European Public & Social Innovation Review

ISSN 2529-9824

Research article

Hands-on science education in elementary schools: challenges and gaps in Brazil

Educación científica basada en la experimentación en la escuela primaria: desafíos y brechas en Brasil

João Batista da Silva[1]: State University of Ceará (UECE), Brazil.
joaobatista.silva@aluno.uece.br
Luís Carlos Assis da Costa: Federal University of Ceará (UFC), Brazil.
luiscarlos.costa@educacao.fortaleza.ce.gov.br
José Nilson dos Santos: Fametro University Center (UNIFAMETRO), Brazil.
jsantostar@alu.ufc.br
Raquel Oliveira da Silva Batista: Fametro University Center (UNIFAMETRO), Brazil.
raquel.batista01@aluno.unifametro.edu.br
Givaldo Henrique dos Santos: Federal University of Ceará (UFC), Brazil.
givaldo.santos@educacao.fortaleza.ce.gov.br
Aline de Oliveira Rebouças: University of Fortaleza (UNIFOR), Brazil.
aline.reboucas@aluno.uece.br
Patrícia Félix Duarte: State University of Ceará (UECE), Brazil.
patricia.felix@aluno.uece.br
Carlos Kley Araujo Costa: State University of Ceará (UECE), Brazil.
carlos.kley@educacao.fortaleza.ce.gov.br
José Gleison Gomes Capistrano: Federal Institute of Education, Science and Technology of Ceará (IFCE), Brazil.
josegleison.gomes@educacao.fortaleza.ce.gov.br
Solonildo Almeida da Silva: Federal Institute of Education, Science and Technology of Ceará (IFCE), Brazil.
solonildo@ifce.edu.br
Sandro César Silveira Jucá: Federal Institute of Education, Science and Technology of Ceará (IFCE), Brazil.
sandro@ifce.edu.br

Reception Date: 09/08/2025

Acceptance Date: 10/09/2025

Publication Date: 15/09/2025

[1] **Corresponding author:** João Batista da Silva. State University of Ceará (Brazil).

How to cite the article

Batista da Silva, J., da Costa, L. C. A, dos Santos, J. N., da Silva Batista, R. O., dos Santos, G. H., de Oliveira Rebouças, A., Félix Duarte, P., Araujo Costa, C. K., Gomes Capistrano, J. G., da Silva, S. A., & Jucá, S. C. S. (2026). Hands-on science education in elementary schools: challenges and gaps in Brazil [Educación científica basada en la experimentación en la escuela primaria: desafíos y brechas en Brasil] *European Public & Social Innovation Review*, 11, 01-18. https://doi.org/10.31637/epsir-2026-1919

Abstract

Introduction: The purpose of this article was to map research on hands-on activities in science education in the elementary school in Brazil. **Methodology:** To this end, a Systematic Literature Review (SLR) was conducted from high-quality databases, including Web of Science, Scopus, Dialnet, and CAPES Periodicals Portal, from 2013 to 2023. **Results:** The results revealed that the 2nd and 5th grades of elementary school were the most investigated, possibly because these school grades are subject to large-scale diagnostic assessments in Brazil. We highlight the lack of studies involving students with disabilities. Furthermore, we observed a concentration of research in the South and Southeast regions of Brazil, with less representation in the North, Northeast and Central-West regions. **Discussions:** We believe that part of the difficulty in implementing hands-on activities in elementary schools is related to the lack of physical structure and adequate teacher training. **Conclusions:** Finally, although the focus of this study is on the Brazilian educational context, the challenges and gaps identified resonate with global educational issues, particularly in developing countries.

Keywords: science education; science teaching; hands-on activities; experimental activities; scientific practices; experimentation; elementary education; natural sciences.

Resumen

Introducción: El propósito de este artículo fue cartografiar la investigación sobre actividades experimentales en la enseñanza de las ciencias en la escuela primaria en Brasil. **Metodología:** Para ello, se realizó una Revisión Sistemática de la Literatura (RSL) a partir de bases de datos de alta calidad, incluyendo Web of Science, Scopus, Dialnet y el Portal de Periódicos de CAPES, en el periodo de 2013 a 2023. **Resultados:** Los resultados revelaron que los cursos de 2º y 5º grado de la escuela primaria fueron los más investigados, posiblemente porque estas etapas escolares están sujetas a evaluaciones diagnósticas a gran escala en Brasil. Se destaca la falta de estudios que involucren a estudiantes con discapacidad. Además, se observó una concentración de investigaciones en las regiones Sur y Sudeste de Brasil, con menor representación en las regiones Norte, Nordeste y Centro-Oeste. **Discusión:** Consideramos que parte de la dificultad para implementar actividades experimentales en la escuela primaria está relacionada con la falta de infraestructura física adecuada y con la formación docente. **Conclusiones:** Finalmente, aunque el enfoque de este estudio está en el contexto educativo brasileño, los desafíos y brechas identificados resuenan con problemáticas educativas globales, particularmente en países en desarrollo.

Palabras clave: educación en ciencias; enseñanza de las ciencias; actividades prácticas; actividades experimentales; prácticas científicas; experimentación; educación primaria; ciencias naturales.

1. Introduction

In Brazil, elementary school is a stage of basic education structured in two periods: the initial years (from 1st to 5th grade) and the final years (from 6th to 9th grade). Each period has specific objectives and characteristics, which directly influence teaching methodologies and the cognitive development of students (Fialho & Sousa, 2021). In the context of teaching Natural Sciences, this organization is reflected in the performance of different professionals, whose training and pedagogical practices vary according to the demands of each phase (Reis & Mortimer, 2020).

In the initial years, science classes are taught by professionals who have graduated in a full degree course in Pedagogy (Brzezinsk, 2008). These teachers have generalist training (Smyth & Hamel, 2016), which covers two main axes: disciplinary content (appropriation of knowledge of Mathematics, Portuguese Language, History, Geography, Science, and others subjects) and pedagogical content (aimed at mastering methods, strategies, and teaching resources appropriate to the specific needs of each stage of schooling).

