

Challenges and Strategies in Integrating Game Design in Education: A Systematic Literature Review

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Abstract—This research full paper describes how technological advancements have made digital games an everyday element, especially among young people, contributing to pedagogical innovations and improvements in learning. However, there are challenges such as the complexity of making these artifacts, correcting game design documents and motivating students. This study aims to investigate these difficulties in order to better understand the gaps in the integration of Game Design in education. By exploring these obstacles, it seeks to identify opportunities to improve pedagogical practices, increasing student motivation and engagement, with the aim of promoting more meaningful learning. The literature review indicates that, even in the face of challenges in applying Game Design in education, there are productive strategies for overcoming them. These not only increase student motivation and engagement, but also foster deep and meaningful learning. Therefore, the findings establish a robust basis for directing future strategies for incorporating Game Design into the educational context.

Index Terms—Games, Gamification, Classroom, Design based learning, Systematic review.

I. INTRODUCTION

Since the 1970s, electronic games have gradually become more widespread. Starting with basic titles such as Pong and progressing through the 1980s with the expansion of arcades, until reaching the 1990s with the introduction of gaming systems from the main corporations that lead the sector today: Sony, Microsoft and Nintendo. Over the years, electronic games have developed a range of functionalities and can now be applied in a multitude of contexts.

Games promote agile and engaging interactions, since they are designed to meet the specific needs of their various target audiences. Furthermore, they make it easier to maintain a continuous connection between players, thanks to their simplified and intuitive accessibility [1].

Considering these characteristics, studies claim that games have stood out as effective tools in the educational context, exploiting their accessibility and intuitiveness to engage students. Game-Based Learning (GBL) takes advantage of these strategies to maintain a continuous connection between students through playful activities [2].

In this way, the introduction of gaming elements in educational environments intensifies student engagement, enriches learning experiences, improves knowledge retention and expands the possibilities for interaction and active learning, making the learning process more attractive [3] [4].

With this in mind, recent studies [5] [6] [7] [8] [9] are dedicated to creating projects that involve teachers and students in making their own games. The adoption of this pedagogical technique in the school environment highlights the link between the educational institution and new technologies, as long as it is adjusted to meet the defined learning objectives. This approach has shown benefits in the development of computational thinking skills, as well as contributing to the understanding of the subjects covered by the games.

This skill, when integrated into the development of electronic games, not only strengthens the pedagogical approaches already mentioned, but also broadens the understanding and implementation of these computational fundamentals in the various areas of knowledge covered by educational games. This makes it easier to identify and solve problems in a collaborative and structured way, allowing those involved to carry out tasks more productively [10].

Given the current scenario, the need for a systematic review of the literature on educational Game Design is timely. Such a review would not only facilitate the application of these methodologies by teachers, providing a consolidated understanding of the most productive practices and the challenges faced, but would also highlight unexplored research opportunities in this field. It is important to highlight the innovative nature of this study, which not only highlights a significant gap, but also represents an opportunity for the academic community to promote advances in relation to educational Game Design.

To manage the SLR, we used the *Parsifal* system, an online tool developed to support researchers in conducting systematic literature reviews [11]. *Parsifal* was chosen because of its specific features which make it easier to manage the review process in an organized way. This tool allows for the definition of a detailed protocol, including inclusion and

exclusion criteria, the formulation of search strategies and data management, which ensures a quality analysis of the selected studies. However, a limitation of Parsifal is the lack of support for advanced statistical analysis. But as our project did not require the use of advanced statistical tools, the system fully met our needs.

This article is structured as follows: Section II describes the protocol used in the systematic review; Section III details the data collected and its condensation to answer the research questions; and in Section IV, we discuss the conclusions and potential directions for future research.

II. SYSTEMATIC REVIEW PROTOCOL

A systematic review is a research method based on the literature on a specific subject. This type of analysis compiles evidence found in data sources on a particular topic, using rigorous and structured procedures for searching, critically evaluating and aggregating the selected information. Given their nature, systematic reviews are classified as secondary studies, whose main sources are primary studies. Primary studies are characterized by scientific articles that present data and results obtained directly from original research [12]. Thus, by compiling and critically analyzing these sources, the systematic review provides a comprehensive and up-to-date view of the topic under investigation, offering a robust synthesis that can influence future research and practice in the area.

For clarity, this methodology involves the stages of planning, conducting and reporting, which guarantee a complete and reliable analysis of the data [13]. By adopting this structured approach, systematic reviews maximize transparency and replicability, which are essential for the evolution of scientific knowledge.

In summary, the planning phase aims to identify the need for the research and to define the protocol that will be adopted throughout the study. In turn, the conduct of the study involves the careful selection of studies in the selected databases, according to the initial and quality criteria previously defined, with the ultimate goal of writing the report, a time to consolidate all the work done, identify gaps in the scientific literature and suggest the next steps for future research.

