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Design-based research in education: co-creation, innovation, and collaborative practices in focus

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Abstract: This article presents a bibliographic analysis of the use of Design-Based Research (DBR) in the Brazilian educational context, with the aim of mapping trends, challenges, and potentialities of this approach for pedagogical innovation. This is a qualitative, hermeneutic, and exploratory study that examines 12 works published between 2014 and 2024 in the *Scientific Electronic Library Online* (SciELO) and Brazilian Digital Library of Theses and Dissertations (BDTD) databases. The concept of *design,* understood here as a heuristic, creative, and collaborative process of designing learning experiences, guides the reading of the educational practices analyzed. The results indicate three principal axes: participatory and co-creation methodologies, interdisciplinarity and creative imagination, and openness to diversity in investigative practices. It is concluded that the literature highlights PBD as a methodological approach with transformative potential, which articulates theory and practice in reflective cycles, favoring the collective construction of knowledge and experimentation in school environments. However, gaps are pointed out in comparative and longitudinal studies that deepen the impacts of PBD in different contexts, highlighting the need for future research to consolidate its application in the educational field.
Keywords: design-based research; innovation; co-creation; inclusive education; collaborative practices.

1 Introduction

Design-Based Research (DBR)1 is recognized as an empirical, participatory, and interdisciplinary methodology that seeks to bring theory and practice together through iterative cycles of analysis, design, implementation, and evaluation. Initially

[1] With its interactive, cooperative, experimental, and reflective nature, it promotes effective integration between theory and practice, offering the opportunity to conduct flexible research on the use of digital technologies in school environments without compromising scientific rigor. DBR acts as the guiding thread in this collaborative construction between researchers and participants, something that responds to contemporary demands, valuing both prior knowledge and the formulation of solutions to complex problems (Jobim; Giraffa, 2024).

developed in the 1990s, it has become established in education as a strategy for investigating complex problems and proposing interventions appropriate to diverse sociocultural contexts (Barab; Squire, 2004; Wang; Hannafin, 2005).

In this study, *design*[2] is understood, in light of the New London Group (NLG, 1996) and Cope and Kalantzis (2020), as a heuristic and creative process of designing educational actions, which is not limited to the development of products, but involves the planning and continuous redesign of learning experiences and environments. This perspective breaks with instrumental conceptions and highlights *design* as a mediating and provocative language that articulates multiple forms of knowledge, cultures, and practices.

His work aims to map and analyze recent bibliographic production on PBD in the Brazilian educational field, identifying how this approach has been conceived and applied in research focused on pedagogical innovation, co-creation[3], and educational inclusion. In addition, it seeks to point out challenges and limitations evidenced by the studies themselves. It is, therefore, qualitative, exploratory, and hermeneutic research, anchored in the interpretive perspective of Gadamer (1999) and Sanches and Conte (2017), which understands understanding as a dialogical process between the researcher and the analyzed texts.

In explaining the bibliographic nature of this work, it should be noted that the analyses of the 12 studies found in the SciELO and BDTD databases, published between 2014 and 2024, do not derive from empirical interventions conducted by the authors, but from critical interpretations of the results and arguments presented in the selected studies. Thus, the aim is to contribute to the expansion of the academic debate on the potential of PBD in the school context, where teachers investigate their own practice and foster cooperative, purposeful, and dialogical work environments, highlighting both its scope and the gaps to be explored in future studies (Conte, 2016). This is because the adoption of this methodological approach was oriented towards

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[2] "Design, in turn, as an applied social science, seeks, in a broad sense, to understand the objectives that human beings develop from their interaction with material resources, whether objects, places, or experiences resulting from this interaction," in order to expand *design* practices and principles to consolidate knowledge seen in school (Avila, 2022, p. 17).

[3] On the experience of co-creation in pedagogical practice, see: Hands-on education. São Paulo, University of São Paulo. Interview with Paulo Blinkstein for the Porvir website during the FabLearn Conference, Brazil, 2016. Available at: http://porvir.org/especiais/maonamassa/?gclid=Cj0KCQjwnNvaBRCmARIsAOfZq-3osMD1faI72ktI-caMXwySkVQsMnq3EBpDwHCJOg5Fa187ZpY-kk8aApqIEALw_wcB. Accessed on: Mar. 28, 2024.

development research in various areas, “[...] more specifically towards the development of proposals for cognitive processes in digital educational environments” (Matta; Silva; Boaventura, 2014, p. 23).

Given this scenario, PBD is understood as a research approach in everyday school life, characterized by iterative cycles of analysis, design, and evaluation. Still, it also reveals itself as an object of interdisciplinary knowledge. It is a field that adopts an intentional and learning-based methodological design, supported by a (re)creative language that strengthens collective intelligence, stimulating autonomous, formative, and democratic initiatives to produce knowledge (Fontana; Conte; Habowski, 2019).

The practice of PBD requires the development of various skills, such as the understanding and use of multimodality, in addition to the (re)construction of meanings in school environments. This investigative process in praxis considers social, linguistic, and cultural differences and pluralization, without neglecting the problems and experiences of the subjects and contexts involved. Throughout this study, we seek to understand how PBD contributes to the development of educational practices that integrate tradition and innovation, expanding the protagonism of participants in the collaborative construction of knowledge and understanding of the conditions necessary for their action inside and outside the school. Considering that, “[...] in the *design-based research* methodology*,* the work goes through the following phases: analysis and definition of the problem, development of a proposal, evaluation, and reflection for the generation of design principles” (Oceja, 2024, p. 2). To this end, we pose some key questions that we will attempt to answer, including: How can PBD contribute to pedagogical innovation and subject engagement, promoting critical thinking in learning processes? What investigative principles are essential for the implementation of PBD processes in educational contexts? What are the main impacts of PBD in terms of inclusion, creativity in scripts, mapping, designs, and critical knowledge in education?