At this stage in students' lives, science education plays an introductory role, prioritizing the development of fundamental skills and promoting students' natural curiosity (Pereira & Sampaio, 2024). Pedagogical activities are planned to encourage exploration of the environment, observation and the practice of simple experiments, consolidating an initial basis for scientific literacy. This approach aims to foster students' interest in research and understanding of the natural world, in addition to preparing the ground for more complex learning in later stages of education.

In the final years of elementary school, classes are taught by teachers with interdisciplinary training, predominantly in undergraduate courses (Biology, Physics or Chemistry), which requires a great effort from teachers to integrate the different disciplinary knowledge that makes up science (Reis & Mortimer, 2020). Professionals teaching in the final years have in-depth knowledge in their areas of expertise and are exclusively responsible for the subject of Natural Sciences, allowing for a more detailed and analytical approach to scientific topics (Pereira & Sampaio, 2024; Sganzerla et al., 2022).

Reis and Mortimer (2020) argue that the training of academics who will work as science teachers in elementary education should be focused on learning based on prior experiences. However, in Brazil, the challenges of teaching Natural Sciences are great, especially in basic education (Silva et al., 2018; Moreira, 2021). The situation is worse when it comes to teaching science in the elementary school, generally serving students between 6 and 10 years of age (Moraes & Diniz).

There are several challenges to implementing experimental activities: weaknesses in the initial training of teachers who teach science (Chemistry, Physics, and Biology) in elementary school (Nunes et al., 2010; Paula et al., 2017); lack of adequate physical structure, especially science laboratories; insufficient workload for teaching the subject, often limited to two hours per week; among others (Silva et al., 2024). The insufficient workload is related to the schools' focus on external evaluations, since they prioritize the teaching of Portuguese and Mathematics to the detriment of science (Pereira et al., 2016; Bergmann et al., 2017).

Bergmann et al., 2017 emphasize that the lack of structure, the lack of knowledge and the lack of material resources are elements that make up the tripod for the adequate implementation of experimental activities.

Furthermore, the lack of support from management, the lack of pedagogical guidance and the lack of preparation in teaching staff training courses are also some of the factors responsible for the fact that teachers do not use experimentation in a continuous and systematic way (Ramos & Rosa, 2008).

Experimentation is very important for the development of scientific thinking (Rosa et al., 2013). In this article, we consider hands-on activities as any science teaching or learning activity in which students observe and/or manipulate the objects or materials they are studying. Whether this activity is conducted individually or in small groups (Millar, 2010; Marounová & Kácovský, 2022). Scientific literature indicates that hands-on activities in science education, from the early years, tend to awaken children's interest in natural phenomena (Pereira et al., 2016; Marounová & Kácovský, 2022).

In addition, experimental activities can contribute to the development of affection, respect for divergent opinions and the appreciation of group work (Silva & Serra, 2013). However, most research on this topic is theoretical and discursive, and there is still little empirical research on the importance of experimentation in science education, particularly in the elementary school (Silva & Serra, 2013; Rosa et al., 2013; Lima et al., 2017; Biagini & Gonçalves, 2017; Heldt et al., 2018; Porto & Almeida, 2018; Cardoso et al., 2019; Mendonça et al., 2020; Jesus & Santos, 2020; Oliveira et al., 2020; Sasseron, 2021; Santo et al., 2021; Souza et al., 2021).

Thus, this study was guided by the following general research question: What is the current state of research on experimental activities in science education for elementary school students in Brazil? Accordingly, the purpose of this article is to examine Brazilian academic production on hands-on activities in science education at this level from 2013 to 2023. To achieve this, a Systematic Literature Review (SLR) was conducted, guided by the following Research Questions (RQ):

QP 1: Which grade levels have been most investigated?

QP 2: What is the average sample size?

QP 3: What are the main topics covered?

QP 4: Which studies focus on the inclusion of students with disabilities?

QP 5: How are research studies on experimental activities in science education distributed across Brazil?

In view of this, hands-on experiences play an essential role in the development of critical thinking, in the construction of scientific concepts and in the understanding of the scientific method by students. In the context of elementary education, this approach is particularly important as it aligns with a school period in which students consolidate investigative skills and deepen their knowledge of natural sciences.

Therefore, understanding how Brazilian researchers are approaching this topic is important to identify trends, gaps, and opportunities for research in science education. Given the relevance that science education research plays in the formulation and improvement of educational policies in Brazil, the results of this research may be useful for several other countries that face similar problems in relation to their educational structure.

2. Methodology

2.1. Data Collection

A Systematic Literature Review (SLR) was conducted using the PRISMA protocol (Page et al., 2021). This protocol guided the development of clearly defined, pre-formulated research questions, as detailed in the introduction section. Furthermore, following the recommendations of Klun et al. (2003), Roever (2017), and Durso & Arruda (2022), rigorous methods were employed to identify and critically assess highly relevant studies on the investigated topic.

To identify relevant studies in the literature, we used four databases: Web of Science, Scopus, Dialnet, and the CAPES Periodicals Portal. The CAPES Periodicals Portal, maintained by the Brazilian government, provides access to thousands of scientific journals and various databases, such as Scopus and Web of Science, for researchers affiliated with educational and research institutions in Brazil. Dialnet is a database that brings together Latin American periodicals and provides access to a large volume of scientific content, especially focused on publications in Spanish and Portuguese.

2.2. Search Strategy

On September 10, 2024, a scientific search was conducted using a research protocol that combined the following terms: "hands-on activities", "experimental activities", "experimentation", "experimental practices", "science education", "science teaching" and "elementary education". Based on these terms, the general search expression was created (Table 1).

Table 1.

General search expression used in databases

Language	Search terms
Portuguese	("atividade experimental" OR "atividades experimentais" OR "experimentacao" OR "praticas experimentais") AND "ensino de ciencias" AND "ensino fundamental"
English	("Hands-on activities" OR "experimental activities" OR experimentation OR "experimental practices") AND ("science teaching" OR "science education") AND "elementary school"

Source: Own elaboration (2024).

2.3. Inclusion and Exclusion Criteria

After determining the language, inclusion and exclusion criteria were developed (Table 2). These criteria were developed to ensure that only relevant and high-quality studies were considered, increasing the validity and reliability of the research results.

Table 2.

