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Statistical education in the early years: perspectives of an experience in a multi-grade classroom

Statistical education in the early years: perspectives from a multi-grade classroom experience

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SUMMARY

This article is an excerpt from an investigation into statistics teaching in the early years of elementary school, linked to the Teacher Training research line of the Graduate Program in Education at the University of Pernambuco, Mata Norte Campus. The research adopted a qualitative and exploratory approach, grounded in the Theory of Meaningful Learning, Statistical Literacy, and the Investigative Cycle (PPDAC), focusing on the thematic block of probability and statistics. The study was conducted with students from a multi-grade class in the 4th and 5th grades, highlighting the importance of considering prior knowledge when reading and interpreting graphs and tables. Analysis of the simulations included in the adopted textbook (Leonardo, 2019) highlighted gaps in the development of skills H25 and H26, guided by the curricular guidelines and the Investigative Cycle. A survey was also conducted with teachers from the Ipojuca municipal school system to identify the statistical content covered in the classroom. Based on this, a pedagogical intervention proposal was developed with contextualized activities involving the collection of real data, organization in tables, and the construction of column graphs, stimulating critical thinking and the discussion of local issues. The research also included the analysis of official documents, teaching materials, and a literature review on the topic. The results indicate that the investigative and contextualized approach promotes greater student engagement, making math classes more dynamic and meaningful. The study reinforces the relevance of statistical literacy for the development of critical citizens in contemporary society.

Keywords: Teaching Statistics. Statistical Literacy. Early Years of Elementary School. Investigative Cycle. Contextualized Pedagogical Practices.

ABSTRACT

This article presents a segment of an investigation into the teaching of statistics in the early years of elementary education, within the research line of Teacher Education from the Graduate Program in Education at the University of Pernambuco, Mata Norte Campus. The research adopted a qualitative and exploratory approach, grounded in the Theory of Meaningful Learning, Statistical Literacy, and the Investigative Cycle (PPDAC), focusing on the thematic block of probability and statistics. The study was carried out with students from a multigrade 4th and 5th grade class, highlighting the importance of considering students' prior knowledge in the reading and interpretation of graphs and tables. The analysis of mock assessments from the adopted textbook (Leonardo, 2019) revealed gaps in the development of skills H25 and H26, aligned with curriculum guidelines and the Investigative Cycle. A survey was also conducted with teachers from the municipal network of Ipojuca to identify the statistical content covered in classrooms. Based on this, a pedagogical intervention was designed with contextualized activities involving the collection of real data, organization into tables, and the construction of column charts, encouraging critical thinking and discussions on

local topics. The research also included the analysis of official documents, teaching materials, and a literature review on the subject. The results show that the investigative and contextualized approach enhances student engagement, making math classes more dynamic and meaningful. The study reinforces the relevance of statistical literacy for the formation of critical citizens in contemporary society.

Keywords: Teaching of Statistics. Statistical Literacy. Early Years of Elementary Education. Investigative Cycle. Contextualized Pedagogical Practices.

1. STATISTICAL TRAINING IN THE EARLY YEARS: BETWEEN CURRICULAR GUIDELINES, LARGE-SCALE ASSESSMENTS AND PEDAGOGICAL PRACTICES

Observing the current trend of diversification of practices and reviews in the instances curricula dedicated to teaching mathematics, its applicability in various fields is evident, such as science, technology, economics, politics, health, social and cultural issues. In this context, curricular bases have emphasized the importance of mathematical themes in the education of students, covering not only the mastery of numbers and operations, but also skills such as data organization, graph reading and statistical analysis.

These skills are crucial for citizens to understand and evaluate critically information of a quantitative nature, present in various media outlets everyday life, such as news, government reports, market research, and in personal situations, such as financial planning and decision making.

Therefore, mathematics curricular proposals must enable students to use tools and skills necessary to face the challenges of the contemporary world in a active and confident. This contributes to the formation of informed and participatory citizens in a increasingly information-driven society, in which exposure to multiple sets of information data is constant.

Antônio Nóvoa (2019) highlights the importance of teachers' experiences as a valuable source of learning and professional development. Teachers have a wealth of knowledge unique practical experience and a deep understanding of the needs and realities of its students, which points for interventions aimed at improving educational outcomes.

However, it is crucial to recognize that these specificities cannot be replicated and

must be built. This contrasts with the current trend of outsourcing teacher training, where private institutions often provide educational solutions that are not aligned with the needs of students.

For more than a decade working as an Elementary School teacher in the 1990s, Initially, I was able to observe countless times the difficulties of students in the curricular component of mathematics, which often affected their performance and transition to the Final Years of School Fundamental. In this sense, there is a concern regarding the low performance of students in initial years in the mathematical curricular component in general.

The National Curricular Parameters (PCN) establish educational guidelines for the Elementary Education in Brazil. Regarding the teaching of statistics in the early years, the PCN emphasize the introduction of statistical concepts in a contextualized and meaningful way for the students (BRAZIL, 1997).

In turn, the National Common Curricular Base (BNCC) guides the guidelines for the curriculum school at all stages of Basic Education in Brazil. In relation to statistical literacy, the BNCC recognizes the importance of developing statistical skills in students from the age of initial, enabling them to understand and deal with statistical information in different contexts (BRAZIL, 2017).

In the meantime, BNCC considers statistical literacy in an interdisciplinary way, associating it to the teaching of mathematics and other areas of knowledge. The concept of Statistical Literacy (LE), based on Gal (2002), recognizes people's ability to interpret and evaluate critically analyze statistical information, as well as discuss or communicate their reactions and opinions about it the data involved. Thus, the BNCC guidelines emphasize the importance of promoting development of Statistical Literacy from the early years, enabling students to be critical, analytical and aware of the statistical information encountered in their daily lives.

Currently, the implementation of large-scale assessments has become a common practice in schools both in Brazil and around the world. These assessments have the main objective measure a variety of indicators related to the quality of education, covering multiple aspects of the educational process. Particular emphasis is placed on the learning expectations of components of the Portuguese Language and Mathematics, which are considered fundamental for the academic and professional development of students.

In the Brazilian context, students in public schools are subjected to different types of

assessment at national, state and municipal levels. The national assessment is conducted through Basic Education Assessment System (SAEB), while the state or municipal assessment is carried out by the Pernambuco Educational Assessment System (SAEPE), in the specific case of state of Pernambuco, which serves as the central focus of this research.