PBD favors the collective construction of knowledge in everyday school life, “[...] considers community knowledge to be the ultimate authority, and this contributes to the community not being invaded or restricted, much less invalidated or even abducted from its values and knowledge, which are often, even today, appropriated and distorted” (Matta; Silva; Boaventura, 2014, p. 34). Furthermore, it promotes the capacity for interaction between different educational agents and overcomes the

historically standardized and systematized limitations of homogeneous methodologies[4].

By valuing the diversity of perspectives, this approach encourages collaboration among all participants. This methodology involves the development and implementation of interventions and prototypes, tested and adjusted cooperatively and jointly, to meet specific demands in school contexts. The text is structured around the following topics: Methodology and theoretical-practical foundations of PBD - assuming positions aligned with a broad view of a heterogeneous world, recognizing the diversity of cultural ways of seeing, explaining, and understanding reality, which reinforces the assumptions of humanized existence itself; Analysis of empirical research; Challenges of PBD in Brazil; and Final considerations.

2 Methodological Issues: Experiences through Design

The study adopted a qualitative and exploratory approach, justified by bibliographic research. To constitute the *corpus*, the SciELO and BDTD databases were used, chosen because they bring together consolidated scientific productions in Brazil, ensuring access to relevant articles and theses at the interface between education, cooperative work, and innovative methodologies. The survey took place from January 2014 to April 2024, using the keywords “Design-Based Research” and “education”. The inclusion criteria were defined as follows: works published in Portuguese, with explicit application of DBR in the educational context (elementary, secondary, or higher education) and presenting data or reflections on cooperative practices, co-creation, or pedagogical innovation guided by research-inspired topics. Exclusion criteria included studies focused on health, engineering, or those that did not detail the DBA methodology.

The screening followed the steps of reading titles, abstracts, and subsequently the full text, resulting in the final selection of 12 studies. Six scientific articles from SciELO and six theses from BDTD were included, which met the inclusion criteria. The

[4] An illustrative parallel can be found in the shift observed between traditional *design* disciplines, focused on products (visual communication *design*, interior *design*, product *design*, architecture, planning), and emerging disciplines, geared toward a collective purpose, such as *design* for experimentation, *design* for emotion, *design* for interaction, *design* for sustainability, and *design* for transformation (Avila, 2022). This transition highlights how participatory approaches, such as PBD, shift the focus from the object to the process of research and cooperative knowledge construction, expanding co-authorship and the agency of multiple subjects in the educational context.

studies were organized in a spreadsheet with metadata such as authors, year, type of institution, level of education, and methods used. Data analysis was guided by the hermeneutic-interpretive approach of thematic analysis, identifying emerging categories related to participatory methodologies, interdisciplinary work, and inclusive practices. In addition, some relevant characteristics of the PBD or DBR methodology will be highlighted by different researchers, namely: A flexible and dialogical approach, enabling the evolution of iterative cycles and constant *redesign*; Based on the relationship between theory and practice - adjusted to varied contexts in schools and the real world; Relational processes to adapt co-creative games (*co-design)*, generating the production of new knowledge in educational practices that transform social learning (Mesquita *et al.,* 2021).

PBD is an innovative methodology whose main objective is to improve educational practices in an empirical and participatory manner, promoting an environment of co-authorship and co-responsibility for the specific needs of school contexts. This approach involves a continuous process of design, implementation, and evaluation, supported by cycles of formative evaluation and iteration. To this end, PBD follows some essential principles, such as dialogue between theory and practice, the adaptation of data collection methods (among partners) to the contexts investigated, and the use of heuristic resources to generate contextualized results that are useful for other research (Wang; Hannafin, 2005).

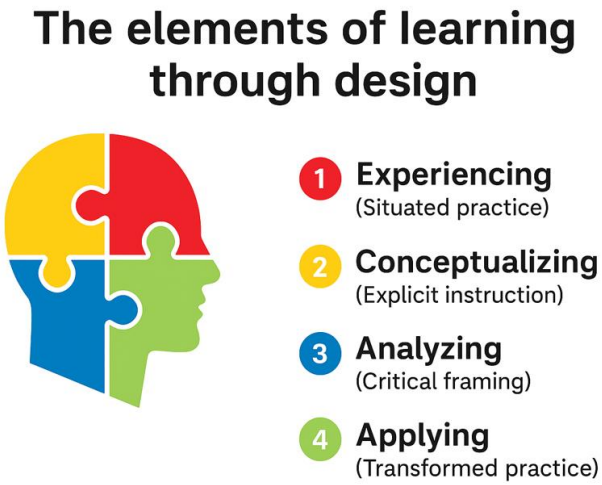
Although they share creative and collaborative elements, PBD and *Design Thinking*[5] are not synonymous. PBD, as Barab and Squire (2004) point out, is a rigorous methodological approach aimed at producing scientific knowledge in authentic contexts, while *Design Thinking* is structured more as a pragmatic approach to problem solving, with roots in industrial and business *design* (Brown, 2009). In education, *Design Thinking* associated with PBD helps to create innovative and flexible learning environments, aligning theory and practice in a cycle of *design,* implementation, and formative assessment.

[5] Researchers use *Design Thinking* to develop innovative teaching materials or strategies. For example, if students have difficulty learning grammar, a virtual laboratory can be created where students interact with the language in a playful and practical way. For more on this type of collaborative initiative, see the dissertation *Collectively authored learning objects in distance learning courses: an opportunity for the formation of collective intelligence?* (Fontana, 2016).

Participatory experiences in the construction of *design-based* qualitative research in education help us understand the implications for ensuring collaboration in the formation of collective potential, especially in the processes of co-creation in this approach in Brazil. Initially proposed by Brown and Collins in 1992, it is also known as *Design-Based Research* (DBR), a participatory *design* from an inclusive perspective (Alves, 2017). It is a technology in the field of Human-Computer Interface (HCI), defined by Rocha and Baranauskas (2003, p. 16) as a "[...] technique that consists of extracting useful information from children for the development of prototypes of the technology under study, through group work using paper, colored pencils, glue, crayons, thus generating new technologies." To redesign learning experiences and the environments themselves so that everyone can learn in a more profound and participatory way, it is necessary to associate co-creation approaches with encounters with others.

