

Construction of an e-book to promote executive functions in early childhood through an intersectoral approach

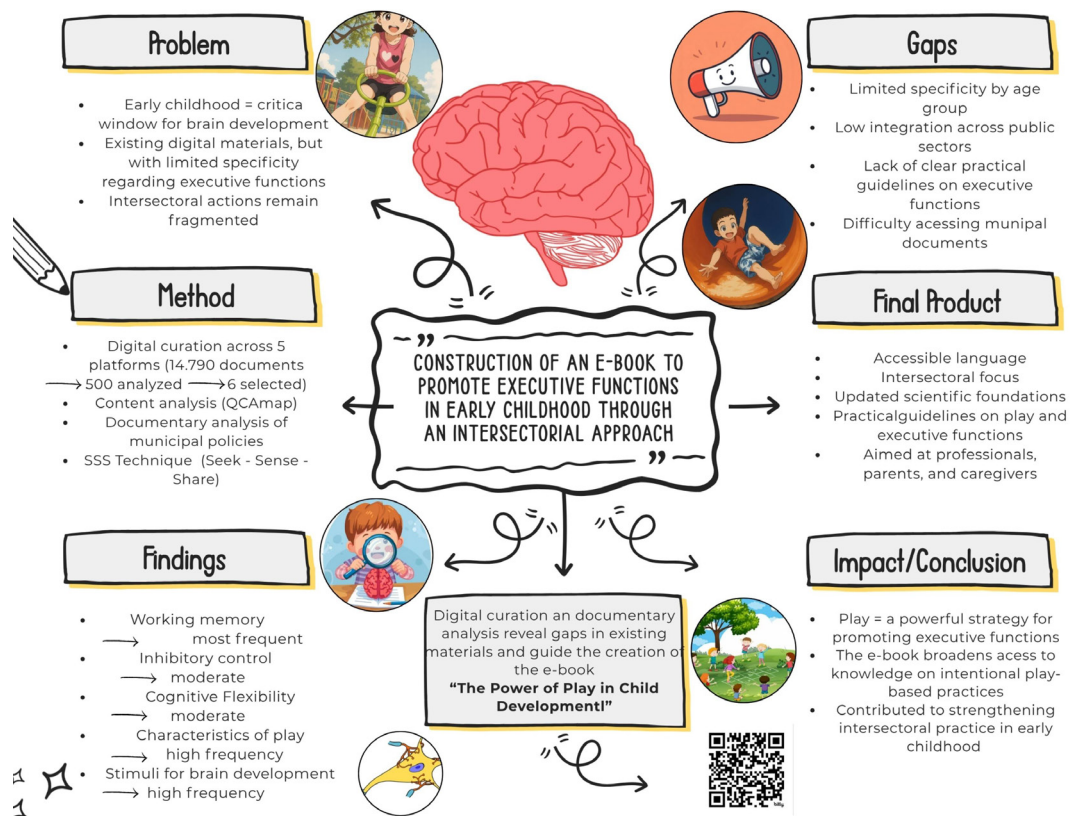
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Graphical Abstract

Highlights

- Play promotes executive development in early childhood.
- A scarcity of public materials on play and child development was identified.
- The produced e-book translates scientific evidence into formative support for intersectoral actions.



Prepared by the authors with the assistance of artificial intelligence (illustrative image).

Abstract

Play, recognized as the language of childhood, constitutes an essential strategy for comprehensive development. This study aimed to identify and analyze strategies, programs, and digital materials related to play that promote the development of executive functions in early childhood, in order to develop an e-book aimed at professionals working in an intersectoral manner. This is a qualitative, descriptive, and exploratory study, grounded in documentary analysis of municipal plans in Education, Health, and Social Assistance, as well as digital curation from five information sources. Thematic content analysis and the SSS technique (Seek, Sense, Share) were applied, based on executive functions: working memory, inhibitory control, and cognitive flexibility. The results show that digital materials highlight the importance of play for the development of the main executive functions. However, specific information by age group is lacking, and intersectoral actions remain fragmented. As an applied technical product, the e-book "The Power of Play in Child Development" was developed, aimed at health, education, and social assistance professionals, as well as parents and caregivers. It was concluded that the e-book has the potential to encourage intentional play to promote comprehensive child development and to valorize the intersectoral perspective in the stimulation of executive functions.

Keywords: Play. Executive Function. Child Development. Health Promotion. Primary Health Care.