A. Planning

In a preliminary analysis, we identified the lack of categorical studies in the area of Game Design that could support relevant evaluations in the area of creating and correcting the Game Design Document (GDD), an artifact prepared by the game designer that details the actions and characteristics of the game, including information such as premises and concepts, descriptions of characters and scenarios, level design and sound effects. In this way, we set out to deepen our understanding of the implementation of Game Design in the educational context, analyzing both the challenges faced by educators and the approaches most commonly used to overcome them.

In this scenario, we established the protocol for carrying out the systematic review with the aim of reducing the risk of interference on the part of the researcher, since this makes the process mechanical and impartial [13].

The objective of this study, as well as the research questions, were defined as illustrated in Figure 1. With these definitions established, we proceeded to develop the search *strings*.

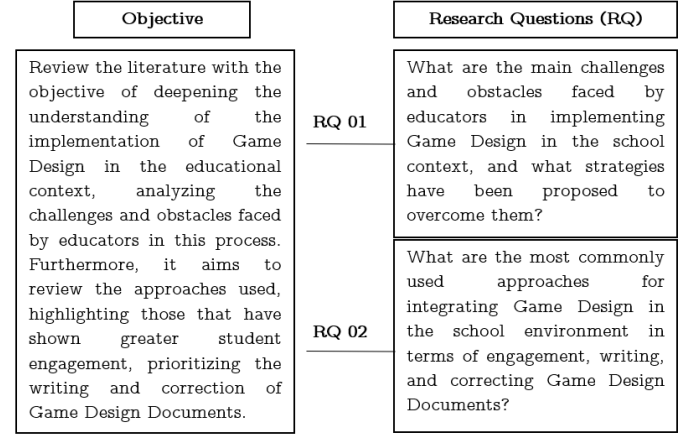


Fig. 1. Objective and Research Questions (RQ)

In the investigation, the method adopted must guarantee the inclusion of all relevant articles or those that could influence the outcome of the analysis. The data collection process begins by establishing terms or keywords, followed by the elaboration of search strategies, selection of databases and identification of other sources of information relevant to the research [14]. In this way, the research questions are used to develop keywords, which in turn are combined to create a single search string, which acts as the basis for identifying publications in the chosen databases.

Initially, we used *String 01* for the search, generated automatically by the *Parsifal* tool. We noticed, however, that the rigid keyword structure significantly limited the breadth of the results obtained. We therefore expanded our search strategy by implementing *Strings 02 and 03*, as detailed in Table I. Each *string* was used because of its ability to identify distinct and complementary records, thus increasing the scope and relevance of the studies collected.

TABLE I
SEARCH STRINGS USED

Evolution of the strings used	
<i>String 01</i>	("Education" OR "Teaching") AND ("GDD" OR "Game Design Document") AND ("Game Design" OR "Design de Jogos")
<i>String 02</i>	(Game Design AND Educação)
<i>String 03</i>	(Game Design) OR (Game Design Document) AND (Education)

To search for primary studies, we turned to three repositories: (I) SBC-OpenLib (SOL) <https://sol.sbc.org.br/>. This is a

digital library maintained by the Brazilian Computer Society (SBC) [15], which offers access to the main events in the field of Education and Games in Brazil, such as: SBGames (Brazilian Symposium on Games and Digital Entertainment), SBIE (Brazilian Symposium on Informatics in Education) and WEI (Workshop on Education in Informatics). (II) IEEE Xplore <https://ieeexplore.ieee.org/> which offers access to a wide range of scientific articles and research on education and games in the English language and (III) Scopus <https://www.scopus.com/> which contains extensive coverage of global scientific literature, also in the English language.

B. Conducting

The conduct phase applies the protocol impartially to generate reliable answers. It begins with a search of the selected databases, using their own search engines. This allows the inclusion and exclusion criteria presented in Tables II and III, respectively, to be applied, ensuring that only relevant studies are considered.

TABLE II
INCLUSION CRITERIA

Criteria	Description
IC1	Articles in English and Portuguese
IC2	Display the search strings in the title
IC3	Articles published between 2016 and 2023
IC4	Papers published in conferences and journals

TABLE III
EXCLUSION CRITERIA

Criteria	Description
EC1	Duplicate articles
EC2	Documents not accessible
EC3	Abstract outside the scope of the research

The inclusion and exclusion criteria must be based on the research questions. They need to be validated to ensure their reliable interpretation and their ability to classify studies accurately [13].

Applying the search strings and inclusion criteria (IC1, IC2, IC3 and IC4), we identified 89 records. We then applied the exclusion criteria (EC1 and EC2), resulting in the rejection of 16 articles. This left 73 articles to read the abstracts. At this point, we applied criterion EC3 to check that the article was in line with the research. At the end of this stage, 36 articles met the necessary requirements. These articles were read in full and assessed according to the quality criteria in Table IV for the final assessment.