The idea of *design*, advocated by *the New London Group* (NLG), encompasses a heuristic approach, in which meanings emerge from multiple cultural contexts, without following linear or hierarchical rules. This proposal is echoed in the words of Larrosa (2015), who explores how experience allows us to rethink pedagogy and its practices. The *design* of the professional profile, for example, is multifaceted, adapting to new paradigms and contemporary challenges. The choice of this approach to *design* is justified by its ability to respond to today's complex educational demands, given that the elements of learning through *design,* in field research, can promote inclusive, humanized, purposeful, critical, dynamic, and flexible training with others.

Figure 1 – Elements of *design-based* learning



Source: Adapted from NLG (1996)

It should be noted that the first step in *design-based* research is to deeply understand the problem to be solved and the specific issues of the context in question, putting oneself in the shoes of those involved. For example, in an educational context, researchers talk to teachers, students, and other participants to understand their needs, challenges, and expectations. After (re)cognizing, collecting information, and experiencing the reality of those involved, the next step is to clearly define the specific problem to be solved. This step is essential to direct research efforts toward finding practical solutions to be proposed together, in line with contextual needs and demands.

Next, a brainstorming session is held, where researchers and participants propose creative and purposeful solutions for the context, exploring different possibilities to solve the defined problem. Based on the ideas generated, interventions are developed, and prototypes or initial versions of possible solutions are built. For example, if the issue involves a lack of student engagement, researchers may create interactive teaching materials or educational applications. These prototypes are then tested in real-world contexts to assess their impact and resonance, as PBD emphasizes constant evaluation and feedback collection from participants (such as students, teachers, or patients) to improve the solutions. Based on these results, researchers adjust and refine the prototypes in a reflective spiral of continuous testing, learning, and improvement, allowing for evolutionary revisions over time.

Inspired by *DBR Collective* (2003), Alves (2017) states that the approach can help create and expand knowledge about innovative educational practices. In this context, PBD aims to improve educational practices through a systematic, flexible, and interactive process of analysis, design, development, and implementation, supported by mutual collaboration in real-world contexts[6] .

The demands and forms of language associated with PBD are multiple and complex. Using the study by Alves (2017), we illustrate some of the interactive phases and cycles necessary to validate its applications and interventions, enabling systematic and ongoing analysis and review of *the design*. In addition, we observe the conjectures and trends in praxis associated with the capacities involved in these interpersonal and co-creative relationships in this approach.

[6] An introductory video, produced in Brazil, which provides a summary of PBD as a methodological approach, is available at: https://www.youtube.com/watch?v=bWX8CJk2VJ8

Table 1 – *Design* phases in the school field: support for critical thinking

Phase		Description
Phase 1	Analysis of a practical problem by researchers and participants in collaboration	Must identify the problem together with the participants. However, it may also come from the advisor and their research lines. Literature review to support the "draft" of the intervention. This must be continuous throughout the process.
Phase 2	Development of solutions informed by existing design principles and technological innovations	Here the description of the proposed intervention is defined, based on a new theoretical framework. The draft and principles of the intervention are defined.
Phase 3	Iterative cycles of testing and refining the solutions in practice	Implementation of the intervention in iterations. These must occur in two or more cycles. Definition of participants. Data collection and analysis. The next interventions are defined after the previous one, since they depend on those results.
Phase 4	Reflections to produce "design principles" and improvement of the implemented solution	Present the knowledge and products. Principles and design artifacts.

Source: Alves (2017, p. 28)

It is essential to investigate PBD also as a way of documenting learning processes in complex school contexts, refining educational theories and practices. The studies analyzed show how this methodological approach follows paths of co-creation, dialogue, and collective knowledge construction, highlighting the value of listening, observation, and attention to the interactions and memories that emerge in educational practices.

The work of Cope and Kalantzis (2020), in discussing multiliteracy, reinforces the importance of pedagogical perspectives that respond to the diversity of languages and media present in today's society. This concept fits into the context of PBD by proposing that educational practices consider multiple forms of communication and expression through the inclusion of diverse cultural and cognitive approaches in the learning process. This theoretical link is relevant because PBD, as indicated by Barab and Squire (2004), aims not only at the development of theories but also at the creation of experiential and transformative educational practices. In the context of PBD, pedagogical documentation emerges as an innovative device to foster active student participation, promoting a more dynamic, critical, and dialogical school environment.

To illustrate how PBD can be developed in practice, this study mapped empirical productions in the field of education that illustrate the variety and flexibility of this approach. Initially, we mapped critical approaches to PBD through a review of studies

in SciELO[7] and BDTD[8] over the last ten years. Next, we sought to (re)cognize existing research networks in Brazil and new discoveries in co-creation proposals in educational practices. The mapped works were tracked using the following keywords: *Design-based* research in the field of education (SciELO); *Design-based* research and education (BDTD). Some of the findings collected were disregarded in the review analysis because they were specifically focused on the health field. The study by Silva, Fidelis, and Antonella (2024) on a virtual laboratory for teaching grammar and science education shows how DBR can integrate digital technologies to improve students' linguistic comprehension, demonstrating a practical application of interactive experiments that promote engagement and conceptual understanding.

There are already movements that question why *design* should be used in public education. Experiences such as that of Avila (2022) show that the development of a Teacher Training Guide for Project-Based Learning (PBL) projects in elementary school, justified by participatory *design*, deep ecology, and interpretive methodologies, highlights the power of PBD to transform school practices. The study concludes that *design,* incorporated as an intervention device, is valid for interdisciplinary and cooperative projects, as it allows for continuous reevaluation of stages and constant revisions by all involved, including students. Furthermore, as pointed out by Mesquita *et al. (*2021) point out, the aspirations of DBR in education are not restricted to the creation of cultural products or artifacts, but involve the planning of contextualized theories, projection environments, and the expansion of human capacity for procedural innovation through partnerships between researchers, education professionals, and students, which generate *design* principles with an impact on praxis.

