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Recebido: 23/08/2022 ■ Aprovado: 05/07/2023 ■ Publicado: 01/10/2023

eISSN 2179-426X
10.26843/rencima.v14n4a08

Revista de Ensino de Ciências e Matemática

Research on the use and creation of paradidactic books for teaching probability in the final years of Elementary School in Brazil

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Abstract: The objective of this work was to systematically analyze the literature in Brazil that used or created paradidactic books for the teaching of probability aimed at the final years of Elementary School. Twelve studies were considered as results, from 2014 to 2021, and the IRaMuTeQ software was used for the multidimensional analysis from the organization in texts (corpus). Each text was prepared considering what was emphasized in the research, the methodology or methodological approach used, the context in which it was developed and the types of study and areas involved and the main results and conclusions. We emphasize that research on the use or creation of paradidactic books in the teaching of probability for Elementary School is still incipient, with the concern with the student's profile and its relations with experiential knowledge and everyday life being evidenced.

Keywords*:* Teaching Probability. Paradidactic Books. Elementary School. Systematic Literature Review. Multivariate Textual Analysis.

Investigación sobre el uso y la creación de libros de texto para la enseñanza de la probabilidad en los últimos años de la Enseñanza Fundamental en Brasil

Resumen**:** El objetivo de este trabajo fue analizar sistemáticamente la literatura en Brasil que utilizó o creó libros paradidácticos para la enseñanza de la probabilidad dirigida a los últimos años de la Enseñanza Fundamental. Se consideraron como resultados 12 estudios, de 2014 a 2021, y se utilizó el software IRaMuTeQ para el análisis multidimensional de la organización en textos (corpus). Cada texto fue elaborado considerando lo que se enfatizó en la investigación, la metodología o enfoque metodológico utilizado, el contexto en el que se desarrolló y los tipos de estudio y áreas involucradas y los principales resultados y conclusiones. Destacamos que la investigación sobre el uso o la creación de libros paradidácticos en la enseñanza de la probabilidad para la Enseñanza Fundamental es aún incipiente, evidenciándose la preocupación por el perfil del alumno y sus relaciones con el conocimiento experiencial y la vida cotidiana.

Palabras clave: Enseñanza de la Probabilidad. Libros Paradidácticos. Enseñanza Fundamental. Revisión Sistemática de la Literatura. Análisis Textual Multivariado.

A pesquisa sobre a utilização e criação de livros paradidáticos para o ensino de probabilidade no Ensino Fundamental no Brasil

Resumo: O objetivo deste trabalho foi analisar sistematicamente a literatura no Brasil que utilizou ou criou livros paradidáticos para o ensino de probabilidade voltado aos Anos Finais do Ensino Fundamental. Doze estudos realizado no período de 2014 até 2021 foram considerados como resultados, e o *software* IRaMuTeQ foi utilizado para a análise multidimensional a partir da organização em textos (*corpus*). Cada texto foi

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elaborado considerando o que foi enfatizado na pesquisa: a metodologia ou enfoque metodológico utilizado, o contexto em que foi desenvolvido, os tipos de estudo e áreas envolvidas e os principais resultados e conclusões. Ressaltamos que as pesquisas sobre a utilização ou criação de livros paradidáticos no ensino de probabilidade para o Ensino Fundamental ainda são incipientes, sendo evidenciada a preocupação com o perfil do aluno e suas relações com o conhecimento experiencial e com o cotidiano.

Palavras-chave: Ensino de Probabilidade. Livros Paradidáticos. Ensino Fundamental. Revisão Sistemática de Literatura. Análise Textual Multivariada.

1 Introduction

For Benetti (2008), from an editorial point of view, the paradidactic is defined as a commercial book, without commitment to scientific formality, with the objective of bringing information about science in a relaxed and informal way. In addition, for Trevizan (2008), in paradidactic texts, themes are usually presented in a way that is less committed to isolation and fragmentation, enabling the relationship with other areas of knowledge, and should be used in the classroom to complement the textbook, articulated with other disciplines and with the student's daily life.

We highlight the lack of didactic resources that can contribute to the teaching of probability in Elementary School, and Dalcin (2007) recalls that research on paradidactic books portrays the written form, the image and all mathematical symbols as part of a new way of learning. teaching approach.

In this sense, Oliveira Júnior and Ciabotti (2018) state that research related to Elementary Education, especially in the teaching of probability, represents a great contribution to the area of Mathematics Education. However, it is clear that there are still gaps to be filled. Such finding provokes the need to study, research and produce didactic material to support the teaching of probability for Elementary School.

Thus, this investigation deals with a Systematic Literature Review (SLR), a form of secondary study using a well-defined methodology to identify, analyze and interpret all evidence related to a research question (KITCHENHAM and CHARTERS, 2007). Therefore, we sought to provide a review of studies on the use and creation of paradidactic books for teaching probability in the Final Years of Elementary School in Brazil, published by Brazilian researchers. In the sections that follow, we discuss more properly about the paradidactic book, we address the methodology used in this work and we present our systematic review on the proposed theme.

2 Theoretical framework

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According to Lima et al. (2013), paradidactic books can encourage reading and serve as a link between mathematical contents that are approached in a diversified way through a story in which everyday situations of the characters occur. Thus, the teacher also has the possibility of working on circumstances of the students' daily lives, so that the book becomes an ally, considering that it helps in understanding and approaching different contents.

Reinforcing the importance of paradidactics, in the National Common Curricular Base - BNCC (BRAZIL, 2018), it is considered that, throughout the years of training of students in Basic Education, one should expand and support the selection of information sources and knowledge, such as: 1) paradidatic reference books; 2) repositories (contains useful digital resources for formal or non-formal learning) or repositories (repositories that hold resources on a given subject) of digital learning objects; 3) educational platforms; 4) educational channels and science communication videos; etc. (BRAZIL, 2018).

