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Relationships between self-efficacy and statistical literacy in basic education

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Abstract: This article aims to present the results of a study involving potential relationships between self-efficacy beliefs, as conceptualized by Albert Bandura, and the performance of 9th-grade students in elementary school and 165 3rd-year high school students, in solving tasks related to statistical literacy, from the perspective of Iddo Gal. In this research report, we present a qualitative analysis of data collection involving numerical quantification and justifications for positive or negative self-efficacy beliefs and student performance in solving three tasks comprising data collection and organization, construction and interpretation of tables and graphs. The results of this study revealed that the content of positive and negative self-efficacy beliefs influenced the students' success and failure in solving the tasks. Analysis of the written protocols revealed gaps in statistical and mathematical knowledge and literacy skills, which interfere with the development of statistical literacy.

Keywords: Likert Scale. Statistics. Literacy.

Relaciones entre autoeficacia y competencia estadística en la enseñanza básica

Resumen: El objetivo de este artículo es presentar los resultados de un estudio sobre las posibles relaciones entre las creencias de autoeficacia, desde la perspectiva de Albert Bandura, y el rendimiento de 163 estudiantes de 9º curso de primaria y 165 estudiantes de 3º de secundaria, en la resolución de tareas relacionadas con la alfabetización estadística, desde la perspectiva de Iddo Gal. En este informe de investigación presentamos un análisis cualitativo de la recogida de datos que incluye la cuantificación numérica y las justificaciones de las creencias de autoeficacia positivas o negativas y el rendimiento de los estudiantes en la resolución de tres tareas relacionadas con la recogida y organización de datos, la construcción e interpretación de tablas y gráficos. Los resultados de esta investigación revelaron que el contenido de las creencias de autoeficacia positivas y negativas influyó en el éxito y el fracaso de los estudiantes en la resolución de las tareas. El análisis de los protocolos escritos reveló lagunas en los conocimientos estadísticos y matemáticos y en las habilidades de alfabetización, interfiriendo así en el desarrollo de la alfabetización estadística.

Palavras clave: Escala Likert. Estadística. Alfabetización.

Relações entre autoeficácia e letramento estatístico na educação básica

Resumo: Este artigo tem por objetivo apresentar os resultados de uma pesquisa que envolve possíveis relações existentes entre as crenças de autoeficácia, sob o enfoque de Albert Bandura, e o desempenho de 163 alunos 9º ano do Ensino Fundamental e 165

estudantes da 3ª série do Ensino Médio, na resolução de tarefas relacionadas ao letramento estatístico, na perspectiva de Iddo Gal. Neste relato de pesquisa, apresentamos uma análise qualitativa da coleta de dados envolvendo a quantificação numérica e justificativas para as crenças de autoeficácia positiva ou negativa e o desempenho dos estudantes na resolução de três tarefas que compreendem coleta e organização de dados, construção e interpretação de tabelas e gráficos. Os resultados deste estudo revelaram que o teor das crenças de autoeficácia positivas e negativas influenciaram em situações de êxito e fracasso dos alunos na resolução das tarefas. A análise dos protocolos escritos apontou lacunas no conhecimento estatístico, matemático e habilidades de letramento, o que interfere no desenvolvimento do letramento estatístico.

Palavras-chave: Escala Likert. Estatística. Literacia.

1 Introduction

The article in question involved the analysis of a school performance test containing five items with statistical propositions distributed in three tasks, so that students can express and justify their positive or negative self-efficacy beliefs, assigning points from one to six on a Likert-type scale. Students are then asked to solve the content of the three statistical tasks in writing.

The aim of this research is to analyze the relationship between self-efficacy beliefs and the development of statistical literacy, taking into account the spontaneous participation of 328 students from three public schools in the municipality of Pilar do Sul, located in the metropolitan region of Sorocaba, state of São Paulo.