Inclusion and exclusion criteria used in the search and selection of studies

Criteria	ID	Description
Inclusion	I1	Articles published in journals between 2013 and 2023.
	I2	Articles written in Portuguese and English.
	I3	Articles that contain the search terms in the title, abstract, or keywords.
	I4	Applied research in Brazil.
	I5	Research on the teaching of applied sciences in schools with students.
Exclusion	E1	Duplicate Articles.
	E2	Articles not available in full online.
	E3	Articles that are only theoretical, without practical application.
	E4	Articles applied in other school stages (Middle School, high school, higher education).
	E5	Research applied in teacher training programs.
	E6	Articles that was not carried out at school, but only in university laboratories, teacher training centers, among others.

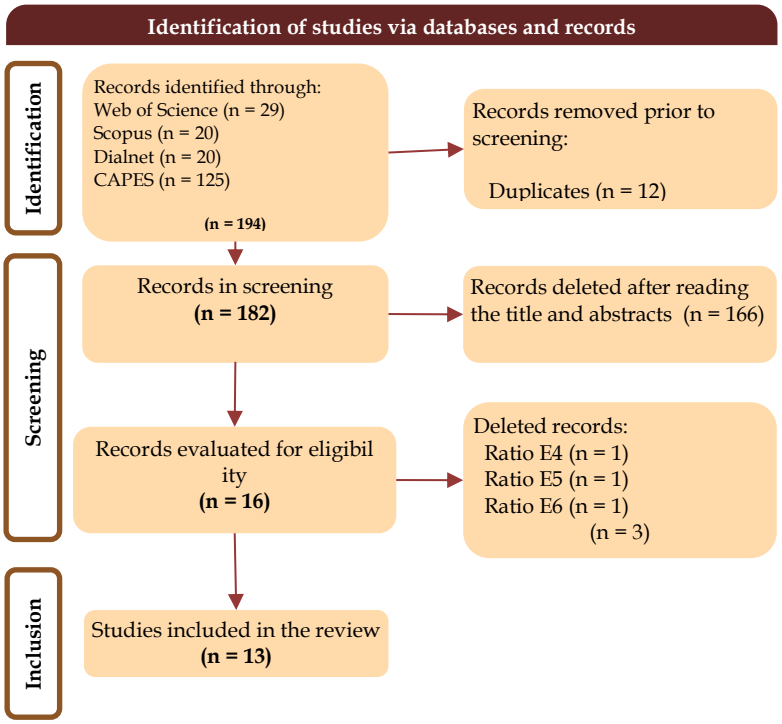
Source: Own elaboration (2024).

2.4 Selection of Studies

Considering the inclusion and exclusion criteria, 194 papers were identified (Table 1). After the initial identification, we proceeded with the removal of 12 duplicate papers. A summary of the results by database can be seen in the flowchart (Figure 1) that illustrates the number of papers considered in each stage of the process of selection and analysis of the papers, from the initial identification to the final inclusion phase, providing a clear and systematic view of the method used in the research.

Figure 1.

PRISMA Flow Diagram used for systematic filtering of articles



Source: Own elaboration (2024).

During the screening, the titles and abstracts of the 182 studies were analyzed to verify their relevance according to the inclusion and exclusion criteria. At the end of this stage, 166 studies were eliminated because they did not meet the criteria (Table 2), leaving 16 studies that were read in full. After the full reading, 13 studies were included in the review.

3. Results and Discussion

En la sección de resultados, se presentan los datos obtenidos de manera organizada y sistemática, usando tablas, figuras, y análisis estadístico para ilustrar los hallazgos principales. Esta sección se enfoca en exponer los resultados de manera objetiva, evitando interpretaciones o conclusiones prematuras, y destacando cómo estos hallazgos se alinean o desvían de las expectativas basadas en los objetivos o hipótesis planteadas.

Table 3 summarizes the 13 selected studies, organized by year of publication, authors, and title. These studies represent a significant contribution to the understanding of the role of hands-on activities in the teaching and learning process in the elementary school.

Table 3

Studies included in the review

Year	Authors	Title
2013	Silva & Serra	Research on experimental activities of physical knowledge in the initial series
2013	Rosa et al.	Estudo de conceitos físicos no ensino fundamental: Atividades experimentais e modelagem matemática
2017	Lima et al.	Experimental activities in the early years of elementary school: a methodological tool for construction of the teaching-learning process
2017	Biagini e Gonçalves	Experimental activities in the early years of elementary school: analysis on a backdrop with blind students
2018	Heldt et al.	Physics in the early years of elementary school: activities on frictional electrification to encourage scientific and technical literacy
2018	Porto & Almeida (2018)	Practical activities in the classes of science in the initial years: pathways for significant learning and for scientific literacy
2019	Cardoso et al.	Chemistry teaching for children: from childhood curiosity to training for citizenship
2020	Mendonça et al.	Projeto de Extensão Brincando com a Física: instigando a curiosidade e o espírito investigativo nas séries iniciais a partir da experimentação e do lúdico.
2020	Jesus & Santos	Experimentation as a facilitator for education: action research in science education in the second year of fundamental education
2020	Oliveira et al.	A percepção dos sentidos e significados no processo de aprendizagem de ciências da natureza nos anos iniciais do ensino fundamental
2021	Sasseron	Constitutive practices of inquiry planned by students in science lesson: analysis of an example
2021	Santo et al.	Use of technology in the development of electronic educational games for the promotion of oral health and environmental education
2021	Souza et al.	Awakening to the Sciences

Source: Own elaboration (2024).

It is worth noting that the fact that only 13 studies were found does not necessarily mean that there are no more studies on this topic. However, using the research protocol, we detected only this amount. Therefore, we believe that these results are sufficient to answer the research questions and meet the objective of this study. Thus, with the results in hand, we sought to answer the following research questions (RQ), presented previously in the introduction to this article.

