

How high school students organize a research report

Cómo los estudiantes de educación secundaria organizan un informe de investigación

Comment les élèves du lycée organisent un rapport de recherche

Como estudantes do Ensino Médio organizam um relatório de pesquisa

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Abstract

The research has a qualitative approach with an interpretative emphasis, developed through research into one's own practice with the aim of investigating how students in a high school class plan, organize, collect, analyze and produce a sample research report. The corpus of the analysis method consisted of written records (questionnaires and reports produced) and utterances during the proposed meetings. The episodes described in this work were selected according to the critical events, which gave rise to the events described, from which we constructed the plot and composed the narrative. These episodes were analyzed focusing on the potential of the proposed investigative task in the light of Content Analysis. We noticed that the students mentioned in this study organize the research process by initially thinking about the questions to be asked in a questionnaire. Furthermore, in their questions, direct questions initially arise, related to the research question. Without an interest (or knowledge about the

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importance of knowing a sample), they do not include delimitation questions to understand the sample. However, with some motivating questions, questions arise naturally, arising from the knowledge of the world that students bring.

Keywords: Investigative tasks, Teaching statistics, High school.

Resumen

La investigación tiene un enfoque cualitativo con énfasis interpretativo, desarrollada a través de una investigación de la propia práctica, con el objetivo de investigar cómo estudiantes de una clase de educación secundaria planifican, organizan, recopilan, analizan y producen un informe de investigación muestral. El corpus de análisis estuvo constituido por los registros escritos (cuestionarios e informes producidos) y por las intervenciones orales durante los encuentros propuestos. Los episodios descritos en este trabajo fueron seleccionados de acuerdo con eventos críticos, que dieron origen a los acontecimientos narrados, a partir de los cuales construimos la trama y compusimos la narrativa. Dichos episodios fueron analizados con un enfoque en las potencialidades de la tarea investigativa propuesta, a la luz del Análisis de Contenido. Observamos que los estudiantes mencionados en este estudio organizan el proceso de investigación pensando inicialmente en las preguntas que se incluirán en un cuestionario. Además, en sus cuestionamientos surgen inicialmente preguntas directas, relacionadas con el problema de investigación. Sin un interés (o conocimiento sobre la importancia de conocer una muestra), no incluyen preguntas de delimitación para comprender dicha muestra. No obstante, con algunas preguntas motivadoras, los cuestionamientos van surgiendo de forma natural, provenientes del conocimiento del mundo que los estudiantes traen consigo.

Palabras clave: Tareas investigativas, Enseñanza de estadística, Educación secundaria.

Résumé

La recherche adopte une approche qualitative avec une emphase interprétative, développée à partir d'une recherche sur la propre pratique, dans le but d'étudier comment des élèves d'une classe de lycée planifient, organisent, collectent, analysent et produisent un rapport d'enquête par sondage. Le corpus d'analyse est constitué des enregistrements écrits (questionnaires et rapports produits) ainsi que des paroles échangées lors des séances proposées. Les épisodes décrits dans ce travail ont été sélectionnés en fonction d'événements critiques, qui ont donné lieu aux situations

décrites, à partir desquelles nous avons construit le récit et composé la narration. Ces épisodes ont été analysés en mettant l'accent sur les potentialités de la tâche d'investigation proposée, à la lumière de l'Analyse de Contenu. Nous avons constaté que les élèves mentionnés dans cette étude organisent le processus de recherche en réfléchissant d'abord aux questions à inclure dans un questionnaire. De plus, leurs interrogations prennent d'abord la forme de questions directes, en lien avec la problématique de recherche. En l'absence d'un intérêt (ou d'une connaissance sur l'importance de connaître un échantillon), ils n'incluent pas de questions permettant de délimiter cet échantillon. Cependant, à l'aide de quelques questions stimulantes, les interrogations émergent naturellement, issues des connaissances du monde que les élèves apportent avec eux.

Mots-clés : Tâches d'investigation, Enseignement de la statistique, Enseignement secondaire.

Resumo

A pesquisa possui uma abordagem qualitativa com ênfase interpretativa, desenvolvida por meio de uma pesquisa da própria prática com o objetivo de investigar como estudantes de uma turma do Ensino Médio planejam, organizam, coletam, analisam e produzem um relatório de pesquisa amostral. O corpus de análise foi constituído pelos registros escritos (questionários e relatórios produzidos) e pelas falas durante os encontros propostos. Os episódios descritos neste trabalho foram selecionados de acordo com os eventos críticos, que deram origem aos eventos descritos, a partir dos quais construímos o enredo e compusemos a narrativa. Esses episódios foram analisados com foco nas potencialidades da tarefa investigativa proposta à luz da Análise de Conteúdo. Notamos que os estudantes mencionados, neste estudo, organizam o processo de pesquisa pensando – inicialmente – nas questões a serem colocadas em um questionário. Além disso, em seus questionamentos, surgem questões diretas, relacionadas à pesquisa. Sem um interesse (ou conhecimento sobre a importância de se conhecer uma amostra), não incluem perguntas de delimitação para o conhecimento da amostra. No entanto, com algumas perguntas motivadoras, os questionamentos vão surgindo de forma natural, advindos do conhecimento de mundo que os estudantes trazem.

Palavras-chave: Estudantes, Ensino médio, Relatório de pesquisa, Estatística.

How high school students organize a research report

Introduction

Brazilian society has gone through several changes, and, among these, we can highlight those related to education. The *New High School* implemented with Law 13.415, February 16, 2017, revealed how complex problems in Brazilian education are. These go from teacher training, the relationship between the school and the community to learning both at a micro and macro level. Although the reform was presented as way to make the curriculum more flexible and bring it closer to student needs, its implementation has been the target of criticism for increasing inequalities and ignoring the real conditions of public schools. Challenges go from the growing precariousness of teacher training to the widening disparities among educational systems, besides a possible decline in basic education in essential areas of knowledge.

The 2022 Program for International Student Assessment (PISA) shows that the average of Brazilian students is lower than that of students in the countries that are part of the Organization for Economic Cooperation and Development (OECD) in Mathematics, Reading and Sciences. In Mathematics, 27% of students reached at least level 2, where they are able to interpret and recognize, without direct instruction, how a simple situation can be presented mathematically. For example, they can compare the total distance of two alternative routes or convert prices to a different currency. In comparison, the average of OECD students at this level is 69%.

The Brazilian Department of Education (MEC) points out that the aim of these changes in how High School is structured is to ensure that quality education is provided and to bring schools closer to the reality students face today, considering the new demands and complexities of the working world and life in society (Brazil, 2018). The new society mentioned constantly tackles a barrage of information, due mainly to how quickly it reaches us.