These assessments not only provide a broad overview of students' academic performance, students, but are also used to guide educational policies, identify areas for improvement and promote accountability in the education system. Furthermore, they play a crucial role in identification of inequalities in performance between different groups of students and in the formulation of strategies to reduce these disparities, thus contributing to the construction of a system more equitable and inclusive educational system.

In order to support the relevance of the object of study and provide subsidies for the choosing the focus of this research, we analyzed the results of the Educational Assessment System of Pernambuco (SAEPE) in the years 2021 and 2022. Through Tables 1 and 2, below, we demonstrate the descriptors of the 2nd and 5th years of Elementary School, elucidating considerations on the mathematical object and the curricular contents associated with its interest study.

Develop skills that involve formulating questions based on reality, collection, organization and presentation of information, as well as the observation and interpretation of phenomena, are fundamental skills that must be encouraged from the early years of Elementary School. At this early stage, it is crucial to broaden and deepen these skills.

Specifically, the issues addressed should involve broader themes, capable of to spark student interest and promote comprehensive training. Working with tables and graphics should not be restricted to reading and interpretation, but should be expanded to include situations that allow students to deal with sets of information, formulate conjectures and identify relevant aspects of the data presented (PERNAMBUCO, 2012).

This research compared the learning achievement indices of the initial years of Elementary Education, emphasizing students' understanding of reading and interpretation of tables and graphs, as well as highlighting some results from rural and urban schools in the network municipal government of Ipojuca/PE. For this purpose, a survey was conducted regarding the prior knowledge of the students, belonging to the same multi-grade class of 4th and 5th grade of Elementary School, with emphasis on skills (H25 and H26), assessed by the SAEPE and SAEB test.

The performance of students in a multi-grade class with 4th and 5th grade students was analyzed. of the 5th year of Elementary School on skills (H25 and H26) both in relation to schools in rural as well as urban ones that were evaluated in SAEB 2021. The school selected for the investigated emphasis is located in a rural area of the municipality of Ipojuca, operates under conditions of precariousness in terms of infrastructure and access to teaching-pedagogical resources and has suffered rumors and threats of being closed and/or nucleated due to its enrollment number being insufficient to form unified classes. In this sense, it is important to look at the process of mathematical teaching and learning that is established in this scenario.

It is essential in this analysis that we understand the knowledge of the context in perspective of Statistical Literacy by Gal (2002), through the stages of the Investigative Cycle, considering the prior knowledge of learning students in a multi-grade class of the 4th and 5th year of Elementary School, focusing on the use of statistical data presented in tables, pictorial, column and bar graphs as a pedagogical tool.

To achieve this objective, the research seeks to collect, organize, describe, analyze and interpret statistical data in a school context, investigating how these tools can contribute for the teaching and learning process in this specific environment. The dissertation aims not only examine the use of these resources, but also understand the perceptions of students and teachers about its effectiveness, their preferences regarding different types of visual representations of data and the perceived impacts on student understanding and engagement. In the end, we hope if it provides relevant *insights* for pedagogical practice.

To achieve this objective, the stages of the investigative cycle were adopted, with the aim of explore how students formulate questions, create hypotheses, and investigate information that emerge from observation of their environment; how they develop hypotheses or predictions about the results; what methods are used to read, interpret, collect and organize the data and how communicate the information obtained. During data analysis, we used graphical understanding based on Curcio (1989), detailed in three distinct levels.

At the first level, data reading, the individual is able to read statistical information presented in a graph or table, but without necessarily interpreting or understanding them completely. At the second level, reading between data, there is the ability to read implicit data, that is, identify the mathematical relationships presented in the graphical representations, as well as understand the properties of the graph being analyzed. At the most advanced level, data inference,

the reader is able to make generalizations and inferences from the information presented in the graph

2 PERSPECTIVES ON THE THEORY OF MEANINGFUL LEARNING

In the context of interaction between teacher and student, it is essential that cognitive processes involved in the construction and solidification of learning are based on a theory that is aligned with the educational objectives. Therefore, in this study, we chose to adopt the Theory of Meaningful Learning (TAS), proposed by David Paul Ausubel (1918-2008), among others reasons, due to its structure aimed at application in the classroom, as evidenced by Pozo (1998). Furthermore, the value given by Ausubel to prior knowledge of the learner, understanding that the assimilation of new content must be anchored in existing ideas in the cognitive structure (Ausubel, 2003).

The TAS, conceived by David Ausubel in 1963 and improved in 1988, represents a milestone fundamental in educational psychology. Ausubel introduced a revolutionary approach that emphasizes the importance of synergy between new knowledge and pre-existing cognitive structure of the learner. From this perspective, learning achieves meaning when new concepts are integrated organically and substantially into the framework of previous knowledge, enabling the assimilation and reconfiguration of current mental schemes.

At the core of Meaningful Learning Theory (SLT) is the premise that assimilation of new knowledge is more effective when it is integrated into the learner's cognitive context in a coherent and relevant manner. Ausubel argues that meaningful learning is opposed to mere memorization, in which knowledge is acquired superficially and disconnected from prior understanding of the learner. According to Ausubel, meaningful learning promotes a deeper cognitive restructuring, resulting in a more solid and actionable understanding transfer to new contexts.

Ausubel highlights three essential elements that shape the occurrence of learning significant: the learner's prior knowledge, the organization of the material to be learned and the own learning process. Prior knowledge serves as pillars for absorption of new knowledge, offering a mental framework in which new concepts can be fit. The structure of educational content plays a vital role in presenting information

in a coherent and relevant manner, facilitating its understanding and integration with knowledge previous. Finally, the learning process is characterized by the learner's mental activity in selection, organization and integration of information, promoting an active construction of knowledge.

Studies related to various areas of knowledge have been increasing in recent decades that seek to investigate how students' prior knowledge culminates and how it occurs the process of interaction and stimulation of teaching and learning in the school environment.

Based on Pozo (1998), prior knowledge can originate from conceptions spontaneous, induced or analog, which respectively merge into interactions throughout the world natural, cultural and academic. In turn, understanding that people already arrive at school with knowledge and practices arising from a local culture, refers to the view that this knowledge/practices can influence the understanding of school knowledge and vice versa.