An initial difficulty faced in this review is the lack of an agreed definition of study "quality", attributable to the diversity of approaches and criteria adopted by researchers, which vary between different academic fields. In view of this,

TABLE IV
QUALITY CRITERIA

Quality Assessment	
Criterion	Description
QA1	Is the article about Game Design?
QA2	Does the article describe methodologies used in the development of Game Design?
QA3	Does the article describe problems with Game Design writing?
QA4	The article reports on student/teacher motivation in the use of Game Design?
QA5	Does the article report problems in correcting Game Design?
QA6	Does the article present relevant considerations for research?
QA7	Does the article describe practices in education?

we used the criteria described above in order to assess the accuracy, research and reliability of the research methods used.

Each item listed in Table IV was associated with three possible answers: "YES", "PARTIALLY" and "NO". These answers correspond to scores of 1.0, 0.5 and 0.0 respectively, where "YES" indicates full compliance, "PARTIALLY" indicates partial compliance, and "NO" indicates non-compliance, according to the quality criteria.

Only documents with a score of 3.5 or more were accepted for data extraction and analysis, with the aim of answering the research questions posed.

Figure 2 shows a graph with the summarized results of this analysis. This graph illustrates the distribution of the total scores achieved by the articles reviewed for each quality criterion.

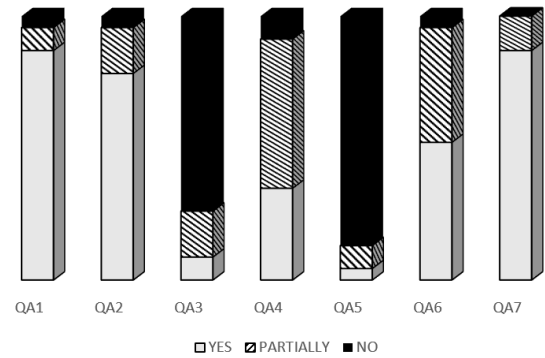


Fig. 2. Quality Analysis

The graphical representation makes it easier to understand the general trends and discrepancies in the quality of the studies, allowing for a clear and concise view of the current panorama in the literature on the subject being researched.

A strong trend of conformity was observed in the topics directly linked to the use of game design and its methodologies in the educational environment, indicating that most of the studies analyzed address these aspects on a recurring basis, standing out as a well-developed area in most studies.

On the other hand, there are significant gaps, especially in aspects related to writing and the challenges associated

with correcting these projects. These areas often showed low compliance, indicating a greater need for attention and further development in the literature.

The graph illustrated in Figure 3 provides a visual analysis of the distribution of articles by database. It provides a clear representation of how the articles are distributed in the different databases, highlighting the predominance of certain databases in relation to the number of qualified publications.

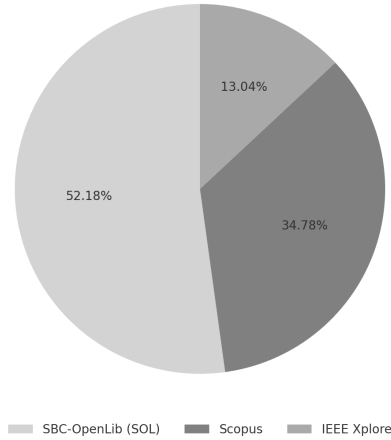


Fig. 3. Distribution of Articles by Database

When comparing the databases where the scientific articles were published, we observed interesting differences in terms of the number of articles and their quality ratings. The SBC-OpenLib (SOL) database has the largest number of classified articles, with an average quality rating of 4.54 and a standard deviation of 0.69. These values indicate variability in the evaluations, but also high quality consistency.

On the other hand, the Scopus database shows a slightly lower quality average of 4.19. The variability in the evaluations of these articles is lower, as shown by the standard deviation of 0.53, suggesting that the articles have fairly uniform qualities.

IEEE Xplore, on the other hand, has an average quality rating of 4.00. With a standard deviation of 0.50, this shows less variability in the evaluations, indicating that the quality of the articles is more consistent. Even so, this average is in a high quality range, comparable to those observed in the other databases.

These differences may be due to various factors, such as article selection criteria, the thematic focus of the databases, or the editorial policies of each one. This analysis highlights the importance of considering the source when assessing the quality of scientific articles, especially when used for research or academic review.

By applying the quality criteria, the selected studies demonstrated an alignment with the best practices in educational game design, fitting the objectives of this research. The selection included 23 articles referenced in Table V, which met or exceeded the required quality threshold. These articles were chosen for data extraction and to answer the research questions proposed in the study.