The three statistical tasks were formulated considering, on one hand, the content of the statistical literacy model proposed by Gal (2002, 2019) and, on the other hand, research results obtained by the Grupo de Estudos e Planejamento de Aulas de Matemática (GEPLAM) (Study and Planning Group for Mathematics Classes), such as Cobello and Oliveira (2019). These authors, when analyzing the São Paulo State Curriculum (São Paulo, 2012) and its supporting materials, found that the Statistics content contained in the Numbers and Relationships thematic blocks excessively focused on calculations and the construction of graphs and tables, particularly emphasizing measures of central tendency (mean, median, and mode) and measures of dispersion (mean deviation and standard deviation), revealing gaps in data production for statistical interpretation of the presented information.

We have considered that statistical literacy requires a diagnosis by the teacher of the students' prior knowledge, specifically basic notions of Statistics and Probability. According to Gal (2002), these concepts cannot be discussed in absolute terms as they depend on the level of statistical literacy expected by citizens. Moreover, they are fundamental to understanding how and why a particular data collection was carried out, in addition to familiarity with different forms of representing statistical information, their interpretations, and communication of statistical inferences (Moraes & Oliveira, 2022).

The structure of this article comprises primary sections containing the presentation of the theoretical foundation of the research (statistical literacy and self-efficacy beliefs), the description of the methodological approach including the nature of the study, the instruments used to produce and analyze the information, as well as the participants involved in the research.

2 Theoretical aspects of the research

Iddo Gal's doctoral studies in cognitive psychology at the University of Pennsylvania led him to research decision-making and probabilistic reasoning. Later on, he questioned how statistical reasoning and probabilistic skills could be enhanced more broadly.

The author presents a broad conception of statistical literacy, encompassing different components:

> a) People's ability to interpret and critically evaluate statistical information, arguments related to data or random phenomena, which can be found in various contexts; b) People's ability to discuss or communicate their reactions to statistical information, such as their understanding of the meaning of the information, their opinions about its implications, or their concerns about the acceptability of certain conclusions (Gal, 2002, p. 2).

Gal (2002) focused on examining how people can become effective readers of information with statistical data. To this end, he proposed a model that implies statistical literacy requires the simultaneous activation of five interrelated knowledge bases: literacy skills, statistical knowledge, mathematical knowledge, contextual knowledge and and a critical stance. Interconnected with these knowledge bases, Gal (2002) also considered two dispositional elements: critical attitude together with beliefs and attitudes.

Gal (2002, 2019) argued that the topic of statistical literacy should be widely discussed in academic and educational circles, as our society has increasing access to information in various ways. However, how is this information being interpreted, understood and what is the purpose of its production? This is a relevant question because people appropriate statistical information, often without producing it themselves or even knowing the process of producing and disseminating such information.

A critical attitude involves the student's willingness to question the content of the information obtained, which may present biased or incomplete data, whether intentionally or not. Attitudes are stable and intense feelings that develop through gradual understanding of emotional responses, positive or negative (liking/disliking, pleasant/unpleasant).

In the Brazilian literature on the Psicologia da Educação Matemática (Psychology of Mathematical Education), Brito's (1996, p. 11) definition of what attitude is is notorious. This definition associates the individual's personal disposition to act in certain situations, i.e. it is "[...] directed towards objects, events, or people, assuming different directions and intensities according to the individual's experiences. Moreover, it presents components of affective, cognitive, and motor domains."

Belief is related to the individual's capacity for statistical reasoning, which depends on the development of a positive view of oneself, as well as the desire to "think statistically" in certain situations. We agree with Martins and Ponte (2010, p. 9) when they state that literacy, reasoning and statistical thinking are three interrelated concepts, because literacy or "statistical literacy is based on statistical thinking and this, in turn,

has statistical reasoning as its fundamental core". For these authors, statistical reasoning includes ways of reasoning and solving problems specific to statistics, emphasizing techniques, representations and inference processes.

Statistical thinking involves the need to take account of the nature and variability of statistical data, placing decisive value on the role of context, which is essential not only for observing, but also for interpreting the messages in the data and inferring judgments about real situations. Finally, considerations about the aims of teaching statistics in today's society have brought concerns about statistical literacy to the forefront.

