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# GAMES, GAMIFICATION, AND DIGITAL TECHNOLOGIES IN SCIENCE EDUCATION: STATE OF THE ART (2021–2025)

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**Abstract:** The objective of this study is to analyze the State of the Art (2021–2025) on the use of games in Science Education, using as corpus dissertations available in the repository of Capes and of the Graduate Program in Natural Science Teaching of the Federal University of Mato Grosso. The investigation demonstrated advances in digital games, gamification practices, and virtual environments, in addition to the limited number of studies on online games. The study concludes that it is necessary to expand studies that integrate online games into digital education policies, especially the National Policy for Digital Education.

**Keywords:** Science Education; Gamification; Digital Education.

# JOGOS, GAMIFICAÇÃO E TECNOLOGIAS DIGITAIS NO ENSINO DE CIÊNCIAS: ESTADO DA ARTE (2021–2025)

**Resumo**: O objetivo deste estudo é analisar o Estado da Arte (2021–2025) sobre o uso de jogos no Ensino de Ciências, utilizando como *corpus* dissertações disponíveis no repositório da Capes e do Programa de Pós-Graduação em Ensino de Ciências Naturais da Universidade Federal de Mato Grosso. A investigação evidenciou avanços em jogos digitais, práticas de gamificação e ambientes virtuais, além da baixa presença de pesquisas sobre jogos online. O estudo conclui que é necessário ampliar estudos que integrem jogos online às políticas de educação digital, especialmente à Política Nacional de Educação Digital.

**Palavras-chave:** Ensino de Ciências; Gamificação; Educação Digital.

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# JUEGOS, GAMIFICACIÓN Y TECNOLOGÍAS DIGITALES EN LA ENSEÑANZA DE LAS CIENCIAS: ESTADO DEL ARTE (2021–2025)

**Resumen:** El objetivo de este estudio fue analiza el estado del arte (2021–2025) sobre el uso de juegos en la enseñanza de las ciencias, basándose en el análisis de tesis de Capes y PPGECN/UFMT. La investigación mostró avances en juegos digitales, prácticas de gamificación y entornos virtuales, además de la baja presencia de investigaciones sobre juegos en línea. Se concluye que es necesario ampliar los estudios que integren los juegos en línea en las políticas de educación digital, especialmente la PNED.

**Palabras clave:** Enseñanza de Ciencias; Gamificación; Educación digital.

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## 1 INTRODUCTION

The incorporation of Digital Information and Communication Technologies (DICTs) into Science Education has consolidated itself as a strategic field of investigation for pedagogical innovation and teacher education in Brazil. Between 2021 and 2025, there is a significant growth in research and educational products aimed at the use of digital resources, active methodologies, and ludic approaches, especially in professional graduate programs. Within the scope of the Graduate Program in Natural Science Teaching of the Federal University of Mato Grosso (PPGECN/UFMT), this movement is evident in the production of materials that explore virtual laboratories, mobile applications, artificial intelligence, and digital games, revealing an institutional effort to strengthen digital culture in science education.

In this process, the growing integration of digital technologies into education, combined with the advancement of active learning methodologies, has broadened interest in the use of games as pedagogical resources in Science Education. Although online games are widely used in different school contexts, significant gaps still persist regarding the understanding of how they have been addressed in academic research, which theoretical foundations sustain their use, and which pedagogical impacts have been observed. This scenario demonstrates the need for studies that systematize the existing production and make it possible to understand how games have been incorporated into educational and investigative practices.

In this scenario, it becomes essential to understand how analog, digital, and online games have been incorporated into educational and research practices in Science Education. Conducting a study of the State-of-the-Art type makes it possible to map trends, identify recurrences, highlight gaps, and critically analyze the panorama of recent academic production. As Ferreira (2002) emphasizes, this type of investigation seeks to systematize existing knowledge, offering input for the theoretical and methodological advancement of the field. Furthermore, when considering the contemporary context marked by the consolidation of digital education policies, such as the National Policy for Digital Education (PNED), it becomes necessary to articulate the findings of the survey with the emerging demands of digital culture in schools.

Given this, this article has as its general objective to analyze recent academic production on games, gamification, and digital technologies in Science Education, identifying trends, theoretical approaches, methodologies, and gaps in research conducted between 2021 and 2025. To achieve this

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purpose, the following specific objectives were defined: to map the types of games (analog, digital, and hybrid) used in the dissertations and educational products analyzed; to identify the main thematic axes related to the use of games, gamification, and DICTs in Science Education; to analyze the presence and role of digital and online games, highlighting their low incidence in the corpus; to relate the findings of the survey to theoretical references on games, learning, and digital culture; to highlight gaps and research opportunities, especially on online games and gamified environments; and to understand the integration of DICTs and games with digital education policies, such as the PNED.

By gathering and critically interpreting national and regional production, this study seeks to contribute to strengthening discussions on the role of games and digital technologies in science education, offering input for researchers, teachers, and other professionals interested in expanding the pedagogical use of these resources.