TABLE V
ELIGIBLE ARTICLES

Eligible Articles	
Ref.	Paper
[16]	Design and Evaluation of a Board Game in Food and Nutrition Education
[5]	An Evaluation of Game Design Documents Written by Students
[17]	Balancing Pedagogy, Emotions and Game Design in Serious Game Development
[18]	Constructive Alignment in Game Design for Learning Activities in Higher Education
[19]	Timing Game - Serious Game for the Study of Time Perception with Participatory Design: Prototype and Game Design
[20]	A Game Design Proposal for Structural Educational Gamification through Story Creation
[21]	Extracting Design Guidelines for Augmented Reality Serious Games for Children
[22]	Embracing Applied Behavior Analysis on a Serious Game Design Document Model
[23]	Machine Learning Role Playing Game: Instructional Design of AI Education for Age-appropriate in K-12 and Beyond
[6]	Application of Game Design in the Refactoring of a Game with a Focus on Computational Thinking
[24]	Game Design, Gender and Personalities in Programming Education
[25]	Proposal for a Game Design Document Model for Creating Educational Games to Teach Computational Thinking
[26]	Methodologies Used in the Development of Educational Electronic Games: A Literature Review
[27]	Paper Prototyping in the Development of Digital Games in the Classroom
[28]	Serious Games and Soft Skills in Higher Education: A Case Study of the Design of Compete!
[29]	Creativity Training Model for Game Design
[30]	Mixed Assessment of Virtual Serious Games Applied in Architectural and Urban Design Education
[31]	Use of Game Design for the Development of a Gamified Assessment in Higher Education
[32]	Identifying Characters in Student-Created Game Designs
[33]	An Experience Report on the Application of Gamification and Game Design with Teachers
[34]	Designing Engaging Games for Education: A Systematic Literature Review on Game Motivators and Design Principles
[35]	A Data Driven Review of Board Game Design and Interactions of Their Mechanics
[36]	Design Recommendations to Promote Engagement in Educational Digital Games: A Systematic Mapping of the Literature

The results of the quality assessment of the studies indicate an overall average of 4.35 out of a possible maximum of 7.00 points. This average reveals moderate variability in the quality of the articles analyzed, with a standard deviation of approximately 0.63.

III. REPORTING AND ANALYSIS OF RESULTS

After collecting the data, we proceeded to check the correspondence between the results observed and those expected as outlined by the research questions.

In this section we present a detailed analysis of the data collected during our investigation. The results are discussed in the light of the study's objectives, exploring the implications and trends observed.

A. RQ 01 - What are the main challenges and obstacles faced by educators when implementing Game Design in the school context, and what strategies have been proposed to overcome them?

To promote a clearer and more detailed understanding, we have divided the first research question into two essential sub-themes. The first focuses on the challenges and obstacles that educators face when implementing Game Design in educational settings, which we will refer to here as Limiting Factors. We explore the main difficulties encountered in this process. The second sub-theme addresses the strategies most commonly adopted to overcome these challenges, which we will call Strategies.

a) *Limiting Factors:* The analyses carried out on the documents indicate a number of factors that can hinder the use of Game Design in the educational environment.

- **Resistance to change:** Resistance to change is a recurring obstacle presented in the literature. Many educators prefer traditional teaching methods and are reluctant to adopt new approaches. Studies [6]- [36]- [20]- [30]- [19]- [5] underline that this resistance is amplified by the fear of disruptions to established traditional practices. The complexity of implementing new educational tools, as mentioned in the studies [27]- [18]- [19]- [28], can overwhelm educators.

Likewise, lack of familiarity with technology is also a critical factor. Studies highlight that many educators are not comfortable with digital tools, which hinders the adoption of game design.

Limited understanding of the benefits of game design also contributes to resistance. The [33]- [23] studies indicate that many educators do not clearly understand how these methodologies can improve the learning experience. Anxiety and fear of new technologies exacerbate this reluctance.

- **Lack of consensus on methodologies:** Diversity of approaches and varying exposure to game design principles contribute to this lack of uniformity. Educators face challenges in assessment, including disagreements over methods and criteria for game design projects, which makes it difficult to implement a standard methodology. [17]- [31].

Studies [26]- [21] point out that educators do not have a consensus on game design methodologies for educational games and lack a systematic approach. This lack of agreement can be attributed to the lack of structured frameworks to guide the development of educational games.

This lack of clear and uniform guidelines contributes to uncertainty during the implementation process, making it difficult for teachers to determine the best way to apply these innovative techniques in their pedagogical practices.

- **Lack of Training:** Educators can face difficulties when trying to implement game design in their teaching practices due to a lack of adequate training and specific

skills. This lack is evident in the studies [20]- [33]- [25], which discuss the widespread gap in Game Design and Gamification training.

Specific studies show how the lack of training impacts different aspects of game design. The study [5] highlights that the lack of training in audio and soundtrack design affects the quality of games. Similarly, [28] points out that a lack of training can oversimplify complex concepts, compromising the educational effectiveness of games.