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INTRODUCTION

Play constitutes a central experience in childhood and plays a fundamental role in the comprehensive development of the child, particularly regarding executive functions, understood as a set of cognitive abilities responsible for working memory, inhibitory control, cognitive flexibility, planning, and decision-making¹. These functions are essential for behavioral self-regulation, problem-solving, adaptation to new situations, and learning, exerting a decisive role in academic, social, and emotional development throughout life.

Recent findings from developmental neuroscience demonstrate that early experiences directly influence brain architecture, making early childhood a sensitive period for the maturation of cognitive, emotional, and social skills^{2,3}. In this context, play stands out as a privileged practice, as it simultaneously mobilizes attention, memory, emotional regulation, language, social interaction, and symbolic elaboration, fostering the progressive consolidation of executive functions.

In the educational field, official Brazilian documents, such as the National Common Curricular Base (BNCC)⁴, recognize play and interactions as structural axes of early childhood education. However, the literature has shown that pedagogical practices oriented toward intentional play still face challenges related to teacher training, pedagogical planning, and the articulation of learning objectives associated with play-based experiences^{5,6}. Although play is widely recognized as a child's right and a strategy that promotes development, productions that explicitly articulate its relationship with the promotion of executive functions remain limited.

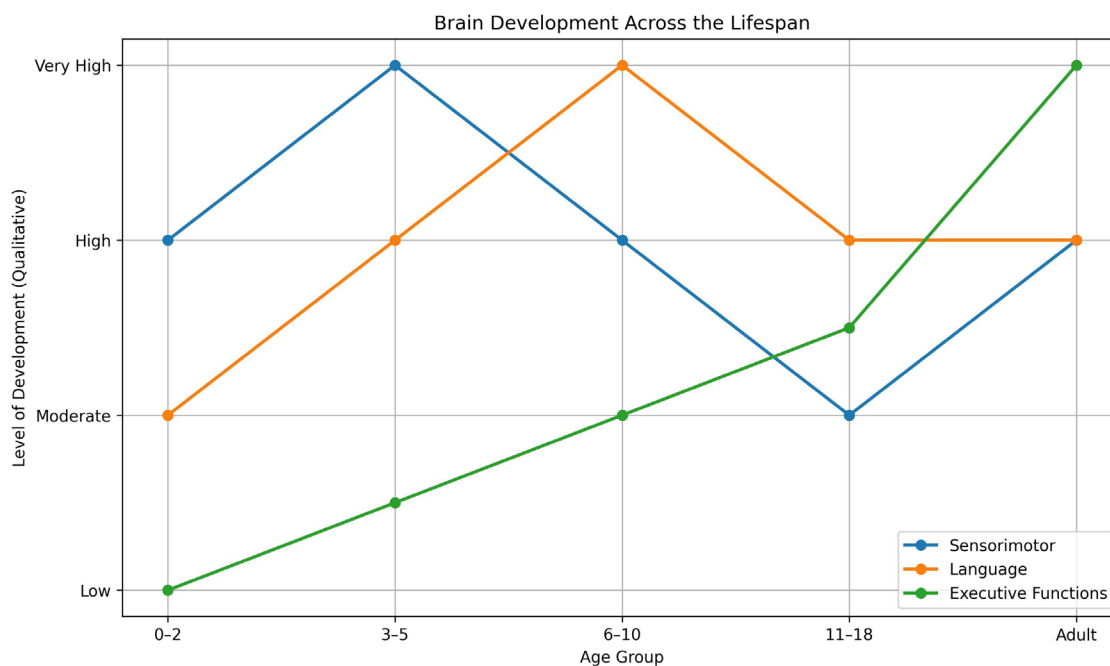
In this direction, recent studies show that play, when intentionally planned, significantly promotes the development of executive functions in early childhood – especially working memory, inhibitory control, and cognitive flexibility – with positive repercussions for learning, self-regulation,

and socioemotional development^{5,6}. Despite this advance in the theoretical and interventional field, the literature still points to a scarcity of guiding materials and applied resources that translate these scientific findings into strategies accessible to professionals in education, health, and social assistance, particularly in specific territorial contexts.

From the historical-cultural perspective of Lev Vygotsky⁷, learning occurs within the zone of proximal development (ZPD), understood as the distance between what the child accomplishes independently and what the child can achieve with assistance. In this sense, intentional play practices, mediated by adults and by qualified social interactions, foster the progressive expansion of the capacity to retain information, self-regulate, make choices, plan actions, and solve problems, contributing to comprehensive development.