In general, the curricular changes – especially those resulting from the Base Nacional Comum Curricular (BNCC – Common Curricular National Basis) – both for Primary and High School Education, brought along a new organization for Mathematics and its Technologies. Statistics, considering the demands in today's society, is an area for growing examination and, as Gal (2022a) has posited, in many contexts related to curriculums, both nationally and internationally, it is important for education. It has the unmistakable importance of educating people to act critically in a society that is saturated with information. Therefore, basic knowledge in Statistics is a requirement

so that future adults can become better informed adults. With this in mind, the BNCC presented a thematic unit called Probability and Statistics.

Until almost the 1990s, statistical knowledge was practically ignored in Primary Education in Brazil. From this moment on, with the publication of the National Curricular Parameters (PCN), Statistics was officially incorporated to the curricular structure of Mathematics, both in Primary Education and in High School. In the PCN, Statistics is part of a block called Information Analysis (Cazorla & Utsumi, 2010).

With the inclusion of the Common Curricular National Basis – published in 2018 – skills are organized according to the units of knowledge within an area itself. Statistics occupies a specific area within the Probability and Statistics block. According to the document, it is expected that students have the opportunity to plan and carry out sample research, besides communicating the results obtained through reports.

With this perspective in mind, our aim is to investigate how students in a High School class plan, organize, collect, analyze and produce a sample research report.

We believe learning Math is not a matter of just memorizing processes that have already been carried out before, but developing critical thinking that can explore, infer and investigate (Fonseca & Gontijo, 2020, 2021). Hence, mathematical investigations are procedures that introduce this way of thinking to students, having them conduct explorations and discover strategies that are indispensable for the learning of Math.

Theoretical revision

In this topic, we will address the difference between task and activity; we will also explore different types of tasks, such as problems, exercises, investigations, projects and modellings, with two fundamental dimensions in mind: the degree of the mathematical challenge and the structural degree. Furthermore, we will discuss the teaching of Statistics in Primary Education, highlighting its evolution towards a more practical, contextualized and exploratory approach. We will emphasize the importance of enabling students to have statistical skills to understand the world that surrounds them and make informed decisions, emphasizing the application of statistical concepts in real world situations.

Tasks

The concept of task can take on different meanings depending on the context which is being developed (Enríquez, 2019). In this study, we will consider the concept

attributed by Ponte (2005; 2014) that a task is the aim of an activity, both being fundamental mediation tools in Math teaching.

In this regard, Stein and Smith (1998; 2010) argue that math tasks are not merely exercises or problems that must be solved, but essential tools that shape a student's learning experience. The authors emphasize the need for a variety of mathematical tasks, including those that encourage the exploration, investigation, practice and application of concepts. The diversity of tasks is seen as being crucial to engage students in different ways and promote a deeper understanding of Math.

We also see tasks as something the teacher asks a student to do, while activities are the processes of answering these tasks. A task is more than a simple printout of a list of problems. It is impacted by the way a teacher presents it in the classroom. Thus, the task can be altered according to the different ways the students interpret it (Swan, 2017).

According to Ponte (2014), tasks have a fundamental role in teaching and learning Math. Within the context of an education that sees the value of a student's active role in their learning process, tasks are essential since they organize the activities of those who learn. While education that is based on the masterful exposition of the teacher may not find the notion of the task as significant, teaching that sees the student as the main character absolutely depends on this notion.

Swan (2017) defines the types of mathematical tasks according to the educational objective one wants to reach in a class. There are four objectives: 1) to develop factual knowledge and processual fluency; 2) to develop conceptual understanding; 3) to observe strategic competence and 4) to develop critical competence.

Table 1

Relation between objective x concept x types of tasks according to Swan (adapted from Swan's text (2017)).

Objective	Concept	Types of Tasks
To develop factual knowledge and processual fluency	This objective is related to the development of factual knowledge and the skill to carry out mathematical procedures quickly, efficiently and with confidence.	Practice of procedures and notation.
To develop conceptual understanding	This objective is related to understanding the concepts and products expected from students to show understanding. It should include descriptions, classifications, representations, justifications and structural analyses.	To observe, classify and define mathematical structures and objects. To represent and translate mathematical concepts and their representation. To justify and/or demonstrate mathematical conjectures, connections and procedures. To identify and analyze the structure within situations.
To observe the strategic competence	This objective is related to a student's skill to solve non-routine problems at several stages and extend this skill to formulating real life problems.	To solve a non-routine problem by creating and developing a chain of reasoning. To formulate and interpret the mathematical model of a situation that can be adapted and used in a variety of situations.
To develop critical competence	For this objective, students are expected to work on mathematical products developed by others. The products in this objective can be characterized as critical commentaries.	To analyze and criticize the mathematical explanation of a procedure or concept. To analyze and criticize a strategy for the solution of problems or the mathematical model of a phenomena.

These tasks present different typologies and can be presented as problems, exercises, investigations, projects and modellings (Ponte, 2005), characterized by two dimensions that are considered fundamental in the *corpus* of a task: the degree of challenge and the structural degree. In the figure below, the relations between some types of tasks, according to Ponte's notion (2005), can be seen:

Figure 1

Relations between some types of tasks and their degree of challenge and structure (Ponte, 2005, p. 8).



This visual representation by Ponte (2005) allows for the understanding of the dimensions through a continuum – observing that this instrument reveals approximations, superpositions and degrees among the types of tasks. This structural degree provides a good idea of the divisions, although the tasks do not always follow the quadrant lines and may have very subtle differences. The author himself points out that tasks that are exercises, or exploration can be clarified in the formulation depending on a student's previous knowledge.

Investigative tasks – which is the object of this study – are, according to Ponte (2005), open, high-level tasks, different from exploratory tasks in their degree of challenge because students can begin and develop the task without much planning.

As addressed by Ponte, Quaresma and Branco (2011), exploratory and investigative tasks in Math present significant differences. Exploratory tasks generally involve a more open and preliminary approach, allowing students to investigate, find patterns and build meaning through the manipulation of mathematical concepts. They promote active participation and a deep understanding of concepts. Investigative tasks, on the other hand, are more complex and challenging, demanding the formulation of hypotheses, collecting data and the development of mathematical arguments. These tasks develop the capacity to solve complex problems and apply solving strategies, encouraging independent investigation. Both are important and complementary for the development of mathematical reasoning in students.

Task duration and context are also very important. In terms of duration, tasks can vary between a short or long duration. Long-term tasks – such as investigative tasks and projects – are marked by a deeper level of learning, but can risk becoming

tedious to students, leading them to lose interest or reach a stalemate that makes the task frustrating (Ponte, 2005).

According to Martins (2005), the use of investigative practices can promote the construction of knowledge by students, stimulating active participation, critical thinking and the understanding of statistical concepts in a deeper and more contextualized way. According to the author, by exploring the application of investigative practices, using the tasks proposed by Ponte in the context of statistics teaching, the study promotes methodological innovation and encourages reflection on different approaches to mathematics teaching, especially in areas that are considered challenging.

