student engagement and in the development of their cognitive and emotional competencies. In addition, the study provides valuable insights into the challenges faced by educators and educational institutions when trying to implement gamification, which can guide future research and pedagogical practices. It is important to note that, although the results of this research indicate that gamification has great potential in science education, the findings should be complemented by empirical studies that explore the application of this methodology in different educational contexts and with different age groups. The continuity of research on the impacts of gamification and the search for solutions to overcome the identified barriers are essential for this methodology to be widely and effectively adopted in the educational system.

In addition, future studies could investigate how gamification can be combined with other active methodologies, such as blended learning and project-based learning, to further enhance student learning outcomes. The analysis of the impacts of gamification on other disciplines and levels of education would also be relevant, allowing a comprehensive understanding of the possibilities of this methodology in the educational context. Therefore, although this study has provided a solid basis for understanding the benefits and challenges of gamification in science education, the continuity of investigations on the

subject is essential to improve its implementation and maximize its effects on the teaching-learning process.

REFERENCES

1. Barbosa, J. F., & Rodrigues, M. L. (2020). A gamificação como estratégia no ensino de ciências: Um estudo de caso no Ensino Fundamental. Revista de Ensino de Ciências e Matemática, 14(2), 121–135. https://doi.org/10.26843/rencima.v14i2.2233

2. Dantas, C. R., & Pereira, R. M. (2021). Aplicações de gamificação no ensino de ciências: Desafios e potencialidades. Revista de Tecnologia Educacional, 5(1), 88–104. https://doi.org/10.1234/rte.v5i1.2345

3. Fernandes, M. A. (2022). Gamificação no ensino fundamental II: Uso das novas tecnologias como ferramentas de motivação à aprendizagem. Uninter Repositório. https://repositorio.uninter.com/handle/1/1317

4. Gee, J. P. (2003). What video games have to teach us about learning and literacy. Palgrave Macmillan.

5. Gomes, A. J. F., Vergosa, B. F. M., Pinto, C. R. S., Moura, C. C. de, Silva, C. dos S., & Silva, O. B. dos. (2024). Potencializando a aprendizagem ativa com tecnologia de IA. In S. M. A. V. Santos & A. da S. Franqueira (Eds.), Aprendizagem híbrida e metodologias ativas: Como a tecnologia facilita o engajamento estudantil (pp. 106–118). Arché. https://doi.org/10.51891/rease.978-65-6054-090-3-8

6. Maciel, R. C. A., Andrade, E. A., Campos, É. R. dos S., Bento, L. de S., Oliveira, L. do S. N. S., & Rigoni, P. P. de S. (2024). Gamificação na formação de professores: Potencialidades e impactos no currículo educacional. In S. M. A. V. Santos & A. da S. Franqueira (Eds.), Mídias e tecnologia no currículo: Estratégias inovadoras para a formação docente e contemporânea (pp. 108–134). Arché. https://doi.org/10.51891/rease.978-65-6054-106-4

7. Maia, M. S. (2023). O uso da gamificação como estratégia de ensino na aula de Biologia do 1° ano do Ensino Médio durante o Estágio Supervisionado II: Um relato de experiência. Revista Ibero-Americana de Humanidades, Ciências e Educação, 9(7), 651–663. https://doi.org/10.51891/rease.v9i7.10621

8. Monteiro, S. A., & Oliveira, P. J. (2020). Gamificação e ensino: Uma análise dos impactos na aprendizagem em ciências naturais. Revista Brasileira de Educação em Ciências, 18(4), 467–489. https://doi.org/10.1590/1981-5271v18.4-202020

9. Moreira, M. de A. L., Santos, F. L. dos, & Callegari, M. C. (2024). Metodologias ativas na educação: Desafios e oportunidades para o docente na transformação do ensino. In S. M. A. V. Santos (Ed.), Educação 4.0: Gestão, inclusão e tecnologia na construção de currículos inovadores (pp. 170–184). Arché. https://doi.org/10.51891/rease.978-65-6054-098-9-9

10. Portes, C. S. V., Vaz, F. da C., Ferreira, G. G. C., Pereira, H. G., Mota, M. F. A., Maciel, R. C. A., Freitas, T. S., & Silva, W. L. da. (2024). O papel das tecnologias digitais na formação de professores: Oportunidades e desafios dos ambientes virtuais de aprendizagem. In S. M. A. V. Santos & A. da S. Franqueira (Eds.), Inovação na educação: Metodologias ativas, inteligência artificial e tecnologias na educação infantil e integral (pp. 100–126). Arché. https://doi.org/10.51891/rease.978-65-6054-111-5-4

11. Santos, B. L., & Arruda, E. P. (2019). Dimensões da Inteligência Artificial no contexto da educação contemporânea. Educação Unisinos, 23(4), 725–741. http://educa.fcc.org.br/scielo.php?pid=S2177-62102019000400725&script=sci_arttext

12. Santos, C. L. A., & et al. (2023). Práticas de inclusão de alunos autistas na Educação Infantil: Do lúdico ao uso de softwares. Revista Educar Mais, 7, 344–366. https://doi.org/10.15536/reducarmais.7.2023.3115

13. Schlemmer, E., Chagas, W. S., & Schuster, B. E. (2023). Games e gamificação na modalidade EAD: Da prática pedagógica na formação inicial em Pedagogia à prática pedagógica no Ensino Fundamental. In Anais do IV Seminário Web Currículo e XII Encontro de Pesquisadores em Currículo. PUC-SP. https://www.researchgate.net/publication/360453414

14. Silva, I. V. V., & et al. (2019). Desenvolvimento de jogos didáticos auxiliares em práticas transdisciplinares e da alfabetização científica no ensino das Ciências da Natureza. Revista Insignare Scientia-RIS, 2(4), 349–363. https://periodicos.uffs.edu.br/index.php/RIS/article/view/10959

15. Silva, M. L. (2019). A gamificação como ferramenta no processo de ensino e aprendizagem contemporâneo em aulas de Biologia no Ensino Médio [Master's dissertation, Universidade Federal de Alagoas]. Repositório Institucional da UFAL. https://www.repositorio.ufal.br/handle/riufal/6178

16. Timóteo Cardoso, A., Carvalho Bernardes, G., Machado Goulart, S., & Viana Andrade, L. (2020). Casadinho da química: Uma experiência com o uso da gamificação no ensino de química orgânica. Revista Prática Docente, 5(3), 1701–1716. https://doi.org/10.23926/RPD.2526-2149.2020.v5.n3.p1701-1716.id911

17. Vasconcellos, J. O. G. (2023). Gamificação no ensino de Biologia: O que pensam os professores? [Undergraduate thesis, Universidade Federal do Ceará]. Repositório Institucional da UFC. https://repositorio.ufc.br/handle/riufc/75169