Other studies such as [32] mention that the lack of training leads to tedious manual processes, while [24] notes that while programming learning environments meet the needs of students, on the other hand, they lack specific training. This gap is even more noticeable in specialized areas, such as designing serious AR games for children [21] and nutrition education in schools [16].

- **Time and Resource Constraints:** Integrating game design into the school curriculum can require an excessive amount of planning and implementation time, which can be difficult for educators to accommodate within existing schedules [22]- [21] and achieve the expected competencies [34]- [28]. In addition, limited access to technology and the necessary resources is another obstacle that can prevent the effective implementation of game design in educational environments [33]- [35].
- **Evaluation Difficulties:** Evaluating student performance and learning outcomes in game design activities presents constant challenges, as pointed out by the [31] study. These challenges include the subjective nature and inherent complexity of these activities, which make it difficult to measure educational impact. Some studies, such as [20]- [26]- [35], highlight the difficulties of evaluation related to the cognitive implications of the stimuli and the lack of direct references to game design, as well as educators' uncertainty about how to measure learning outcomes.

In addition, the [32] study mentions that processes such as manually reading game documents can be extremely time-consuming for teachers, which adds another layer of difficulty to the evaluation process.

b) *Strategies:* To overcome the challenges mentioned above, some studies suggest strategies that can be implemented to facilitate the use of Game Design in the educational environment.

- **Gamification:** Gamification, which incorporates elements such as leaderboards, badges and rewards, can make the learning process more attractive and motivate educators to use game design in their teaching methods, as indicated by the study [31]- [33]- [30]- [16]. In this context, gamification is used in educational games to enhance student engagement, leading to improvements in learning outcomes and promoting more positive attitudes, according to the studies [32]- [36]- [25]. Teachers and students benefit from this technique, which helps to improve teaching and learning, as shown by the study

[33].

- **Training:** When addressing the importance of continuous training for the use of Game Design in education, several studies stand out for their contributions. The study [29] emphasizes the need for continuous training to foster creativity and innovation in the game design process, which is key to keeping educators and students up to date. In addition, it highlights that the use of game design documents as reference materials can enhance the generation and development of creative game ideas. The study then shows how this training not only improves students' game design skills, but also contributes to the creation of high-quality educational games, which are important for improving the learning experience. The study [36] reinforces that continuous training improves engagement and learning in educational digital games, highlighting the effectiveness of gamification techniques. Finally, the study [33] focuses on understanding game concepts and mechanics, which are essential for applying these techniques in the educational environment. Together, these studies form an overview of the relevance of continuous training, from improving technical skills to innovation and quality in the development of educational games.
- **Collaborative Learning:** In the context of collaborative learning in Game Design, the study [31] demonstrates how game design not only promotes collaboration between students through interactive and engaging activities, but also how the incorporation of elements such as chats and online assistance can intensify this interaction and collaboration. This is followed by the study [5], which details how game design facilitates collaborative and interactive learning experiences, allowing students the opportunity to create games by defining their own narratives, gameplay, challenges and visual elements, which encourages active and collective participation in the educational process. The [32] study complements this view by showing that collaborative learning improves writing skills in educational game design contexts. Finally, the study [20] reinforces these points by elucidating how game design can significantly enhance collaboration between students within the context of educational gamification, providing a solid foundation for the development of essential skills such as teamwork and problem solving.
- **Game Design Models:** With regard to the use of models in Game Design, the study [5] details how game design models not only make it easier to visualize game projects, but also guide all team members towards a common goal, ensuring project cohesion and direction. The study [32] highlights how these models speed up the game creation process by helping to identify characters, rules and scenarios, simplifying the complexity involved in game design and ensuring a clear structure for development. The [29] study highlights the effectiveness of the LK2RBPD model in promoting creativity in game design and the importance of usability testing in iden-

tifying and solving design problems. Finally, the study [20] illustrates the importance of game design models in simplifying gamification processes, especially in the educational context, where these models provide clear guidelines for developing game elements that are pedagogically functional. These studies collectively highlight the value of game design models as fundamental tools for structuring and guiding the creation and implementation of educational games.

B. RQ 02 - What are the most commonly used approaches for integrating Game Design in the school environment in terms of engagement, writing and correcting Game Design Document?

To address the second research question in a more organized way, we will adopt the strategy used previously, segmenting it into two main themes: Engagement and Writing/Correcting Game Design Documents. This division will allow us to explore each area in depth, ensuring a more detailed analysis of the game design process.

a) *Engagement:* This topic analyzes selected studies on engagement in the context of educational game design, highlighting practices that can improve the learning process.