In Gal's (2002, 2019) theoretical-methodological framework, we felt the need to measure the subject's belief, i.e. how much the individual believes they are capable of interpreting statistical information. We turned to the Social Cognitive Theory (SCT), which considers human behavior as an expression of a relationship called triadic reciprocity, in which the individual's behavior, personal factors and the environment influence each other (Bandura, Azzi & Polydoro, 2008).

In this context, the school is a potential environment for relationships between its members and, as a consequence, behavioral changes in students are expected. Pajares and Olaz (2008, p. 97) draw on SCT to advise us that "teachers can work to improve their students' emotional states and to correct their self-beliefs and negative habits (personal factors), improve their academic skills and self-regulatory practices (behavior) [...]".

The notion of self-efficacy is also a fundamental construct in Social Cognitive Theory (SCT), defined by Bandura (1994) as people's belief in their ability to control their functioning and the events that affect their lives. The greater the sense of self-efficacy, the greater the individual's efforts. According to Bandura (1994, p. 71), "people with high beliefs in their abilities approach difficult tasks as challenges to be overcome rather than threats to be avoided [...]". On the other hand, people who doubt their abilities avoid tasks they consider difficult because they see them as threatening. Bandura (1994, p. 71) adds that people with low self-efficacy have "low aspirations and weak commitment to the goals they have chosen to pursue".

In Silva's (2021) study, which aimed to verify the correlations between the performance, attitudes and self-efficacy beliefs of mathematics undergraduates in relation to trigonometry, a characterization questionnaire, an attitude scale, two self-efficacy belief scales and a test covering trigonometry content studied in high school were used. The author identified, through the responses of 161 survey participants, that the trigonometry content considered complex and, consequently, more aversive, is related to equations, inequalities and trigonometric functions, especially when they are linked to the study of the trigonometric cycle.

Thus, the items on the self-efficacy scale and the test related to these contents scored below the average, indicating negative self-efficacy. This established a relationship of influence between self-efficacy beliefs and the performance of undergraduates, in line with Bandura's (1994) theoretical assumptions.

As far as attitudes are concerned, since this is a scale with more generic items involving only the term *trigonometry* and not specific content, it was not possible to analyze the relationship between attitude and performance. However, it was found that undergraduates with more negative attitudes showed lower performance on the items

related to this content and lower levels of self-efficacy beliefs when compared to the *test* instrument.

In the statistical treatment of the empirical information from the research, Silva (2021) identified positive and significant correlations between the concepts, indicating that as self-efficacy beliefs increase, so do the subject's attitudes and school performance, and vice versa. It was found that content considered more difficult, such as trigonometric functions, in which students performed poorly in the test, is also related to lower self-efficacy beliefs. Similarly, content considered easier, such as trigonometric ratios in the right triangle, in which students performed better in the test, had higher scores on the self-efficacy belief scale.

We now turn to the methodological aspects of the research, specifically its nature and the process of producing and analyzing the information.

3 Research methodology

The study as a whole involved the characteristics of qualitative-quantitative research, which, according to Creswell (2010, p. 35), uses a mixed methodology, in which

> employs research strategies that involve simultaneous or sequential data collection to better understand the research problems. Data collection also involves obtaining both numerical information (for example, in instruments) and textual information (for example, in interviews), so that the final database represents both quantitative and qualitative information.

Based on the theoretical contributions of statistical literacy and the belief in self-efficacy, on the one hand, a school performance test was designed to obtain numerical information using a Likert-type scale. On the other hand, three statistical tasks were solved in writing with 163 students from the 9th grade of elementary school and 165 students from the 3rd grade of high school.

With regard to the production of quantitative information in this study, we will present it briefly, as the analysis of this set of data was systematized in the publication by Oliveira, Marques Jr. and Pirola (2020).

The Likert-type self-efficacy belief scale consisted of five items, grouped into three statistical tasks. The following scores were given for each proposition: strongly disagree (one point), disagree (two points), mostly disagree (three points), mostly agree (four points), agree (five points) and strongly agree (six points).

The Likert scale is the technical name given to the response scale used to analyze statistical tasks. Created in 1932 by the American Rensis Likert, this scale is used to measure the degree of confidence a student has in being able to solve a given question or not.