According to Ponte and Quaresma (2012), context influences mathematical problem solving by making learning more meaningful and facilitating the application of concepts. Realistic, semi-realistic, and mathematical contexts provide concrete situations that help students understand and use mathematical concepts in a practical way. These contexts also inspire the generation of mathematical ideas and suggest solution strategies. For example, problems contextualized in everyday situations allow students to better visualize the application of concepts in the real world, making the solution more understandable and relevant. In summary, context is fundamental to enrich the learning and application of mathematical concepts.

The teaching of statistics in Primary Education

The teaching of Statistics in primary education has evolved with time to incorporate a more practical and contextualized approach with the aim of equipping students with relevant statistical skills for understanding the world around them and for informed decision-making (Ballejo et al., 2020; Espanhol, 2020; Melo & Groenwald, 2018; Santos, 2022). In this context, it is important to highlight a practical and contextualized approach for teaching Statistics that will enable students to apply statistical concepts in real-world situations.

The teaching of Statistics in Primary Education also focuses on practical skills students can apply to their daily lives, such as interpreting graphs, understanding probabilities and analyzing research and media data (Cazorla et al., 2017). An exploratory and investigative approach is encouraged, actively involving students in collecting and analyzing data, instead of simply receiving ready-made information. This active and investigative approach promotes the construction of knowledge by students, enabling them to own statistical concepts and procedures (Cazorla et al., 2017; Samá, Amorim & Batanero, 2023; Santana & Cazorla, 2020).

Gal (2021) sees Statistical Literacy as a complex and independent competence with unique elements that go beyond the mere knowledge of Statistics and Math. The author emphasizes that Statistical Literacy involves the motivation and the capacity to access, understand, interpret, critically evaluate and express opinions about statistical messages and arguments related to data. Different from those who equate Statistical Literacy with basic statistical knowledge taught in schools or introductory college classes, Gal argues that Statistical Literacy goes beyond basic content and embraces a deeper understanding and a critical involvement with statistical messages in the real world and arguments based on data found in different contexts.

Sharma (2017) states that, in our technological society guided by data, we feel the need to understand and be able to apply Statistical Literacy essentially in all the areas of our life. This perspective points to Statistical Literacy as a fundamental skill for informed decision-making in a world that is increasingly driven by statistical data and information.

There has been an effort to develop Statistical Literacy in students, helping them understand and interpret statistical information found in research, the media and other sources. Teachers often emphasize the application of Statistics in the real world to show students its relevance in different areas, such as health, economy, the environment and sports. The emphasis on the application of Statistics in the real world helps make the content more relevant and motivating to students and, at the same time, develop their capacity to critically analyze statistical information in different contexts. "Statistical Literacy deals with the study of arguments that use Statistics as a reference, i.e., the ability to argue by correctly using statistical terminology" (Campos; Wodewotzki & Jacobini, 2011, p. 23).

The comparative chart below shows how the stages proposed by Sharma (2017) for the understanding of statistics can be aligned with the levels of graph comprehension defined by Curcio (1989), indicating a similar progression in the ability of interpreting and extracting meaning from the visual representation of data.

Table 2

Comparison between stages of statistical understanding (Sharma, 2017) x levels of graph comprehension (Curcio, 1989)

Stages of Statistical Understanding (Sharma, 2017)	Levels of Graph Comprehension (Curcio, 1989)
Stage 0/1: Able to extract specific information from simple graphs and tables.	Basic Level: Focus on basic extraction of data from graphs and tables.
Stage 2: Demonstrates uni- and multi-structural thinking, focusing on one single relevant aspect of data.	Beginning of Intermediate Level: Initial integration of data, beginning to perceive relations.
Stage 3: Demonstrates characteristics of relational thinking, integrating more than one relevant aspect of data.	Totality of Intermediate Level: Interpretation of multiple relations in data.
Stage 4: Demonstrates advanced abstract thinking, integrating statistical and contextual knowledge to conduct predictions, generalizations and reflections.	Advanced Level: Extrapolation of data and analysis of implicit relations; able to make sophisticated inferences and predictions.

Gal (2021) also emphasizes the importance of systemic thinking to refine the teaching of Statistics within formal educational systems with the aim of improving statistical literacy. The author highlights the need to change the infrastructure, the relevant teaching methods and the professional development of teachers to effectively promote statistical literacy among students.

The teaching of Statistics has gone through significant transformations through time (Lugo-Armenta & Pino-Fan, 2022; Pfannkuch & Wild, 2003; Zieffler et al., 2018). Initially rooted in the areas of Math and scientific education, it evolved to become an interdisciplinary field focused on the teaching and learning of Statistics in all educational levels (Zieffler et al., 2018). Despite progress, Statistics education still faces challenges such as connecting the content being worked on, going beyond the mere assimilation of concepts and formulas and contemplating practical aspects that Statistics can offer in elaborating solutions to problems and decision-making based on data. In addition, a fundamental component is teacher training to develop what Statistics can offer, as well as the creation of didactic material that is aligned with directives outlined by documents that guide the development of curriculums on Statistical education. These challenges present opportunities for continuous development and innovation in Statistical education (Silva & Castro, 2023).

The Investigative Cycle proposed by Wild and Pfannkuch (1999) is a structure that guides the investigation and learning of Statistics and is composed of five phases. In the Problem (P) phase, students define the problem that will be studied and set the objectives. In the Planning (P) stage, they develop a plan for collecting data and choose analysis methods. The Data (D) phase requires them to collect the necessary data; the Analysis (A) leads them to applying statistical techniques and interpreting results. Finally, in the Conclusion (C), students present and discuss their conclusions. This cycle fosters critical thinking skills, as well as those pertaining to problem solving and communication, exploring questions related to the real world in a meaningful way. Authors such as Santana and Cazorla (2020) use this cycle, called PPDAC, to base and develop their work. According to them, introducing PPDAC through structured and contextualized tasks aims at promoting active student participation, collaborative construction of meaning and the practical application of statistical concepts hence contributing to a meaningful and reflexive learning process.

These innovations in Statistics education also depend on the teacher's knowledge regarding the concept of Statistics itself (Barreto et al., 2022; Fernandes et al., 2019; Gal, Ginsburg & Schau, 1997) which in the case of Primary Education involves what the Math teacher knows about Statistical education. Teachers must highlight the importance of interpreting graphs, understanding probabilities, analyzing data, and encouraging an investigative and active approach (Cazorla et al., 2017). This methodology promotes critical and practical skills which are essential for understanding the use of Statistics in daily life. In a world driven by data, this competence is fundamental for informed and critical decision-making (Gal, 2021; Sharma, 2017).