## 2 DEVELOPMENT

In this section, we will present the theoretical foundation, how the methodological choice was made, and the results achieved with this research.

### 2.1 THEORETICAL FRAMEWORK

Understanding the role of games, gamification, and Digital Information and Communication Technologies (DICTs) in Science Education requires a theoretical framework that articulates concepts, pedagogical approaches, and contemporary educational policies. Between 2021 and 2025, the advancement of active learning methodologies, the consolidation of digital culture, and the implementation of national guidelines such as the National Policy for Digital Education (PNED) have broadened interest in ludic and digital resources as instruments of learning mediation. This subsection presents operational definitions and theoretical references that support the analysis of the investigated corpus.

#### 2.1.1 Games and learning in Science Education

Games have been recognized as tools capable of promoting engagement, motivation, problem-solving, and meaningful learning. In the field of Science Education, their use is associated with

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cognitive mediation, the development of investigative competencies, and the construction of scientific concepts through playful experiences.

The documents analyzed highlight that "games, in their various modalities, digital or analog, have been widely recognized as tools capable of promoting engagement, cognitive mediation, and the development of scientific competencies," demonstrating their pedagogical relevance. This perspective dialogues with authors such as Caillois (1958) and Kishimoto (2011), who understand the game as a cultural practice, a structured activity, and an educational resource.

In Science Education, games can assume different functions, acting as conceptual mediators; assisting in the understanding of abstract contents, instruments of investigation, when articulated with active learning methodologies, assessment strategies, especially in gamified proposals and inclusion resources; and also favoring multiple forms of participation.

### 2.1.2 Digital games and online games: operational definitions

To ensure methodological rigor, it is necessary to distinguish digital games from online games. In this case, a digital game is an interactive software-based resource, executed on computers, tablets, or mobile devices, which may or may not require an internet connection. It includes simulations, educational applications, platform games, and gamified environments. An online game, in turn, is a subcategory of digital games that requires an internet connection and operates in shared virtual environments, allowing interaction among users, dynamic updating of content, and collection of learning data. Examples include: browser games, gamified platforms, collaborative virtual environments, and educational games hosted on servers.

Games have been recognized as fundamental cultural and educational practices, as pointed out by Huizinga (1938), who describes them as structuring elements of human culture; and by Caillois (1958), who demonstrates their diversity and organization through categories such as agon, alea, mimicry, and ilinx. In the field of learning, Piaget (1970) highlights that play favors the construction of cognitive structures by allowing the subject to assimilate and reorganize experiences; while Vygotsky (1933) emphasizes its mediating role by creating conditions for the student to act at higher levels of development through social interaction and shared rules.

In the educational context, Kishimoto (2011) reinforces that games, by articulating challenge, pleasure, and active participation, constitute pedagogical resources capable of promoting engagement,

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problem-solving, and conceptual understanding, aspects that are essential for Science Education. Considering the contemporary scenario marked by digital culture, it can be observed that online games expand these possibilities by integrating networked collaboration, synchronous interaction, and collective construction of knowledge. Thus, it is understood that online games configure particularly powerful learning environments, since they articulate classic ludic elements discussed by these authors with digital dynamics that favor participation, authorship, and engagement on an expanded scale, justifying their growing relevance in educational practices mediated by DICTs.

### 2.1.3 Gamification: concepts and applications

Gamification refers to the use of game elements such as points, levels, challenges, rewards, and narratives in non-ludic contexts, with the aim of promoting engagement and motivation. In Science Education, gamification has been used to structure didactic sequences; support assessment processes; encourage active participation; and promote challenge-based learning.

In this regard, Kapp (2012) highlights that gamification is not a game, but a pedagogical strategy that appropriates the logic of games to transform educational practices. In turn, the study by Santos, Santos, and Duarte (2024) demonstrates that gamification, integrated with immediate feedback, acts as a structuring mechanism capable of raising motivation and sustaining student retention in Distance Education. In this process, the expansion of the use of gamified environments reveals a strong approximation between pedagogical practices and digital culture, indicating that these resources have been perceived as powerful tools to stimulate engagement, favor more dynamic learning, and promote the intellectual autonomy of students.

### 2.1.4 Digital Information and Communication Technologies (DICTs)

DICTs encompass tools, platforms, and digital resources used to support teaching and learning processes. They include virtual and remote laboratories, mobile applications, virtual learning environments, artificial intelligence, digital and online games, interactive simulations, and computational modeling.

Online games can be considered an integral part of DICTs, since they configure interactive digital environments capable of promoting active learning, inquiry, and student engagement, which

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justifies their inclusion as an analytical category. In the context of professional programs, DICTs have been mobilized to develop innovative educational products; support inquiry practices; promote remote experimentation; and expand access to digital resources.