[7] Searches for *design-based* research in the field of education that we have found over the last ten years, available at: https://search.scielo.org/?q=Pesquisa+baseada+em+design&lang=pt&count=15&from=0&output=site&sort=&format=summary&&fb=&page=1&filter%5Bin%5D%5B%5D=scl&q=Design-based+research+in+the+field+of+education&lang=pt&page=1

[8] Refined search link (with quotation marks): https://bdtd.ibict.br/vufind/Search/Results?join=AND&bool0%5B%5D=AND&lookfor0%5B%5D=%22Pesquisa+baseada+em+design%22+%22educa%C3%A7%C3%A3o%22&type0%5B%5D=AllFields&filter%5B%5D=%7Eformat%3A%22doctoralThesis%22&illustration=-1&daterange%5B%5D=publishDate&publishDatefrom=2014&publishDateto=

3 Analysis of Empirical Research

The doings and sayings of research are not just messages to be (de)coded, but effects of meanings to rethink strategies that are produced in concrete conditions and that are somehow present in the way we act, leaving traces so that we can learn and evolve our investigations. They are clues that we learn to understand the movements produced, relating to their conditions of (co)production. These meanings have to do with what is said in the specific context, but also in other places, as well as with what is omitted or cannot be said. Thus, the boundaries of interventionist practice are also part of PBD, as referenced in the following three principles:

a) Participatory methodologies and co-creation: Work that collaboratively investigates teaching and learning processes, involving teachers, students, and researchers, promoting co-authored construction and highlighting the potential and challenges of implementing PBD in educational contexts.

b) Interdisciplinarity and creative imagination: Research that explores the field of education in an interdisciplinary manner and focuses on the challenges of validating the results of educational practices developed from *design-based* research.

c) Openness to diversity in notably inclusive and co-authored research practices: Studies that recognize the contradictions and differences present in the school context when applying DBP, highlighting how this approach can contribute to critical and transformative reflection in educational processes.

This methodological process of DBP, as already mentioned, requires records of formative innovation as a creative dimension that is articulated with tradition and scientific rigor, in addition to an adequate theoretical-methodological orientation. Innovation in education involves precisely the dimension of creativity as an expression of co-creation, cooperative work, and freedom in the process of analyzing errors and the potential for the development of social learning. Burke (2009) offers a crucial reflection when he states that innovation in education, as in other fields, does not occur abruptly or individually, but gradually and collaboratively, as we see in the PBD approach. This way of thinkin ly relevant to research processes in schools and with others, since the evolution of pedagogical practices needs to be rooted in previous traditions and, at the same time, open to new perspectives.

The idea that there are traditions of innovation highlights that, even in practices considered innovative in PBD, there is often a deep connection with pedagogical foundations that have been adapted over time to promote inclusive research as a social practice. Appreciating the new that PBD brings implies a transformation in the educational perspective, which values diversity and interdisciplinary dialogue, shifting the focus from the object of study to an authentic encounter with human singularities in their contexts, transforming the classroom into a dynamic space, a melting pot of desires and needs, which welcomes circles of culture and encourages a lively learning environment. This interaction requires making teaching practices less routine and repetitive, with welcoming gestures, sincere smiles, and the almost magical ability to persevere amid chaos, seeking support and partnerships to learn by being open to new ideas in school. By embracing differences and learning from them, the school is strengthened, gaining a richness that only diversity can provide. Analysis of studies indicates that educational institutions that value diversity tend to have environments that are more open to innovation, engagement, and the shared construction of knowledge.

After searching for works on the SciELO platform and reading the titles and abstracts, we were able to select six (6) studies that were related to the specific theme. Some were excluded because they did not correspond to the specified ten-year period or because they were focused on the training of health professionals.

Table 2 – Studies analyzed

Study	Objective	Methodology	Results
Virtual school research laboratory with grammar (Silva; Fidelis; Antonella, 2024)	Explore the interaction between digital technology and grammar teaching.	DBR with development of a virtual laboratory.	Improved linguistic comprehension and student engagement.
Analysis of the thematic development of studies on games in education (Antunes; Rodrigues, 2022)	Analyze trends and debates on the use of games in education.	Systematic review and thematic analysis.	Identification of trends and challenges in the implementation of games as pedagogical tools.
Mapping research in education on ethno-racial relations (Rodrigues; Barbosa; Ribeiro, 2022)	Map academic production on ethno-racial education.	Literature review and methodological analysis.	Contribution to inclusive educational strategies and debate on cultural diversity.
Innovating in thinking and acting differently: the Design Thinking method for nursing (Paiva; Zanchetta; Londoño, 2020)	Explore the application of Design Thinking in nursing.	Case study with Design Thinking.	Proposal of an innovative method for solving clinical problems.
Immanence between critical theory and empirical research (Maranhão; Vilela, 2017)	Discuss the relationship between critical theory and empirical research.	Theoretical and empirical analysis.	Reflection on research practice and the potential of critical approaches.
TPACKPEC: Design of learning situations mediated by ICT in physical education (Hernando; Catasús; Arévalo, 2018)	Explore the use of the TPACK model in physical education.	Qualitative research applying TPACK.	Demonstration of how ICT can promote learning and motor development.

Source: The Authors

As discussed earlier, the study by Antunes and Rodrigues (2022) explores the intersection between *Design Thinking* and PBD, focusing on engagement via educational games. It also emphasizes how *Design Thinking* within PBD can be a viable way to create motivating learning experiences, with a direct impact on student engagement. This work highlights trends and challenges in the application of games as pedagogical devices, suggesting the need for more comparative data to assess the possibilities and limitations of this approach.

In the research mapping by Rodrigues, Barbosa, and Ribeiro (2022) on ethnic-racial education, PBD is used to build inclusive strategies that directly address cultural issues, legitimizing the knowledge of the subjects, recognizing diversity, and discussing experiences of interculturality in dialogue. The research points to the importance of empirical methodologies that deal with diversity and educational inequalities, reinforcing the social value of PBD.