Pajares and Olaz (2008, p. 108) point out that "there are different levels of demand within a given domain that the researcher can investigate". In the case of the formulation of the four tasks in our research tool, the level of demand was based on the prescriptions relating to the statistical content belonging to the thematic unit "Probability and Statistics" in the Common National Curriculum Base [BNCC] (Brasil, 2018).

Pajares and Olaz (2008, p. 108) state that the manifestation of self-efficacy "can predict the behaviors that most correspond to these beliefs", by assigning and justifying the points on the scale. Considering the minimum value of seven points (totally disagree on all propositions) and the maximum value of 42 (totally agree on all seven propositions), the average point is 24.5. Students who score above the midpoint of the scale have a positive self-efficacy belief and those who score below have a negative belief. Students with a negative sense of efficacy tend to have little confidence in their abilities to develop statistical literacy.

In formulating the content of each of the five propositions, we used the expression "I am capable of" as a way of expressing in writing the student's "judgment about ability" in solving or not solving a proposed statistical task (Polydoro, Azzi & Vieira, 2010, p. 193).

Respecting ethical procedures, the students who took part in the data collection process voluntarily were previously instructed for the empirical phase of this research. In order to obtain quantitative information, we instructed the students to read the statement of each task and, without initially solving it, to assign a natural number (point) on the Likert scale, from one to six, expressing their degree of belief (I am capable of...) as to whether or not they were able to solve what was proposed.

The database of qualitative information involved several sources, the first of which was the content of the justification given for choosing a point (one to six) on the Likert scale to express each student's belief in self-efficacy. The second source came from the resolution of four tasks formulated based on the specific competences and skills designed for the study of statistical content belonging to the thematic unit "Probability and Statistics" in the Common National Curriculum Base (Brazil, 2018).

The National Common Core Curriculum is guided by the concept of competence defined as "the mobilization of knowledge (concepts and procedures), skills (practical, cognitive and socio-emotional), attitudes and values to solve complex demands of everyday life, the full exercise of citizenship and the world of work" (Brasil, 2018, p. 8).

The development of the concept of competence in the BNCC involves the critical use of different languages, in a practical dimension, permeated by teaching-learning processes that involve different types of literacy. We rely on Kleiman (2008, p. 18-19) to understand literacy "as a set of social practices that use writing, as a symbolic system and as a technology, in specific contexts, for specific purposes".

We understand, according to the BNCC, that the plural of the term *literacy refers to* the fact that students recognize which types of texts circulate in Maths, English and History classes, among other subjects. Finally, they appropriate some forms of speech so that they can interact with those who already master school discourse, i.e. the teacher (Oliveira & Batista, 2018).

In the BNCC, the definition of *mathematical literacy* was taken from the 2012 assessment matrix of the International Student Assessment Program (PISA), in the form of

> skills and abilities to reason, represent, communicate and argue mathematically, in order to favor the establishment of conjectures, the formulation and resolution of problems in a variety of contexts, using mathematical concepts, procedures, facts and tools (Brazil, 2018, p. 266).

Probability and Statistics as a thematic unit of Mathematics in the BNCC includes the competences and skills of learning to collect, organize, represent, interpret and analyze data in a wide variety of contexts and make decisions based on them, as a means of developing statistical literacy.

The third source of qualitative information for the database was interviews with the teaching coordinators of each of the three schools taking part in this research . We used this source of data collection to understand certain contents of the justifications for the students' self-efficacy beliefs as to whether or not they were capable of solving the statistical tasks.

From the data collected for this research, we selected the qualitative information production database for the discussion and presentation of results. More specifically, we describe the content of the items in the three statistical tasks formulated with support for the elements of knowledge, according to Gal's model (2002, 2019), and the competences and skills prescribed in the BNCC (Brazil, 2018). Next, we present a recommended solution for each of the tasks based on the most frequent correct answers given by the students taking part in the research, transcribed using single quotation marks. To preserve the anonymity of each participant, we use the name A_i with $1 \leq i \leq 163$ for students in the 9th year of elementary school, and B_i with $1 \leq i \leq 165$ for students in the 3rd year of high school. Finally, based on the students' repertoire of inadequate answers, we analyzed the gaps that can compromise the development of statistical literacy.