### 2.1.5 Digital culture and active learning methodologies

Digital culture implies new forms of interaction, knowledge production, and social participation mediated by technologies. In Science Education, it is articulated with active learning methodologies, such as inquiry-based teaching, flipped classroom, problem-based learning, creative learning, and gamified teaching sequences. These approaches value student agency, problem-solving, and the use of digital resources to support inquiry processes.

### 2.1.6 PNED: guidelines and implications for Science Education

The National Policy for Digital Education (PNED), established in 2023, sets forth guidelines for the digital transformation of Brazilian education. Its main axes include digital inclusion, teacher education for digital culture, technological infrastructure, production and use of digital educational resources, and research, innovation, and technological development. The PNED reinforces the need to integrate DICTs, digital games, and virtual environments into pedagogical practices, encouraging the development of digital materials, the use of interactive platforms, teacher education for the critical use of technologies, and research on digital innovation.

## 2.2 METHODOLOGY

This study is characterized as a State-of-the-Art type of research, an approach that seeks to map, systematize, and critically analyze existing academic production on a given topic, identifying trends, patterns, and gaps (Ferreira, 2002). It is a bibliographic and documentary investigation, based on the analysis of already published materials, as guided by Gil (2008), allowing for the deepening of the accumulated knowledge and its critical interpretation.

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### 2.2.1 Type of study and methodological approach

The research adopts a qualitative approach, focusing on the interpretation of data, the identification of patterns, and the analysis of the contributions and limitations of the literature, following the guidelines of Creswell (2010). The central objective is to analyze recent academic production on games, gamification, and digital technologies in Science Education, considering the period from 2021 to 2025.

### 2.2.2 Research corpus

The corpus was composed of 38 works – distributed into 28 dissertations located in the Catalog of Theses and Dissertations of Capes, belonging to the Multidisciplinary broad area and to the Teaching evaluation area, and 10 dissertations and their respective educational products from PPGECN/UFMT – defended between 2021 and 2025.

### 2.2.3 Search and selection procedures

The search was carried out in two complementary stages, namely:

a) National survey: use of the descriptor "games" in the Capes Catalog; refinement for professional master's dissertations; period 2021–2025; productions available in full; works linked to Science Education, Mathematics, or related areas. Subsequently, works outside the temporal scope, unavailable, without direct relation to games or DICTs, and belonging to non-educational areas (Psychology, Computer Science, Design) were excluded.
b) Regional survey: selection of dissertations defended between 2021 and 2025, including only works institutionally linked to PPGECN/UFMT, accompanied by an educational product, explicitly related to the use of DICTs, and inserted in Science Education.

### 2.2.4 Analysis criteria

The analysis was conducted in three stages, the first being an exploratory reading to identify recurring themes, types of games used, pedagogical approaches, and technologies mobilized; the second being thematic categorization with the organization of the works into analytical categories

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such as analog games, digital games, online games, gamification, DICTs and digital culture, active learning methodologies, and digital educational products; and the third being the interpretive synthesis with the integration of results, identification of gaps, and articulation with theoretical frameworks and with the PNED.

### 2.2.5 Justification for the temporal scope (2021–2025)

The period was chosen for three reasons: post-pandemic transformations, which intensified the use of DICTs and active learning methodologies; the growth of digital educational products in professional programs; and the implementation of the PNED (2023), which reinforces the need to investigate digital technologies, games, and virtual environments in teaching.

### 2.2.6 Methodological limitations

Although the corpus is representative, some limitations must be considered, among them, the predominance of analog games and gamification, reducing the analysis of online games; the institutional asymmetry in production; the lack of access to the full text of two dissertations listed on the platform; the focus on professional programs, which may prioritize educational products to the detriment of in-depth theoretical analyses.

## 2.3 RESULTS AND DISCUSSION

The systematization of the data referring to the selected dissertations and educational products made it possible to map the institutional and programmatic distribution of production, contributing to the analysis of emerging trends and gaps identified in the field under study. Furthermore, this process of methodological organization of the data allowed not only for visualizing the different institutions involved and the programs related to production but also for establishing significant correlations between research lines and institutional contexts. In this way, it became possible to identify recurring patterns, as well as discrepancies that indicate areas of lesser development or underexploration in the analyzed field.

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### 2.3.1 Institutional distribution and asymmetries in production

The distribution of the Capes dissertations can be visualized in Box 1, discriminating the institution and demonstrating thematic concentration in certain Graduate Programs.