- **Gamification:** When discussing gamification as an engagement strategy in Game Design, the study [20] highlights that this methodology can increase student engagement by offering interactive learning experiences. This study highlights that engagement is promoted by incorporating playful elements such as challenges, villains and drastic changes, which keep students involved. The [31] study exemplifies the use of the Unity game development engine to create interactive digital environments. Finally, the study [32] illustrates how natural language processing can be used to identify characters in game designs, pointing out that tools that take advantage of this technology not only improve engagement, but also facilitate learning by making content more relevant and adapted to students' needs.
- **Others:** In the exploration of engagement strategies in Game Design, the study highlights student-centered learning and collaborative learning. These approaches promote active student participation. In parallel, the study [18] emphasizes the importance of the iterative design process and project-based learning. These methodologies allow students to continually refine their creations, applying theoretical concepts to practical situations that symbolize real challenges. In addition, the [19] study highlights the role of interactive learning platforms, which use technology to create more dynamic and adaptive educational environments. The study [20] complements these ideas by discussing the use of advanced technologies in teaching, indicating that modern tools can improve engagement by making learning more accessible. Together, these studies demonstrate a variety of strategies that can be implemented to increase student engagement through game design, showing that the combination of interactive, participatory and technological methods is key.

b) Writing and Correction: This topic deals with writing and correcting game design in the school environment. As mentioned earlier in Figure 2, studies into these topics indicate that there are relatively few records dedicated to this area.

- **Workshops:** In the context of writing and correcting Game Design in educational environments, the approach is typically centered on workshops, as illustrated by the study [33], where educators introduce the concepts of game design and ask students to develop documents focused on specific themes. This method is corroborated by the studies [5]- [20]- [19], which highlight the importance of continuous revision of these documents, a practice also emphasized in the studies [22]- [25]. After this development and revision phase, the documents are usually presented in seminars or presentations, as described again by the [33] study.
- **Rubrics:** Regarding the correctness of game design artifacts, the study [5] stands out by detailing ten evaluation questions, equivalent to a correctness rubric, used to evaluate Game Design Documents (GDDs). Complementing this approach, other studies such as [31] report on the use of gamified evaluation, while [36]- [25] discuss the application of collaborative design and feedback during the correction process, respectively.

Although these collective methodologies help to improve writing and correctness in game design and promote a more interactive learning environment, they still lack technological innovation in their treatment of the subject.

IV. CONCLUSION AND FUTURE WORK

This paper presents the conclusions of a systematic review whose aim was to deepen understanding of the implementation of Game Design in the educational context. We analyze the challenges and obstacles faced by educators in this process, as well as the game design approaches that most engage students, with special attention to the writing and correction of Game Design Documents.

The development of this study proved to be particularly challenging due to the lack of standardization in the methodologies employed in game design. It was observed that each process adopted reflects a specific technique, generally adapted to the intended target audience. This diverse panorama required a more careful analysis in order to identify good practices that could be replicated in the educational environment.

The analysis grouped together a series of studies focused on the use of Game Design in the educational context, ranging from the evaluation of game design documents written by students to the application of gamification by teachers, and highlighting the creation of models to enhance creativity and teaching. Each study contributed varied perspectives on the effectiveness and challenges of integrating game design into learning environments.

The data showed that high school students face difficulties in understanding fundamental aspects, such as the importance of audio in games, showing variations in their performance in criteria for evaluating game design documents. At the same

time, it was observed that gamification can serve as a powerful motivator for higher education students, promoting engagement, interaction and collaboration. This engagement trend is also manifested in game design initiatives that incorporate the creation of stories for educational purposes, which have been well received and shown to be effective.

Similarly, teachers who apply gamification and game design report improvements in teaching and learning, demonstrating the viability of creating educational solutions through these techniques. In addition, the application of a game design document model for teaching computational thinking in educational games suggests that such approaches offer more immersive learning experiences.

The result of this systematic review should bring new knowledge, going beyond the mere compilation of information that already exists in the literature. This requirement becomes particularly relevant in view of the gap identified in this study, which refers to the writing and correction of game design documents, as already mentioned in the graph in Figure 2. This "scientific silence" reveals the lack of in-depth, structured research focused on robust methodologies and evaluation criteria for drafting and revising these documents.

This need is amplified by the fact that there is also a clear lack of consensus on specific methodologies for the development of educational electronic games.

In response to the findings of this research, we propose three complementary works that will serve as extensions of this study.

Development of a Framework of Methodologies for Educational Game Design: This study proposes the creation of a comprehensive framework that systematizes specific methodologies for the development of educational electronic games. The aim would be to harmonize the different approaches found, creating a consensus that facilitates the adoption of validated and replicable practices, as well as allowing consistent evaluations of the usability of games in the educational context.

