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Approaches and contexts for developing graphs and tables

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SUMMARY

This paper highlights some aspects of a study on statistics teaching in the early years of elementary school, conducted in the second semester of 2023 in the Graduate Program in Education at the University of Pernambuco. The investigation took place at a public school in the municipal network of Ipojuca, Pernambuco, focusing on reading and interpreting graphs and tables, as outlined in the local curriculum. Student performance in external assessments was analyzed, comparing rural and urban schools. A multi-grade class of 4th and 5th graders, excluded from external assessments, was observed using the textbook used. A didactic sequence based on Meaningful Learning, Statistical Literacy, and the Investigative Cycle was implemented. A survey of teachers was also conducted to understand the contexts addressed in the classroom in statistics teaching. The study revealed gaps in the consolidation of statistical skills and highlighted the importance of working with contextualized and real data. Students actively participated in collecting and transforming data into graphs, which promoted reflection, engagement, and motivation. The proposal validated the Investigative Cycle as an effective methodology in teaching statistics and showed that statistical literacy can make teaching more meaningful. The work also pointed out limitations of the textbook and proposes more contextualized pedagogical practices, aiming to stimulate critical thinking and the construction of lasting knowledge, transforming the classroom into a more dynamic and participatory space.

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

ABSTRACT

This paper presents the results of a research study on the teaching of statistics in the early years of elementary school, conducted in the second semester of 2023 as part of the Graduate Program in Education at the University of Pernambuco. The investigation took place in a public school in the municipal network of Ipojuca/PE, focusing on students' skills in reading and interpreting graphs and tables, as outlined in the local curriculum. Students' performance on external assessments was analyzed, comparing rural and urban schools. A multi-grade class from 4th and 5th grade, excluded from external assessments, was observed based on the textbook used. A didactic sequence was implemented, grounded in Meaningful Learning, Statistical Literacy, and the Investigative Cycle. A survey was also conducted with teachers to understand the contexts addressed in teaching statistics in the classroom. The study revealed gaps in the consolidation of statistical skills and highlighted the importance of working with contextualized and real data. Students actively participated in data collection and transformation into graphs, which promoted reflection, engagement, and motivation. The approach validated the Investigative Cycle as an effective methodology for teaching statistics and showed that statistical literacy can make learning more meaningful. The study also pointed out limitations in the textbook and proposed more contextualized pedagogical practices,

aiming to stimulate critical thinking and the construction of lasting knowledge, transforming the classroom into a more dynamic and participatory space.

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

1. TEACHING STATISTICS IN THE EARLY YEARS: PRACTICES CONTEXTUALIZED AND THE POTENTIAL OF THE INVESTIGATIVE CYCLE FOR THE STATISTICAL LITERACY

The ability to read and interpret statistical data is of great importance in the initial stages of elementary education, as it contributes to the development of various essential skills for the student's comprehensive education. Firstly, when dealing with data, children develop critical thinking, being encouraged to question information, understand contexts and make decisions based on concrete evidence. This skill makes students more aware and able to navigate the vast universe of everyday information.

Furthermore, statistical understanding plays a fundamental role in the formation of active citizenship. Statistics are present in social, economic and politicians, and understanding graphs, tables, and ratios allows students to participate in these discussions in a more informed and well-founded manner. This helps them become citizens capable of interpreting data presented in different formats, such as news and campaigns, developing a critical sense in relation to the information they consume.

Another relevant aspect is the contribution of statistics to problem-solving. interpret data, students learn to identify patterns, compare information, and draw conclusions. conclusions, essential skills not only for school performance, but also for practical life. This practice also strengthens the connection between mathematics and other disciplines, such as science, geography and history, by providing contextualized learning and interdisciplinary.

Preparing for the future is another key point. From an early age, when interpreting data, students develop skills that will be useful in different contexts, such as in the market in work, everyday life, and personal decisions. The ability to analyze research, interpreting financial results or assessing risks are examples of how this skill has practical application.

In an increasingly digital trend, exposure to graphics and data on networks social media, apps and media outlets require people to be able to recognize reliable information and avoid manipulation or misinterpretation. Teaching statistics in the early years helps prepare students for this reality, promoting greater digital awareness and ensuring they can navigate safely in a environment full of information.

Thus, the inclusion of reading and interpretation of statistical data in the curriculum of the years elementary school education goes beyond teaching mathematics. It contributes to the formation more critical, autonomous and participatory individuals, prepared to understand the world around you and act responsibly in society. When approaching the reading and interpretation of statistical data with students in the early years, the teacher can adopt an approach gradual and engaging that makes use of practical and meaningful resources for students.

2 PROMOTING MEANINGFUL LEARNING IS NOT A PROCESS INTUITIVE

Meaningful Learning, characterized by being deep and lasting, goes a long way beyond a simple or automatic process, although it may seem easy or intuitive at first view. It involves complex challenges, such as the connection between new knowledge and what the student already knows, in a relevant and contextualized way. For this to happen effectively, it is necessary to adopt a strategic and careful approach.