The paradidactic book, according to Campos and Perin (2021), has been used in Brazil as a support to the pedagogical process in several disciplines, having a different purpose than the textbook, as it usually deepens some important subjects for school disciplines, using, for this, a more attractive language for the student. In addition, according to Souza (2013), it provides the development of a study based on the historical, social and cultural aspects surrounding the topic addressed, leading both students and teachers to explore a reality that is often unknown. In this sense, these books are presented as an essential resource in teaching, requiring a clear definition of objectives and meanings to interact positively and productively, as well as the other contents studied.

3 Methodology

The study was developed under the guidelines proposed by Kitchenham and Charters (2007) to carry out an RSL, comprising three phases: planning, process and reporting of results. In the planning phase, a protocol for the literature review was elaborated, establishing the interaction that researchers should have, the definition of the procedure to conduct the review, the formulation of the research question, as well as the search strategies, inclusion criteria and data deletion, collection, and analysis. In the second phase, the process focused on the execution of the review protocol. Finally, in the third phase, based on the results, a final report was prepared.

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In the planning phase, we selected how we would carry out the consultation and decided that it would be online in the main national databases, specifically in this order: (1) Public Domain Portal; (2) Scientific Electronic Library Online (SciELO); (3) Brazilian Digital Library of Theses and Dissertations (BDTD); (4) Catalog of Theses and Dissertations of the Coordination for the Improvement of Higher Education Personnel (CAPES); and (5) Google Scholar.

The keywords were used in conjunction, with the term paradidatic as the first option: (AND) Probability; (AND) Teaching; (AND) Education; (AND) Elementary Education; (AND) Final Years. The criteria adopted to compose the corpus were: (a) theses or dissertations published in Brazil; (b) articles published in scientific journals; (c) books; and (d) national and international scientific events by Brazilian researchers.

In the second stage, that of the processes, specifically, a search was made in the databases through the keyword system, reading the title and abstract of each work. The inclusion criterion adopted was linguistic, that is, an overview of academic production in Portuguese (privileging Brazilian publications) that mentioned in the title or abstract references to the use and creation of paradidactic books for teaching probability in the Final Years of Teaching Fundamental. As exclusion criteria, studies that did not correspond to the theme mentioned in the inclusion parameter were considered, as well as those repeated, already identified in the search in another database and published in another language. Finally, we read the full texts considered as results.

Thus, when searching the databases, the Public Domain Portal and SciELO, no papers were found. In the BDTD, two studies were retrieved, one of which was discarded because it referred to the use of paradidactics in another area of knowledge and in another teaching cycle. In the CAPES catalog, ten works were identified, all of which were eliminated considering the exclusion criteria, except for the one that had already been selected in the BDTD. In Google Scholar, 118 works were retrieved, among which, eleven met the inclusion parameter, the others being excluded.

After completing the search, we evaluated the results and selected the eligible studies. To avoid biases in the verification of the works, the selection was carried out by two researchers, independently and based on the eligibility criteria of the review. Each reviewer recorded whether or not they agreed with the inclusion of the study,

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based on the evaluation of titles, abstracts and full texts, in that order. Discordant cases were resolved by consensus or through a third researcher.

Referring to the third phase, based on the results, a final report was elaborated with reference to the analysis of the data obtained through the search for articles (journals and scientific events) and Brazilian theses and dissertations in the main national databases, through a Descending Hierarchical Classification (DHC). For each database located, a record of the search strategy used, the results found and the date of the search was kept. This note was useful for writing the article and for keeping the memory of the procedures performed.

Camargo and Justo (2013) point out that the corpus suitable for DHC-type analysis, performed by the IRaMuTeQ software, needs to consist of a textual set centered on a theme. According to the analysis through the DHC, Salviati (2017) recalls that it aims to obtain classes of text segments (ST) that, at the same time, have vocabulary similar to each other and different vocabulary from the TS of the other classes. This analysis is based on lexical proximity and the idea that words used in similar contexts are associated with the same lexical world and are part of specific mental worlds or representational systems.

The text segments are classified according to their respective vocabulary, and the set of terms is partitioned according to the frequency of the roots of the words. The system looks for classes formed by words that are significantly associated with that class. That is, the DHC analysis originates classes that group the words of the textual corpus according to the values of the chi-square test and allows the researcher to build the subcategories (classes) to be analyzed. In order to carry out the DHC analysis, it is necessary to build a textual corpus containing the research subjects' responses to the proposed question.

For this purpose, the IRaMuTeQ software (R Interface for Multidimensional Text and Questionnaire Analysis) was used, with the aim of improving the research work, by optimizing the organization process and the more specific delimitation of the selected texts, enabling the survey of the constituent elements of socially shared representations, which highlight traces of mental worlds through lexical worlds that he outlined and, later, inferred using the content analysis technique (MUTOMBO, 2013).

Thus, the set of selected works was organized into a single text (corpus), each of which was defined by the IRaMuTeQ program as a “text segment”, that is, what was

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emphasized in the research, the methodology or methodological approach used, the context in which it was developed and the types of study and areas involved, and the main results and conclusions. The corpus was organized by command lines called "asterisk lines", in which the text identification numbers are informed, followed by some indispensable variables for carrying out the textual analysis. In this research, the variables were coded as follows:

(1) Text: text_01 and so on up to text_12;

(2) Type of publication: pubType_01, theses or dissertations; pubType_02, articles published in scientific journals; pubType_03, books; pubType_04, articles published in international scientific events; pubType_05, articles published in national scientific events.