Brain development follows a dynamic, progressive, and differentiated course across neural systems. Sensorimotor abilities show early maturation and rapid consolidation in the first years of life. Subsequently, there is intense specialization of neural language networks, particularly between the ages of 3 and 10 years – a period marked by lexical and grammatical expansion and by the decisive influence of auditory and interactional experiences^{8,9}.

Executive functions, predominantly mediated by the prefrontal cortex, present a later and more gradual developmental course. They begin in the first years of life, with significant acceleration between ages 3 and 5, when abilities such as inhibitory control, sustained attention, working memory, and cognitive flexibility intensify. This refinement extends throughout childhood and adolescence, reaching greater consolidation at the onset of adulthood, in line with cortical and synaptic maturation^{3,10}.



Source: Lenroot and Giedd¹⁰.

Figure 1 - Graph of brain development across the lifespan.

Brain development follows a dynamic and progressive course. Sensorimotor abilities develop early, while language shows accelerated growth in early childhood. Executive functions, in turn, mature progressively throughout childhood and adolescence, reaching greater consolidation in adulthood¹⁰.

Figure 1 highlights early childhood as a strategic window of opportunity for investing in skills associated with quality of life and social, physical, and cognitive development. In this context, it becomes relevant to investigate how institutional materials, programs, and guiding documents address the relationship between play and the development of executive functions during this period of the life cycle.

Thus, the present study analyzes digital produc-

tions and public documents from a municipality in the state of São Paulo with the aim of understanding how the promotion of executive functions through play is addressed, identifying gaps, potentialities, and possibilities for improving intersectoral performance among education, health, and social assistance sectors. It is assumed that this understanding can strengthen articulated practices across different sectors, fostering environments that promote comprehensive child development, especially in vulnerable territories. To this end, the objective was to identify and analyze strategies, programs, and digital materials related to play that promote the development of executive functions in early childhood, thereby providing a basis for the development of an e-book aimed at professionals working in an intersectoral manner.

MATERIAL AND METHOD

This study is characterized as qualitative, exploratory, and descriptive research, developed through digital curation and documentary analysis. The choice of this approach is grounded in the need to identify, systematize, and interpret educational materials available in digital media that address play and the development of executive functions in early childhood.

The research was conducted between the first and second semesters of 2024 and structured in five

stages: (1) digital curation, (2) documentary analysis of municipal public policies, (3) data organization and processing using specific software, (4) qualitative content analysis, and (5) development of the educational product.

Stage 1: Digital Curation

Digital curation was guided by the 3S model (Seek, Sense, Share), developed by Harold Jarche in 2014, which entails seeking, attributing meaning to,

and sharing knowledge¹¹.

In the screening stage, five digital platforms allowing access to public materials and search by descriptors were consulted. For each platform, the first 100 results returned by the search filters were considered, totaling 500 materials initially identified.

- Bing (Microsoft) (www.bing.com.br)
- Fiocruz Institutional Repository (arca.fiocruz.br)
- EduCAPES Educational Portal (educapes.capes.gov.br)
- MEC Digital Educational Resources Platform (www.plataformaintegradamec.gov.br)
- Virtual Library of Fundação Maria Cecília Souto Vidigal (www.biblioteca.fmcsv.org.br)

Selection criteria were applied in two complementary stages. In the first stage, a formal criterion was adopted, with the exclusive inclusion of materials available in the formats of guides, manuals, or booklets. In the second stage, a thematic relevance criterion was applied through reading of the titles and abstracts of identified materials, seeking explicit evidence of the relationship between play and child development. In cases where thematic relevance was not sufficiently clear based on initial information, an exploratory reading of the full content was performed to support the final inclusion or exclusion decision. After the initial screening of the 500 materials analyzed, six documents fully met the established criteria and constituted the analysis corpus.

Stage 2: Documentary Analysis of Public Policies

In Stage 2, a survey of publicly available municipal documents was conducted with the aim of understanding the institutional, normative, and territorial context of actions directed at childhood in the investigated municipality. The choice of these documents was grounded in their relevance for identifying guidelines, goals, intersectoral strategies, and planned actions oriented toward child development – particularly those related to play, education, health, social assistance, and the organization of urban spaces. The search was conducted on the official website of the municipality of Cabreúva/SP, including the Municipal Health Plan, the Municipal Education Plan, the Municipal Social Assistance Plan, and the Land Use and Occupation Master Plan. Additionally, representatives of public facilities were requested to provide access to the mentioned documents.