In the field of nursing, Paiva, Zanchetta, and Londoño (2020) study *Design Thinking* for clinical problem solving, suggesting that creativity and collaboration are central to educational practices in the health field. The research presents PBD as a methodology adaptable to different areas of knowledge, highlighting its ability to engage professionals in reflective and collaborative processes.

The first selected article, *Virtual School Research Laboratory with Grammar: Science Education in Mother Tongue Classes* (Silva; Fidelis; Antonella, 2024), presents a virtual laboratory geared toward school research with a focus on grammar and science education in mother tongue classes. The text explores the interaction between digital technology and grammar teaching, proposing innovative approaches to improve students' linguistic comprehension.

The second is entitled *Analysis of the thematic development of studies on games in education*, by Antunes and Rodrigues (2022). This work conducts a thematic analysis of studies on games in education, evaluating how games have been incorporated as pedagogical tools, as well as revisiting previous research to understand trends and debates on the implementation of games in the educational environment, emphasizing student learning and engagement.

Mapping research in ethnic-racial relations education (Rodrigues; Barbosa; Ribeiro, 2022) is the third article that maps academic production related to ethnic-racial relations education. The research seeks to identify the main themes, methodological

approaches, and advances in the field of ethnic-racial education, contributing to the deepening of the debate and the formulation of inclusive educational strategies.

The fourth text, *Innovating in scientific thinking and action: the Design Thinking method for nursing* (Paiva; Zanchetta; Londoño, 2020), explores the application of *Design Thinking* in nursing, presenting it as an innovative approach to problem solving and clinical practices. The research proposes the method as a strategy that encourages creativity, collaboration, and the generation of solutions centered on the needs of patients and the community.

The fifth work, *The immanence between critical theory and empirical research: contributions to organizational studies* (Maranhão; Vilela, 2017), discusses the relationship between critical theory and empirical research, exploring how the immanence between the two can contribute to organizational studies. The study proposes a reflection on research practice and the potential of critical approaches to offer deeper partnerships on organizational dynamics.

The sixth article, *TPACKPEC: Design of ICT-mediated learning situations in physical education* (Hernando; Catasús; Arévalo, 2018), explores the use of the TPACK model (Technological, Pedagogical, and Content Knowledge) to create learning situations in physical education mediated by Information and Communication Technologies (ICT). The authors examine the integration of these technologies in physical education teaching, highlighting the importance of combining pedagogical, technological, and content knowledge to improve educational practices. The work presents examples of the practical application of ICT in physical education, demonstrating how they can be incorporated to promote learning and the development of motor skills in students. The study contributes to the understanding of practices at the intersection of technology and physical education, proposing strategies that educators can adopt to improve the teaching and learning process.

In the studies analyzed, we observed the following convergences around *design-based* research*:* Both articles address the introduction of innovative elements in the educational context, whether using virtual laboratories, games, teaching strategies focused on ethnic-racial issues, or the application of *Design Thinking* in nursing and physical education. There is a clear trend toward using creative technologies and methods as ways to improve teaching and learning processes. They also reinforce proposals for an interdisciplinary approach, as the textual compositions

indicate that *design* research appears in multiple areas, including grammar, physical education, nursing, ethnic-racial relations, and organizational studies. This diversity shows that the *design-based* approach can be designed, planned, contextualized, and implemented through dialogical and cooperative relationships in various fields of study, indicating its comprehensive potential.

In general, studies emphasize the need to consider new methodologies for addressing different educational topics. For example, the application of the TPACK model in physical education and the use of *Design Thinking* in nursing highlight the importance of incorporating new ways of thinking and acting in planned teaching environments in the interconnection of people who build knowledge together and transform reality.

There is an effort to promote more inclusive and diverse educational strategies, as in the study on ethnic-racial education, and to understand organizational dynamics through critical perspectives, which converges with innovative pedagogical practices. The absence of methodological triangulation, impact indicators, and long-term evaluations limits the reliability of the results presented in the studies. Only two texts specify the methodology for evaluating prototypes and interventions, which compromises comparability between different educational contexts. In some cases, there is a lack of comparative data that clearly demonstrates the impacts of the methodologies discussed, such as the integration of ICT in physical education or the virtual laboratory for teaching grammar, in relation to traditional methods. Research in the context of PBD itself does not foster a culture of comparison for conducting studies and meetings in other contexts, for example.

The question that remains is: to what extent can the results presented in these articles be generalized to other educational and cultural contexts? The diversity of themes and areas suggests that the proposed methods are situational, and it would be interesting to explore how these diverse practices can be contextualized to different realities. There are doubts about how the teachers and professionals involved are being trained to coordinate and propose these innovative approaches. For example, in applying the TPACK model in physical education, what are the challenges for educators to effectively integrate technological, pedagogical, and content knowledge into their practices?

For some articles, such as the first Virtual Laboratory for School Research with Grammar, a more in-depth analysis of how the critical analysis of the data was carried out is necessary. Specifying the number of comments analyzed and how they were classified could enrich the understanding of the results presented. In addition, in studies that revisit previous research, such as the second article on games in education, it would be relevant to deepen the critical analysis of the trends discussed. Instead of merely mapping existing debates, the authors could question the implications and limitations of these approaches.

In the article on the relationship between critical theory and empirical research in organizational studies, it would be helpful to discuss in more detail how *design-based* research can create a balance between theory and practice, providing applicable results and experiences with participants at the interfaces. Often, several articles present proposals and theoretical discussions but lack a stronger empirical basis. The practical implementation of the proposed approaches, followed by a critical analysis of the results obtained, could strengthen the arguments presented in the field of education.

The convergences between these studies suggest a movement toward the application of innovative, inclusive, and interdisciplinary practices with concrete materials in the educational context. However, there are doubts regarding the effectiveness and generalization of the proposed methodologies, as well as the continuing education of the professionals who will implement them.

Would it be possible to circumscribe and validate PBD in different contexts and schools through research in the field, providing even more robust details with cultural artifacts and new proposals? Before discussing the challenges and limitations identified in the application of PBD in Brazil, a comparative summary of the studies analyzed is presented below, focusing on their contributions and weaknesses.