Thus, aware of the value attributed by Ausubel (2003) to prior knowledge and, in particular, to subsumers for meaningful learning, it makes sense to think that when they come from own contexts, the possibility of enhancing this form of learning in both the contexts.

From the TAS perspective, the assimilation of new information occurs when it is related to a relevant concept already present in the individual's knowledge structure, resulting in meaningful learning (Ausubel, 1963). In this process, the prior knowledge that facilitate this interaction are called subsumers. Their recognition in the educational field describes as a process in which new information is integrated in a non-arbitrary and substantial way to the learner's cognitive structure. Thus, meaningful learning, as theorized by Ausubel (1968), occurs when new information connects to previous knowledge, acting as anchoring in the student's cognitive structure.

According to Ausubel, as cited by Moreira (2012), two prerequisites are essential for for meaningful learning to occur:

> The first condition implies 1) that the learning material (books, lessons, applications, ...) has logical meaning (that is, it is relatable in a non-arbitrary and non-literal way to an appropriate and relevant cognitive structure) and 2) that the learner has in his/her cognitive structure relevant anchor ideas to which this material can be related. That is, the material must be relatable to the cognitive structure and the learner must have the necessary prior knowledge to make this relationship in a non-arbitrary and non-literal way (Moreira, 2012, p. 8).

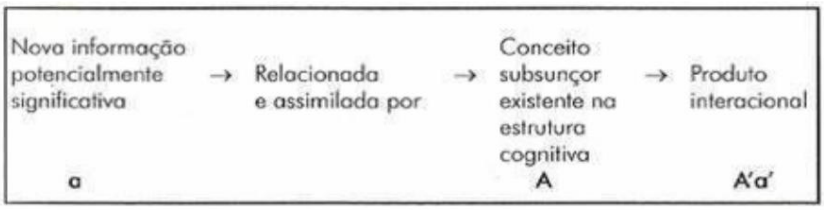
Considering the first aspect, it is essential that the learning material has a intrinsic logic that relates in a non-arbitrary and non-literal way to the cognitive structure of the student. This leads to the second point, which concerns the connection between the material, its cognitive basis, and the student's prior knowledge.

When new information fails to establish associations with existing knowledge previous, what is called Mechanical Learning occurs, which tends to be fleeting and easily forgotten. On the other hand, Meaningful Learning is more lasting, as it allows for the application practice in the student's daily life. The non-arbitrariness of this process develops gradually and permanent, requiring sensitivity and initiative to discover the symbols that are truly meaningful to the learner.

> Cognitive structure, considered as a structure of interrelated and hierarchically organized subsumers, is a dynamic structure characterized by two main processes: progressive differentiation and integrative reconciliation. Progressive differentiation is the process of assigning new meanings to a given subsumer (a concept or a proposition, for example) resulting from the successive use of this subsumer to give meaning to new knowledge (Moreira, 2012, p. 5-6).

According to the theorist, the occurrence of Significant Learning requires three conditions essential: the first is linked to the desire and motivation to learn; the second is that the content to be to be learned must have meaning, that is, it must be logically and psychologically relevant; and third condition concerns the existence of a base of prior knowledge, called by author as subsumers, which makes it possible to fulfill the second condition.

Image 1: Ausubelian meaning assimilation scheme



Source: Moreira (2006, p. 29).

In the Ausubelian approach, the consolidation of Meaningful Learning depends on the construction of subsumers that allow students to assign meaning and generate meanings. Ausubel (2003)

argues that, in the process of signification, as new concepts and ideas are incorporated into cognitive structure, the retention of meanings requires an active approach, requiring that phenomena are first acquired through a highly engaging learning process and participatory.

> Prior knowledge is, in Ausubel's view, the single most important variable for the meaningful learning of new knowledge. That is, if it were possible to isolate a single variable as being the one that most influences new learning, this variable would be prior knowledge, the subsumers already existing in the cognitive structure of the learner (Moreira, 2012, p. 7).

In this active role of developing learning, Ausubel emphasizes that the material presented must be intrinsically significant. To define this type of material, we will resort to the following excerpt from Rufino e Silva (2020, p. 105):

> Regarding the material's meaningful potential, since this is the focus of the work in question, Moreira (2006) explains that it must have "logical meaning," that is, it must be sufficiently non-arbitrary and non-random, thus being relatable to the cognitive structure in a substantive rather than literal way. Thus, the aim is for the student to attribute to the new knowledge conveyed by the learning materials the meanings accepted in the context of the teaching subject, based on the subsumers they possess.

In this study, the meanings within the field of Statistical Education, in particular the practices Statistical Literacy in the view of Gal (2002), are essential. The focus is on the ability to develop skills to interpret and critically evaluate statistical information, enabling students to build solid arguments both in the school environment and in other spheres.

This highlights the creation of teaching activities that sharpen the student's desire to learn, using situations that promote the negotiation of meanings between knowledge acquired outside of the school and institutionalized knowledge about Statistical Literacy. It is also worth highlighting that the value of local culture in the process of exchanging meanings in different educational contexts can stimulate the desire to learn, as advocated by Ausubel.

> The instructional material used, according to Ausubel (2000), must relate to some relevant aspect or content already existing in the student's cognitive structure. This may include "an image, an already significant symbol, a concept or a proposition, or even some more general but relevant set of ideas in your knowledge structure (Ausubel, 2000, p. 68).

In turn, Moreira and Masini (1982) describe the assimilation process as a tool to better understand the acquisition and organization of meanings in the cognitive structure of the student. In this process, an interaction occurs between an existing anchor idea and a new one information.

The process of Meaningful Learning involves the interaction of new information with specific structure of knowledge of the individual, called subsunçor. Moreira (2012, p. 02) defines subsumer as the structure of knowledge that allows meaning to be attributed to new knowledge presented or discovered by the individual.

2.1 IMPLICATIONS OF STATISTICAL LITERACY FOR MATHEMATICAL LEARNING

Discussions surrounding the term “literacy” have gained prominence in research educational, driven by the contributions of authors such as Kato (1986) and Kleiman (1995). In their analyses, both offer valuable perspectives that enrich the debate on the literacy and its application in different social and educational contexts. It is interesting to know that The use of the term literacy emerged in the 1990s, initially discussed in Brazil by Kleiman (1995) and Soares (1998), with the aim of conducting the reading and writing processes in social practices.