Methodological aspects

This research adopted a qualitative approach with interpretative emphasis (Bogdan & Biklen, 1994). The choice for this approach was based on considering it the most adequate for the proposed problem which is to investigate how students in a high school class plan, organize, analyze and produce a sample research report. Within this approach, the type of research developed was our own practice (André, 2012) where the researcher is involved as a participant since the researcher is also the teacher of the class under investigation.

This article is the result of the research entitled "Investigative tasks for teaching Statistics in High School" and was submitted to the Ethics Committee of the Universidade Federal do Oeste da Bahia – UFOB, number CAAE:

71678923.9.0000.8060. All the procedures adopted were approved by the Committee and followed all the legal protocols necessary for the research to be conducted.

Context and participants of the research

The research involved 29 students in the second year of high school at a public state school in the state of Bahia, Brazil, in the town of São Desidério, from September to November 2023. This class was already part of the *New High School*. The students who took part of the task that was implemented went to class in the morning and were between the ages of 15 and 17. They are mostly students who live in the town seat; three live in the rural area. It is also important to mention that these students experienced the last years of Primary Education remotely due to the COVID-19 pandemic.

We used the *New High School* syllabus, from the subject called *Making Decisions based on Numbers* which is part of the axis *Transdisciplinary Formative Itinerary I*, a component of the second year.

This curricular component contains a syllabus which, in its beginning, encompasses the content of Descriptive Statistics, inductive and inferential. The phases of the statistical method are also expected, including data collection, data criticism, data presentation and result analysis.

To develop the proposal we worked with the students through the implementation of an investigative type of task (Ponte, 2005, 2014).. The steps for developing the task were carried out according to the concept by Swan (2017) with the objectives of developing factual knowledge and processual fluency; conceptual understanding; strategic competence and critical competence. There was also a high cognitive demand on the part of the students involved (Swan, 2017).

In this process, we had seven weekly meetings, with a duration of two classes and 50 minutes for each of the meetings with students. In the first and seventh meeting, diagnostic tasks were conducted with the aim of verifying what the students understood regarding the concepts of Descriptive Statistics (sample and census research, variables, statistical series, tables, graphs, central tendency measures and dispersion measures).

Figure 2

Task proposed to the students

INVESTIGATIVE TASK – A PROPOSAL FOR SAMPLE RESEARCH

Observe the extract below from an article published on the site Modern Consumer, by Lara Madeira:

90% of Brazilians are adopting strategies to reduce costs. This is the headline of an article by Lara Madeira published August 24, 2023, on the site Modern Consumer. The survey was conducted by *McKinsey & Company* simultaneously in 10 countries. The research concluded that, until August 2023, “Nine out of ten consumers state they adopted strategies to reduce spending on different categories of products regardless of their position in different social classes. Items such as decoration, household products, clothing and electronics – known as discretionary items – are among the most affected by this tendency. The research also identified that many consumers are choosing trade-downs where they replace brand items for more economical options.”

Adapted from: <https://www.consumidormoderno.com.br/2023/08/28/brasileiros-estrategias-reduzir-gastos/>
Accessed on 09/15/2023

Question: Conduct a statistical study and verify if the conclusion of this survey carried out by McKinsey & Company can be confirmed in your community

With this task, our aim was to carry out a statistical research to verify if the survey by McKinsey & Company could be conducted by people in the community.

Subsequently, two stories from TV Bahia were shown to the students in which people were adopting strategies to reduce household expenses and how they were economizing in the post-COVID-19 period. The aim of this practical and contextualized approach was for students to relate statistical concepts to daily life situations.

On the second week, there was the presentation of the task proposal to be conducted and the planning of the research. The class was divided into six groups with a maximum of six students in each, distributed as seen below:

Table 1

Organization of the groups participating in the research

Groups	Students in the group
Group 1	E01, E10, E11, E12 e E23
Group 2	E08, E22 e E27
Group 3	E04, E06, E09, E13, E14 e E16
Group 4	E03, E15, E20, E24, E28 e E29
Group 5	E02, E05, E07, E17 e E18
Group 6	E19, E21, E25 e E26

The formulation of the questionnaire (instrument) for data collection was also defined in this meeting. Teacher and students agreed that Google Forms would be used as an instrument to collect data.

On the third week, the organization and beginning of data analysis occurred. In this meeting, doubts began to arise and students became anxious as to how they would

treat the collected data. Students were directed to form groups and instructed to begin data analysis. In this meeting, a brief revision of the calculation of central tendency measures and dispersion measures was also done. The motivation behind this revision will be described in Episode 2.

On weeks four and five we went on with the data analysis and the creation of the report, as well as the production of the material for presentation. In this phase, groups were directed to consider the crossover of the information obtained, creating bivariate graphs (Cazorla & Utsumi, 2010).

On week six the students' production and the teacher's systematization was shared. Hence, we could contrast what the students described in their reports and their presentations to classmates.

Procedures and instruments for data collection

Producing research data arose from the task proposed to the students with the aim of observing the research participants' interactions, the way they conceived the steps and the strategies that they used to solve the task. The following instruments were used: 1) participatory observation: this was action research in which the teacher-researcher was part of the process. This instrument verified the consistency between what the research participants said and wrote. 2) filming during the entire process of development, execution and presentation of the proposed tasks. The idea of recording what was said was needed in the process for the researcher to be able to watch the process of the discussion among the participating students several times for analysis of the data worked on to form episodes (Grando & Nacarato, 2011; Pellatieri & Grando, 2010; Powell et al., 2004; Trevisan & Araman, 2021).

Building the analysis episodes

The extracts of the episodes described here were chosen according to the critical events defined as significant moments within a learning situation that revealed challenges, conceptual advancement or changes in the strategies adopted by the students (Powell et al., 2004). These events were anchor points for the construction of the plot and narrative presented in this analysis. These episodes were analyzed focusing on the potentialities of the investigative task proposed (Swan, 2017) to develop Statistical Literacy (Cazorla & Utsumi, 2010; Gal, 2002b, 2024). The written records (questionnaires and reports produced) and what was said during the proposed meetings made up the *corpus* of the analysis.

Data analysis design

To treat the data, we used Content Analysis according to Bardin (2016), following the three main stages: pre-analysis, exploring the material and treatment of results, data inference and interpretation.

In pre-analysis, we conducted a set of preliminary activities to prepare the data for detailed analysis. The written records (questionnaires and reports that were produced) and what was said during the proposed meetings were the *corpus* of the analysis. We carried out an initial reading of the written records and the transcription of talks to become familiar with the content. We defined the analysis by focusing on the potentialities of the investigative task proposed for the development of Statistical Literacy, according to the theoretical references of Gal (2002b, 2024) and Cazorla and Utsumi (2010). We chose the critical episodes according to Powel et al. (2004) which became the basis for constructing the plot and narrative.

We segmented the written records and talks into significant units (analysis episodes), identifying topics and patterns related to the investigative potentialities and the development of Statistical Literacy. The episodes included the organization and initial planning of the research, the treatment of variables after data collection and the comparison between what the students presented in their reports and their presentation of results.