**Box 1 –** Dissertations related to Teaching, Games, and Education available in the Catalog of Theses and Dissertations of Capes

| Autor | Título | Ano | Universidade | Cidade |
|---|---|---|---|---|
| CHAVES, A. B. | Educação ambiental e o ensino de ciências: tensões e potencialidades na educação infantil | 2022 | Universidade Estadual do Sudoeste da Bahia | Jequié |
| SILVA, J. C. E. | Alfabetização matemática nos cadernos de formação do PNAIC: concepção e perspectiva metodológica | 2022 | Universidade Federal do Amazonas | Manaus |
| ALMEIDA, D. P. A. | Representações sociais de formação continuada compartilhadas por professores de matemática que atuam no ensino médio do sertão do Alto Pajeú | 2021 | Universidade Federal Rural de Pernambuco | Recife |
| BRAUNER, E. K. | Ambientes inovadores de aprendizagem em educação matemática nos anos finais do ensino fundamental: jogos, desafios e curiosidades matemáticas | 2022 | Universidade Luterana do Brasil | Canoas |
| BRITO JUNIOR, J. J. R. T. | Modelagem de padrões comportamentais para a identificação do engajamento de estudantes em jogos de aprendizagem. | 2023 | Universidade Federal Rural de Pernambuco | Recife |
| COLARES, N. C. V. | Eletron Bank: utilizando a gamificação no ensino de química orgânica | 2023 | Universidade Luterana do Brasil | Canoas |
| COSTA, G. R. | Jogos e atividades lúdicas: aplicações de critérios de usabilidade na gamificação em ambiente virtual de aprendizagem destinado à formação de professores | 2023 | Universidade Federal do Amazonas | Manaus |
| CRUZ, A. M. | Concepções de professores de matemática sobre jogos e sua utilização | 2023 | Universidade Federal de Sergipe | São Cristóvão |
| DIAS, A. R. S. | Os jogos de papéis como recurso lúdico colaborativo à interpretação e à solução de problemas matemáticos por alunos do 5º ano do ensino fundamental | 2021 | Universidade Estadual Paulista Júlio de Mesquita Filho | Bauru |
| DIAS, R. S. B. | Possibilidades de ensino e aprendizagem em ciências no ensino fundamental através do uso da função remix do software Scratch | 2021 | Universidade Luterana do Brasil | Canoas |
| FERREIRA, N. L. | Educação para a sustentabilidade: práticas desenvolvidas no ambiente escolar remoto em tempos de covid-19 | 2021 | Universidade Luterana do Brasil | Canoas |
| GAIA, S. D. C. | Um jogo digital como um instrumento de mediação no ensino de Biologia | 2022 | Universidade Federal do Amazonas | Manaus |
| JUNIOR, J. J. R. T. B. | Modelagem de padrões comportamentais para a identificação do engajamento de estudantes em jogos de aprendizagem | 2023 | Universidade Federal Rural de Pernambuco | Recife |
| LEITE, A. L. M. | Desenvolvimento de jogos digitais com foco na aprendizagem criativa no ensino de Física | 2021 | Universidade Federal do Amazonas | Manaus |
| LEMOS, J. M. | O enfoque CTS em jogos digitais desenvolvidos para o ensino de química sobre uma perspectiva sociocultural | 2022 | Universidade Federal do Maranhão | São Luís |

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| | | | | |
|---|---|---|---|---|
| LIRA, F. A. L. | A apropriação por professores de matemática de jogos sobre equação do primeiro grau propostos em livros didáticos | 2022 | Universidade Federal Rural de Pernambuco | Recife |
| MARTINS, T. R. S. | O estudo de frações no 6º ano do ensino fundamental a partir da metodologia da sala de aula invertida | 2023 | Universidade Luterana do Brasil | Canoas |
| MENDES, C. F. C. | O uso das tecnologias digitais no ensino das operações com números inteiros | 2022 | Universidade Luterana do Brasil | Canoas |
| MENEZES, T. C. | Influências da neurociência cognitiva no ensino de química: como os conhecimentos sobre atenção seletiva poderiam auxiliar na aprendizagem das funções orgânicas | 2022 | Universidade Federal de Sergipe | São Cristóvão |
| NASCIMENTO, A. C. M. | Gamificação de um projeto temático para o ensino de conceitos, análise e interpretação de dados estatísticos | 2023 | Universidade Federal do Amazonas | Manaus |
| NASCIMENTO, G. V. | Divulgação científica por meio do Museu Game Ciência numa perspectiva sociocultural | 2022 | Universidade Federal do Maranhão | São Luís |
| NUNES, M. Y. | O uso de jogos matemáticos na educação de jovens e adultos (EJA) de uma escola municipal de Manaus – Amazonas | 2023 | Universidade Luterana do Brasil | Canoas |
| OLIVEIRA, S. G. | Formação continuada de professores em matemática: a prática docente nos anos iniciais do ensino fundamental e a BNCC | 2023 | Universidade Luterana do Brasil | Canoas |
| PACHECO, A. C. R. | Pressupostos de avaliação da aprendizagem na aplicação de jogos digitais voltados para o ensino de química: uma análise a partir da revisão sistemática da literatura | 2022 | Universidade Federal do Maranhão | São Luís |
| SANTOS, V. S. | Conceitos básicos de genética numa abordagem construtivista de transposição didática | 2021 | Universidade Federal do Amazonas | Manaus |
| SCHNEIDER, L. L. | A gamificação como estratégia significativa no ensino de química orgânica | 2023 | Universidade Luterana do Brasil | Canoas |
| SEVERO, C. | O papel mediador dos jogos didáticos no olhar de licenciandos de Ciências Biológicas | 2023 | Universidade Franciscana | Santa Maria |
| SILVA, G. C. | Uma abordagem de Game Learning Analytics para identificação de perfis comportamentais na utilização de jogos educacionais | 2022 | Universidade Federal Rural de Pernambuco | Recife |
| SIMÕES, D. G. | Formação continuada para professores dos anos iniciais do ensino fundamental envolvendo frações | 2022 | Universidade Luterana do Brasil | Canoas |