(3) Year of publication of the text: yearPub_01, published in 2014; yearPub_02, published in 2015; yearPub_03, published in 2016; yearPub_04, published in 2017; yearPub_05, published in 2018; yearPub_06, published in 2019; yearPub_08, published in 2020; yearPub_08, published in 2021.

(4) Audience for which the work is intended: publicTeaching_01, student in the Final Years of Elementary School; publicTeaching_02, students and teachers of the Final Years of Elementary School.

(5) Brazilian region where the work was developed: PubRegion_01, state of Minas Gerais; PubRegion_02, state of São Paulo.

In addition, the texts that make up the textual corpus were configured as defined in the IRaMuTeQ tutorial (CAMARGO and JUSTO, 2013), mainly regarding accentuation, use of special characters and formatting. The procedure for organizing the command lines for inserting scientific productions can be seen in the example of part of the fragment of the first text:

> ****** *text_01 *pubType_04 *yearPub_01 *publicTeaching_01 * PubRegion_01**
> Recognizing themselves as an important aspect for teaching probability, paradidactic books are presented as a resource that requires objectives and meanings that will be acquired to interact with other subjects, without being confused with them in a positive and productive way for Mathematics. Therefore, this work presents the elaboration of a paradidactic book specifying probabilistic contents, registering the possibility of working this theme in Mathematics classes, based on the paradidactic book in elaboration.

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Thus, we use Reinert's method (1998), which proposes a DHC that aims to obtain classes of text segments (ST) that, at the same time, have similar vocabulary among themselves and different vocabulary from the ST of the other classes. The interpretation of the DHC results is based on the hypothesis that the use of similar lexical forms is linked to common representations or concepts (REINERT, 1987). For this reason, the Reinert method is often used to identify themes underlying a set of texts.

We emphasize that the choice to use one or another analysis technique depends on the characteristics of the problem and the research objectives (LEBLANC, 2015). In this sense, the researcher's theoretical-methodological framework, plus the support of lexicometric analysis software, can provide greater reliability to the inferences made in qualitative research (JUSTO and CAMARGO, 2014; SANTOS et al., 2017). In view of this, the study presented here describes and discusses the characteristics of the use of IRaMuTeQ in the analysis of data from scientific works aimed at the use and creation of paradidactic books for teaching probability in the Final Years of Elementary School published by Brazilian researchers between 2014 and 2021.

Therefore, this analysis is based on lexical proximity and the idea that words used in similar context are associated with the same lexical world and are part of specific mental worlds or representational systems. In this analysis, the text segments are classified according to their respective vocabulary, and the set of terms is partitioned according to the frequency of the roots of the words. The system tries to obtain classes formed by words that are significantly associated with that class (significance starts with the chi-square test - χ^2).

According to Oliveira (2015), the chi-square test is one of the most important analyzes of IRaMuTeQ, as it uses the correlation logic, starting from segmentations of the textual corpus, together with the list of reduced forms and the dictionary (in Portuguese) available to present a hierarchical scheme of classes. Thus, the text is processed so that vocabulary classes can be identified, making it possible to infer which ideas the textual corpus wants to convey, that is, the analysis is made from a statistical logic applied lexically.

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4 Results and Discussions

Figure 1 shows the data collection flow. In the first column, the number of works identified in the databases considered for this research is presented, starting from the indicated keywords. In the second, there are those who were selected after applying the inclusion criteria.

Figure 1: Data collection flow and number of studies retrieved in each database

Works identified in the databases through highlighted keywords	Identification, after applying the inclusion criteria, of the number of selected papers
Public Domain Portal = 1	Public Domain = 0
SciELO - Scientific Electronic Library Online = 0	SciELO = 0
Brazilian Digital Library of Theses and Dissertations (BDTD) = 2	BDTD = 1
CAPES Theses and Dissertations Catalog = 10	CAPES = 0
Google Scholar = 118	Google = 11

Source: Prepared by the authors (2022).

Therefore, this search returned 12 results, reading all titles, abstracts and texts to identify proposals aimed at the use and creation of paradidactic books for the Final Years of Elementary School for teaching probability in Brazil (Table 1). The studies were categorized in order to answer the research question, highlighting: How has research on the use and creation of paradidactic books for the Final Years of Elementary School contributed to the teaching of probability in Brazil?

Table 1: Identification of texts selected in the database search

Text	Authors	Publication type	Educational institution	Text title	Target audience
1	Oliveira Júnior *et al*. (2014)	National Scientific Event	Universidade Federal do Triângulo Mineiro (UFTM)	The use and elaboration of a paradidatic book in the teaching of probability in the Final Years of Elementary School	Students
2	Oliveira Júnior *et al.* (2015a)	International Scientific Event	Universidade Federal do Triângulo Mineiro (UFTM)	Elaboration of a paradidatic book in the teaching of Probability in Elementary School	Students
3	Oliveira Júnior *et al.* (2015b)	International Scientific Event	Universidade Federal do Triângulo Mineiro (UFTM)	Paradidactic book on probability teaching in elementary school	Students
4	Ciabotti (2015)	National Scientific Event	Universidade Federal do Triângulo Mineiro (UFTM)	The use of paradidactic books for teaching probability in Elementary School	Students
5	Ciabotti (2016a)	Academic Master's	Universidade Federal do Triângulo	Elaboration of a paradidatic book for teaching probability: the trail	Students