During the phase of result treatment, inference and data interpretation, we synthesized the categorized data and interpreted the results according to the research objectives. We crossed the descriptions of the critical episodes and the identified categories with the aim of understanding how investigative tasks can contribute to the development of Statistical Literacy. We then reached conclusions about the transformations that took place in the practices of the participants, their beliefs and what they learned during the investigative tasks they carried out.

Presentation and discussion of data

Here we will present the data collected and provided by the students in the development of the research reports and the results of the analyses in a three-episode layout. In episode 1, we carried out the presentation of the proposed task conducted by the students and the way they planned and organized the research process and the creation of the questionnaire for interviews. In episode 2, we will address the treatment students gave to the analysis of variables collected with the application of the

questionnaires. This episode is made up of two meetings lasting 100 minutes each. In episode 3, we will present how the students transcribed what they reported in the presentation to a written record.

Episode 1 – First steps, planning and organization

In this episode, the report of meeting 2, the teacher exposed the task that needed to be figured out, followed by two stories on TV Bahia concerning the price increase of products. In one of the examples mentioned, there was a direct relation with the increase in the price of canister gas and what families were doing to cut down its use. One of the stories mentioned the replacement of gas with a wood burning stove since it was more cost-effective. Some opinions were given such as seen with student E04:

- (1) **E04 (G3):** *I had already seen a story that mentioned that some families rather have dinner than lunch.*

At this moment, students were challenged to reflect on the text presented in the task about the survey conducted by McKinsey & Company about replacing brand names for cheaper options.

- (2) **Teacher:** *In more generic examples, such as make-up?*
(3) **E27 (G2):** *Normally I choose the cheaper option.*
(4) **Teacher:** *But when you're out buying, do you tend to look at the brand or the price?*
(5) **E27 (G2):** *The price.*
(6) **E01 (G1):** *Usually the price is more important. Almost nobody cares about the brand, they look at the price. Regardless of the product, when you're after something specific, you're not as interested in the brand as the price you're going to pay.*

This initial exposition was very important to bring up the first debates and challenge the students to examine things that could lead to an investigative activity: to verify if the conclusion of the survey conducted applies to the people in their community and how they could verify this.

In this initial conversation, we can verify three categories: 1) acknowledgment of the relevance of economic factors; 2) preferences when purchasing; 3) economic and behavioral context. In the process of writing their reports, we noticed that groups 1 and 2, which students described in utterances 3 and 6 are a part of, presented the concerns and motivations they expressed as objectives of the research, as can be seen below:

Figure 3

Extract from the report by group 1.

It is within the scope of this context that we conducted a quantitative and qualitative research with the aim mainly of collecting data about whether the parents of the students in the second-year, class A, morning period, consider strategies to reduce expenses and how they are implementing these strategies. With this small sample of our society, we can have an idea of its behavior in relation to strategies to reduce spending in the family environment.

Based on this, students were directed to give the research a structure according to the stages of the statistical method (Santana; Cazorla, 2020), starting with the definition of the problem and what the possible hypotheses would be.

(7) **E05 (G5):** *Mr. __, would we have to define a public for the research?*

(8) **E26 (G6):** *It can be our family, right?*

The teacher questioned if a single family would be enough to validate the initial investigation and asked students to define the public and the sample they would work on. The question asked in 8 reveals a doubt regarding what a sample would be, establishing uncertainty as to what an accurate sample for the research would be.

We can separate, within a category, which would be Planning and Organization of the research, two sub-categories presented in the conversations: 1) the need to define the sample; 2) comparison with previous experiences. We can see this in the conversation below:

(9) **E10 (G1):** *How many people do we have to interview?*

(10) **Teacher:** *Who is the target audience of the interview? Who do you think you'll interview? After defining that, we can determine the number of people.*

(11) **E01 (G1):** *Is this like what we did last time?*

(12) **Teacher:** *Something like it.*

(13) **E01 (G1):** *But what is it for? Oh, for discussion. But the material is all ready, right?*

In this conversation among students in group 1 and the teacher, there are two points that need to be addressed. First, in 11, there is reference to a previous study. These students have already been asked to do research about real-life situations (Santana & Cazorla, 2020; Skovsmose, 2000). When a student questions the reason for the research (13), there is an understanding that the research presented in the introductory research has already been done and there would be no need to do it again. The teacher explains that the proposal is the validation of this research *in loco*. These

students are concerned with the logistics and purpose of the task and there is additional clarification.

As for the presentation of the report, we can observe that the students understand the task proposal, opposing what was said by E01 (G1) (13) exposed at the beginning of the discussions. Comparing these two moments – initial planning and final report – clearly shows how students think about the research initially and how they interpret the result.

Figure 4

Introduction of report by group1.

INTRODUCTION

In a world of increasing financial demands, having a solid financial education is becoming more and more important. However, it is clear that not everyone has the opportunity to develop the necessary skills to manage their finances efficiently. Often, pursuing strategies to reduce expenses is not only an intention but a need. Having a solid financial education is essential in everybody's life although adopting strategies to reduce spending is not always planned. Low wages for basic needs, inflation and faulty management of wages are some of the main reasons to implement these strategies.

The groups presented different samples, which was applicable to what was being proposed. Among the audiences collected were 1) the students' parents; 2) school staff; 3) students who receive the attendance-grant card from the school; 4) those living in the neighborhoods near where the students live; 5) clients in a supermarket. The diversity of the sample allowed the students to explore different perspectives and obtain a broader view of the issue at hand. Two groups used those living in the neighborhoods near their own homes as samples, thus counting two different audiences.

As for the questionings, initially students addressed the issue of whether the audience economized or not directly. The teacher then began to challenge the students to know the sample being interviewed in more detail and if the answers to the other questions would influence their perception of the initial answer. With this, other questions developed by the students began to come up:

- (14) **E25 (G6):** Do we ask them their age?
- (15) **Teacher:** Stop your discussions now just to listen to what your classmate asked. From what I observed here (pointing to groups 1, 4 and 5) I can see that this hasn't been mentioned. I am just asking you about this. But your classmate just asked. Repeat what you said.
- (16) **E25 (G6):** Do we ask how old they are?
- (17) **Teacher:** So? Do we?

- (18) **E03 (G4)**, E27 (G2): No...
- (19) **E17 (G6)**: Yes!
- (20) **Teacher**: Does age influence what you do financially?
- (21) **E03 (G4)**: Oh yeah.
- (22) **E15 (G4)**: Young people today spend more, don't they, Mr. _____?
- (23) **E01 (G1)**: No they don't.
- (24) **E15 (G4)**: Because of their age, they don't have a clue.
- (25) **E01 (G1)**: It isn't how old you are, its whether you know things.
- (26) **E15 (G4)**: The older you are, the more you know!