3.1 Analysis of the first task

The content of the first task involved the main police incidents recorded from January to May in the municipality of Pilar do Sul in 2019, as summarized in Table 1:

Table 1: Record of police incidents. Municipality of Pilar do Sul from January to May 2019

Occurrences	January	February	March	April	May
Homicide	2	2	0	1	2
Bodily injury	9	12	4	11	11
Rape	0	0	1	1	1
Robbery	1	4	2	3	2
Theft	2	24	19	15	16

Source: Adapted from https://www.ssp.sp.gov.br/estatistica/pesquisa.aspx. Accessed on: June 20, 2023.

Based on the content of the information shown in Table 1, two questions were asked: a) to identify the statistical variables and the respective number (frequency) of police incidents (item 1); b) to interpret the information on the frequency of police incidents recorded from January to May 2019 (item 2).

The belief in positive self-efficacy (points 4 to 6 on the scale) for 'item 1', expressed by 117 students from the 9th grade of Primary Education (PE) and 140 students from the 3rd grade of Secondary Education (MS), was reflected in the number of correct answers: 124 correct answers by students from the 9th grade (PE) and 136 correct answers by students from the 3rd grade (MS). Student A's written entry$_{36}$ illustrates the correct solution to this item: 'the variables are those in the first column, i.e. homicide, bodily injury, rape, robbery and theft'.

Similarly, the positive self-efficacy belief for 'item 2', expressed by 132 students in the 9th grade of elementary school and 152 students in the 3rd grade of high school,

was reflected in the number of correct answers: 128 correct answers by students in the 9th grade and 137 correct answers by students in the 3rd grade. Student B's written record$_{24}$ shows the correct solution to this item: 'the sum of the numbers in each of the lines was done: 7 cases of homicide, 47 of bodily injury, 3 of rape, 12 robberies and 76 thefts' (reports from a 3rd grade EM student).

Success in solving the first task (items 1 and 2) shows a convergence between the level of self-efficacy beliefs expressed by the students and their written output. However, we identified gaps in literacy skills in student A's written protocol$_{36}$, as homicide, bodily injury, rape, robbery and theft are results of the nominal qualitative variable 'police occurrence'. No student mentioned the results January to May as elements of the ordinal qualitative variable that can be designated as 'month'. With regard to frequency, the correct statement is that the number of occurrences (frequency) was recorded for each observed result of the variable 'police occurrence', i.e. 7 cases of homicide, 47 of bodily injury, 3 of rape, 12 robberies and 76 thefts.

In item '2', it is worth highlighting the importance that many students gave to the context of the topic 'police occurrences', according to one of the written protocols: 'in the city there are several cases, mainly theft. And also because I've seen it' (student A's report$_{53}$). On the other hand, we highlight the case of student B$_8$ who answered 'item 2' correctly, but took a critical stance towards the statistical data on the rape variable, as expected in Gal's literacy model (2002, 2019): 'Pilar do Sul is a small town, so there are few cases. But I'm sure that the data on rape is quite wrong'. As there was no opportunity for the researcher to question the participant about the content of their response, due to their anonymity, only their argument was recorded in our field diary.

The pattern of answers considered to be correct, based on the analysis of the students' written output, relates to what was most frequent in police incidents: "what happened most was theft and bodily injury" (report by A$_{26}$). In all of these answers, both from students in the 9th grade (ES) and from the 3rd grade (HS), there was no written report on the occurrences with the lowest frequency.

We went on to analyze the answers associated with negative self-efficacy beliefs. The number of inadequate answers to 'item 1' (a total of 39) for 9th grade students was lower than the level of negative self-efficacy beliefs, in this case 46. Based on Gal's model (2002, 2019), there was a situation of school failure both in statistical knowledge, more specifically in the concept of statistical variable, and in literacy skills, due to the difficulty expressed by 30 in interpreting the data in a table.