Table 3 - Comparative summary of the studies analyzed on PBD in Brazilian education (2014-2024)

No.	Authors (Year)	Area/Context	Type of Production	PBD Category	Highlights	Limitations identified
1	Silva, Fidelis, and Antonella (2024)	Mother tongue / Virtual laboratory	SciELO article	Co-creation and technology	Integrates digital technology and interactive experimentation	Lack of detail in data analysis
2	Antunes and Rodrigues (2022)	Games in education	SciELO article	Creativity and engagement	Encouraging active learning through games	Little critical analysis of trends

No.	Authors (Year)	Area/Context	Type of Production	PBD Category	Highlights	Limitations identified
3	Rodrigues, Barbosa, and Ribeiro (2022)	Ethnic-racial education	SciELO article	Diversity and inclusion	Valorization of cultural knowledge	Requires more comparative data
4	Paiva, Zanchetta, and Londoño (2020)	Nursing / *Design Thinking*	SciELO article	Interdisciplinary adequacy	Application in clinical problems with creativity	Little articulation with formal education
5	Maranhão and Vilela (2017)	Organizational studies	SciELO article	Critical theory and PBD	Epistemological reflection between theory and empiricism	Limited generalization
6	Hernando, Catasús, and Arévalo (2018)	Physical education and ICT	SciELO article	TPACK integration	Practical application with ICT and design	Comparison with traditional methods is lacking
7	Mülbert (2014)	Distance learning / mobile devices	BDTD thesis	Co-creation and scalability	Proposal for *a* collaborative *framework*	Context restricted to higher education
8	Pacheco (2022)	Elementary School / Graphic Representations	BDTD Thesis	Co-creation and teacher training	Teacher-student interaction	Analysis limited to the products generated
9	Müller (2015)	Teaching calculus / multimodality	BDTD thesis	Error analysis and *design*	Active collaboration and methodological innovation	Application restricted to specific content
10	Santos (2020)	Public education / sciences	BDTD thesis	Creative imagination	Comprehensive education and creativity	Small sample size
11	Amaral (2024)	Games and neuroscience	BDTD thesis	Interdisciplinarity and *design*	Use of the brain-computer interface	Highly technological context
12	Pelli (2024)	Higher education / virtual geometry	BDTD thesis	Digital inclusion	Adaptation in times of pandemic	Situational and emergency generalization

Source: The Authors

For future improvements in studies in the field in the school context, a fundamental point would be self-criticism and the proposal of new elements for intervention between education professionals and the cooperative production of knowledge, as mentioned previously in the production of a guide for teachers (Avila, 2022). In addition, it would be essential to invest in ongoing pedagogical training, promoting the projection of knowledge by *design* between contexts locally and globally (Fontana; Conte; Habowski, 2019; Guimarães, 2020).

4 Challenges of PBD in Brazil

Although innovative, PBD faces significant challenges, including the lack of comparative data between traditional and innovative methods, insufficient continuing education for PBD-based practices, and the difficulty of generalizing results to different socioeconomic contexts. These limitations suggest the need for further research to consolidate PBD. PBD proposes an empirical and participatory approach, focused on solving real problems in teaching and learning processes. However, it is necessary to take a critical look at the practical impact of these methodologies in comparison to

traditional educational methods, as well as to analyze the extent to which the results obtained in PBD studies can be made flexible and contextualized in other academic contexts.

Some studies use PBD or DBR in the field of education and propose a conceptual framework for the investigative process, according to the following steps: 1. Grounding, designing, and leading: Establishing the vision, theorizing, data collection, and defining the approach. 2. Conjecturing: Manifestation (projections), Mediation Processes with Teachers, Defining Artifact (Pedagogical Approach). 3. Wholeness of relationships (establishing relationships): Creating, Testing, (Re)conjecturing, Realigning *Design* and Method, Reorganizing Contextual Requirements, and Data Collection Adjustments. 4. Reflecting: Reviewing Hypothesis, Adjusting Domain Theories, New Perceptions and Knowledge Constructions, Reviewing *Design* Principles and Processes for Sharing. (Jobim; Giraffa, 2024).

In turn, the guidelines of Scott, Wenderoth, and Doherty (2020) are divided into three phases following a reflective spiral: a) *Design* - development of theory-based artifacts to solve learning problems; b) Testing - implementation and continuous review of participatory approaches in the classroom; c) Evaluation/reflection - analysis of learning and the environment to (re)evaluate intervention processes, with new proposals in the circularity of investigative coexistence capable of creating and learning together. PBD in the field of education covers interdisciplinary areas and pluralistic training, bringing different and complementary perspectives. These experiences range from books to computers, from science laboratories to research centers, relating perspectives on education from the conceptual to the school floor.

Given this, the first step in the research in the BDTD repository of Brazilian theses and dissertations consisted of a preliminary search of academic publications, using the keywords: *Design-based* research and education without quotation marks[9]. This initial procedure aimed to identify the breadth and diversity of works that have addressed the theme over the last ten years. When conducting this broad search, we found a significant number of occurrences, indicating the relevance and growing interest in the application of DBP in the field of education. However, bringing this extensive survey to light also generated a large volume of works on how DBP has been discussed and applied in educational contexts.

Given the high number of results found in the first search, we refined the search terms by placing quotation marks around the keywords "*design-based* research" and "education" to restrict the results to works that specifically discuss the relationship between these concepts. This step aimed to increase the accuracy of the search, reducing the amount of works and making the findings more specific to our research needs. This refined search also revealed a set of theses that discuss the use of DBR as a methodological strategy to address contemporary challenges in education, such as the integration of digital technologies and the development of more participatory curricula.