The disagreement seen in answers 18, 19, 22 and 23 reveal different perceptions about the importance of age in the economic context. The exchange between E03, E15 and E01 demonstrates the collective construction of an understanding (conversations 20 -26).

The interaction shows the complexity of understanding economic concepts among the students, with special attention to the discussion about the relationship between age and economic behavior. The teacher's mediation was crucial to direct and deepen the discussion, allowing the students to express their opinions and justify their answers. The diversity of opinions and collaborative argumentation contributed to the critical and reflexive development of the students.

When planning the task we had delineated some variables that were necessary to know the defined sample. However, actively in the classroom, the students naturally started sharing their questions with the teacher's constant challenges. The cooperation between teacher and students ensured that the questionnaires addressed all of the aspects that were relevant to the research, upholding the quality of the data collected.

Still during the development of the questionnaire, student E20 (G4) asked if there was any chance we could apply it with Google Forms since he said it would be easier to collect data that way. This idea was shared with the class since the students were skilled in using this tool, having used it at other moments.

With the preparation of the questions on forms, we noticed that the students did not include several factors associated with the initial inquiry, such as income, the number of people living in the home, the type of residence (rent, own home, loan) and the way they traveled to work/school, among other things, with no plenary discussion among the groups.

At the end of the meeting, the students had created the questions they thought were necessary for the questionnaire and sent the forms link to the teacher. With Cazorla and Santana's (2010) emphasis in mind, as soon as we had defined the topic and questions of the research, we raised the issue of the importance of defining the

population. In the second meeting reported here, questions had already been raised about the collection, and students were directed by the teacher to pay attention to the choices regarding the audience. With the population samples defined, the students were told to carry out the collection during the week.

In the second meeting, the strategic competencies and the critical competence of the students were developed, considering that “strategic competence refers to the capacity students have to resolve non-routine problems at several stages and extend this capacity to the formulation of problems in the real world” (Swan, 2017, p.70). The products the students developed were designated as solution to problems.

Episode 2 – Working with the variables

The plan for the second and third meetings was that students conduct the collection and analysis of data. However, more time was needed due to the dynamics and resourcefulness of the students. In a process in which it was predicted we would begin the analysis in person and finish the following week, another in-person meeting was held exclusively to analyze the data collected. The difficulties the students encountered will be listed throughout this episode. At the stage of the task, we expected to address the development of factual information, processual fluency and strategic competence defined by Swan (2017).

We define variables as the characteristics of a population that are common to all individuals but that vary one from another or in the same individual with time, while data are values collected from the variable being studied (Costa Neto, 2005).

The process of collecting data took place with the Google Forms platform which made this much easier. However, we noticed in the development of data analysis that the students believed the analysis of collected information was done, since Google Forms itself generated automatic graphs. This view shows what students think statistical research is, that being just the presentation of graphs and tables without any treatment of the collected data.

At this point, the teacher intervened, challenging the students to analyze the collected data so more variables could be related, leading to the creation of tables with double headers, seen by Cazorla and Santana (2010) as bivariate, relating two variables in one table or graph.

(27) **Teacher:** You were asked to set up an Excel spreadsheet ... What question does that income bracket answer? It is important to know, for example, who stated receiving a minimum wage and whether this person saves money or

not. And if a person with five minimum wages economized or not. Do the Forms provide these answers?

- (28) **E01 (G1)**: Mr. ___, is the way we're doing this the right way? [referring to the graphs collected from the Forms].
- (29) **E23 (G1)**: We are putting in the question and the graph with the answers.
- (30) **Teacher**: And how can we relate the information in this graph with the information in another question?
- (31) **E23 (G1)**: We would then have to count one by one.
- (32) **E01 (G1)**: That'll be too much work, don't you think?
- (33) **Teacher**: The data hasn't been counted? The Forms were used to help with the counting.

Utterance 29 reports on one of the procedures used by the students to develop the reports. 31, on the other hand, reveals that the student has begun to see a relationship among the data collected when a manual count is suggested. The interaction shows there is a dynamics of clarification and guidance in using the technological tools to analyze data. The insistence of the teacher in questioning the methodology of the students demonstrates the concern with using the procedure correctly and effectively. The students demonstrated a practical understanding of the task, but also a concern with the workload involved.

Another interesting aspect observed in the students' analyses is that none of the quantitative variables collected had received a more concise treatment that could help in the interpretation of these variables. Cazorla and Utsumi (2010) propose that the treatment of data cannot be limited only to presenting the concepts and procedures but also implies in discussing how to choose the most adequate procedures to analyze each situation.

- (34) **Teacher**: Do the Forms give you an average of the age of those who answered?
- (35) **Students**: No.
- (36) **Teacher**: If it's quantitative, you need the average. You need the mode, median and standard deviation. So, why isn't this happening in your analyses?
- (37) **E27 (G2)**: And how do we do that?
- (38) **E08 (G2)**: We could download the spreadsheet like we did in our IT class. After that, we use the formula, which I forgot, to calculate.

This conversation reveals the need for a greater understanding and application of the descriptive statistical methods on the part of the students. The teacher's intervention is crucial to guide the students to include averages, modes, medians and standard deviations in their analyses. E27's answer (line 37) shows uncertainty, while

E08 (line 38) suggests a practical solution, indicating that the students need additional guidance about how to use the tools and formulas to carry out statistical calculations.

At this moment mentioned above, an intervention was made with a revision of the content needed for the analysis of data with the aim of having the students introduce this content in their reports. We worked on revising the content related to central tendency measures and dispersion measures both for ungrouped classified data and grouped classified data.

Explanations on the content was done in a contextualized manner, simulating a hypothetical case of what the students were working on. In this case, a table on the board was simulated exposing data collected about age to help students understand what was being done in their collected information. On this table, how the calculations of central tendency measures and dispersion measures should be conducted and how they should proceed with ungrouped and grouped data was exposed.

During discussions, the students also presented doubts in creating the tables for grouped classified data. An example of this took place in a conversation with student E21 when it was asked how to construct a table for the age group of dwellers. The doubt came up when she observed that she had done the collection in intervals and not in absolute data, as seen below:

Figure 5

Questions in one of the questionnaires about the age of dwellers.

Question	Possible answers
People who are 0 – 10 years old	0 -1 -1 -3 -4 or +
People who are 11 – 16 years old	0 -1 -1 -3 -4 or +
People who are 17 – 23 years old	0 -1 -1 -3 -4 or +
People who are over 24 years old	0 -1 -1 -3 -4 or +

We observed that the intervals used in the questionnaire did not clearly contemplate some age groups, joining too many of the age groups in the last bracket. The lack of clarity does harm the elaboration of an analysis. When the issue was exposed to the teacher, it was bypassed by the fact that the students knew all the homes interviewed and the people dwelling in them since the sample was a community with six houses. They were then asked to redo the classification of data for a better explanation.