		Dissertation in Education	Mineiro (UFTM)	of a proposal for the Final Years of Elementary School	
6	Oliveira Júnior, Ciabotti and Dos Anjos (2016)	International Scientific Event	Universidade Federal do Triângulo Mineiro (UFTM)	The trail of a proposal for a paradidactic book for teaching probability for the Final Years of Elementary School	students and teachers
7	Ciabotti (2016b)	National Scientific Event	Universidade Federal do Triângulo Mineiro (UFTM)	Research trends on the use of paradidactics in probability teaching for Elementary School	students and teachers
8	Oliveira Júnior and Ciabotti (2017)	Scientific article	Universidade Federal do Triângulo Mineiro (UFTM)	Aspects of preparing a paradidactic book for teaching Probability in the Final Years of Elementary School	Students
9	Oliveira Júnior and Ciabotti (2018)	Scientific article	Universidade Federal do Triângulo Mineiro (UFTM)	Discussion on the elaboration process of a paradidactic book for teaching probability in the light of the Anthropological Theory of Didactics	Students
10	Ciabotti and Oliveira Júnior (2019)	Book	Universidade Federal do Triângulo Mineiro (UFTM)	Paths for the elaboration of the didactic book Playing in the National Probability Olympiad in Elementary School	Students
11	Lozada (2020)	International Scientific Event	Universidade Federal do ABC (UFABC/SP)	Systematic Literature Review on Paradidactic Books on Mathematics and Probability in the Final Years of Elementary School	students and teachers
12	Lozada and Oliveira Júnior (2021)	International Scientific Event	Universidade Federal do ABC (UFABC/SP)	Development of a paradidatic book for teaching probability in the early years of elementary school	students and teachers

Source: Prepared by the authors (2022).

The IRaMuTeQ program works with initial context units (ICI) that can be structured in different ways depending on the character of the collected data. When working with the selected studies, each text must compose a UCI. The set of UCI composed the corpus of analysis that the program divides into text segments, which are the elementary context units (ECU). Specific questions (SQ) were proposed at the UCI, which collect, organize and present relevant information about the development of research aimed at the use and creation of paradidactic books for teaching probability in the Final Years of Elementary School in Brazil, namely: SQ1: What was emphasized? SQ2: What is the methodology or methodological approach used? SQ3: What is the context in which it is developed? SQ4: What are the types of studies and areas involved? SQ5: What are the main results and conclusions?

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Starting the study, the first analysis option that IRaMuTeQ makes available is related to the statistical data of the textual corpus (Figure 2), providing the number of texts and text segments, occurrences, average frequency of words, as well as the total frequency of each form and its grammatical classification.