3.1. The most investigated grade levels in elementary education

The analysis of the included studies revealed that, of the 13 studies reviewed, only 2 involved 1st-grade students (Souza et al., 2021; Sasseron, 2021), 7 addressed the 2nd grade (Silva & Serra, 2013; Lima et al., 2017; Jesus & Santos, 2020; Oliveira et al., 2020; Santo et al., 2021; Souza et al., 2021; Sasseron, 2021), 4 dealt with the 3rd grade (Biagini & Gonçalves, 2017; Cardoso et al., 2019; Souza et al., 2021; Sasseron, 2021), 3 examined the 4th grade (Mendonça et al., 2020; Souza et al., 2021; Sasseron, 2021), and 5 studies included the 5th grade (Rosa et al., 2013; Heldt et al., 2018; Porto & Almeida, 2018; Souza et al., 2021; Sasseron, 2021).

The results showed that there is a lack of research involving experimental activities in elementary school, since we only found 13 studies. In addition, we noticed that few investigations work with the 1st and 4th grades of elementary school, which reinforces the evidence of a gap in this field of research that has not yet been fully explored. The most studied grades were the 2nd and 5th grades of elementary school.

We believe that the emphasis given to the 2nd and 5th grades in academic studies reflects both the pedagogical relevance of these stages and the influence of public policies and large-scale diagnostic assessments (Vidal et al., 2024), such as the Basic Education Assessment System (Saeb), which focuses on monitoring and improving the quality of basic education in Brazil (Costa, 2023). Teachers at this stage often participate in ongoing training and institutional initiatives that favor the implementation of new methodologies and pedagogical approaches (Brzezinski, 2008). This engagement not only enhances innovation in teaching practices, but also facilitates researchers' access to classrooms and data collection.

3.2. The average sample size

In general, the average sample size was 22 students per study. This is a very significant sample size because these are intervention studies, deserving special care, especially with students in this age group. It is worth noting that only two studies did not report the sample size (Porto & Almeida, 2018; Oliveira et al., 2020).

The results of the analysis indicate that the study conducted by Souza et al. (2021) presented the largest sample among the studies analyzed, covering a total of 150 participants distributed among five school grades, from 1st to 5th grade of elementary school. This data is significant, as it contrasts with the sample profile observed in the other studies reviewed, which generally worked with smaller groups.

Another relevant aspect identified is that all the studies analyzed adopted a qualitative approach, highlighting the use of observation as the main data collection instrument. This methodological pattern reflects the researchers' interest in understanding educational phenomena in depth, prioritizing contextual and subjective aspects of pedagogical interactions and teaching-learning processes.

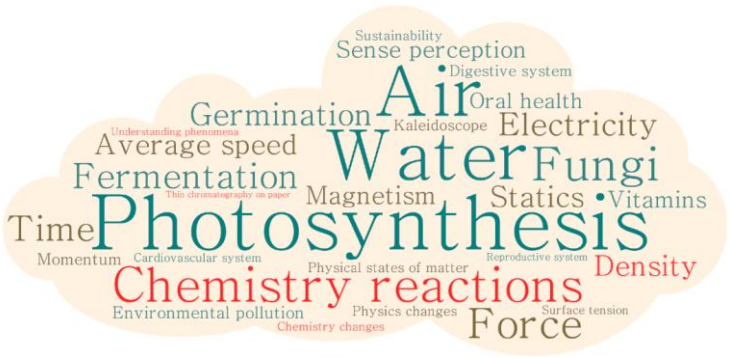
On the other hand, it is important to note that the absence of a quantitative approach may limit the generalization of results. The lack of numerical data or statistical analyses may make it difficult to identify patterns and compare different educational contexts. In addition, the qualitative approach, although rich in details, may be more subjective, depending on the researcher's interpretation, which may generate greater variability in results. A balance between qualitative and quantitative approaches could enrich research, providing a more comprehensive understanding of the impact of experimental practices on science education.

3.3. The main topics covered

Regarding the contents covered, we found a wide variety: water, water treatment and use, fermentation, circulatory system, respiratory system, reproductive system, photosynthesis, germination, kaleidoscope, among others (Figure 2). Some studies carried out activities with more than one content area (Porto & Almeida, 2018; Souza et al., 2021). We believe that the diversity of content is related to the complexity of training to teach science, which is based on knowledge from three major areas: Chemistry, Physics, and Biology.

Figure 2

Main topics covered in hands-on activities



Source: Own elaboration (2024).

The content covered in the pedagogical practices analyzed reveals a wide thematic diversity, including topics such as water and its treatment, fermentation, circulatory, respiratory, and reproductive systems, as well as processes such as photosynthesis and germination, and even objects such as the kaleidoscope, among others. In some cases, the pedagogical activities covered more than one topic simultaneously (Porto & Almeida, 2018; Souza et al., 2021). This diversity can be interpreted as a reflection of the complexity inherent in teacher training in Natural Sciences, which integrates knowledge from three major fields: Chemistry, Physics, and Biology.

The intersection of these fields imposes on educators the challenge of articulating different scientific perspectives in their teaching practices. This requires not only theoretical mastery but also the ability to contextualize concepts in a way that is meaningful to students. This multidisciplinary approach is essential to respond to the contemporary demands of science education, which seeks to educate critical citizens capable of understanding and interacting with natural and technological phenomena in an integrated manner (Cardoso et al., 2019).

In addition, the diversity of content reflects the need for educators to adapt to the specificities of each class, school context, and pedagogical objectives. This flexibility is crucial to promote meaningful learning that transcends the mere memorization of information and stimulates the development of scientific and investigative skills (Mendonça et al., 2020).

3.4. Research focused on the inclusion of students with disabilities

Through the results, we realized that the inclusion of students with disabilities in hands-on activities in the classroom is still far from what is desired. This can be evidenced by the existence of only one study (Biagini & Gonçalves, 2017) that addressed this issue, highlighting the gap in the academic literature and practical efforts to ensure accessibility and educational equity in the context of experimental activities.

In the study, Biagini and Gonçalves (2017) developed a proposal for multisensory experimentation (touch, smell, hearing, and vision) to teach about the importance of water in a class of 29 students in the 3rd grade of elementary school. The class was divided into groups, and each participant received a task: reader (to read the experiment script aloud); scribe (to record the discussed answers); communicator (to communicate the results to the class); coordinator (to receive the experimental materials, organize their distribution in the group, and guide colleagues in handling them). During the activities, the importance of working on multisensory skills (touch, hearing, smell), the transcription of the experimental script in Braille, and concern for the physical placement of the student were highlighted, placing them in the center of the room to facilitate integration with the other classmates.