Episode 3 – Presentation x Report

In the sixth meeting, it was expected that students would present the data with a quantitative research in an organized manner where, in their reports, the following topics would appear: 1) introduction; 2) data collection; 3) presentation of data; 4) analysis and discussion of results; 5) conclusion and final comments; 6) bibliography (Sampaio, 2010). Also, in their presentations, it was expected that the students would include their statements and analyses regarding each of the points described.

Besides this structure in their reports, it was expected this information would be part of the presentations of the groups during the socialization moments. We created an analytical chart of the reports, comparing each structure, whether there was a presentation or not of each topic described here, and comparing this with the group presentations during the socializations.

Table 2

Topics that students were expected to present

Expected topics	Presentation of the structure in the report	Structure in the presentation
1. Introduction	G1; G2; G3; G4; G5.	G1; G2; G5.
2. Data collection	G1; G4; G5; G6.	G1; G2; G4; G5.
3. Presentation of data	G1; G2; G4; G5; G6.	G3; G2; G4; G5.
4. Analysis and discussion of results	G1; G2; G4; G5.	G2; G4; G5.
5. Conclusions and final comments	G2; G3; G4; G5.	G1; G2; G3; G4; G5.
6. Bibliography	G4; G5.	G4; G5.

Group 6 chose not to present the research results and handed in the report they wrote. Hence, this group is not in the presentation column.

In the group presentations, the variables presented on the bivariate tables were described by the participants without an analysis of the information that was being read, as seen in Figure 9.

Figure 6

Group 4 slide with double headed table.

Wage	Compares prices	Yes	No
500/800	2		0
1200/1500	6		0
1300/1500	5		0
1600/2000	7		1
2100/2500	4		1
3000/+	0		4

In Group 4's report, this information was not presented as seen in the slide, and during the presentation there was only a descriptive reading of the data without any comment or interpretation. According to Curcio (1987, apud Cruz & Ferreira, 2022), the students go through three stages in the interpretation of graphs. What we can infer is that these students are in the elementary level, that of *reading data*.

- (39) **Teacher:** Based on the data collected, what conclusions can you come up with?
- (40) **E24 (G4):** Many people here save their money, but not a majority.
- (41) **Teacher:** What does this table (Figure 6) indicate to you?
- (42) **E24 (G4):** It shows that people compare or do not compare prices in relation to their wages.

The teacher asks the group again about what information this table is giving them and this is the answer:

- (43) **E03 (G4):** That the majority compare prices.
- (44) **E28 (G4):** That people who make more don't compare.

What is seen above is that students are beginning to interpret and analyze the data they collected. The initial answer (40) is a general view, while the subsequent answers in (43) and (44) provide a more detailed and contrasting analysis. This demonstrates that the students are developing critical thinking skills to interpret and contextualize statistical data.

Utterance 42 expresses a greater understanding of what the information is giving us, therefore, placing it in an intermediate level of understanding. It reflects not only

reading, but also an interpretation of the data presented. We can also see this in 45 concerning the information found in Figure 7.

Figure 7

Group 5 slide with double header table.

Income bracket of those who most saved money		
Income bracket	Saved	Did not save
Less than the minimum wage	4	2
1 - 2 minimum wages	19	2
2 - 3 minimum wages	6	1
3 - 5 minimum wages	2	1
More than 5 minimum wages	2	1

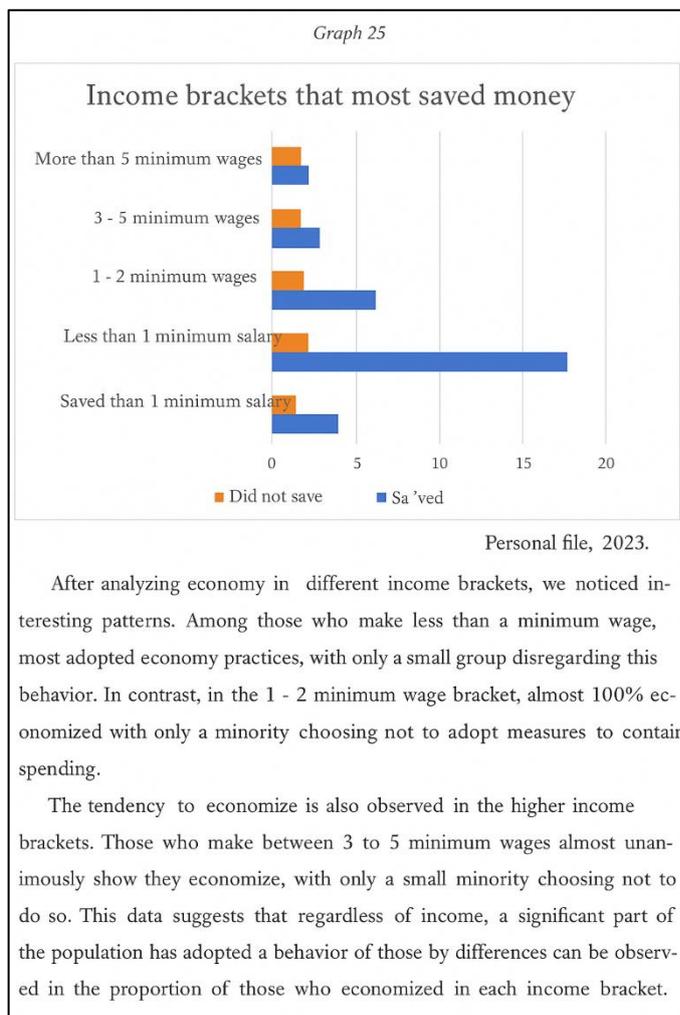
- (1) **E02 (G5):** After analyzing all the data and questions, we verified that nine out of ten Brazilians that adopted economic strategies confirmed our results. Most of the 41 families interviewed also adopted strategies and believed that the economic situation in the country, especially after the pandemic, demanded a reduction in spending and the implementation of these strategies.

The extrapolation of data when conducting an inference based on the analysis presented is highlighted by Ballejo, Bueno and Lima (2020) as a positive aspect and a more advanced level of statistical understanding.

Group 5, who created a similar table to that of Group 4, presents a different interpretation of the data they presented, as we can see in the written report.

Figure 8

Extract of Group 5 report with double header graph



The group chose to present data in a graph format in the report, making reference to percentages, although the data presented in seen to be in absolute frequencies which can lead to distorted analyses by the group. An interesting point that stands out are the conclusions that the groups could come to from the research they did with the samples. In utterance 45, the student concluded that regardless of the income bracket, people chose to use strategies to save money, while student E28 (44) came to the conclusion, with the research the group did that the higher the income, the less people will try to economize.