Figure 2: Result of classification by Reinert's method - textual statistics

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+-+-+-+-+-+-+-+-+
|i|R|a|M|u|T|e|Q| - Wed Aug 11 10:25:09 2021
+-+-+-+-+-+-+-+-+
Number of texts: 12
Number of text segments: 244
Number of forms: 1527
Number of occurrences: 8774
Number of lemmas: 1075
Number of active forms: 948
Number of supplementary forms: 100
Number of active forms with frequency >= 3: 400
Average of shapes per segment: 35.959016
Number of clusters: 3
193 segments classified in 244 (79.10%)
##############################
time: 0h 0m 56s
##############################
```

Source: Prepared by the authors (2022).

The result of the analysis of textual statistics brings information that summarizes the textual corpus, as follows:

a) Number of texts: Records contained in the corpus. In this case, for example, the corpus has 12 texts (described in Table 1), corresponding to the paragraphs indicating the specific questions (QE), which, in the case of this work, collect, organize and present relevant information about the development of research aimed at the use or creation of paradidactic books in probability teaching for the Final Years of Elementary School in Brazil;

b) Text segments: The software divided the text into 244 text segments;

c) Number of active and supplementary forms: Words considered active (adjectives, nouns, verbs and adverbs) and supplementary (articles and pronouns). Articles and prepositions were eliminated;

d) Number of occurrences: Total number of words contained in the corpus;

e) Number of lemmas: differs from the number of forms, as the lemmas are the lemmatized forms, that is, the process, effectively, of deflecting a word to determine its lemma (the inflections are called lexemes);

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f) Average of forms per segment: Number of occurrences divided by the number of texts;

g) Number of classified segments: In the present case, 79.1% of the segments were classified due to the choice of word categories in the preferences menu (first menu presented in this analysis), as well as the choice of way of selecting text segments;

h) Number of clusters: number of classes determined by the analysis.

It is important to point out that DHC type analyses, to be useful for the classification of any textual material, require a minimum retention of 75% of the text segments. When an analysis is lower than this value, it is not considered adequate, as it offers only a partial classification (CAMARGO and JUSTO, 2013). In this sense, the textual corpus used for the analysis of the present study is considered representative and useful, given that the use was 79.1%.

Thus, the DHC of the text segments containing the five proposed specific questions (SQ) related to the ICU, highlighted in all 12 publications, was performed, so that it was possible to observe a division into three classes. According to Silva, Fiúza and Pinto (2019), the words contained in each class point to the close relationship of meaning existing between them, thus, DHC divides the text segment into classes, differentiated by colors referring to Factor Analysis by Correspondence (AFC), establishing a hierarchy and relationships between the observed classes, based on the lexical and semantic proximity of the subjects (TORVISCO and CHINEA, 2020).

In this sense, according to Bienemann et al. (2020), DHC aims at clusters of words with specific meanings, resulting from the similarity, association and frequency of their vocabularies. Camargo and Justo (2013) corroborate this argument and argue that, in DHC, text segments are classified according to their respective vocabularies, while the set is divided according to the frequency of reduced forms.

In Figure 3, the three classes are presented. We highlight, supported by Silva, Fiúza and Pinto (2019), that it is not only the words belonging to a class that indicate the approximation of meaning between them, but also the classes themselves, in relation to each other, have different levels of approximation. It is observed that the textual analysis points to a subordination between Class 3 (in blue color), which represents 16% of the textual corpus, with Class 1 (in red color) and Class 2 (in green

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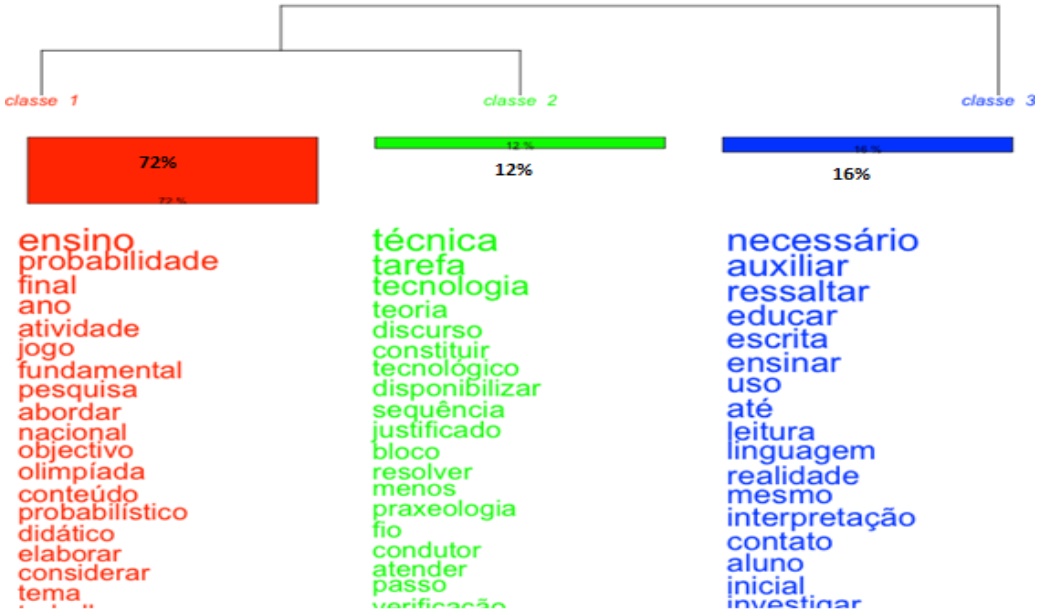
color), which indicate, respectively, 72% and 12% of the total. In addition, there is a direct relationship between Classes 1 and 2. The words are in Portuguese.

Figure 3: Result of DHC by the Reinert Method - Phylogram



Source: IRaMuTeQ output.

Therefore, the three classes contain the active forms or organized words that presented the highest frequency, in descending order, and that were significant to represent each of the subcorpus through the chi-square association test generated in the IRaMuTeQ reports. That is, their greater adherence in the class and between classes, as can be seen in the Phylogram (Figure 3).

Thus, it is observed, in Figure 3, that Class 3 is constituted by the presence of the terms “necessary”, “auxiliary”, “emphasis”, “writing”, “teaching”, “use” and “reading”, among others. less frequently, from which the class was named “Reading and writing through paradidactic books in the development of probabilistic concepts that are taught in the Final Years of Elementary School”, formed by the works of Oliveira Júnior et al. (2014), Ciabotti (2016b) and Lozada (2020), respectively, texts 1, 7 and 11.

Thus, in Oliveira Júnior et al. (2014), text 1, it is indicated that the elaboration of a didactic book can contribute to the study of probabilistic contents of the 6th to 9th grade of Elementary School, in which reading is allowed that develops the ability to interpret texts and make the most pleasurable study of probability. It is noteworthy that the intention of building the paradidactic is not to replace the textbook, but to complement it and insert this material as an essential element in the training of Basic

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Education students. It reinforces the importance of the student having contact with reading, writing and interpretation of texts, being able to have the help of the paradidactic book, so that these three aspects are worked on in an implicit and pleasant way. In terms of content, it is emphasized that the paradidactic is easier to work with interdisciplinarity, culturally helping the student, making him perceive his reality through knowledge.

In Ciabotti (2016b), text 7, it is defined that, in the construction of the paradidactic book, fictional narrative will be used based on Dalcin (2002), who believes that telling a story will provoke greater motivation in students in their reading and use as a tool. element of fixation and learning of probabilistic contents. It also reinforces the importance of the student having contact with reading, writing, interpretation of texts in their initial training, having the support of the paradidactic book in which they will work on the concepts in a less linear way. In addition, it is considered that this type of didactic material should bring a mathematical language with which the student can become familiar.