With regard to the 165 students in the 3rd grade (HS) classes, the number of inadequate answers to 'item 1' (a total of 29, 19 of which were not written down) was higher than the level of negative self-efficacy beliefs, in this case 25.

For 'item 2' of the first task, we counted 35 inadequate resolutions, a higher number than the 31 manifestations of negative self-efficacy beliefs expressed by students from 9th grade (ES). There was a trend towards a standard performance for students in the 3rd grade (HS), i.e. 28 inadequate answers against 13 manifestations of negative self-efficacy, of which we counted 12 blank entries (no written record).

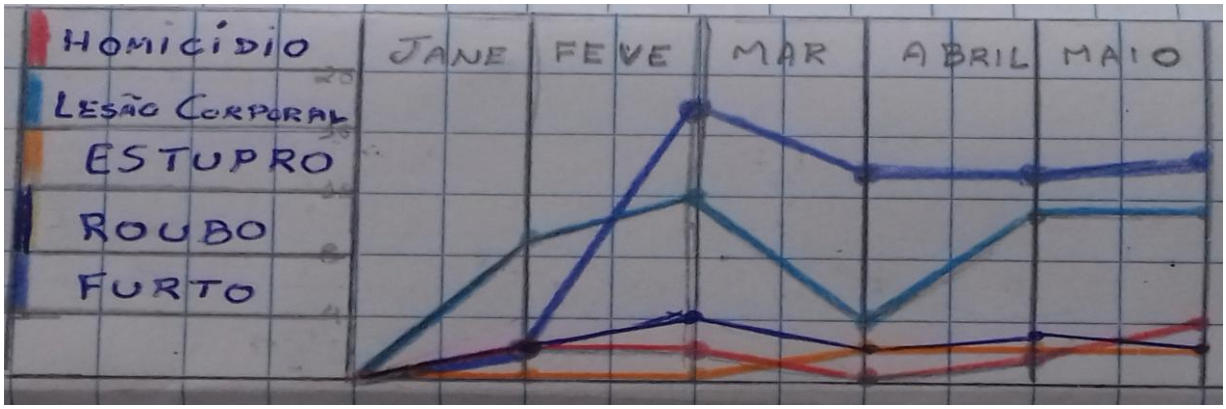
In the case of students from 3rd grade (HS), the absence of written records shows that dropout associated with low self-efficacy helps to promote situations of school failure that reduce confidence and motivation to solve school tasks (Pajares & Olaz, 2008).

3.2 Analysis of the second task

The content of the second task involved drawing up a graph for the first task, which relates each result of the variable 'police occurrence' to its respective numerical quantification (frequency). In relation to the classes at 9th grade, there was a similarity between the manifestation of self-efficacy in being able to construct the appropriate graph for the solution to 'item 3' and the total of 122 correct solutions. In the classes of 3rd grade (MS), the level of self-efficacy beliefs in the total of 143 manifestations was higher than the number of correct solutions (total of 129 cases).

Based on the number of correct solutions to this task, we identified two types of graphs. The continuous line graph used by 108 students associated each police incident shown on the vertical axis of the graph with the sequence of months from January to May on the horizontal axis, as shown in Graph 1:

Graph 1: Student B's answer$_{45}$ from Pilar do Sul-SP



Source: Research data.

The other graph used by 143 students was that of vertical bars, all with the same width, arranged on the horizontal axis. Each set of bars was related to a type of police incident.

It is important to note that 14 third-year high school students who claimed to be able to construct the graph for this task were unsuccessful in their activity, due to errors in the scale of the numerical values presented on the vertical axis. Difficulties with the notion of ratio compromise Gal's (2002, 2019) model regarding the element of mathematical knowledge, as distortions in the arrangement of numerical values impaired mathematical literacy skills in terms of reading and interpreting the information presented in the graph.

The correlation between negative self-efficacy and the number of incorrect solutions involved 41 students from 9th grade (ES). The negative self-efficacy belief expressed by 22 students in the 3rd grade (HS) was lower than the number of 36 situations of school failure. Justifications such as 'I don't like constructing tables and graphs', 'I couldn't work out the graph' resulted in 6 students from the 9th grade (ES) and 14 from the 3rd grade (HS) not having any signs of graphical representation. According to Pajares and Olaz (2008), a mixture of negative beliefs and giving up can lead to school failure, causing a lack of willingness to learn.