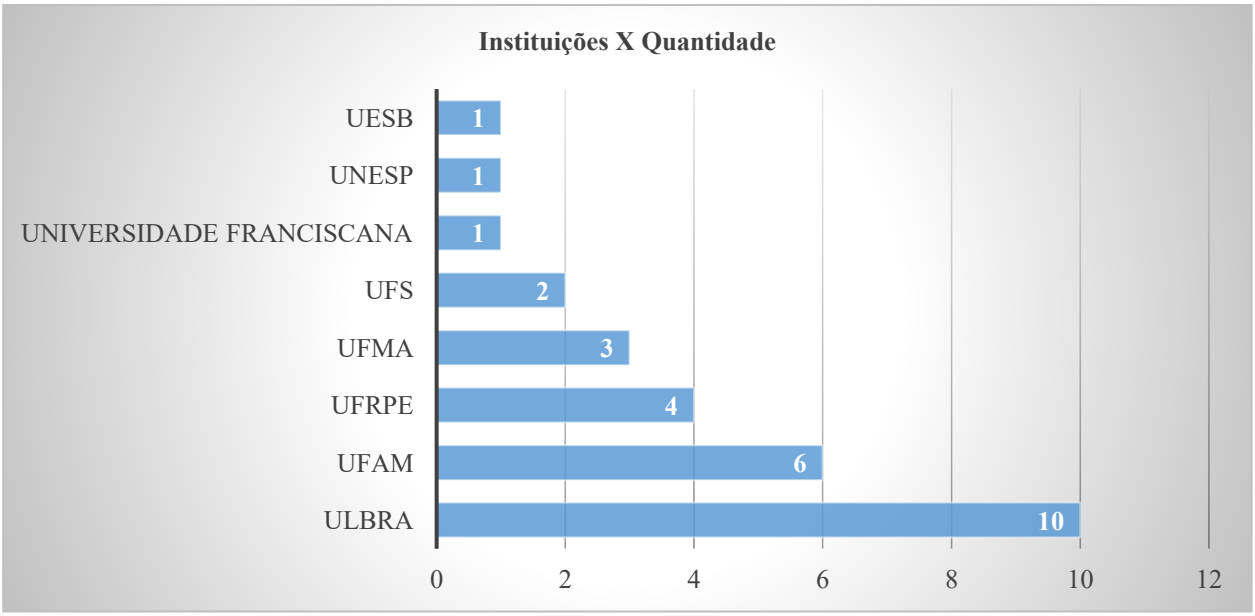
**Source:** the authors (2026).

The institutional distribution can be seen in Graph 1 below, which presents the number of dissertations per institution.

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**Graph 1 –** Number of dissertations per institution at the national level




**Source:** the authors (2026).

The exploratory reading of the dissertations revealed that most investigations use analog games, traditional playful activities, or hybrid proposals that combine digital and physical elements. Although the descriptor "games" was effective in locating productions related to Science Education, it covers a broad spectrum of approaches, which resulted in a diversified corpus, but with a low incidence of complex digital games or online environments. This predominance can be explained by factors such as the ease of implementing analog games in school contexts, less dependence on technological infrastructure, the historical tradition of using physical games in Mathematics Education, and connectivity challenges in Brazilian public schools.

Despite the advancement of DICTs and digital culture, few works address online games as a central object of investigation. In many cases, digital games appear as complementary resources, without in-depth analysis of their pedagogical potential, limitations, or didactic implications.

Furthermore, the limited presence of online games contrasts with the expansion of virtual learning environments; the growth of gamified platforms; the guidelines of the PNED, which encourage the use of interactive digital resources; and the popularization of browser-based educational games. This absence reveals a field of research still in consolidation, with broad potential for future investigations, especially regarding collaborative learning, the analysis of educational data (learning analytics), and integration with digital education policies.