This data highlights the importance of developing research that considers the inclusion of people with different disabilities. The lack of studies in this area may indicate that many activities are still not adapted, which limits the access of students with disabilities to learning experiences equivalent to those of other students. According to Nunes et al. (2010), most teachers are not being adequately prepared to receive students with disabilities.

The training of science teachers should focus on adapting to the needs of these students (Nunes et al., 2010) and on reflecting on the implementation of common activities for both students with and without disabilities (Paula et al., 2017). In this sense, inclusion is an essential aspect of equity in educational opportunities, as it ensures that all students, regardless of their physical or sensory limitations, have the same opportunities to participate and learn. Furthermore, adequate inclusion fosters the development of a culture of empathy and understanding in schools.

The scarcity of studies in this area indicates not only a limitation in the development of inclusive pedagogical practices but also a lack of policies and guidelines that encourage research and the adaptation of experimental activities to meet the needs of students with disabilities. This gap reflects a structural and cultural challenge, which involves both the initial and ongoing training of teachers and the provision of material and technological resources that enable accessible experimental practices. Finally, we point out that future studies should include research and development of hands-on experiences aimed at children with disabilities.

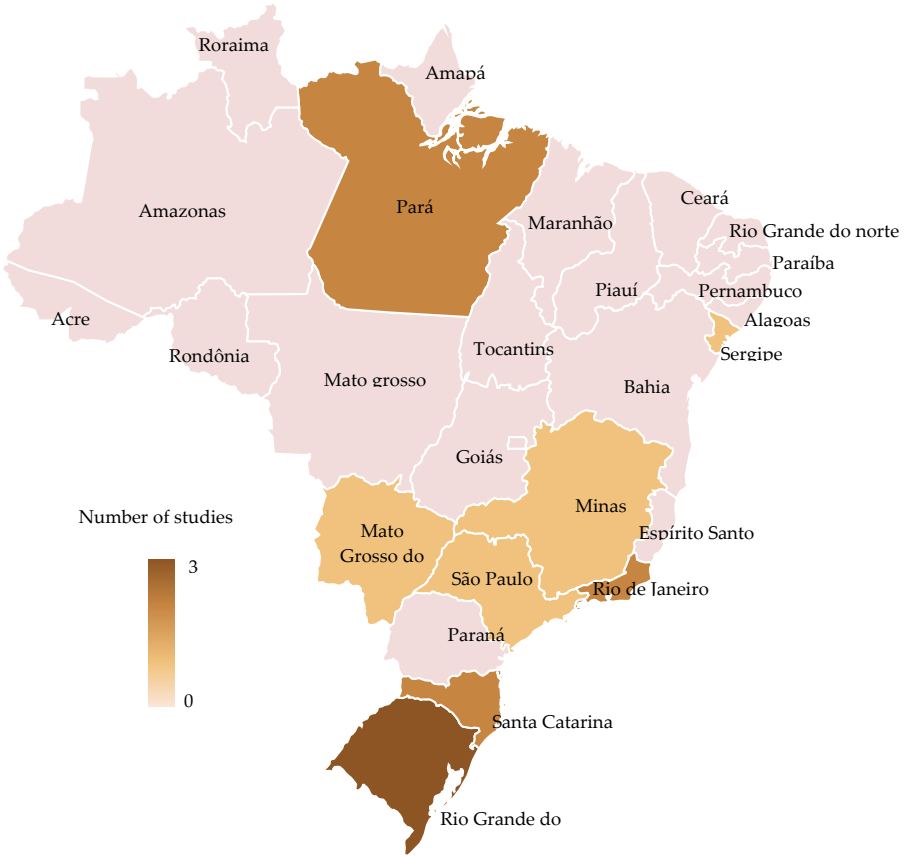
3.5. The geographical distribution of research on experimental activities in science education across Brazil

The data analysis revealed a significant geographic concentration, with these studies being implemented in only eight of the 26 Brazilian states, indicating an inequality in the representation of studies on experimental activities across different regions.

Among the states, Rio Grande do Sul had the highest number of studies implemented, with three studies, followed by Pará, Rio de Janeiro, and Santa Catarina, each with two studies. The states of Mato Grosso do Sul, Minas Gerais, São Paulo, and Sergipe each had only one study. This distribution is presented in Figure 3, which shows the number of studies implemented by state.

Figure 3

Number of studies by Brazilian states where hands-on activities were implemented in elementary school



Source: Own elaboration (2024).

The analysis of the data shows a concentration of research in certain regions, especially in the South and Southeast of the country, with less representation in the North, Northeast, and Central-West regions. This unequal distribution may be associated with factors such as the concentration of research centers in specific geographic areas and differential access to resources for the implementation of experimental activities.

These results suggest the need for policies that encourage the expansion of research on experimental activities in science education in underrepresented states, contributing to greater equity in the provision of practical teaching and learning experiences throughout Brazil.

4. Conclusions

The purpose of this paper was to analyze Brazilian academic production on hands-on activities in science education at the elementary school level from 2013 to 2023. To achieve this purpose, a systematic literature review (SLR) was conducted with full methodological rigor, from the development of the protocol to the data analysis.

The results showed that there is a significant lack of research directed at this stage of education; in total, only 13 studies were found. We believe that other studies may exist in the area; however, using the protocol and the inclusion and exclusion criteria, we were only able to identify these. We believe that part of the difficulty in implementing hands-on activities lies in the lack of teacher training.

The results of this research indicate that the 2nd and 5th grades of elementary school stand out as the most investigated grades in the field of Science education. This trend can be attributed, in part, to the relevance of these grades in large-scale assessments, such as the Basic Education Assessment System (SAEB), which often uses these stages as a reference. In addition, the more active involvement of teachers in these grades in educational projects facilitates data collection for academic studies, making them attractive to researchers.

Analyzing Brazilian academic production, a methodological diversity is observed, with a predominance of qualitative studies that use observation as the main data collection tool. Although this approach is valuable for capturing nuances of the school context, complementing it with quantitative methods and using larger samples are essential for generalizing the results and deepening the understanding of the phenomena investigated. The combination of different methods, such as interviews and questionnaires, may allow for a triangulation of information to enrich the analysis of the data.