Therefore, promoting genuine learning that makes sense to the student requires more than just transmitting content; it requires a well-structured pedagogical practice, which take into account the individual needs of the student and the learning environment in in which he is inserted. In this sense, in order to have a real perception of what the student has already managed to assimilate and consolidate learning, there must be stages sequential and/or different teaching instruments that can support the strategies and the point starting point that the teacher should use to intervene and collaborate with the best performance of the students.

In the context of teacher-student interaction, it is essential that the processes cognitive processes involved in the construction and consolidation of learning are based on

a theory that is aligned with educational objectives. Therefore, this study, even before materializing, he used the Theory of Meaningful Learning (TAS), proposed by David Paul Ausubel, whose structure is especially applicable to the school environment, as evidenced by Pozo (1998). One of the main aspects highlighted by Ausubel is the valuing the learner's prior knowledge, arguing that the assimilation of new content must be anchored in ideas already existing in the cognitive structure (Ausubel, 2003).

Initially developed in 1963 and refined in 1988, TAS represents a milestone fundamental in educational psychology. Ausubel introduced an innovative approach that emphasizes the importance of integration between new knowledge and cognitive structure preexisting knowledge of the student. From this perspective, learning becomes meaningful when new concepts are substantially incorporated into existing knowledge, promoting the assimilation and reconfiguration of the learner's mental schemes.

The core of the Theory of Meaningful Learning lies in the premise that assimilation of new knowledge is more effective when it is connected in a way coherent and relevant to the student's cognitive context. Unlike simple memorization, in in which knowledge is acquired superficially and disconnected from previous experience of the learner, meaningful learning promotes a more cognitive restructuring deep, resulting in a solid understanding that can be applied in new contexts.

Ausubel identifies three essential elements for the occurrence of learning significant: the learner's prior knowledge, the organization of the material to be learned and the learning process itself. Prior knowledge serves as a foundation for the absorption of new concepts, offering a cognitive structure in which new information can be assimilated. The organization of educational content plays a crucial role, as it must present information in a coherent and relevant manner, facilitating its integration with previous knowledge. Finally, the learning process involves the learner's mental activity in selecting, organizing, and integrating information, promoting an active and conscious construction of knowledge.

In recent decades, studies in various areas of knowledge have focused to investigate how students' prior knowledge is formed and how it occurs process of interaction and stimulation of learning in the school context. According to Pozo (1998), this prior knowledge can originate from spontaneous conceptions, induced

or analogical, which are amalgamated in students' interactions with the natural, cultural world and school.

According to Ausubel, as cited by Moreira (2012), two prerequisites are essential 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 an intrinsic logic that relates non-arbitrarily and non-literally to the structure cognitive 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 the prior knowledge, 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 practical application in the student's daily life. The non-arbitrariness of this process develops gradually and permanently, requiring sensitivity and initiative to discover the symbols that are truly meaningful to the learner.

In the Ausubelian approach, the consolidation of Meaningful Learning depends on 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 the cognitive structure, the retention of meanings requires an approach active, requiring that phenomena be first acquired through a process of highly engaging and participatory learning.

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2.1 CHOOSING 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 subject, curriculum and experience. In this sense, the relevance of the application of the investigative methodology corroborates the treatment of concepts statistics that specifically refers 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.

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 even if you want to find the solution and look for the necessary tools to do so.

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

Mendonça (2008) highlights the importance of providing conditions for students develop autonomously and cooperatively, building their own knowledge. Your work suggests that a Mathematical Modeling Environment can contribute to involving students in the teaching and learning process, making scientific concepts more meaningful and awakening 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 course of Pedagogy, encompassing all stages of the investigative cycle. His work proposes the following phases: Definition of the theme; Planning of actions; Carrying out of actions; Elaboration of analyses and conclusions; Disclosure and communication of results. Information processing, starting from a problem to be investigated and following the phases of investigative cycle.

The investigative cycle is understood as a process in which students work with real problems, participating in all phases of the process (Ponte, Brocardo & Oliveira,

2013). Teaching Statistics is an opportunity to transform the classroom into a learning environment. stimulating and meaningful for students. However, statistical concepts often are presented in an isolated manner, 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 no interest in learning.

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

This approach stands out even more when students are actively involved in the process of data collection and analysis. They can contribute data related to themselves themselves, their community or even collect data as part of a business activity. learning. This active participation not only makes learning more meaningful, but It 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 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 statistical concepts, this approach also develops essential life skills such as thinking critical and problem solving.

By following this model, students were guided from problem definition to data analysis, promoting a deep and meaningful understanding of the concepts statistical. In this sense, the PPDAC Investigative Cycle proposed by Wild and Pfannkuch

(1999), was fundamental to develop statistical investigations in a systematic and effective, and also supports a complete approach to solving statistical problems.

3. THE FEASIBILITY OF ACTION RESEARCH AS THE ADOPTED METHOD

Action research was conceived from investigations that emerged from the sciences social in the late 1940s, being disseminated in the United States and Europe. The research-action subsidizes a portfolio of research methodologies, seeking change through action, enabling a better understanding of the investigation itself.