Kato (1986) emphasizes literacy as an intrinsically sociocultural process linked to the ability to understand and critically use written language in various contexts. For her, literacy transcends the simple decoding of letters and words, including also the understanding of the social and cultural practices that permeate the use of writing. Through a psycholinguistic approach, it examines the cognitive processes involved in learning of writing, considering influences such as family, school and media in the formation of skills children's reading and writing skills.

On the other hand, Kleiman (1995) expands the concept of literacy, highlighting its nature multifaceted and complex. For Kleiman, literacy is not limited to the ability to read and write,

but also encompasses the understanding of social and discursive practices related to language writing. By adopting a social interactionist approach, she analyzes how social interactions influence the construction of meanings and the interpretation of written texts. Furthermore, Kleiman highlights the importance of critical reflection on written language, encouraging readers and writers to question and interpret texts actively and consciously.

The analyses by Kato (1986) and Kleiman (1995) provide a comprehensive overview of the literacy, considering its cognitive, sociocultural and discursive aspects. These works continue to be important milestones for researchers, educators, and practitioners seeking understand and promote literacy in different social and educational environments. By incorporating these perspectives, we can advance in the understanding and practice of literacy as a essential skill to validate effective participation in contemporary social and civil spheres.

The term "statistical literacy" has been the subject of study by several researchers over the years. over time. Although there are no specific theoretical precursors who coined the term just as happened with linguistic literacy, some scholars have contributed significantly to the development of this field of research.

Ernest (1991) highlights the importance of statistical understanding for effective participation in society, exploring the idea of "statistical literacy". Frankenstein (1998), in turn, emphasizes the need for a critical approach to teaching and learning statistics, considering the social, political, and cultural influences on students' statistical understanding. Presmeg (2006) focuses on the cognitive and social aspects of statistical literacy, analyzing the development of students' statistical skills and their influence by the educational context and cultural.

Although these authors did not necessarily coin the term "statistical literacy," in itself, his contributions were fundamental to the development and understanding of this concept over the years. These studies continue to influence the field of statistics education and promote more holistic and critical approaches to teaching and learning statistics.

Statistical literacy goes beyond the simple ability to interpret data. It is the ability to understand the role of statistics in the contemporary world, allowing individuals to do make informed judgments and actively engage with statistical concepts in a variety of contexts. People proficient in statistical literacy not only use statistics practical way, but also have the ability to reflect on their concepts and apply them in

interpretation of the world around you.

According to Fonseca (2004), statistical education from the perspective of literacy aims not only provide access to statistical concepts and procedures, but also develop strategies to interpret the world based on statistics, considering its relationships, criteria and cultures. Therefore, teaching statistics with this approach in the early years is crucial. It not only develops critical thinking from an early age, but also establishes a solid foundation for construction of knowledge in other areas. Furthermore, it promotes a greater understanding in-depth analysis of statistics as an essential tool for active and conscious participation in contemporary society.

Gal (2002) emphasizes that Statistical Literacy encompasses two fundamental dimensions. One of them concerns people's ability to interpret and analyze critically statistical information, arguments, and stochastic phenomena in different contexts. The other dimension refers to the ability to communicate and discuss the relevance of statistical information, taking into account not only the objectivity of the data, but also the subjectivity and understanding of its meaning. This implies the ability to express opinions and make critical questions about the context in question.

This inherent potential that the practice of LE has in establishing a connection with the local knowledge and sociocultural influences point to the defense of Lucena (2004) on the need to broaden our perspective beyond the restricted institutionalized mathematics in curricula. For Fonseca (2004), literacy includes a range of possibilities of social practices of use of mathematics and that its educational social role is to promote access and development of strategies and possibilities for reading the world, establishing concepts and relationships, criteria and procedures, and encouraging a critical view of everyday life.

The concept of Statistical Literacy, based on Gal (2002), considers the people's ability to interpret and critically evaluate statistical information, arguments related to data or stochastic phenomena, found in various contexts. Furthermore, it highlights the ability to discuss or communicate, when relevant; reactions to statistical information, such as their understanding of the meaning of the information; their opinions on the repercussions of this information or their considerations regarding the acceptance of the conclusions provided.

In turn, regarding Statistical Literacy, it is worth highlighting Gal's definition (2002, p. 1): “the

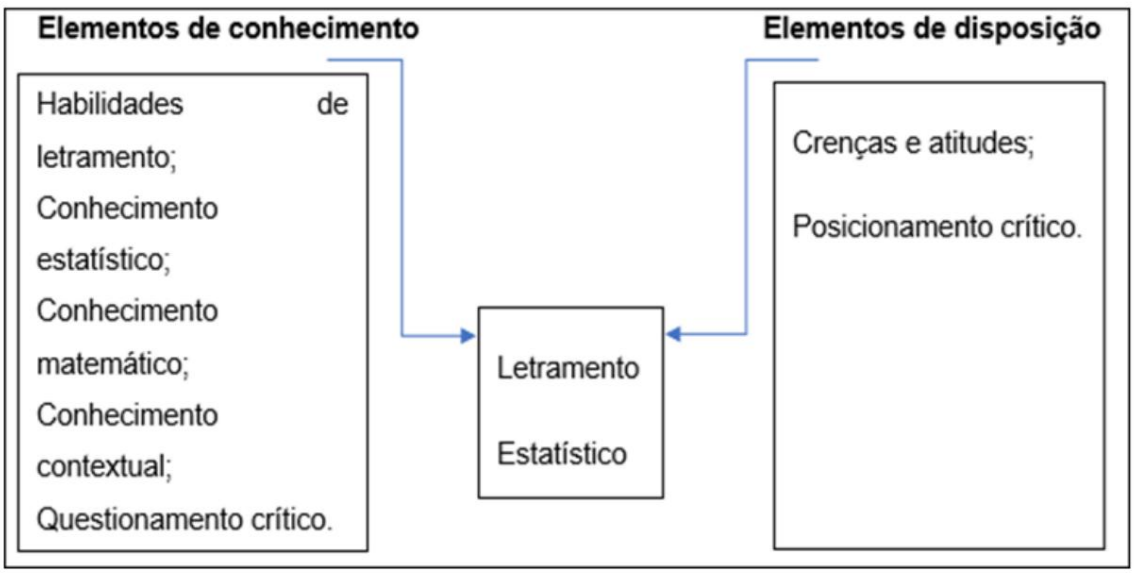
ability to interpret, critically evaluate and communicate statistical messages and information". In addition, it points out that this definition has been adopted in many related studies and calls attention to two interrelated components:

> (a) people's ability to interpret and critically evaluate statistical information, arguments related to data, or stochastic phenomena, which can be found in various contexts; (b) the ability to discuss or communicate their reactions to statistical information, as well as their understanding of the meaning of the information, opinions regarding its implications, or their concerns regarding the acceptability of the conclusions obtained (Santos, 2021, p. 107).