Regarding the distribution of content, the research covers the areas of Chemistry, Physics, and Biology in a balanced manner, demonstrating the scientific community's concern with approaching science in a holistic way. However, the geographical distribution of research is uneven, with a concentration in the South and Southeast regions. This disparity reflects the historical and structural inequalities in investment in science and education in the different regions of Brazil.

A significant gap in the literature is the scarcity of studies on the inclusion of people with disabilities in experimental practices. The only research found in this area highlights the need for more studies and public policies that promote accessibility and educational equity. This gap reflects a structural and cultural challenge involving teacher training and the provision of resources.

Despite the focus of this study being on the Brazilian educational context, the challenges and gaps identified in the implementation of hands-on science activities in elementary schools resonate with global educational issues, particularly in developing countries. The lack of teacher training, the unequal distribution of educational resources, and the scarcity of inclusive practices in science education are not exclusive to Brazil but are shared concerns in many regions worldwide. By investigating the Brazilian case, this study contributes to the broader discussion of how practical science education can be improved globally, offering perspectives into policies and practices that could be applicable to other nations striving to enhance their science curricula and ensure educational equity.

Finally, we highlight as future research the development and evaluation of inclusive pedagogical practices that enable the participation of all students in experimental activities.

6. References

Bergmann, A. B., Maman, A. S., Neide, I.G., Dullius, M. M., & Quartieri, M. T. (2017). Atividades experimentais no ensino de ciências nos anos iniciais do ensino fundamental: percepção de um grupo de professores. *Enseñanza de las ciencias: revista de investigación y experiencias didácticas*, Extra, 2065-2070. https://raco.cat/index.php/Ensenanza/article/view/337505

Biagini, B., & Gonçalves, F. P. (2017). Atividades experimentais nos anos iniciais do ensino fundamental: análise em um contexto com estudante cego. *Ensaio Pesquisa em Educação em Ciências*, 19, e2703, 1-21. https://doi.org/10.1590/1983-21172017190130

Brasil. Ministério da Educação. (2015). *Base nacional comum curricular. Brasília*, DF: MEC. http://basenacionalcomum.mec.gov.br/

Brzezinski, I. (2008). Políticas contemporâneas de formação de professores para os anos iniciais do ensino fundamental. *Educação & Sociedade*, *29*(105), 1139-1166. https://doi.org/10.1590/S0101-73302008000400010

Cardoso, A. C. O., Silva, H. N., Oliveira, D. A. A. S., & Messeder, J. C. (2019). Ensino de química para crianças: da curiosidade infantil à formação para a cidadania. *Revista Eixo*, *8*(2), 156-164. https://acortar.link/AlfyqZ

Costa, D. O. (2023). Censitarização das avaliações externas em larga escala: uma análise da universalização e da divulgação de resultados do ensino médio no Saeb-Ideb/2017. *Pesquisa e debate em educação*, 13, 1-16, e35586. https://doi.org/10.34019/2237-9444.2023.v13.35586

Durso, S. D. O., & Arruda, E. P. (2022). Artificial intelligence in distance education: A systematic literature review of Brazilian studies. *Problems of Education in the 21st Century*, *80*(5), 679-692. https://doi.org/10.33225/pec/22.80.679

Guerra, A. L. R., Matos, D. V., Costa, M., Rozendo, J. F., & de Melo, N. J. G. (2023). Procedimentos metodológicos de classificação das pesquisas científicas. *EDUCERE - Revista da Educação da UNIPAR*, *23*(1), 303-311. https://doi.org/10.25110/educere.v23i1-018

Heldt, P. H. T., Cardoso, D. H., & Moura, S. R. (2018). Física nos anos iniciais do ensino fundamental: atividades sobre eletrização por atrito para incentivar a alfabetização científica e técnica. *Experiências em Ensino de Ciências*, *13*(5), 441-446. https://fisica.ufmt.br/eenciojs/index.php/eenci/article/view/114

Jesus, C. S., & Santos, M. A. (2020). A experimentação como facilitadora de ensino: pesquisa-ação em ensino de ciências no ensino fundamental. *Civicae,* *2*(1), 1-17. https://doi.org/10.6008/CBPC2674-6646.2020.001.0001

Lima, A. S., Azzolin, K. A. S., Moresco, T. R., Rocha, J. B. T., & Barbosa, N. V. (2017). Atividades experimentais nos anos iniciais do ensino fundamental: ferramenta metodológica para a construção do processo de ensino-aprendizagem. *Revista de Ensino de Bioquímica*, *15*(1), 40-63. https://www.bioquimica.org.br/index.php/REB/article/view/678

Marounová, J., & Kácovský, P. (2022). Experimenty ve výuce fyziky: Kde se čeští učitelé inspirují?. *Scientia in Educatione*, *13*(2), 26-35. https://doi.org/10.14712/18047106.2169

Mendonça, A. P. A., Müller, A. D., Priebe, P. C., & Morescki Jr., L. F. M. (2020). Projeto de Extensão Brincando com a Física: instigando a curiosidade e o espírito investigativo nas séries iniciais a partir da experimentação e do lúdico. *Caminho Aberto: Revista de extensão do IFSC*, 12, 95-99. https://doi.org/10.35700/ca202001295-992529

Millar, R. (2010). Practical work. In J. Osborne & J. Dillon (Eds.), *Good practice in science teaching: What research has to say* (pp. 108-134). Open University Press.