With the refinement of the search, we selected six theses for reading and in-depth analysis. The theses, spanning from 2014 to the present, explore various approaches to Design-Based Research within the educational context. Among the recurring themes, the emphasis on the co-creation of academic solutions and the importance of open dialogue between researchers and participants as a mechanism for the collective construction of knowledge stand out. The works analyzed provided theoretical and practical contributions to DBR, focusing on the implementation of collaborative projects that seek to transform the educational environment, integrating dialogues with new technologies and rethinking ways of educating. The analysis of the works included the identification of emerging categories, such as pedagogical innovation, the role of digital technologies, and the active participation of students and teachers in the construction of solutions to complex educational problems. Based on these readings, we developed a research framework, which will also be used to support the next phase of the investigation, orchestrating practices in a specific educational environment, with a focus on co-creation, open dialogue, and flexible and collective construction of (act/re) cognition.

Table 4 - Theses related to PBD in the field of education

Thesis	Authors	Objective	Methodology	Results/Contributions
The Implementation of Media in Mobile Devices	Mülbert (2024)	Propose a framework for the implementation of mobile media in higher education.	DBR with collaborative intervention cycles.	Development of large-scale sustainable educational interventions.
Transversal Insertion Program of GRS in Elementary School 1	Pacheco (2022)	Promote the collaborative construction of knowledge with Graphic Synthesis Representations (GRS).	DBR focused on participatory practices.	Contribution to collaborative practices between teachers and students in Elementary School.

Multimodal Learning Objects and the Teaching of Calculus	Müller (2015)	Test multimodal learning objects to overcome difficulties in teaching Calculus.	DBR with error analysis and collaboration.	Improvement in the teaching of Calculus through multimodal objects and collaboration between students and teachers.
Contributions of Creative and Meaningful Learning in Science Education	Santos (2020)	Explore creative and meaningful learning in science education.	DBR with an interdisciplinary approach.	Promotion of children's holistic education through creative and investigative practices.
Development of Educational Games and Brain-Computer Interface	Amaral (2024)	Develop educational games with brain-computer interface.	DBR focused on neuroscience and design.	Stimulation of cognitive aspects in the learning process through educational games.
Virtual Learning of Euclidean Geometry in Digital Spaces	Pelli (2024)	Investigate the interaction between students and digital media in the teaching of Geometry.	DBR with adaptation to the virtual environment.	Adaptation of teaching practices to the virtual environment, promoting inclusive learning.

Source: The Authors

Below are the main characteristics of these works, grouped into the categories mentioned above:

a) Participatory methodologies and co-creation: The first thesis, the *implementation of media on mobile devices: a framework for large-scale and sustainable application in distance education*, by Mülbert (2024), proposes a framework for the implementation of mobile media in higher education, using PBD to develop educational interventions in collaboration with professionals in the field. The focus on cycles of interventions with experts and students reflects the emphasis on co-creation and active participation of those involved. On this topic, there is also similar research on the validation of technologies with *a framework for podcast design,* making it possible to consider "[...] the relevance of revisiting the foundations of educational technology, formulating new proposals for different training practices." (Herarth; Wunsch; Bottentuit Junior, 2021, p. 491).

In Pacheco's thesis (2022), *Cross-cutting insertion program of GSR - Graphical Synthesis Representations - in Elementary School*[1]*,* addresses the use of Graphical Synthesis Representations (GSR) as a resource that promotes the collaborative construction of knowledge between teachers and students in Elementary School 1, contributing to participatory and co-creation practices. In turn, Müller's (2015) thesis, *Multimodal Learning Objects and Calculus Teaching: A Proposal Based on Error Analysis,* when testing multimodal learning objects, promoted collaboration between students and teachers to overcome difficulties in teaching calculus.

b) Interdisciplinarity and creative imagination: Santos' thesis (2020), *Contributions of creative learning, meaningful learning, and inquiry-based teaching to the comprehensive education of children in public schools,* which explores creative and meaningful learning in science education, stands out for its interdisciplinary approach, integrating different areas of knowledge to promote the comprehensive education of children. *The Programmers Club* project highlights the use of creative imagination by involving students in the construction of real and functional products. Amaral's (2024) research, *Development of educational games and their cognitive characterization through the brain-computer interface,* focused on the development of educational games through this interface, also explores interdisciplinarity by combining neuroscience and game *design* to stimulate cognitive aspects in the learning process.

c) Openness to diversity in inclusive and co-authored research practices. In Pelli's thesis (2024), *Virtual learning of spatial Euclidean geometry: interactions between higher education students and digital media,* which investigates the interaction between students and digital media in the teaching of Spatial Euclidean Geometry, PBD is used in an inclusive learning context, adapting teaching practices to the virtual environment during the pandemic. This thesis reflects a co-authorial practice by integrating the voices of students and teachers in a process of knowledge construction in challenging times. Santos' thesis (2020) also aligns with this category, as it promotes a diversified approach to science teaching, focusing on investigative processes that value the diversity of materials and experiences. These theses explore PBD in different educational contexts and approach the categories by promoting co-creation and active participation (Mülbert, 2015; Pacheco, 2022), fostering interdisciplinary dialogue and the use of creative imagination (Santos, 2020; Amaral, 2024), and by opening space for inclusive and co-authored investigative practices (Pelli, 2024; Santos, 2020). These categories help map the commonalities and paths of inquiry about PBD in the field of education.

The studies reviewed indicate that PBD promotes educational innovation by encouraging co-creation and open dialogue between teachers, students, and researchers. This approach allows for continuous contextualization of methods to the specific needs of participants, increasing motivation and engagement. However, a persistent question is the ability of these approaches to generate sustainable, long-

term results, especially when compared to traditional educational methods, which tend to be based on proven and widely accepted practices.

Analysis of PBL studies reveals a strong trend toward incorporating digital technologies and creating interactive learning environments. For example, the introduction of educational games, virtual laboratories, and collaborative methodologies has the potential to transform the way students interact with content and with each other. However, the reflective praxis of these interventions still requires more robust empirical validation. It is necessary to verify whether these innovative practices actually improve learning processes in the long term or whether the results are only temporary and specific to the context in which they were carried out.