Closing this grouping (Class 3), Lozada (2020), text 11, believes that this type of book brings a more playful language, allowing the student to get used to the probabilistic language and even help in the use of the concepts expressed at BNCC (BRAZIL, 2018), for example: determining the probability of occurrence of a result in random events, when all possible results have the same chance of occurring (equiprobable) or planning and carrying out occasional experiments or simulations that involve calculation of probabilities or estimates through frequency of occurrences.

Regarding aspects related to reading and writing through paradidactic books in the development of probabilistic concepts that are taught in the Final Years of Elementary School, Class 3, it is emphasized that the intention of building this type of material for teaching probability did not is to replace the textbook and, yes, complement it, inserting the paradidactics in the training of students in the Final Years.

The connection between the classes generated by DHC points to a relationship between the terms present in Class 3, referring to the use of reading and writing through paradidactic books in the development of probabilistic concepts that are taught in the Final Years of Elementary School, with Class 2 that presents the use of the Anthropological Theory of the Didactic (ATD), by Yves Chevallard, denoted by the terms “technique”, “task”, “technology” and “theory”, and the period/cycle and content

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in which the work was designed (Class 1), supported by the words “teaching”, “probability”, “final”, “year”, “activity”, “game” and “fundamental”. With this, a discussion is indicated towards the development of an investigative process for the creation of a didactic book aimed at the Final Years of Elementary School, based on the National Curriculum Parameters (PCN) and on the BNCC.

Class 2, which we called “Bringing the Anthropological Theory of the Didactic – ATD, by Yves Chevallard, as a methodological model for the elaboration of a paradidactic book for teaching probability in the Final Years of Elementary School”, was formed through what was described in the works of Ciabotti (2016a), Oliveira Júnior, Ciabotti and Dos Anjos (2016), Oliveira Júnior and Ciabotti (2018) and Ciabotti and Oliveira Júnior (2019), texts 5, 6, 9 and 10.

In Ciabotti (2016a) and Oliveira Júnior and Ciabotti (2018), texts 5 and 9, it is explained that, based on the ATD, the elaboration of a paradidactic book is presented to support the teaching of probabilistic contents of the Final Years. The book will consist of problem situations or types of tasks, which can be performed using various techniques justified by the technology that uses Probability Theory as an object of study. Chevallard (1999) proposal for evaluating tasks, techniques, technologies and theories were also taken as a reference, considering that: 1) The projected tasks aim to be well identified according to the contents and reason for their proposal and whether it is suitable for students of the intended cycle (Final Years of Elementary School); 2) The set of tasks provides a view of the mathematical (probabilistic) situations used in the paradidactic book; 3) The technique will be made available in a complete way, that is, step by step, or only outlined; 4) The technology/theory block will be expressed throughout the book and with technological justifications.

In Ciabotti (2016a), Oliveira Júnior, Ciabotti and Dos Anjos (2016), Oliveira Júnior and Ciabotti (2018), texts, 5, 6 and 9, in the elaboration of the paradidactic book and in compliance with the principles of ATD, care was taken with the construction of the statements of the tasks to be developed. It was checked whether the book provided at least one way to solve the task, in addition to being suitable for the corresponding cycle and whether there was a discourse on the technique. In addition, in Oliveira Júnior, Ciabotti and Dos Anjos (2016), text 6, it is presented that, in the proposition of problem situations or tasks in the paradidactic book, the frequentist and classic

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approaches of probability were integrated, reinforcing the belief of making meaningful and comprehensive learning regarding the initial concepts of this content.

Oliveira Júnior and Ciabotti (2018) – text 9 – presents the process of preparing tasks for the paradidactic book called “Playing in the National Probability Olympiad”, a fictional narrative, aimed at teaching probability in the Final Years of Elementary School under the light of the ATD, in the didactic and mathematical (probabilistic) praxeological organization that contemplates aspects related to the probabilistic contents and that meets the needs of understanding and assimilation by the students who are finishing a cycle of studies.

In addition to the aspects presented in the previous paragraph, for Oliveira Júnior and Ciabotti (2018), text 9, the complexity that permeates the elaboration of the tasks – and among them those that structure the mathematical (probabilistic) organization – clearly imposes, not only because it requires the mathematical context, but also by the presence of influences that condition the choices, for example, the official curriculum, the teaching tools available and the textbooks adopted by the school as institutional study works, in this case, the paradidactic book.

Going deeper into the construction of the paradidactic book, Ciabotti (2016a), Oliveira Júnior, Ciabotti and Dos Anjos (2016) and Oliveira Júnior and Ciabotti (2018) – texts 5, 6 and 9 – present probabilistic concepts using history as a conducting wire. For example, the character representing the teacher appropriates a rational discourse to justify the techniques, using the technologies that allow him to perform the tasks. Thus, around a type of task, there is a trio formed by a technique, a technology and a theory. Whatever the task, technique is always accompanied by at least a trace of technology. This block constitutes a praxeology consisting of two parts: technological-theoretical, indicated as knowledge, and practical-technical, which constitutes know-how.

Closing the description of Class 2, Ciabotti and Oliveira Júnior (2019), text 10, point out that, in ATD, according to Chevallard (1999), for a praxeology to be specified, it is necessary to understand some fundamental concepts: type of task, task, technique, technology and theory. The “how to solve the task” is the engine that generates a praxeology, that is, it is necessary to have (or build) a technique that must be justified by a technology, which, in turn, needs to be justified by a theory. They

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indicate that the word technique will be used as a structured and methodical, sometimes algorithmic, process, which is a very particular case of technique.