Documentary analysis focused on identifying explicit or indirect references to policies, programs, facilities, public spaces, intersectoral actions, and

institutional strategies aimed at childhood and child development, in order to verify the extent to which these normative instruments addressed play as a dimension promoting the comprehensive development of the child.

Stage 3: Data Organization and Processing

The selected materials were organized and imported into Qualitative Content Analysis software (QCAmap), version 1.2.0, a collaborative, online platform for qualitative content analysis based on Mayring's methodological framework¹². Initially, the documents were converted into a compatible format and entered into the software environment, where the pre-defined categorical system was structured. The three analytical categories – working memory, inhibitory control, and cognitive flexibility – were registered in QCAmap as deductive categories, accompanied by their respective operational definitions and observable indicators, in accordance with the theoretical framework of executive functions. As the unit of record, textual excerpts (sentences, paragraphs, or descriptive guidelines) were adopted that presented explicit reference to play situations with the potential to mobilize executive functions.

Stage 4: Qualitative Content Analysis

The analysis followed the systematic procedure described by Bardin¹³, encompassing pre-analysis, material exploration, and the processing, inference, and interpretation of results. In the coding process in QCAmap, the materials were read in their entirety, followed by the selection of excerpts that presented explicit demands for the activation of executive functions. These excerpts were linked to the previously registered categories, in accordance with the predominant analytical focus identified in each excerpt.

Data organization in the software enabled the systematic grouping of excerpts by category, facilitating the subsequent interpretative analysis of the identified patterns. When a given excerpt simultaneously presented more than one executive function, coding considered the category of greatest analytical centrality, according to the object of the study. For the operationalization of the analysis, three analytical categories were established based on the executive function literature: working memory, inhibitory control, and cognitive flexibility. The first encompassed excerpts related to the retention and manipulation of information during play, particularly in situations involving rules, sequences, and instructions. The second covered manifestations of emotional and behavioral self-regulation, such as waiting one's turn, containing impulses, and following

shared rules. The third corresponded to the capacity to adapt strategies, evidenced by actions such as altering plans, creating solutions, and varying behaviors during play experiences. Only segments presenting explicit demands for the activation of these abilities were coded.

Stage 5: Development of the Educational Product

As an applied outcome of the research, the e-book “The Power of Play in Child Development” was developed with the aim of providing formative material for parents, educators, and professionals in health and social assistance. The content was structured based on an updated theoretical framework, presented in accessible language, with graphic resources and public domain illustrations, with the goal of democratizing access to knowledge.

The review stage involved professionals from the fields of education, health, and graphic design, who analyzed the material with regard to textual clarity, conceptual adequacy, coherence between content and objectives, relevance of practical guidelines, visual organization, readability, and appropriateness

of graphic resources for the target audience.

Based on the feedback received, textual adaptations were made to enhance objectivity and accessibility of language, adjustments were introduced in the sequence of content presentation, visual elements were revised, and the layout was refined, in order to broaden the comprehension and applicability of the material in educational and intersectoral contexts. Following this stage, the e-book was finalized and made available in digital format for public access.

As a strategy to broaden the dissemination and access to the educational product, the e-book was published in the Open Books Portal of the Universidade de São Paulo, through the Agency for Libraries and Digital Collections, under an open access regime, with its own DOI registration, thereby reinforcing its academic accessibility and potential for intersectoral reach. To facilitate circulation among professionals, families, and community services, a QR Code was also created for quick access, available in Figure 2, along with a shortened link for sharing in formative and institutional activities.

<https://bit.ly/4bFtcb9>



Figure 2 - QR code for accessing the e-book.

The construction of the e-book prototype was based on a survey of syntheses of sound evidence and consensus on the promotion of play in an intersectoral manner, as indicated by three specialists in neurosciences and child development, in addition to the curation of similar educational materials and

analysis of institutional documents from the municipality of Cabreúva-SP. The participation of specialists was characterized as technical consultancy, with no systematic data collection from human subjects, in accordance with National Health Council Resolution CNS No. 510/2016.

RESULTS

Digital curation aimed to identify, select, and analyze digital materials addressing the relationship between play and the development of executive functions in early childhood – a crucial phase for brain development. The guiding research question (RQ1) was: To investigate whether, in digital materials, there

is evidence that play promotes executive functions, particularly in early childhood. From this axis, five analytical sub-questions were structured to guide the coding of materials:

- RQ1-1 – Executive Function: Working Memory

- RQ1-2 – Executive Function: Inhibitory Control
- RQ1-3 – Executive Function: Cognitive Flexibility
- RQ1-4 – Characteristics of Play in Digital Materials
- RQ1-5 – Stimuli Associated with Brain Development

Five search sources were used: Bing, ARCA Fiocruz, EduCAPES, Integrated MEC Platform, and Fundação Maria Cecília Souto Vidigal (FMCSV). The survey retrieved 14,790 documents, of which 500 were subjected to convenience analysis, considering the first 100

results from each platform.