Moraes, F. V., & Diniz, R. E. S. (2013). A atividade experimental no ensino de ciências para crianças no Brasil: uma investigação com professores. *Enseñanza de las Ciencias: revista de investigación y experiencias didácticas*, no. Extra, 3817-21. https://raco.cat/index.php/Ensenanza/article/view/308677

Moreira, M. A. (2021). Ensino de ciências: Críticas e desafios. *Experiências em Ensino de Ciências*, *16*(2). https://if.ufmt.br/eenciojs/index.php/eenci/article/view/910

Nunes, B. C., Duarte, C. B., Padim, D. F., Melo, I. C., Almeida, J. L., & Teixeira Júnior, J. G. (2010). Propostas de atividades experimentais elaboradas por futuros professores de Química para alunos com deficiência visual. In *XV Encontro Nacional do Ensino de Química*. Brasília, DF. https://www.sbq.org.br/eneq/xv/resumos/R1092-1.pdf

Oliveira, D. M., Rocha, A. A. H., Prestes, L. B., & Santos, V. J. R. M. (2020). A percepção dos sentidos e significados no processo de aprendizagem de Ciências da Natureza nos anos iniciais do ensino fundamental. *Cadernos do Aplicação*, *33*(1), 1-8. https://doi.org/10.22456/2595-4377.104528

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hrobjartsson, ´ A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*(71). https://doi.org/10.1136/bmj.n71

Paula, T. E., Guimarães, O. M., & Silva, C. S. (2017). Necessidades Formativas de Professores de Química para a Inclusão de Alunos com Deficiência Visual. *Revista Brasileira De Pesquisa Em Educação Em Ciências*, *17*(3), 853-881. https://doi.org/10.28976/1984-2686rbpec2017173853

Pereira, C. L. Ensino de ciências: a potencialidade dos textos científicos e atividades experimentais investigativas para alfabetização científica de alunos dos anos iniciais numa escola quilombola. In: *VI Congresso Nacional de Educação*, 2019. Disponível em: https://www.editorarealize.com.br/index.php/artigo/visualizar/60256

Pereira, G. R., Paula, L. M., Soares, K. C. M., Paula, L. M., & Coutinho-Silva, R. (2016). Atividades experimentais e o ensino de Física para os anos iniciais do Ensino Fundamental: análise de um programa formativo para professores. *Caderno Brasileiro De Ensino De Física*, 33(2), 579-605. https://doi.org/10.5007/2175-7941.2016v33n2p579

Porto, M. B. D. S. M., & Almeida, C. V. (2018). Atividades práticas nas aulas de ciências nos anos iniciais: caminhos para a aprendizagem significativa e para a alfabetização científica. *Kiri-Kerê*, 4, 150-166. https://periodicos.ufes.br/kirikere/article/view/19705

Ramos, L. B. C., & Rosa, P. R. S. (2016). O ensino de ciências: fatores intrínsecos e extrínsecos que limitam a realização de atividades experimentais pelo professor dos anos iniciais do ensino fundamental. *Investigações em Ensino de Ciências*, *13*(3), 299-331. http://143.54.40.221/index.php/ienci/article/view/444

Roever, L. (2017). Compreendendo os estudos de revisão sistemática. *Revista da Sociedade Brasileira de Clínica Médica*, *15*(2), 2017. https://www.sbcm.org.br/ojs3/index.php/rsbcm/article/view/276

Rosa, C. W., Rosa, Á. B., Carlos, L. M. C., & Perez, A. S. (2013). Estudo de conceitos físicos no ensino fundamental: atividades experimentais e modelagem matemática. *Revista Iberoamericana de Educación*, *63*(2), 1-8. https://doi.org/10.35362/rie632639

Santos, M. S., Pereira, F. M., Medeiros, A. M., & do Nascimento, L. S. (2021). Uso de tecnologia no desenvolvimento de jogos educativos eletrônicos para a promoção de saúde bucal e Educação Ambiental. *Revista Thema*, *17*(4), 843-854. https://doi.org/10.15536/thema.V17.2020.843-854.1180

Sasseron, L. H. (2021). Práticas constituintes de investigação planejada por estudantes em aula de ciências: análise de uma situação. *Ensaio Pesquisa em Educação em Ciências*, 23, 1-18. https://doi.org/10.1590/1983-21172021230101

Silva, J. B., Sales, G. L., & Castro, J. B. (2019). Gamificação como estratégia de aprendizagem ativa no ensino de Física. *Revista Brasileira de Ensino de Física*, *41*(4), e20180309. https://doi.org/10.1590/1806-9126-RBEF-2018-0309

Silva, J. B., Santos, G. H., Santos, F. J. S., Costa, C. K. A., Gonçalves, P. V. S., Melo, G. K. V., Capistrano, J. G. G., Costa, L. C. A., Costa, D. F. D., & Albuquerque, F. C. F. (2024). Science education based on interactive computer simulations. *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, *29*(9), Series 14, 11–16. https://acortar.link/OaoHfd

Silva, S. M., & Serra, H. (2013). Investigação sobre atividades experimentais de conhecimento físico nas séries iniciais. *Revista Brasileira De Pesquisa Em Educação Em Ciências*, *13*(3), 09-23. https://periodicos.ufmg.br/index.php/rbpec/article/view/4269

Silva, S. M., & Serra, H. S. (2013). Investigação sobre atividades experimentais de conhecimento físico nas séries iniciais. *Revista Brasileira de Pesquisa em Educação em Ciências*, *13*(3). https://periodicos.ufmg.br/index.php/rbpec/article/view/4269

Souza, A. G., Peralta, C., Silva, A. N. A., Tarôco, H., Melo, J. O. F., & Garcia, E. (2021). Despertando para as ciências. *Cataventos*, *13*(1), 48–65. https://doi.org/10.33053/cataventos.v13i1.466

Vidal, E. M., Silva, J. B., Marinho, I. C., & Nogueira, J. F. F. (2024). Avaliações municipais e a relação com o IDEB, segundo o questionário contextual do SAEB 2019. *Práxis Educacional*, *20*(51), e13559. https://periodicos2.uesb.br/index.php/praxis/article/view/13559

AUTHORS' CONTRIBUTIONS, FUNDING AND ACKNOWLEDGEMENTS

Authors' contributions:

Conceptualization: Silva, João Batista da; **Software:** Santos, Givaldo Henrique dos; **Validation:** Batista, Raquel Oliveira da Silva; **Formal analysis:** Costa, Luís Carlos Assis da; **Data curation:** Costa, Carlos Kley Araujo; **Writing-Preparation of the original draft:** Silva, João Batista da; **Writing-Review and Editing:** Santos, José Nilson dos; **Visualization:** Duarte, Patrícia Félix and Rebouças, Aline de Oliveira; **Supervision:** Silva, Solonildo Almeida da and Jucá, Sandro César Silveira; **Project administration:** Silva, João Batista da and Capistrano, José Gleison Gomes; **All authors have read and acceptedthe published version of the manuscript:** Silva, João Batista da. Costa, Luís Carlos Assis da. Santos, José Nilson dos. Batista, Raquel Oliveira da Silva. Santos, Givaldo Henrique dos. Rebouças, Aline de Oliveira. Duarte, Patrícia Félix. Costa, Carlos Kley Araujo. Capistrano, José Gleison Gomes. Silva, Solonildo Almeida da. Jucá, Sandro César Silveira.