Aware that Gal (2002) does not refer to students but to adults living in industrialized societies, this requires something to get around this situation. Thus, from the point of view of learning, Bishop's (1988) argument regarding the assimilation of specific forms of mathematical representation involves the assimilation of values inherent to them and requires care with the processes of enculturation and acculturation, respectively, when the child is being induced in the mathematics of the local culture and in the mathematics of cultures other than the local one.

In this sense, for the student to become statistically literate, a process is required progressive learning process that takes time, making it necessary, within the educational path, that starts in the early years, going through Elementary School, High School, going up to Graduation.

Table 3: A Model of Gal Statistical Literacy



Source: Gal (2004, p.51, author's translation).

The author developed a model consisting of elements of knowledge (cognitive) and dispositional elements (beliefs, attitudes and critical positioning), but highlights that, despite the distinction of the two blocks, its model develops with all the elements in a dynamic way, which may vary depending on the context and provisions.

Table 2 describes the model proposed by Gal (2002), which involves two components: the cognitive and attitudinal. The cognitive is developed by five elements that are responsible for competence in understanding, interpreting and critically evaluating statistical information: literacy; statistical knowledge; mathematical knowledge; knowledge of context, and the competence to formulate questions. Regarding attitudinal components, they are defined by the relationship with people's attitudes and beliefs, their points of view and, as far as the critical stance, the ability to question statistical information.

Statistics, a discipline intrinsically linked to everyday life, plays a role vital in interpreting the world around us and making evidence-based decisions. In the context of the curriculum for the initial years of Elementary Education, understanding the essence of Statistics is essential not only for educators, but also for students, who acquire valuable skills and abilities to deal with quantitative data critically and informed.

To understand the relevance of Statistics, it is essential to explore its origins and evolution throughout history. Since ancient times, data collection and analysis have been fundamental to understanding the population and its characteristics, allowing governments to make decisions based on facts. The term "Statistics" emerged in the 18th century, associated with the constitution and organization of the State, reflecting the importance of demographic and economic studies for the effective governance.

Over time, Statistics has consolidated itself as a scientific discipline in its own right itself, expanding its scope of application and becoming an essential tool in various fields of knowledge. Its association with applied mathematics was deepened, developing specific processes for collecting, presenting and interpreting sets of data, providing a deeper understanding of reality and supporting decision-making decisions in a variety of contexts.

In the educational context, the presence of Statistics in the initial years of Elementary Education

is extremely important. By learning statistics from an early age, children develop skills essential skills in observation, data collection and organization, enabling them to perform simple analyses and draw informed conclusions. Furthermore, the interdisciplinarity of Statistics establishes valuable connections with other areas of knowledge, enriching learning and providing a broader and more comprehensive understanding of the world around us.

The importance of Statistics transcends the walls of the classroom, permeating our everyday life in various forms. From interpreting news and research to analyzing graphs and data-driven decision-making, Statistics plays a fundamental role in understanding and assessing social, economic, and environmental trends. Furthermore, it provides the necessary basis for the formulation of evidence-based public policies, contributing to sustainable development and the well-being of society as a whole.

Therefore, understanding and mastering the principles of Statistics, from the early years of Elementary education is not just an academic issue, but a fundamental skill for life. Enabling children to interpret and analyze data critically not only prepares them for face the challenges of the contemporary world, but also empowers them as informed citizens and aware of their role in society.

Studies in the field of Mathematics Education have demonstrated a growing concern with the understanding, application and interpretation of mathematical knowledge as a construct social, cultural and historical, intrinsically linked to political-pedagogical practices. The presence of mathematics permeates all stages of formal education and is integrated into the various areas of knowledge, influencing individual and collective relationships in people's lives.

However, recognition of the importance of this field of research was gradual, emerging of discussions between teachers and researchers about the teaching and learning processes of mathematics. Thus, different fields of research emerged, such as Education Statistics, which, among other objectives, seeks to promote social, economic and political dynamism, contributing to the formation of critical students.

In the content block on Information Processing in Elementary Education, by For example, the importance of students sharing knowledge about collection is highlighted, organization, communication and interpretation of data, using tables, graphs and representations related to their daily lives, with the aim of expanding their understanding of relationships social, cultural and work.

> With regard to Statistics, the purpose is to make the student construct procedures to collect, organize, communicate data, using tables, graphs and representations that frequently appear in their daily lives (BRASIL, 1999, p. 59).

Thus, this belief involving such educational intent finds support in the argument about the dimensions of the development of teacher training, in particular in the following excerpt from Multilinear development of Mathematics, pointed out by Gerdes (2010, p. 160):

> Although mathematical ideas can be very different across cultures and in distinct social and cultural contexts, it is still possible to discover commonalities. In other words, based on the teacher's experience and study, it is possible to recognize or understand mathematical aspects in different cultural contexts.

According to Santos (2022), Statistical Education in Brazil had its initial phase in 1980s and reached maturity in the 1990s, even being incorporated into the Parameters National Curricular Guidelines (PCN), 1997. These guiding documents recommend strategies to enhance mathematical learning, aiming to provide students with an understanding deeper understanding of the reality in which they are inserted.

3. THE OPTION FOR THE INVESTIGATIVE CYCLE

In an investigative methodology, students take an active role throughout the process, based on the first hypotheses and formulations of the problem highlighted. It is assumed, then, the teacher's ability to mediate and intervene in facts that arise in a unexpected, filtering the definition of decisions that put the collection process in check and data analysis.

Tardif (2014) reiterates the triad that encompasses investigative methodology, highlighting knowledge of the discipline, curriculum and experience. In this sense, the relevance of application of investigative methodology supports the treatment of statistical concepts which refers specifically to the Investigative Cycle.

Teaching statistics in the classroom is often restricted to mechanical application from formulas to abstract data sets, resulting in a detached approach to reality and lacking in meaning. This overemphasis on calculations can make classes monotonous and unattractive to students, damaging their learning expectations.