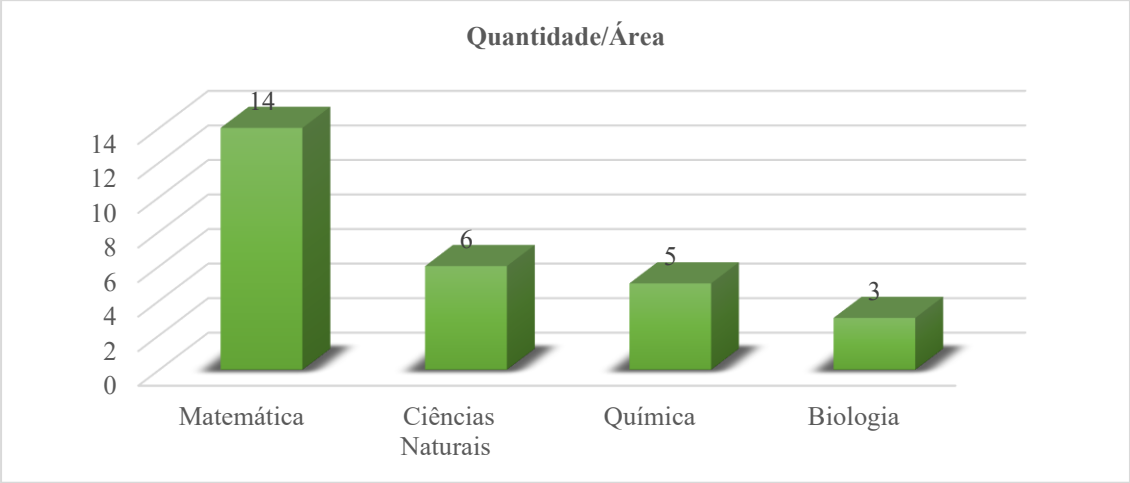
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### 2.3.2 Thematic trends by area of knowledge

The categorization of the dissertations by area of knowledge shows that Mathematics Education concentrates the largest number of works (14), focusing on analog games, mathematical challenges, and gamification; followed by Chemistry, which presents 5 works, many of them related to gamification and the development of digital games; Natural Sciences, which gathers 6 works, with diversified proposals involving DICTs; and Biology, which appears with 3 works, including the use of digital games as conceptual mediators. Graph 2 below presents these data.

**Graph 2 –** Games by area of knowledge in the Dissertations/CAPES




**Source:** The authors (2026).

This distribution demonstrates that the use of games is more consolidated in Mathematics Education, while areas such as Physics and Interdisciplinary Sciences present lower representativeness. The mathematical predominance may be related to the tradition of using games as mediators of abstract concepts and to the strong link between games and problem-solving.

### 2.3.3 Regional production: innovation and centrality of DICTs

The regional corpus of PPGECN/UFMT presents characteristics distinct from the national panorama, as can be seen in Box 2 below.

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**Box 2 –** Educational Products and Dissertations of PPGECN/UFMT 2021-2025

| **Produto Educacional** | **Autores** | **Ano** | **Critérios Características Principais** | **Nome da Dissertação** |
|---|---|---|---|---|
| ChatGPT: desafios e possibilidades – Guia para Professores | Caroline Auxiliadora Ribeiro de Moraes; Miguel Jorge Neto | 2025 | "o ChatGPT pode ser uma aliada valiosa para os professores…"; "é essencial refletir sobre os desafios…" | **Formação de professores no uso do ChatGPT: desafios e possibilidades**. A dissertação afirma: "Esta dissertação aborda a formação de professores para o uso do ChatGPT na prática docente…" |
| Portfólio de Recursos Educacionais | Mariana Cristina Souza Almeida; Miguel Jorge Neto | 2024 | "Os Recursos Educacionais encontrados durante a Curadoria foram classificados em 4 categorias…" | **Curadoria de recursos educacionais para professores de Ciências: uma proposta de apoio à prática docente no contexto da BNCC e do Novo Ensino Médio**. O texto afirma: "implementou-se uma curadoria de recursos e tecnologias educacionais…" |
| TDICs no Contexto Escolar! Educação na Era Digital | Ana Christina Rosa Campos de Freitas; Edward Bertholine de Castro | 2023 | "propomos atividades e avaliações usando as TDICs…" | **Evolução biológica e diversidade das espécies: uma proposta de criação de sequência didática utilizando as TDICs no Ensino Fundamental**. A dissertação afirma: "Este trabalho tem por objetivo desenvolver e validar uma Sequência Didática utilizando as TDICs…" |
| Laboratório Virtual nas Aulas de Ciências e Biologia | Karen Larissa de Lima Ortiz; Débora E. Pedrotti | 2023 | "Chamamos de laboratórios remotos aqueles que não precisam da presença física do aluno…" | **Laboratório virtual nas aulas de Ciências e Biologia**. O texto afirma: "buscamos apresentar aos professores uma estratégia de ensino… por meio do Laboratório Virtual." |
| O Tal Fractal – Roteiro Didático | Carla Magna Moura da Silva Santos; Edna Lopes Hardoim | 2022 | "tem como objetivo levar para a sala de aula a introdução da Geometria Fractal…" | **A Geometria Fractal e a Deficiência Visual no Contexto do Ensino de Ciências Inclusivo e da Educação Integrativa STEAM**. A dissertação afirma: "A questão orientadora da investigação foi como seria a percepção dos alunos, sobretudo dos estudantes com deficiência visual…" |
| Modelos Virtuais e Modelagem Didática: Embriologia Animal | Carlos Faria Silva; Edward Bertholine de Castro | 2022 | "propomos como produto educacional uma Sequência Didática para facilitar o ensino da embriologia…" | **Modelos virtuais e modelagem didática: uma abordagem significativa para o ensino da embriologia animal – do zigoto à neurulação**. O texto afirma: "O presente trabalho busca compreender as contribuições de uma proposta de ensino por meio de uma Sequência Didática…" |
| Roteiro Didático – Connect Park (Trilha Ecológica) | Douglas Mendonça Garin; Edna Lopes Hardoim | 2021 | "o objetivo é oferecer um roteiro didático aos professores com atividades práticas pautadas no uso do aplicativo Connect | **Connect Park: um aplicativo mobile para interações no bioma Cerrado na perspectiva do ensino de Ciências Naturais inclusivo**. A dissertação afirma: "quais as potencialidades do uso de um dispositivo móvel em práticas educativas na área de |