When discussing PBD, a significant limitation is its situational nature, that is, many studies present results that are highly dependent on the context in which they were developed (with access to advanced technologies for schools and institutions), making it difficult to generalize the findings. Another challenge is the ongoing training of professionals to conduct PBD-based research and pedagogical practices. Inquiry-based teaching seems to guide PBD, which requires a balance between the social roles of teacher, *designer,* researcher of one's own practice, and the ability to redesign theories and practices with others and according to real-time data. Most teachers, however, do not have adequate time for research and working conditions to record these complex approaches, especially if they do not obtain support from colleagues in interdisciplinary proposals for cting. Alves (2017), Amaral (2024), and Hernando, Catasús, and Arévalo (2018) serve as references to emphasize practical feasibility and (inter)cultural projections, while Wang and Hannafin (2005) address discussions about training challenges, pointing out limitations that could enrich the understanding of the complexity of the PBD field in educational environments with different citizenship-oriented research (Scott; Wenderoth; Doherty, 2020; Barab; Squire, 2004).

The main trends include interdisciplinary approaches: games, PBD, *Design Thinking,* Co-creation and student leadership, and expanded use of educational technologies (virtual laboratories, multimodality). The gaps point to: Lack of comparative data between traditional and innovative methods; Lack of continuing education for PBD practices; Absence of research on long-term impacts and in diverse socioeconomic contexts.

The limitations in PBD studies are, in many cases, the lack of more robust details, which would enable the reinvention of research in different contexts. The review of the studies showed that, although several approaches explore interdisciplinarity and co-creation, there is a lack of comparative data demonstrating the impacts of these investigative practices in relation to traditional methods. This absence of critical evaluation of the advantages and limitations of innovative approaches in debates on research expressions and logic makes it difficult for educators to discuss the elements of these practices in their school realities.

Future studies could, for example, investigate how PBD can be structured for different cultural and socioeconomic contexts, exploring experimentation in public and private schools and with varying levels of access to technologies. In addition, comparisons between PBD practices and traditional methodologies could offer a broader view of the dialogical and intercultural elements and sociocultural contradictions in the different approaches in their processes. It is essential to adopt investigative approaches that promote reflections aimed at addressing concrete situations. The more we reflect on the educational reality and its concrete condition, the more we become aware of our (co)responsibility in creating strategies to act and transform it.

It is up to us to promote a procedural, humanizing, and innovative education through cooperative work that involves modeling capabilities to create and prototype solutions relevant to the challenges of today's world. It is essential to build a curriculum in action focused on *design* thinking as a central axis that stimulates the construction of knowledge and the relational participation of individuals. This approach is based on the dialectic that (re)constructs the understanding of the world through interaction with technologies that, in turn, evolve and transform themselves based on creativity and human action. This symbiotic relationship between humans and technologies opens the way for the experimentation of hypotheses and the inventiveness of different processes, allowing individuals to test ideas, reflect together on reality, review results, and thus construct proposals for improvement.

5 Final considerations

Based on the analysis of the studies reviewed, it can be concluded that PBD has been valued in Brazilian literature for its ability to articulate tradition and innovation,

theory and practice, establishing itself as a methodological approach that fosters collective protagonism and the co-creation of knowledge. The works analyzed highlight the potential of PBD to build more dialogical, inclusive, and sensitive school environments to sociocultural diversity, while encouraging experimentation and continuous redesign of pedagogical practices.

However, it is essential to note that these conclusions are based exclusively on a bibliographic survey, based on studies that, for the most part, present contextual excerpts and do not comparatively explore their results in relation to traditional methodologies. Thus, there is a need to expand empirical research, mainly longitudinal and comparative studies, which can more accurately assess the impacts of PBD in different educational contexts.

Finally, it is essential to reinforce the importance of consolidating collaborative networks between universities and schools, capable of enhancing training processes that favor the critical and creative integration of PBD in teaching practices. Such a movement contributes to the strengthening of humanizing and democratic education, guided by co-responsibility and commitment to the collective construction of knowledge. It is recognized that the adoption of PBD in education contributes to shifting the focus of teaching from methods and content to a scientific and projective pedagogy guided by problematization, experimentation, questioning, and co-responsibility, opening paths to a democratic school that celebrates the humanities, diversity, creativity, and dialogue as the foundations of lively and transformative learning.

Innovation in education, within PBD, occurs by integrating co-creation and real-world problem solving as central strategies for educational engagement in which everyone is part of this research and learning redesign roadmaps. During the analysis of the studies reviewed, some key questions were answered, including: PBD proved to be viable in promoting active and supportive engagement among teachers, researchers, and students, creating collaborative and humanized learning environments that encourage experimentation, creative imagination, and the will to learn, to read reality, and to co-create learning. The analysis answered the questions initially proposed by demonstrating that PBD has the potential to foster collaborative and contextualized educational practices. However, the absence of longitudinal data and the predominance of descriptive studies limit the generalization of the findings. Further empirical research is recommended, especially with experimental or quasi-

experimental designs, to evaluate the uses of PBD compared to traditional pedagogical approaches.

Although the study has advanced on several issues, some questions remain open, pointing to future investigations that can be speculated and validated in educational contexts with different technological and socioeconomic limitations, to the extent that hypotheses in vulnerable and disadvantaged environments can also be investigated and generalized. Another open question is whether the variety of educational contexts and experiments in PBD has longitudinal effects in relation to the contextual universe of this approach in cultural circles, and whether they could offer a deeper understanding of the critical challenges for a humanizing education focused on social criticism. As described in the theoretical section, PBD transforms educational practices by integrating tradition and innovation.

Finally, the methodology increases the protagonism of participants. It promotes inclusive learning, opening up possibilities for questioning or resistance, becoming indispensable in helping teachers reframe their activity from its deepest core, enabling consistent articulation between everyday classroom practice and social demands, the contradictory social needs, and the horizon of possibilities opened up by PBD to encounters in the search for critical, experimental, and democratic knowledge, to manage and pursue, to build and respect students' creativity and fears, to not give up, to join with others to do things differently. Ultimately, such initiatives translate into cultural products of experiences, socialities, and ways of thinking that are interchangeable in educational contexts, whose paths of cooperation mobilize ways of thinking about protagonism and humanized work, the experimentation of critical literacies, and the construction of new sociocultural meanings.

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