A more effective approach is to anchor statistics teaching in data from real contexts, which are relevant and interesting to students. This implies use examples that reflect social and cultural behavior and observable patterns in habits of students, teachers or specific groups, as well as the analysis of phenomena natural.

These pedagogical practices create a more dynamic and engaging learning environment. meaningful, essential for student development. When working with data within In this context, statistical concepts become more tangible and relevant to the students. Therefore, a fundamental strategy is to integrate the teaching of Statistics with real-world situations so that students understand the applicability and impact practical application of these concepts in their everyday lives.

The PPDAC Investigative Cycle, proposed by Wild and Pfannkuch (1999), comprises five phases: Problem (P), which involves understanding the context of the data and defining needs the problem or phenomenon to be investigated; Planning (P), which encompasses the outlining strategies and actions to conduct the investigation effectively; Data (D), which encompasses the process of meticulously collecting and organizing relevant data; Analysis (A), where the interpretation and detailed analysis of the data obtained takes place; and Conclusion (C), which marks the end of the investigation, presenting a critical and reflective evaluation of the problem, accompanied by the communication of the results obtained. From this conclusion, space opens up for the generation of new ideas and questions, driving the investigative cycle to new discoveries and learnings.

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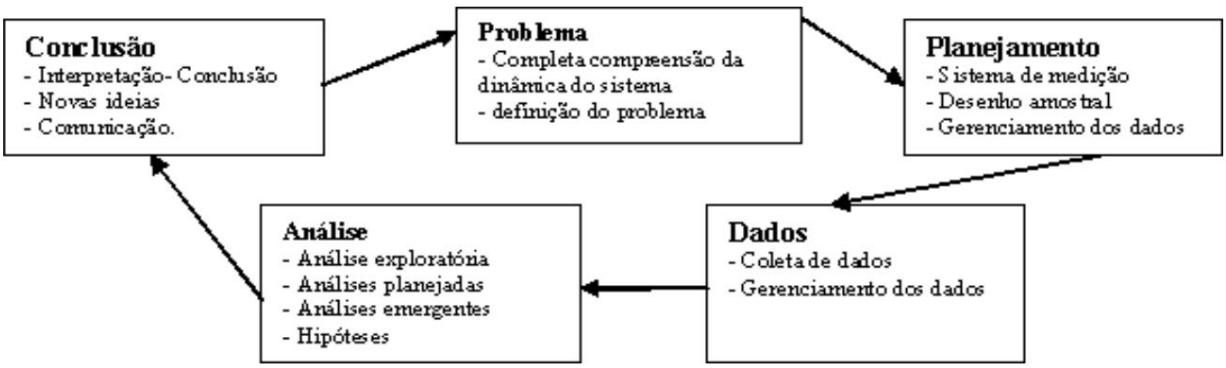
Stages of the Investigative Cycle

Image 4: Phases of the investigative cycle



Source: Silva (2007).

Silva (2007) proposes a model that aims to awaken in the student the need to solve a problem, which can guarantee their involvement. According to this perspective, the student would not solve the problem just because the teacher asked him to, but because He himself wants to find the solution and seeks the necessary tools to do so.

In Souza (2002), we find an activity based on the investigation cycle, in in which students were guided to formulate questions ("Problem") and plan studies to answer them ("Planning"). According to the author, these studies included taking decisions about the type of data needed, how to collect it ("Data Collection") and the interpretation of the collected data ("Analysis"). Upon completion of the study, students communicated the results of their research, preparing arguments to defend their choices and interpretations throughout the process ("Conclusions").

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Phases of the Investigative Cycle experienced with students

Image 5: Investigative cycle

Source: The author (2023).

To achieve these objectives, the investigative process was divided into stages, each with questions to help and encourage students:

1) Preparation of research questions;
2) Data acquisition;
3) Initial data analysis;
4) Assessment of progress made;
5) Preparation of documents;
6) Exhibition of works.

Mendonça (2008) highlights the importance of providing conditions for students develop autonomously and cooperatively, building their own knowledge. His work suggests that a Mathematical Modeling environment can contribute significantly to involving students in the teaching process and learning, making scientific concepts more meaningful and awakening the students' interest in understanding them.

Kataoka and Hernandez (2010), Nagamine, Silva and Santana (2010) and other sequels didactics mentioned in Cazorla and Santana (2010) also present approaches relevant. Biajone (2010), in turn, details the phases of a Statistical Project in a Pedagogy course, encompassing all stages of the investigative cycle. His work proposes

the following phases: Definition of the theme; Planning of actions; Carrying out of actions; Preparation of analyses and conclusions; Disclosure and communication of results.

Lopes (2003), in turn, suggests that teaching activities should cover the entire the process of processing information, starting from a problem to be investigated and following the phases of the investigative cycle. The author presents a scheme, similar to the cycle of the PPDAC model (Problem, Plan, Data, Analysis, Conclusions), by Hand (1994), which contemplates this process, as shown in Figure 2.

Guimarães and Gitirana (2013) defend research as a structuring axis of teaching and propose an investigative cycle divided into eight phases. They justify that teaching Statistics must follow a research perspective, involving the entire cycle investigative in real contexts, drawing attention to the importance of using statistical conceptual relationships, used to understand concepts and/or representations (Wild; Pfannkuch, 1999). Therefore, the investigative cycle is understood as a process in which students work with real problems, participating in all phases of the process (Bridge; Brocardo; Oliveira, 2013).

Teaching Statistics is an opportunity to transform the classroom into a stimulating and meaningful environment for students. However, often, the concepts statistics are presented in isolation, disconnected from the students' reality, which can result in a dull and demotivating approach. When reduced to a series of formulas and calculations without context, teaching Statistics can leave students frustrated and uninterested in learning.

A powerful alternative is to integrate data from real-world situations that are relevant to students. This involves bringing contexts into the classroom social, cultural, and natural that students can recognize and understand. By relating the statistical concepts to everyday issues, such as your own habits, behaviors and observations, it is possible to create an engaging learning environment and significant.

This approach shines even brighter when students are actively involved. in the data collection and analysis process. They can contribute data related to themselves, their community, or even collect data as part of a business activity.

learning. This active participation not only makes learning more meaningful, but also develops critical statistical analysis and critical thinking skills.