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|---|---|---|---|---|
| | | | Park…” | Ciências Naturais…?” |
| Transgênicos em Pauta – Guia Didático | Jonise Marques de Oliveira; Lenicy Lucas de Miranda Cerqueira | 2021 | “apresentamos este Guia Didático com uma proposta de sequência didática com enfoque CTS…” | **Proposta de uma sequência didática para o estudo dos transgênicos a partir da abordagem CTS**. O texto afirma: “Esta pesquisa teve como objetivo apresentar e avaliar uma proposta de sequência didática centrada no tema transgênicos…” |
| Genética: Ensino por Investigação para Professores | Kássia Paula Oliveira da Silva; Lenicy Lucas de Miranda Cerqueira | 2021 | “apresentamos uma proposta de Ensino por Investigação sobre Genética…” | **O ensino de genética no contexto da educação do campo: uma sequência de ensino por investigação**. A dissertação afirma: “O presente trabalho visou desenvolver uma Sequência Didática Investigativa…” |
| Roteiro Pedagógico – Jogo HEBIO (Genética) | Luciele Matos do Carmo Costa; Edna Lopes Hardoim | 2021 | “o objetivo principal do roteiro pedagógico é desenvolver estratégias que facilitem a compreensão dos conhecimentos básicos de genética…” | **Jogos e a aprendizagem híbrida: desafios e possibilidades didáticas colaborativas no ensino de genética**. A dissertação afirma: “O estudo surgiu em uma tentativa de contribuir para reduzir fragilidades no ensino de Biologia…” |

**Source:** the authors (2026).

The content of the works found demonstrates that PPGECN/UFMT has consistently produced materials and research that explore the potential of digital technologies to qualify Science Education. The diversity of proposals, which include artificial intelligence, virtual laboratories, mobile applications, digital modeling, and online games, demonstrates a regional movement of pedagogical innovation aligned with the contemporary demands of science education. Thus, the regional corpus not only reflects the academic production of the program but also reveals how DICTs have been integrated into formative and research practices in the context of Mato Grosso, contributing to the consolidation of more interactive, contextualized, and technologically integrated approaches in Science Education.

The analysis was conducted in two complementary stages. Initially, the full reading of the information reproduced in Box 2 of this article was carried out, focusing on the citations that synthesize the objectives and characteristics of each work. This first stage made it possible to recognize the diversity of technologies mobilized, from artificial intelligence tools (as in the guide on the use of ChatGPT) to virtual laboratories, mobile applications, digital modeling, and educational games. In the latter case, the digital game Hebio stands out, used in Inquiry-based Teaching proposals in the field of Genetics, reinforcing the understanding that online games constitute, in themselves,

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technological resources integrated into the set of ICTs. Thus, their presence in the corpus demonstrates the expansion of pedagogical possibilities provided by interactive digital environments.

In the second stage, the thematic categorization of the works was carried out, considering the type of technology used, the pedagogical approach adopted, the target audience, and the formative objectives. This categorization revealed clear trends in the analyzed period, such as the strengthening of teaching sequences based on DICTs, the incorporation of digital resources for remote experimentation, the use of applications for environmental exploration, the adoption of digital games as an active learning strategy, and the appreciation of inquiry practices mediated by technologies. It was also possible to identify specificities, such as the integration between Fractal Geometry and accessibility for students with visual impairments and the curation of educational resources aligned with the National Common Curricular Base (BNCC) (Brazil, 2018) and the New High School.

The educational products analyzed demonstrate a strong integration of DICTs into pedagogical practices, including virtual and remote laboratories, mobile applications, digital modeling, artificial intelligence, and digital games, such as Hebio. Excerpts from the document reinforce this centrality: "we propose activities and assessments using DICTs…," "We call remote laboratories those that do not require the physical presence of the student…." These pieces of evidence show that the program has invested in pedagogical innovation aligned with the contemporary demands of science education and with the guidelines of the PNED, which encourages the production and use of digital educational resources.