In the first screening, materials not presented in the format of guides, manuals, or booklets were excluded, as were duplicate content, news articles, institutional pages without formative material, and documents without a direct relationship to early childhood. In the second screening, only materials whose titles, abstracts, and content evidenced an explicit association between play, child development, and the mobilization of executive functions were retained. At the end of this process, 6 documents fully met the criteria and constituted the final corpus for qualitative analysis (Table 1).

Table 1 - Summary of digital curation in Cabreúva/SP, 2025.

Source	Documents retrieved	Analyzed (CA)	1 st Selection	2 nd Selection	Result
*Bing (Microsoft)	9,460	100	0	0	0
*Fiocruz Institutional Repository	391	100	4	1	1
*EduCAPES Educational Portal	4,107	100	2	1	1
*MEC Digital Educational Resources Platform	692	100	0	0	0
*VL Fundação Maria C. Souto Vidigal	140	100	7	4	4
Total	14,790	500	13	6	6

Note: CA = Convenience Analysis

The six materials included in the qualitative analysis constituted the analysis corpus and are presented in Table 2, with their respective sources.

Table 2 - Materials included in the qualitative synthesis.

No.	Selected Material	Source
1	<i>Fios do Brincar</i> ¹⁴	Fundação Maria Cecília Souto Vidigal
2	<i>Bebê Cresceu</i> ¹⁵	ARCA Fiocruz
3	<i>Os Primeiros Anos em Suas Mãos</i> ¹⁶	Fundação Maria Cecília Souto Vidigal
4	<i>Manual Brincarte</i> ¹⁷	Fundação Maria Cecília Souto Vidigal
5	<i>Manual sobre os Benefícios do Contato com a Natureza na Infância</i> ¹⁸	Fundação Maria Cecília Souto Vidigal
6	<i>Descobrimo o Potencial Cognitivo dos Jogos Digitais: Guia Prático DESCo</i> ¹⁹	EduCAPES

The analysis was conducted using QCMap software, which generated three main reports: Category System Report, Coding Statistics Report, and Coded Segments Report. These reports made it possible to understand the structure of the categories, the frequency of occurrence of codes, and the content of the coded excerpts. The Category System Report presented the hierarchy of categories and subcategories derived from sub-questions RQ1-1 through RQ1-5, representing how the dimensions of executive func-

tions articulate with play in early childhood. This system consolidated the theoretical-analytical framework of the study, ensuring coherence between data and the conceptual framework (Table 3). In the Coding Statistics Report, the presence of categories was mapped across each document, allowing observation of the incidence of different aspects related to executive functions and play.

In the coding stage, the six materials were read in their entirety in QCMap, and excerpts presenting ex-

PLICIT evidence of executive function mobilization were linked to the previously defined categories. For example, guidelines related to rule memorization, action sequences, and retention of instructions were coded under RQ1-1 (Working Memory); situations involving waiting one's turn, rule following, and behavioral self-regulation were associated with RQ1-2 (Inhibitory Control); and proposals requiring strategy shifting,

adaptation to new rules, or creative problem solving were classified under RQ1-3 (Cognitive Flexibility).

Categories RQ1-4 and RQ1-5 were applied to excerpts describing, respectively, the structural characteristics of play and stimuli associated with brain development, thereby relating the materials' content to the neurocognitive foundations discussed in the theoretical framework.

Table 3 - Frequency of occurrence of categories.

Category	No. of documents in which it appears	Interpretation
RQ1-1 – Working Memory	4	Recurring theme
RQ1-2 – Inhibitory Control	3	Moderate presence
RQ1-3 – Cognitive Flexibility	3	Moderate presence
RQ1-4 – Characteristics of Play	4	Recurring theme
RQ1-5 – Stimuli associated with brain development	4	Recurring theme

The results reveal a higher recurrence of categories related to working memory, characteristics of play, and stimuli associated with brain development – a finding that converges with recent literature in indicating that structured play experiences promote information retention, shared attention, and the integration of cognition, emotion, and social interac-

tion^{5,6}. The moderate presence of inhibitory control and cognitive flexibility suggests that these dimensions, although present, still appear less explicitly articulated in the institutional materials analyzed, reinforcing the gap identified in the introduction regarding the need for formative resources that translate scientific evidence into practical guidelines.