To implement this approach effectively, teachers need to plan carefully consider classroom activities. Tasks should be designed to spark the interest of students and be adapted to the complexity of the statistical concepts to be addressed. Rather than simply providing instructions for performing calculations, the activities should enable students to understand the underlying concepts and their relevance in real world.

In short, by integrating real data and actively involving students in the learning process, learning, teaching Statistics can become an enriching and stimulating for everyone involved. In addition to promoting mastery of concepts statisticians, this approach also develops essential life skills such as critical thinking and problem solving.

By following this model, students were guided from problem definition to data analysis, promoting a deep and meaningful understanding of the statistical concepts. In this sense, the PPDAC Investigative Cycle, proposed by Wild and Pfannkuch (1999), was fundamental in developing statistical investigations in a systematic and effective. Furthermore, it supports a comprehensive approach to problem solving statistical problems.

Thus, with regard to the study, the Problem (P) initially started from the difficulty that students had in associating certain relationships presented in graphs and tables provided by the textbook used, in which we sought to cover the context of the data and clearly define the problem or phenomenon to be investigated. And, so that students identify the key questions and establish the research objectives, it was necessary to associate with problems defined by them.

To this end, students were consulted on topics of interest that they intended to discuss. To do this, the class was divided into three groups of four students. Each group listed topics related to which type of snack they preferred students, what kind of sports students are interested in, vaccination of residents around the school, cases of dengue fever among residents, sales from stalls during the festival of Santa Luzia, and religion of the mill's residents.

Then, during the Planning (P) phase, which focuses on developing a detailed plan for the investigation, it was determined what actions would be taken to collect the necessary data, select the best sampling strategies and define the most appropriate data collection methods.

The third phase is Data (D), where the effective collection of data took place as per planned. In this case, questionnaires, interviews and observations were applied. In Analysis phase (A), the data were organized, summarized and analyzed to identify relevant patterns, trends, and relationships. At this stage, statistical techniques were applied appropriate to extract meaningful information from the data.

Through the Conclusion (C) phase, the results of the analysis were interpreted and used to respond to the problem initially proposed, and the results were communicated clearly and coherently, highlighting key findings and conclusions taken from the investigation.

4. BEYOND THE TEXTBOOK: SURVEYING THE CONTEXTS OF STUDENTS' INTEREST IN STATISTICAL RESEARCH

The initial survey of students aimed to identify a general perception of the identification and clarity about the learning that 4th and 5th grade students have regarding graphs and tables, considering that reading and interpreting them are recommended by the municipal reference curriculum of the municipality of Ipojuca since the 1st year of AIEF, also prescribed in the external assessment descriptors (Saeb).

From these elements, in line with the relationship that was already being developed in science classes, on health and vaccination, there was an inclination on the part of of the students to conduct research with the residents of the sugar mill. In this direction, the students were challenged as to what purpose they would like to discover.

In this sense, a proposal was launched to investigate the vaccination situation against Covid-19 of the residents of Engenho Tabatinga. The collective proposal was organized by distributing the class into three groups of four students each. Together with them, a table was drawn up of questions to be asked, the research stages planned, interviews conducted with the residents, collected the data, created a column chart using *post-its,* and

finally summarized the conclusions.

Each group was responsible for interviewing a group of houses on the sugar mill, thus gathering the information necessary for the analysis. Throughout the process, it was emphasized the importance of critical thinking and statistical literacy in promoting meaningful learning, in addition to the relevance of group work and the variety of didactic-methodological strategies to stimulate dialogue and reflection among students.

It is important to emphasize that, despite being part of a multi-grade class and all being residents of an area characterized as countryside, the students demonstrated understanding and interest in connecting not only with local information but also with global issues, demonstrating a curiosity regarding information that impact society more broadly.

The objective was not to deal in detail here with the elaboration and details of the statistical research, but rather to compare what 4th and 5th grade teachers have addressed this object of knowledge in the classroom, and whether it is associated with the interests of children of this age group. It is also important to highlight the importance and caution in planning this activity with students and make them protagonists in the investigative action.

Students felt motivated to make interdisciplinary connections, compare data and observe the source of information, mainly through integration with projects carried out concurrently with the school, such as a lecture with a nutritionist about healthy eating. During this activity, students had the opportunity to read and analyze the tables with nutritional information of products, which led one of the students to comment that he had never read the fine print on snack and biscuit packets. Some data shared by the health professional scared the children, showing that students are more likely to make choices and decisions consciously, as Gal (2002) reinforces.

In addition to research on the vaccination status, other activities were carried out, such as the survey of preferred snacks, prices and sales recorded at the party stalls of Santa Luzia (local festival), the football team they support and their favorite games. These activities provided students with the opportunity to appropriate the information more broadly, promoting meaningful and interdisciplinary learning.

Table 9: Summary of the context of students' statistical motivation

Soccer team
Favorite snack
Religion of the sugar mill residents
Color of the inhabitants of the mill
Vaccination of the sugar mill residents (covid-19)
Stall sales at the Santa Luzia festival
Favorite sport

Source: The author (2023).

The table above highlights the discrepancy between the topics proposed in the textbook and the contexts of interest of 4th and 5th grade students. This highlights the importance of ensure that the context of statistical literacy skills is legitimate and relevant to students. It is essential that statistics teaching involves activities that
allow students to read and analyze information in graphs, extract and compare data from in a meaningful way. Only then will the learning process be effective and connected. to the realities and interests of students, promoting deeper development of these skills.

FINAL CONSIDERATIONS

The proximity between the skills and competencies existing between the 4th and 5th grades of the 5th year of AIEF allows the policy of continuing education among teachers of municipality of the municipal network of Ipojuca, which work in these years of schooling, occur integrated way. In this sense, from the training group I participated in during the year 2023 school year, once a month, teachers of multi-grade classes and/or classes unified students of the 4th and/or 5th year meet in person with the trainers of Municipal Department of Education to discuss, socialize and debate pedagogical proposals that could enhance the students' learning process.

However, as there is already a monthly agenda determined by the team of trainers, with emphasis on the components to be treated, as there is not much autonomy in the dynamics

as the training takes place, I used the existing space between a closed group on a social network of this group of teachers (WhatsApp), to formalize the sending of the electronic form for this specific group of teachers.