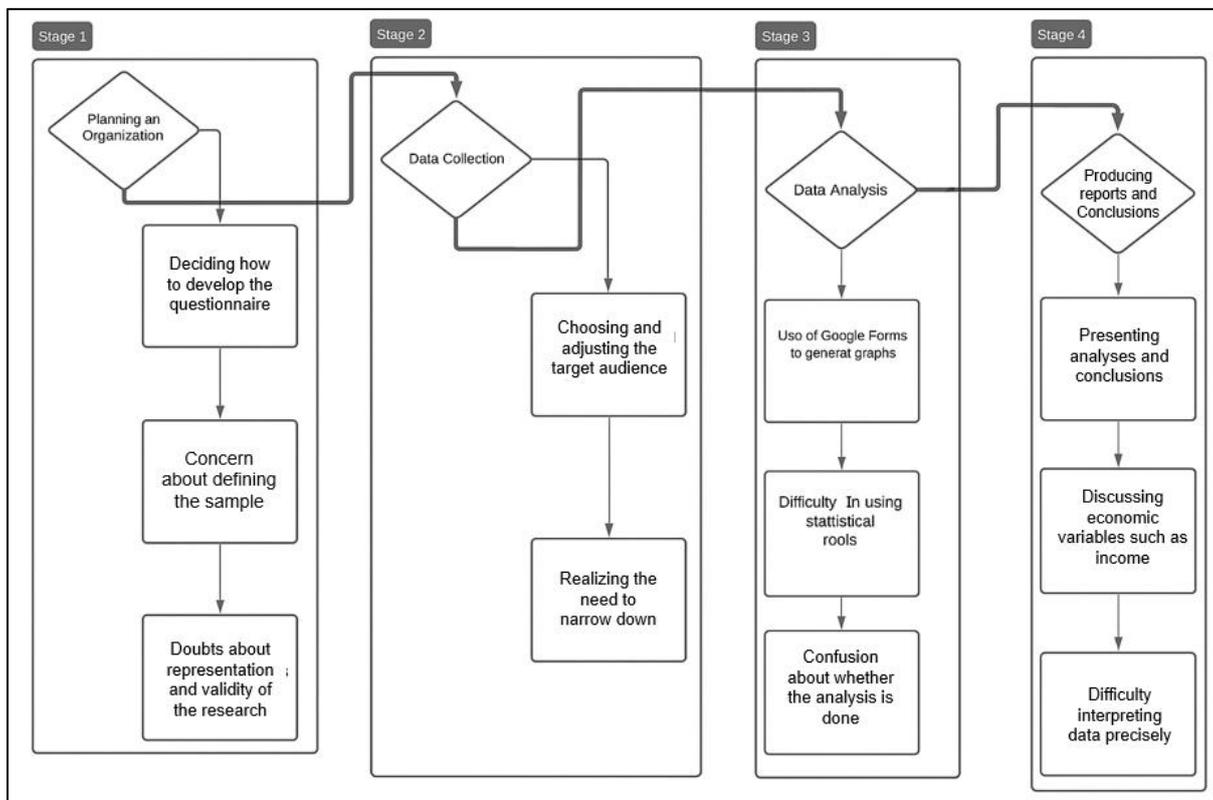
In general, the students presented different structures and information in their reports when compared to classroom presentations, which stems from students understanding that these are different structures. In classroom presentations, data was described better, with more information about the data analysis than in the reports.

Discussion on results

After describing the episodes, we can observe how the students behaved in relation to planning, organizing, collecting, analyzing and producing a sample research report. Initially, in planning and in the data analysis, we observed that the students are concerned about developing a questionnaire first to resolve the initial questioning of the research problem. Choosing the sample is done after that, when they realize they must define an audience to apply the questionnaire.

Figure 9

Student behavior in a sample research.



In the first stage, Planning and Organizing, there were doubts concerning defining the sample which led to a discussion about representation and the validity of the research. This stage accentuated the need to carefully plan the sample and the questionnaires to ensure the quality of the data collected. The concern about choosing the correct sample to validate the data was also seen in a research conducted by Tolio and Viali (2022) in which the explanation on the Statistics content was done as the need arose.

Initially there were disagreements about the development of the questionnaires (utterances 14 – 26). This was also observed by Gonçalves and Lima (2017) who state that other authors had faced the same obstacles and suggesting that one of the causes

of this difficulty is related to the fact that students, due to classroom practice, are used to answering questions much more frequently than creating them.

Students showed they faced challenges in the Data Analysis stage, especially in the use of statistical tools. Some students – initially – considered the analysis was done with the automatic graphs generated by the Google Forms tool.

In the final stage, Producing reports and Conclusions, the students presented their analyses and conclusions. Although there were some gaps in the interpretation of data, the process showed a development in the students' critical analysis skills. The discussion about variables such as income and economic behavior and the comparison between different sample groups provided a broad and reflective view of the economic problems investigated. Similarly to what was seen in the research by Gonçalves and Lima (2017), the greatest problem was the interpretation of data. To these authors, one of the factors that possibly contributed to this issue was the students' lack of experience in developing research.

Final Considerations

The investigative task that was proposed to the students led to the diversified range of answers and patterns they analyzed. This formulation directed them to developing conceptual understanding, strategic competence and critical awareness (Swan, 2017) which gradually arose during the task.

The aim of the proposal carried out was to develop Statistical Literacy (Campos; Wodewotzki & Jacobini, 2011; Gal, 2002b, 2021) among the participants while we observed how the students planned, organized, collected, analyzed and produced their research reports. Tasks of an investigative nature (Ponte, 2005) are useful in Statistical studies, mainly if they are based in reality (Skovsmose, 2000).

There has been quite a lot of discussion about the indices for Primary Education in Brazil, especially in Mathematics and regarding the teaching strategies that could improve these indices that reflect command over and application of content. With this study, besides observing the object mentioned, we could provide an example of non-formal teaching, without the constant repetition of exercises and monotonous classes where the teacher is the main character and the students are supporting actors in their learning process.

We noticed that the students mentioned in this study organized a research process with a questionnaire in mind first. In addition, their questions initially were expressed directly, related to the research but without a focus (or knowledge about the

importance of knowing a sample), and without including questions to define their audience to know the sample. However, with some motivating questions, the inquiries arose naturally, stemming from the knowledge of the world the students have.

The collection of data (a part of the investigative cycle) was done digitally with the use of digital platforms such as Google Forms and Excel, besides the research report that was done on Word. These digital tools were part of the investigative task process and meet what is recommended by the BNCC (Brazil, 2018) which states the use of digital resources for the analysis and interpretation of data.

With this study we emphasize the potential of working with investigative tasks, especially in relation to the teaching of Statistics, a subject that, because of its structure, can lead to several applications and, in teaching practice, encourages communication about different fields of human knowledge. There are limitations and challenges that must be considered and adapted if necessary for working in the classroom. In more general cases, managing time is an issue since investigative tasks demand more time and reveal the complexity of data analysis, demanding more teacher support.

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