### 2.3.4 Articulation with the PNED and implications for digital education

The results reveal that, although the PNED is mentioned in the corpus, its integration into the analyses is still incipient. The policy sets forth guidelines for digital inclusion, teacher education, and the production of digital resources, but few works explicitly articulate their objectives with the practices investigated.

The gap between academic production and digital policies reinforces the need to expand research on online games, develop educational products aligned with the PNED, investigate the impacts of digital culture on science learning, and strengthen teacher education for the critical use of DICTs. The results make it possible to identify four main trends, namely: the consolidation of analog games and gamification as recurring pedagogical strategies; the gradual growth of digital games,

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especially in Chemistry and Biology proposals; the limited presence of online games, revealing a significant gap in recent literature; and the strengthening of DICTs in the regional context of PPGECN/UFMT, with innovative educational products.

In the corpus analyzed, it can be observed that the PNED directly relates to the educational products of PPGECN/UFMT, which include virtual laboratories, applications, digital modeling, and educational games. The presence of proposals such as the guide on ChatGPT and the digital game Hebio demonstrates alignment with the guidelines of the policy. These trends, connected to the PNED, indicate that the field is expanding but still lacks research that explores interactive digital environments, online platforms, and gamified resources more robustly.

### 2.3.5 Limitations of the Study

The State of the Art constituted for this study made it possible to identify trends and gaps regarding games, gamification, and digital technologies in Science Education between 2021 and 2025. In this case, the results should be interpreted in light of methodological and contextual limitations.

Among the limitations, the limited presence of studies on online games stands out, since, although the descriptor "games" retrieved relevant productions, the corpus does not allow for in-depth analyses of interactive digital environments. An institutional concentration of the dissertations is also observed, especially in universities such as Ulbra, Ufam, and UFRPE, which may affect the representativeness of the findings, a fact that can be explained by the selection of professional master's programs.

As for the temporal scope chosen, from 2021 to 2025, although pertinent to the post-pandemic context and to the implementation of the PNED, it may exclude earlier trends or trends still consolidating. Added to this are restrictions on full access to some Capes dissertations and the regional focus on PPGECN/UFMT productions, factors that limit the generalization of the results. Finally, the qualitative nature of the analysis implies interpretive choices in the thematic categorization, subject to revision and further development in future studies.

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## 3 REMARKS

The State-of-the-Art survey, conducted between 2021 and 2025, made it possible to understand in a broad and critical way how games, gamification, and Digital Information and Communication Technologies (DICTs) have been incorporated into Science Education in Brazil. The analysis of the corpus, composed of 38 works, revealed a field in expansion, marked both by significant advances and by gaps that need to be addressed in order to consolidate pedagogical practices aligned with the contemporary demands of digital culture.

The results demonstrate that games play a relevant role in the educational proposals analyzed, especially in Mathematics Education, since playful activities and analog games are widely used to mediate concepts and promote engagement. Despite the growing integration of digital technologies into education, the presence of specific research on online games is still limited, indicating that this type of resource remains underexplored in recent literature. This gap contrasts with the advancement of active learning methodologies, with the popularization of virtual environments, and with the guidelines of the National Policy for Digital Education (PNED), which encourage the use of interactive digital resources and teacher education for digital culture.

Furthermore, the regional production of PPGECN/UFMT stands out for the centrality of DICTs, demonstrated in proposals that involve virtual laboratories, mobile applications, digital modeling, artificial intelligence, and educational games. Excerpts such as “we propose activities and assessments using DICTs…” demonstrate that the program has consistently invested in pedagogical innovation, contributing to the consolidation of inquiry practices mediated by technologies. This regional movement reinforces the potential of DICTs to enhance Science Education and points to promising paths for the development of educational products aligned with the PNED.

Despite the advances identified, the study reveals important challenges, such as the predominance of analog and hybrid games, the institutional asymmetry in production, and the limited presence of online games. These challenges indicate that the field still lacks more robust research that explores interactive digital environments, gamified platforms, and online resources. Furthermore, the integration between academic production and digital education policies remains incipient, suggesting the need to strengthen the connection between pedagogical practices, teacher education, and national guidelines.

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Given this scenario, it is recommended that future investigations expand the development and analysis of online games in Science Education, explore the potential of collaborative virtual environments and learning analytics, investigate the impacts of the PNED on the production of digital educational resources, strengthen teacher education for the critical and creative use of DICTs, and promote research in less represented areas, such as Physics and Interdisciplinary Sciences.

By systematizing trends, patterns, and gaps, this study contributes to the theoretical and methodological advancement of the field and offers input for researchers, teachers, and graduate programs interested in expanding the pedagogical use of games and digital technologies in Science Education. The results reinforce that, although the field is expanding, there is ample room for innovation, especially in the development of online games and in the effective integration of DICTs into contemporary educational practices.

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