Action research promotes articulation between research subjects, participants and researchers, the means to be able to respond to the problems they experience most efficiency and based on transformative action, in an attempt to find solutions for problems on the part of the participants. Based on Pimenta (2005), aspects that characterize and distinguish action research from case study and ethnography, through the link in common between the problem and the interest that exists in the researcher's performance as participant who shares the same desires and searches for solutions regarding the topic investigated, as reinforced by Rodrigues (2013):

> [...]it is necessarily assumed that the group involved with the school has common goals, has common problems, and thus would be more interested in a solution constructed from the context in which they live. Here, the researcher assumes a dual role, as an observer and also as a participant. He or she will help the group to problematize, situate the issue in a broader theoretical context and thus enable the expansion of individuals' awareness of their reality, as well as plan individual actions and institutional practices to overcome [...]. Rodrigues (2013, p.4).

From Thiollent's (1988) perspective, this type of research has an empirical basis around of solving a problem, requiring interpretations of the observed reality, as well as actions of a practical nature, unfolding the involvement between researcher and participants. Action research is a type of empirically based social inquiry that is conceived and carried out in close association with an action or with the resolution of a collective problem in which the researchers and participants representative of the situation or problem are

involved in a cooperative or participatory manner (Thiollent, 1988).

A good starting strategy is to work with simple graphs and tables, such as charts bars or pictograms, which are easy to understand and can be used to represent data topics close to children's daily lives. For example, the teacher can use information about food preferences or most popular types of toys, making the learning closer to the students' reality.

Once students are familiar with the idea of graphs and charts, the next step would be to involve them in the collection of actual data. This can be done in simple ways, such as record the number of days with sun or rain in a week, and then represent this data in graphs, such as bar or column graphs. Collecting real data allows students see the applicability of statistics in everyday life and makes learning more concrete and accessible.

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

Understand students' prior knowledge, their perceptions of the identification and clarity about the learning they have regarding graphs and tables is essential. Contact with reading and interpreting statistical information must start from contexts that students consider familiar and relevant, to the point of dialoguing with their peers and feel motivated to reflect and discuss their results. The discussion on the reading and understanding of graphs and tables by students in multi-grade classes is of great relevance, especially considering the diversity of ages and levels of learning present in these classrooms.

The multi-series environment can provide benefits, such as the possibility of interaction between students of different ages, favoring the exchange of experiences and development of socio-emotional skills. However, it also presents challenges, especially with regard to the adequacy of teaching and teaching materials to the level of each student.

The diversification of activities must include the promotion of literacy Statistical, providing opportunities and respecting the research interests of students, with space

for reflection, critical awareness to make more responsible decisions, as recommended by Gal (2002). Furthermore, it is important to highlight the importance of training continued training of teachers who work in these classes, so that they can develop strategies appropriate pedagogical practices and promote the development of reading and comprehension among students effectively.

In summary, the analysis of students' reading and understanding of graphs and tables in multi-grade classes must consider the challenges and opportunities of this context, aiming to train students with advanced statistical skills. In this sense, it is crucial to adopt pedagogical strategies that adapt to the individual needs of each student, promoting not only the development of cognitive skills, but also civic awareness.

There is a lack of new studies and applications of teaching experiences that encourage statistical research based on local observation, expanding to more specific topics comprehensive across the entire national and/or international territory.

FINAL CONSIDERATIONS

Although Statistics and Probability are incorporated into educational curricula officials in Brazil, their effective approach in classrooms still faces challenges related to teacher training and the lack of prioritization of these topics in teaching.

The implementation of a practice aligned with the BNCC proposals requires a learning environment that immerses children in statistical and probabilistic activities, ensuring that they not only decode mathematical symbols, but also learn to interpret the world around you, formulate hypotheses, analyze data and justify your reasoning. This requires skills in deciding on research questions, collection methods, and organization. of data, as well as choosing the ways to present it.

The BNCC (BRASIL, 2017) is not the only source that guides curriculum development, nor is it the only guide for teachers' pedagogical practice. The following are also considered state and municipal curricula, in addition to teaching materials, initial and continuing education of teachers, educational literature and projects involving collaboration between universities and schools, among others. The crucial role of education professionals in

curriculum implementation process, which can facilitate more coordinated actions and consistent with an emancipatory educational approach.

This experience highlighted the urgent need to rethink teaching and learning in a more holistic way, considering the different dimensions of knowledge and the multiple ways of understanding and expressing students. By opening space for a more comprehensive understanding deep and interdisciplinary nature of the educational process, it was possible to witness the flourishing of more meaningful and engaging learning.

Interpretation of collected data can be facilitated through discussions in group, where students are invited to share their findings and interpret the information obtained. During these discussions, the teacher can encourage critical thinking with questions like "What is this data telling us?" or "What is the most important information? important thing that we were able to observe? This moment of collective reflection can help students develop a deeper understanding of how data can be analyzed and what they really represent.

Another important strategy is connecting data with students' everyday situations. The teacher can carry out practical activities, such as conducting a survey on the favorite color of colleagues or about the most popular sports at school, and, from there, create graphics for analyze the information. This approach makes learning more meaningful because students can see how reading and interpreting data can be applied in a variety of ways everyday situations.

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