Funding: This research has not received any external funding.

Conflict of interests: no conflict of interests.

AUTHORS:

João Batista da Silva
State University of Ceará (UECE), Brazil.

PhD in Education from the State University of Ceará (UECE). Specialist in Physics Education from Candido Mendes University (UCAM). Bachelor's degree in Physics from the Federal Institute of Education, Science and Technology of Ceará (IFCE).
joaobatista.silva@aluno.uece.br

Índice H: 12
Orcid ID: http://orcid.org/0000-0003-3556-9881
Scopus ID: https://www.scopus.com/authid/detail.uri?authorId=57208597437
Google Scholar: https://scholar.google.com.br/citations?user=_vxGS5gAAAAJ&hl=pt-BR
ResearchGate: https://www.researchgate.net/profile/Joao-Silva-102
ResearcherID: https://www.webofscience.com/wos/author/record/N-2754-2018

Luís Carlos Assis da Costa
Federal University of Ceará (UFC), Brazil.

Master's student in Science and Mathematics Teaching at the Federal University of Ceará (UFC). Specialist in Environmental Management from Vale do Acaraú University (UVA). Bachelor's degree in Biology from UVA.
luiscarlos.costa@educacao.fortaleza.ce.gov.br

Orcid ID: https://orcid.org/0009-0002-3000-9770

José Nilson dos Santos
Fametro University Center (UNIFAMETRO), Brazil.

Graduate degree in Pharmacy from the Maurício de Nassau University Center.
jsantostar@alu.ufc.br

Orcid ID: https://orcid.org/0009-0000-1822-3788

Raquel Oliveira da Silva Batista
Fametro University Center (UNIFAMETRO), Brazil.

Graduated in Human Resources from Universidade Paulista (UNIP). Student of Pedagogy at the Fametro University Center (UNIFAMETRO).
raquel.batista01@aluno.unifametro.edu.br

Orcid ID: https://orcid.org/0009-0005-8825-2329

Givaldo Henrique dos Santos
Federal University of Ceará (UFC), Brazil.

Master's student in Public Policy Evaluation at the Federal University of Ceará (UFC). Specialist in Mathematics Teaching Methodology from Faculdade da Aldeia de Carapicuíba. Bachelor's degree in Mathematics from the State University of Vale do Acaraú (UVA).
givaldo.santos@educacao.fortaleza.ce.gov.br

Orcid ID: https://orcid.org/0009-0001-0425-8952

Aline de Oliveira Rebouças
University of Fortaleza (UNIFOR), Brazil.

PhD candidate in Psychology at the University of Fortaleza (UNIFOR). Specialist in Neuropsychopedagogy from Candido Mendes University (UCAM). Bachelor's degree in Pedagogy from the State University of Ceará (UECE).
aline.reboucas@aluno.uece.br

Orcid ID: https://orcid.org/0000-0002-7392-6133

Patrícia Félix Duarte
State University of Ceará (UECE), Brazil.

PhD student in Public Policy at the State University of Ceará (UECE). Master's in Education from the State University of Ceará (UECE). Bachelor's degree in Pedagogy from the Federal University of Ceará (UFC).
patricia.felix@aluno.uece.br

Índice H: 1
Orcid ID: https://orcid.org/0000-0002-3612-4000
Google Scholar: https://scholar.google.com.br/citations?user=tOeTp18AAAAJ&hl=pt-BR

Carlos Kley Araujo Costa
State University of Ceará (UECE), Brazil.

Bachelor's degree in Science and Mathematics from the State University of Ceará (UECE). Elementary school math teacher.
carlos.kley@educacao.fortaleza.ce.gov.br

Orcid ID: https://orcid.org/0009-0004-8699-9747

José Gleison Gomes Capistrano
Federal Institute of Education, Science and Technology of Ceará (IFCE), Brazil.

PhD candidate in Science Education at the Federal Institute of Education, Science and Technology of Ceará (IFCE).
josegleison.gomes@educacao.fortaleza.ce.gov.br

Orcid ID: https://orcid.org/0000-0001-5631-9430
ResearchGate: https://www.researchgate.net/profile/Jose-Gleison-Gomes-Capistrano

Solonildo Almeida da Silva
Federal Institute of Education, Science and Technology of Ceará (IFCE), Brazil.

PhD in Education from the Federal University of Ceará (UFC). Master in Sociology from the State University of Ceará (UECE). Graduated in Pedagogy from the UECE. Graduated in Systems and Digital Media from the UFC. Graduated in Geography Degree from the UECE.
solonildo@ifce.edu.br

Índice H: 16
Orcid ID: https://orcid.org/0000-0001-5932-1106
Google Scholar: https://scholar.google.com.br/citations?user=Xjkh7woAAAAJ&hl=pt-BR
ResearcherID: https://www.webofscience.com/wos/author/record/AAW-9400-2020

Sandro César Silveira Jucá
Federal Institute of Education, Science and Technology of Ceará (IFCE), Brazil.

PhD in Electrical Engineering from the Federal University of Ceará (UFC). Specialist in Industrial Automation and Degree in Physics from the State University of Ceará (UECE). Graduated in Mechatronics Technology from the Federal Institute of Education, Science and Technology of Ceará (IFCE).
sandro@ifce.edu.br

Índice H: 16
Orcid ID: https://orcid.org/0000-0002-8085-7543
Scopus ID: https://www.scopus.com/authid/detail.uri?authorId=8850411300
Google Scholar: https://scholar.google.com.br/citations?user=D_AdH8UAAAAJ&hl=pt-BR
ResearchGate: https://www.researchgate.net/profile/Sandro-Juca
ResearcherID: https://www.webofscience.com/wos/author/record/O-5128-2018