DISCUSSION

The results evidenced a higher recurrence of categories RQ1-1 (working memory), RQ1-4 (characteristics of play), and RQ1-5 (stimuli associated with brain development), indicating that the analyzed digital materials primarily emphasize dimensions of play related to information retention, the organization of play activities, and neurodevelopmental processes. In contrast, RQ1-2 (inhibitory control) and RQ1-3 (cognitive flexibility) showed intermediate frequency, suggesting less depth in the treatment of these components in the examined content.

The interpretation of coded segments in QCAmap demonstrated that play is presented as a strategy promoting self-regulation, operational memory, planning, and problem solving, with emphasis on symbolic play, contact with nature, and guided play activities in family and school environments. These findings converge with national and international literature, which recognizes intentional play as a privileged context for the mobilization of executive functions in early childhood. Adele Diamond³ highlights that structured play experiences particularly

promote working memory, inhibitory control, and cognitive flexibility, while Lev Vygotsky⁷ emphasizes that symbolic play expands the zone of proximal development, promoting planning, self-regulation, and decision-making.

At the national level, materials from Fundação Maria Cecília Souto Vidigal and the BNCC guidelines⁴ reinforce play as a structural axis of child development, in line with studies pointing to cognitive and socioemotional benefits when play experiences are intentionally mediated^{20,21}. At the international level, programs such as Tools of the Mind²² and interventions based on structured play activities such as block play²³ present consistent results in promoting self-regulation and flexible thinking in preschool children, corroborating the findings of this study. Complementarily, the Center on the Developing Child at Harvard University²⁴ highlights that executive functions develop progressively from childhood through adolescence via significant social interactions, play, and structured activities, reinforcing the understanding that mediated play constitutes a privileged context for strengthening working memory,

inhibitory control, and cognitive flexibility.

On the other hand, the lower recurrence of categories related to inhibitory control and cognitive flexibility suggests important gaps in the digital materials and institutional documents analyzed. Although play is widely recognized as a child's right and pedagogical principle, the explicit articulation between play-based practices and the development of executive functions still appears in a fragmented manner, particularly in public policies and municipal documents. This finding confirms the literature pointing to the need for more consistent intersectoral policies capable of integrating play, cognition, and socioemotional development into practical guidelines for education, health, and social assistance.

The present study contributes by proposing a digital curation model applicable to intersectoral training, bringing scientific evidence closer to the production of educational materials. The development of the e-book represents a concrete strategy

of knowledge translation into professional practice, addressing the gap identified in the literature regarding the scarcity of methodologically described and evaluated resources for promoting executive functions in early childhood.

Among the study's limitations, the following stand out: the risk of selection bias inherent to narrative review and convenience sampling in composing the final sample; the specificity of the documentary scope of a single municipality, which may restrict the consideration of different elements of intersectoral play promotion in the selected municipality; and the absence of direct field observation, which may limit inferences about the everyday implementation of the analyzed proposals. Future studies are recommended to broaden the diversity of contexts, digital resources, and age groups, in addition to providing quantitative and/or qualitative assessments of the impact of formative e-books and intersectoral materials on the development of executive functions in real-world contexts of use.

CONCLUSION

In summary, the findings of this investigation confirm that play, understood in its pedagogical, relational, and formative dimensions, constitutes a fundamental element for the development of executive functions in early childhood. The convergence between empirical findings and the broader theoretical framework reinforces that play is a constitutive language of childhood.

The implications of the study's findings are significant for the fields of health, education, and social

assistance. Although the analyzed materials target professionals, parents, and caregivers – rather than children themselves – the need for intentional digital productions that address the multiple dimensions of executive functions in a balanced manner becomes evident. The technological mediation of play reveals itself as a promising strategy for continuing professional development, provided it is anchored in consistent pedagogical principles that are sensitive to the specificities of early childhood.

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Conceptualization: Siqueira, WS. Methodology: Siqueira, WS; Pina-Oliveira, AA. Formal analysis: Siqueira, WS. Investigation: Siqueira, WS; Pina-Oliveira, AA. Data curation: Siqueira, WS. Writing – original draft: Siqueira, WS. Writing – review & editing: Pina-Oliveira, AA. Supervision: Pina-Oliveira, AA.

All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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