Ciabotti and Oliveira Júnior (2019) also explain the procedures for the elaboration of the paradidatic book (Playing in the National Probability Olympiad) that subsidizes the teaching of probabilistic contents for the Final Years of Elementary School following the principles of ATD, based on Chevallard (1996) and Chevallard, Bosch and Gascón (2001), in the didactic and mathematical praxeological organization. In addition, Chevallard (1999) proposals to evaluate tasks, techniques, technologies and theories were taken as a reference.

Thus, Class 2 presents the task elaboration process for the paradidactic book aiming to subsidize the teaching of probabilistic contents of the Final Years of Elementary School, following the principles of the Anthropological Theory of the Didactic (ATD) of Chevallard (1996) and Chevallard, Bosch and Gascón (2001), in the didactic and mathematical (probabilistic) praxeological organization.

Class 1, called “Presenting aspects related to the content to be addressed (probability), the cycle for which it is intended (Final Years of Elementary School), curricular documents and ideas about characters and nature of the publication on the elaboration of a paradidactic book”, is composed by the works of Oliveira Júnior et al. (2015a), Oliveira Júnior et al. (2015b), Ciabotti (2015), Oliveira Júnior and Ciabotti (2017) and Lozada and Oliveira Júnior (2021), texts 2, 3, 4, 8 and 12.

Oliveira Junior et al. (2015a, 2015b) and Oliveira Júnior and Ciabotti (2017), texts 2, 3 and 8, present different aspects about the elaboration of a paradidactic book, specifying probability as a possibility to work on the theme in Mathematics classes. The topics that will be covered in the book are defined according to the Common Basic Content – Mathematics – from the 6th to the 9th grade of Elementary School and the PCN (Mathematics for the Final Years of Elementary School), being: concept of randomness and deterministic; random experiment; sample space; event; probability definition. In addition to these aspects, it was decided to use games to present the probabilistic contents, inserting them as stages of a Probability Olympiad, in which the characters participate seeking to become national champions.

Oliveira Junior et al. (2015b), text 3, emphasize that, in the elaboration of activities to be developed from the paradidactic books, it will include aspects related to probabilistic contents and reading, with the aim of providing students with the

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experience of the processes pointed out by Nacarato and Lopes (2005), that is, communication of ideas, interactions, discursive practices, mathematical representations, arguments and negotiation of meanings. They also reinforce that games can be excellent activities for introducing probabilistic concepts, as they have the potential to contribute to understanding the difference between random and deterministic situations or to differentiate probability possibilities.

In Ciabotti (2015), text 4, it is highlighted that, in the PCN (BRAZIL, 1997), at the end of elementary school, the student must master basic concepts about probability, namely: relating the concept of probability to that of ratio; Solve problems involving calculating the probability of simple events. Given this assumption, references were sought to support the teaching of probabilistic content for the Final Years through paradidactic books, as well as didactic works that addressed this theme.

It started with the idea that it is necessary to investigate and seek a broader and more reasoned understanding of the use of paradidactic books in the development of reading and, consequently, in the probabilistic contents that are taught.

Given the importance of studying the basic contents of probability in the contemporary world and with the purpose of adapting resources as a suggestion for education professionals in the use of paradidactics, the research showed a shortage of material regarding the teaching of probability in this teaching cycle.

In Oliveira Júnior and Ciabotti (2017), text 8, it is highlighted that the following aspects will be carried out concurrently in the preparation of the paradidactic: create the story that will be the guiding thread of the actions to be developed; create characters; choose the contents to be addressed; draw the illustrations and engravings; work out the text. It is reported that, for the choice of probabilistic contents for the Final Years of Elementary Education as the main theme of the paradidactics, the authors relied on Rezende and Ferreira (2011) when stating that the teaching of probability in Basic Education, often, it is left aside and, when it occurs, it is still done by memorizing contents and formulas. Furthermore, probabilistic notions have been proposed since the First Cycle in the PCN, with the aim of making the student understand the different situations of chance and uncertainty that they face in their daily lives (BRAZIL, 1997).

Finally, in the most current work, Lozada and Oliveira Júnior (2021), text 12, based on the Mathematics curriculum of the State of São Paulo and its intersections

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with the BNCC, consider that the paradidactic book for teaching probability can complement the didactic material used in public schools in São Paulo, starting from the indication of applications, games, challenges, history of probability, being a tool that will contribute to the teaching and learning process of content in the Final Years of Elementary School.

In addition, the organization structure of the paradidactic book is presented, indicated in Class 1, generated by the DHC through the IRaMuTeQ software, based on the tasks that will compose the paradidactic book, elaborated based on some games that are important to add motivation to the activities. activities and list the probabilistic contents to be addressed, emphasizing the relevance of the student having contact with reading and interpreting texts.

In addition to the phylogram, this results interface makes it possible to identify the lexical content of each of the classes (Figure 4) and a factorial representation of the DHC. The results obtained with the Reinert method (DHC) can also be represented in a factorial plan constructed by Correspondence Factor Analysis (CFA). Specifically, when used in the Reinert method, the CFA relates linguistic forms and context variables with the classes resulting from the DHC (NASCIMENTO and MENANDRO, 2006).

Remember that the variables used were: type of publication; year of publication of the text; audience for which the work is intended; and Brazilian region where the work was developed. Thus, we present below, in more detail, which variables are used to identify each of the texts and which are significantly associated with each of the classes generated by DHC.