Application of Artificial Intelligence to the Writing and Proofreading of Game Design Documents: Investigating how generative AI technologies can be implemented to assist in the writing and proofreading of game design documents. This project would aim to improve the use of natural language processing algorithms not only to generate and correct game design documents automatically, but also to ensure that they meet specific quality criteria. The central idea is to allow the user's creativity to flow freely, with the technology subtly acting to adjust and refine the information provided.

Longitudinal Study on the Impact of Educational Games Developed with Standardized Methodologies: Carry out a longitudinal study that evaluates the impact of educational games developed using the methodologies proposed in the aforementioned framework. This study would follow the implementation of these games in different educational contexts to measure their effectiveness in terms of engagement and effective learning, providing data on the applicability and benefits of standardized methodologies.

In this way, we believe that the objectives of the study were achieved, offering important insights into the implementation and challenges of game design in the educational context. The analyses conducted identified critical areas that require further development, as well as highlighting methods that can be employed to improve the integration of playful elements in learning. In concluding this study, we have laid a solid foundation for future educational research and practice aimed at using game design in a more effective and innovative way.

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REFERENCES

- [1] A. K. O. Sato, "Game design and prototyping: Concepts and applications throughout the design process," *Proceedings of SBGames 2010*, pp. 74–84, 2010, in Portuguese.
- [2] M. S. Sidhu, *Technology-Assisted Problem Solving for Engineering Education: Interactive Multimedia Applications: Interactive Multimedia Applications*. IGI Global, 2009.
- [3] T. W. Malone and M. R. Lepper, "Making learning fun: A taxonomy of intrinsic motivations for learning," in *Aptitude, learning, and instruction*. Routledge, 2021, pp. 223–254.
- [4] K. Werbach, D. Hunter, and W. Dixon, *For the win: How game thinking can revolutionize your business*. Wharton digital press Philadelphia, 2012, vol. 1.
- [5] B. Neto and E. Aranha, "An evaluation of game design documents written by students," in *Proceedings of the XXIX Workshop on Informatics in School*. SBC, 2023, pp. 648–658, in Portuguese.
- [6] M. Mattos, L. P. de Araújo Kohler, F. D. Zucco, A. Wuo, B. F. Santos, L. Fronza, H. U. C. da Silveira, G. C. Giovanella, L. R. Largura, J. M. de Melo *et al.*, "Application of game design in the refactoring of a game with a focus on computational thinking," in *Extended Abstracts of the XVIII Brazilian Symposium on Human Factors in Computer Systems*. SBC, 2019, pp. 15–16, in Portuguese.
- [7] R. Ribeiro and S. Silva, "Application of socio-interactive game design elements in open code simulations of the phet project," in *Proceedings of the Workshop on Informatics in School*, vol. 23, no. 1, 2017, pp. 618–627, in Portuguese.
- [8] V. Cornejo-Aparicio, W. Ortiz-Mamani, D. Maraza-Itomacedo, and S. Flores-Silva, "Game design document (gdd) for educational use," *Iberian Journal of Information Systems and Technologies*, no. E46, pp. 125–136, 2021, in Spanish.
- [9] L. F. O. Galvão, L. S. García, and T. A. Felipe, "Participatory game design methodology with deaf children," in *Extended Abstracts of the XVII Brazilian Symposium on Collaborative Systems*. SBC, 2022, pp. 17–22, in Portuguese.
- [10] C. Brackmann, "Development of computational thinking through unplugged activities in basic education," Master's thesis, Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil, 2017, in Portuguese. [Online]. Available: <http://hdl.handle.net/10183/172208>
- [11] Parsifal, "About parsifal," 2023, accessed on April 24, 2023. [Online]. Available: <https://parsif.al/about/>
- [12] T. F. Galvão and M. G. Pereira, "Systematic literature reviews: Steps for their preparation," *Epidemiology and Health Services*, vol. 23, pp. 183–184, 2014.
- [13] B. Kitchenham, "Procedures for performing systematic reviews," *Keele, UK, Keele University*, vol. 33, no. 2004, pp. 1–26, 2004.
- [14] R. F. Sampaio and M. C. Mancini, "Systematic review studies: A guide for careful synthesis of scientific evidence," *Brazilian Journal of Physical Therapy*, vol. 11, pp. 83–89, 2007, in Portuguese.
- [15] "SOL - Biblioteca Digital da Sociedade Brasileira de Computação," <https://sol.sbc.org.br/index.php/indice/about>, accessed on April 30, 2024, in Portuguese.