The Free Consent Form for the research was presented and the space provided an opportunity broaden the local perspective on my practice, as I was the only teacher at the school who worked with these levels of education. Regarding statistical knowledge, it was important know the ways in which each teacher has developed and enhanced their capacity of students' reading and interpretation, emerging from graphs and tables.

I considered this interaction fundamental, especially because students, from the 6th year onwards of EF, travel by public transport to schools in urban areas, and go share educational spaces with students from other locations, who come from classes unified.

Therefore, this view, although limited, among teachers who work in this area, contributed greatly to research. Moreira (1988) discusses the crucial role of teachers as researchers in improving teaching. He highlights several reasons that justify this approach, as current knowledge about how students learn and about the influence of the affective domain on cognitive growth is limited.

It should be added that research can provide more comprehensive answers and consistent, enabling a more effective organization of instruction in accordance with this knowledge.

> If research results don't reach the classroom, the practice, such research will be useless. Teachers, therefore, play an indispensable role in educational research as users of research results. But they won't become users if they don't feel committed to these results, if they don't feel that these are also their results. One way to achieve this is to have the teacher themselves as researchers or collaborators (Moreira, 1988, p. 49).

For research results to be effectively applied in practice, it is It is essential that teachers feel committed and involved with these results. One way to ensure this is to involve teachers themselves as researchers or collaborators, making them direct users of the research results.

Moreira (1988) argues that teachers are in a privileged position to record educational events and perform interpretative analyses essential for research educational. Your active participation in this task can add invaluable value to

research. Thus, it emphasizes the importance of training teachers as researchers, not not only to improve science teaching, but also to ensure that research educational has a significant impact on pedagogical practice.

REFERENCES

AUSUBEL, DP **Acquisition and retention of knowledge from a cognitive perspective.** Barcelona: Paidós, 2002.

AUSUBEL, DP **Knowledge acquisition and retention: a cognitive perspective.** Lisbon: Plátano, 2003.

BRAZIL. Ministry of Elementary Education. **National Curricular Parameters:** Mathematics. Brasília: MEC/SEF, 1998.

BRAZIL. Ministry of Education. **National Common Curricular Base (BNCC): Education is the Base.** Brasília, DF, 2017BRAZIL. SAEB Report 2017. Brasília, DF: National Institute of Educational Studies and Research Anísio Teixeira, 2019.

BRAZIL. **Law No. 9,394 of December 20, 1996.** Establishes the guidelines and bases of national education. Brasília, DF, 1996.

GAL, I. Adult's statistical literacy: meanings, components, responsibilities. **International Statistical Review,** vol. 70, no. 1, p. 1-25, 2002.

GERDS, P. **From ethnomathematics to art-design and cyclic matrices.** Belo Horizonte: Autentica Editora, 2010. (Trends in Mathematics Education, 19).

GIL, AC **Social Research Methods and Techniques.** 6th ed. São Paulo: Atlas, 2008.

GUIMARÃES, G.; GITIRANA, V. Statistics in Elementary Education: research as a structuring axis. *In:* BORBA, R.; MONTEIRO, C. (Org.). **Teaching and learning processes in mathematics education.** Press of the Federal University of Pernambuco, 2013. 93-132.

GERHARDT, TE; SILVEIRA, DT **Research methods.** Porto Alegre: UFRGS Press, 2009.

GEHAR, J., & SILVEIRA, M. **Research Methodologies in Social Sciences: An Exploratory Approach.** Academic Press, 2020.

KATO, M. **In the world of writing:** a psycholinguistic perspective. São Paulo: Ática, 1986.

KLEIMAN, AB (Org.). **The meanings of literacy.** Campinas: Mercado de Letras, 1995.

MOREIRA, M.A. **Learning Theories.** 2nd ampl. ed. São Paulo: EPU, 2011.

MOREIRA, MA; MASINI, E. **Meaningful learning – The theory of David Ausubel.** São Paulo: Editora Moraes, 1982.

MOREIRA, M.A. The teacher-researcher as an instrument for improving science teaching. **Brazilian Journal of Science and Technology Teaching,** v. 1, n. 2, p. 29-41, 1988.

NASCIMENTO, RLX **Palmares:** slaves against colonial power. São Paulo: Terceiro Nome, 2014.

NÓVOA, A. **Teacher training and pedagogical work.** Lisbon, Portugal:
Educa. 2002.

PEREIRA, LBC; SANTOS JUNIOR, G. Teaching Statistics in Rural Schools: contributions of teaching through the reality of students in the 6th grade of Elementary School. **EM TEIA,** v. 5, n. 1, p. 1-25, 2014.

PIMENTA, SG Critical-collaborative action research: constructing its meaning based on experiences with teacher training. **Education and Research.** São Paulo, SP, vol. 31, n. 3, p. 521-539, 2005.

PONTE, JP **Mathematics teacher training:** knowledge and action.
Portuguese Mathematical Society. 2007.

RUFINO, MA SILVA, JR Meaningful probability learning: a look at the understanding of elementary school teachers. **Dynamis Magazine,** v. 25, n. 3, p. 115- 137, 2019.

SANTOS, RM The construction of statistical literacy from a perspective of the tests of the Brazilian Mathematics Olympiads for Public Schools – OBMEP.
Amazônia - Journal of Science and Mathematics Education, v. 17, n. 38, p. 105-120, 2021.

SANTANA, ER DOS S.; CAZORLA, IM The Investigative Cycle in the teaching of statistical concepts. **Revemop,** v. 2, p. e202018, Oct. 14, 2020.

SOUSA, O S. Ubiratan D'ambrosio and Ethnomathematics: a theoretical-epistemological-methodological overview. *In:* **II Latin American Conference on Epistemological Studies in Educational Policy,** 2, 2014, Curitiba. Available at: <http://www.relepe.org/images/692.pdf>.

Accessed on: June 12, 2022.

SMITH, **J. Research Ethics:** Principles and Practices. 2nd ed. Rio de Janeiro: Editora X, 2018.

SHULMAN, LS Thosewhounderstand: Knowledgegrowth in teaching. **Educational Researcher,** vol. 5, no. 2, p. 4-14, 1986.

THIOLLENT, M. **Action research methodology.** 18th ed. São Paulo: Cortez, 2011.

WILD, C.J.; PFANNKUCH, M. **Statistical thinking in empirical inquiry.** ***International Statistical Review,*** [S. l.], v. 67, no. 3, p. 223–265, 1999.