In Class 3 “Reading and writing through paradidactic books in the development of probabilistic concepts that are taught in the Final Years of Elementary School”, formed by the texts by Oliveira Júnior et al. (2014), Ciabotti (2016b) and Lozada (2020), texts 1, 7 and 11 respectively, is identified as follows: 1. It was carried out by a research group registered with the National Council for Scientific and Technological Development (CNPq) in a Graduate Program in Education at a Federal University in the interior of Minas Gerais, Southeast Brazil; 2. Production published in scientific articles.

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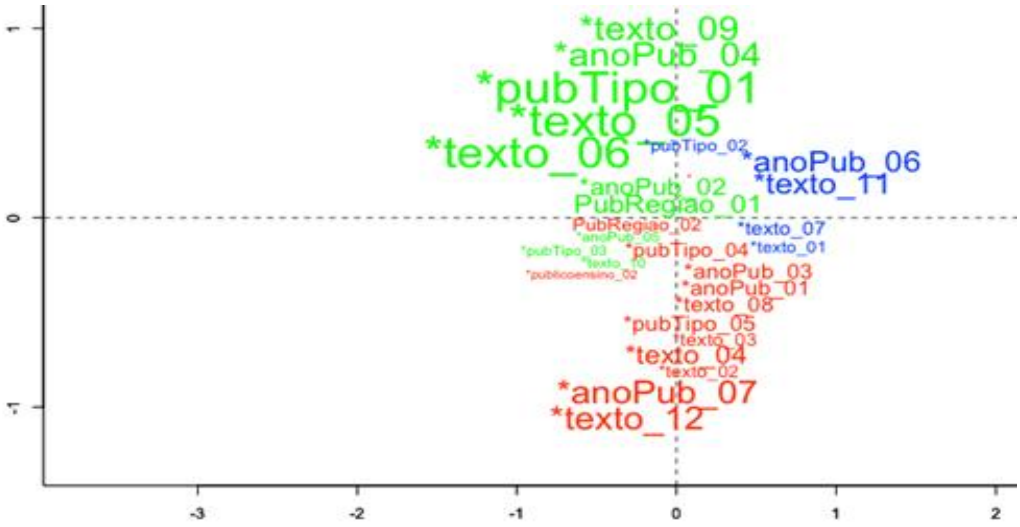
Figure 4: Result of Classification by the Reinert Method - AFC, associated with the highlighted variables



Source: IraMuTeQ output (2022).

When we consider Class 1, referring to “Presenting aspects related to the content to be addressed (probability), the cycle for which it is intended (Final Years of Elementary School), curricular documents and ideas about characters and nature of the publication on the elaboration of a paradidactic book”, formed by the texts of Oliveira Júnior et al. (2015a), Oliveira Júnior et al. (2015b), Ciabotti (2015), Oliveira Júnior and Ciabotti (2017) and Lozada and Oliveira Júnior (2021), texts 2, 3, 4, 8 and 12, is identified by: 1. It was carried out by a research group registered in the CNPq in a Graduate Program in Education at a Federal University in the interior of Minas Gerais and continues to be developed in a Graduate Program in Teaching Science and Mathematics at a Federal University located in the State of São Paulo, both in the Southeast from Brazil; 2. Aimed at students and teachers; 3. Published production in a Master's thesis and in a book resulting from this postgraduate research.

Finally, in Class 2, referring to “Bringing the Anthropological Theory of the Didactic – ATD, by Yves Chevallard, as a methodological model for the elaboration of a paradidactic book for teaching probability in the Final Years of Elementary School”, formed by the texts of Ciabotti (2016a), Oliveira Júnior, Ciabotti and Dos Anjos (2016), Oliveira Júnior and Ciabotti (2018) and Ciabotti and Oliveira Júnior (2019), texts 5, 6, 9 and 10, is identified by: 1. It was carried out by research group registered with CNPq in a Graduate Program in Education at a Federal University in the interior of Minas Gerais and continues to be developed in a Graduate Program in Science and Mathematics Teaching at a Federal University located in the State of São Paulo, both

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in Southeast Brazil; 2. Aimed mainly at students and teachers; 3. Based on articles published in national and international scientific events.

5 Final Considerations

In this text, starting from the objective of the research, we present an analysis of scientific productions in the Brazilian context on the use or creation of paradidactic books for teaching probability in the Final Years of Elementary School. The twelve works selected in this systematic review, from 2014 to 2021, offer important elements to understand the production of knowledge and highlight the contributions and gaps in this area of research and, at the same time, allow this field to be further explored by researchers.

We remind you that data analysis was organized based on the identification of the following variables of interest: type of publication; year of publication of the text; audience for which the work is intended; and Brazilian region where the work was developed. In addition, these variables were associated with specific questions (SQ), which guided the collection, organization and presentation of relevant information, namely: SQ1: What was emphasized? SQ2: What is the methodology or methodological approach used? SQ3: What is the context in which it is developed? SQ4: What are the types of studies and areas involved? SQ5: What are the main results and conclusions?

Thus, the set of works analyzed reveals some important aspects: 1) Research carried out in the period 2014-2021 is concentrated in the Southeast region (Minas Gerais and São Paulo); 2) Most of the research is aimed at students, lacking works more aimed at teachers in effective exercise of their profession or in initial training; 3) The works were carried out in two graduate programs (Education and Teaching; and History of Science and Mathematics) and developed by the same research group registered with CNPq; 4) Consists of a dissertation, a book, two articles published in scientific journals, five articles published in annals of international scientific events (Colombia, Spain and Mexico) and three articles published in annals of national scientific events.

Based on the results of this study, we report that research on the use and creation of paradidactic books in teaching probability for the Final Years of Elementary School is still incipient, remembering that the teaching of this content was inserted in

the Brazilian curriculum structure, in Basic Education, with the PCN, from 1997 for the 1st and 2nd cycles (BRAZIL, 1997), in 1998 for the 3rd and 4th cycles (BRAZIL, 1998) and reinforced in the BNCC (BRAZIL, 2018), when it is indicated that, from the age of six, aspects related to the notion of bad luck should be addressed.

Bringing characteristics related to the analysis of the data of the works highlighted here, in the maximum tree generated in IRaMuTeQ on the set of works, it is evident, in the research, the concern with the student's profile and its relations with the experiential knowledge and with the daily life, contributing to the formation of citizens aware of the development of probability.

It is perceived, in the works, the recognition that probabilistic information is always available to society in the media and, based on this assumption, it is considered that students already have some knowledge about the subject. Therefore, the search for the evaluation of the appropriation of a probabilistic language can help students in the construction of a new critical and autonomous knowledge through the availability of new knowledge.

We reinforce that, although research in Brazil is still incipient in relation to the use and creation of paradidactic books in probability teaching for the Final Years of Elementary School, the works selected in this study show that probability can influence the formation of citizens' opinions, it being essential that knowledge be built from the information conveyed in the media and directly associated with the student's daily life. However, we consider that there is still a need to carry out research addressing, in the Brazilian context, the subject of the study that we bring here, as well as which didactic material(s) students and teachers consider to be adequate to the teaching and learning process explicitly.

In addition, we highlight the possibility of seeking references on paradidactic books for teaching probability in international publications, although we establish the hypothesis that the term paradidactic is restricted to Brazil or other cycles (Initial Years of Elementary School and High School).

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