- [16] F.-K. Chiang, S. Wang, and Z. Tang, "Design and evaluation of a board game in food and nutrition education," *Education Sciences*, vol. 12, no. 3, p. 162, 2022.
- [17] G. C. Natucci and M. A. Borges, "Balancing pedagogy, emotions and game design in serious game development," in *Anais Estendidos do XX Simpósio Brasileiro de Jogos e Entretenimento Digital*. SBC, 2021, pp. 1013–1016.
- [18] M. Romero and G. Kalmpourtzis, "Constructive alignment in game design for learning activities in higher education. information, 11 (3), 126," 2020.
- [19] A. P. A. Santos, A. K. Yasui, A. M. Cravo, A. L. Brandao, and J. P. Gois, "Timing game - serious game for the study of time perception with participatory design: Prototype and game design," in *Extended Abstracts of the XX Brazilian Symposium on Digital Games and Entertainment*. SBC, 2021, pp. 922–931, in Portuguese.
- [20] J. Bernardo, F. Pires, and M. Pessoa, "A game design proposal for structural educational gamification through story creation," in *Extended Abstracts of the XX Brazilian Symposium on Digital Games and Entertainment*. SBC, 2021, pp. 638–644, in Portuguese.
- [21] J. Li, E. Van Der Spek, J. Hu, and L. Feijs, "Extracting design guidelines for augmented reality serious games for children," *IEEE Access*, vol. 10, pp. 66 660–66 671, 2022.
- [22] J. C. Epifânio and L. F. Da Silva, "Embracing applied behavior analysis on a serious game design document model," *IEEE Access*, 2023.
- [23] Y. Kajiwaru, A. Matsuoka, and F. Shinbo, "Machine learning role playing game: Instructional design of ai education for age-appropriate in k-12 and beyond," *Computers and Education: Artificial Intelligence*, vol. 5, p. 100162, 2023.
- [24] A. Theodoropoulos and G. Lepouras, "Game design, gender and personalities in programming education," *Frontiers in Computer Science*, vol. 4, p. 824995, 2022.
- [25] A. K. B. S. da Cruz, C. d. S. S. Neto, M. M. Teixeira, P. T. M. B. da Cruz, K. B. Barbosa, and C. P. L. Brito, "Proposal for a game design document model for creating educational games to teach computational thinking," in *Anais do XXXIV Simpósio Brasileiro de Informática na Educação*. SBC, 2023, pp. 1837–1849.
- [26] P. Oliveira, L. Fontoura, and R. D. Medina, "Methodologies used in the development of educational electronic games: A literature review," *Proceedings of the XXXI Brazilian Symposium on Informatics in Education*, pp. 542–551, 2020, in Portuguese.
- [27] M. R. A. Silva, K. T. Fernandes, and G. L. S. Fernandes, "Paper prototyping in the development of digital games in the classroom," in *Extended Abstracts of the XXI Brazilian Symposium on Digital Games and Entertainment*. SBC, 2022, pp. 572–581, in Portuguese.
- [28] N. McGowan, A. López-Serrano, and D. Burgos, "Serious games and soft skills in higher education: A case study of the design of compete!" *Electronics*, vol. 12, no. 6, p. 1432, 2023.
- [29] R. M. Tap, N. A. M. Zin, H. M. Sarim, and N. M. Diah, "Creativity training model for game design," *International Journal of Advanced Computer Science and Applications*, vol. 12, no. 5, 2021.
- [30] D. Fonseca, J. Cavalcanti, E. Peña, V. Valls, M. Sanchez-Sepúlveda, F. Moreira, I. Navarro, and E. Redondo, "Mixed assessment of virtual serious games applied in architectural and urban design education," *Sensors*, vol. 21, no. 9, p. 3102, 2021.
- [31] D. de Oliveira and M. de Melo Dórea, "Use of game design for the development of a gamified assessment in higher education," in *Extended Abstracts of the XXI Brazilian Symposium on Digital Games and Entertainment*. SBC, 2022, pp. 856–865, in Portuguese.
- [32] B. Neto, K. Araújo, E. Aranha, K. Fernandes, M. Lucena, and G. Fernandes, "Identifying characters in student-created game designs," in *Proceedings of the XXXI Workshop on Education in Computing*. SBC, 2023, pp. 557–567, in Portuguese.
- [33] T. R. Silva, "An experience report on the application of gamification and game design with teachers," in *Proceedings of the Workshop on Informatics in School*, vol. 23, no. 1, 2017, pp. 51–60, in Portuguese.
- [34] T. H. Laine and R. S. Lindberg, "Designing engaging games for education: A systematic literature review on game motivators and design principles," *IEEE Transactions on Learning Technologies*, vol. 13, no. 4, pp. 804–821, 2020.
- [35] D. Samarasinghe, M. Barlow, E. Lakshika, T. Lynar, N. Moustafa, T. Townsend, and B. Turnbull, "A data driven review of board game design and interactions of their mechanics," *IEEE access*, vol. 9, pp. 114 051–114 069, 2021.
- [36] E. D. Bueno, D. M. Beder, and J. L. Otsuka, "Design recommendations to promote engagement in educational digital games: A systematic mapping of the literature," *Proceedings of the XXXIII Brazilian Symposium on Informatics in Education*, pp. 415–426, 2022, in Portuguese.