In relation to negative self-efficacy, 'not liking to do calculations' compromised the construction of the graph by 10 students from the 9th grade (ES) and 15 from the 3rd grade (HS), due to the need to perform calculations to establish the appropriate scale on the vertical axis. The inadequate graphical representation presented by the other

students (25 9th graders and 7 3rd graders) was not linked to any justification of the negative self-efficacy belief.

3.3 Analysis of the third task

This task involved presenting a list of movies available in cinemas in the Sorocaba metropolitan region in the second half of July 2019: "The Lion King"; "Spider-Man: Far From Home"; "Toy Story 4"; "Monica's Gang: Bonds"; "Annabelle 3: Coming Home" and "Pets: The Secret Life of Pets 2". The following situations were proposed to the students: a) together with the teacher responsible for the class, draw up a table containing the frequency of students who watched each of the films (item 4); b) construct and interpret the content of the graph generated by the table in the previous item (item 5).

The analysis of this task took into account both items together, first establishing the correct solution. With regard to 'item 4', 137 9th graders expressed positive self-efficacy beliefs, but 132 students solved this item correctly. For the 3rd grade (HS), 130 students said they were able to collectively construct the table with the proposed data, and this corresponded to 129 correct resolutions.

School performance in the third task was also recognized in 'item 5'. In the case of the 9th grade students, self-efficacy was expressed by 129 students and the respective number of correct solutions was 126. For the 3rd grade classes, positive self-efficacy involved 154 students with 135 adequate answers in terms of solving this task.

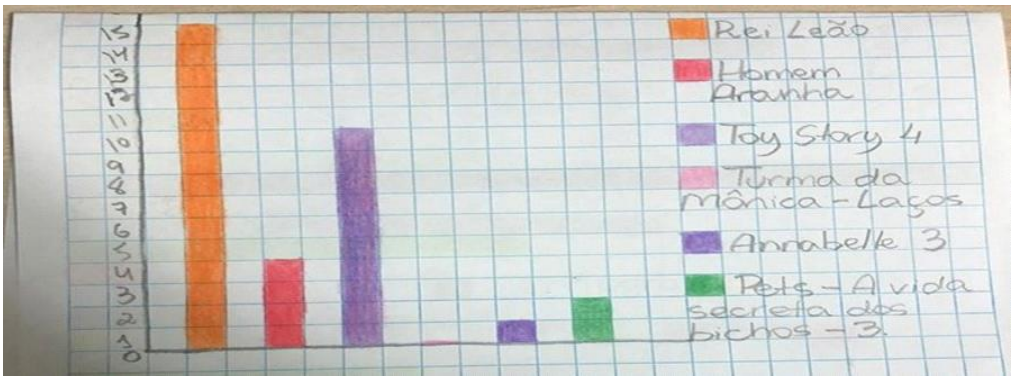
It's worth noting that reading the justifications for the positive self-efficacy beliefs of the majority of the students in the 9th grade classes revealed two facts that contributed to their positive performance in solving the third task. Under the pedagogical guidance of the Director of Education responsible for the state schools in Pilar do Sul, two projects were developed involving the subject of *bullying* and population demography, both of an interdisciplinary nature. The first concerns the "*Bullying* Project", developed in Maths and Portuguese classes, which provided students with the opportunity to study how to collect and organize data for the project, which aimed to discuss, prevent and combat violence and discrimination within each school unit. The second fact concerns the study of graphs and tables in various subjects, such as Geography, which involved discussions about migration, culture and demographics in various countries.

We turned to the pedagogical coordinators of each of the three schools taking part in the research to obtain, through interviews, the information described in the previous paragraph, with the aim of understanding the relationship between school success associated with the positive self-efficacy expressed by 9th grade students.

According to Gal (2019), as well as described in the BNCC (Brazil, 2018), the study and interpretation of information in macro contexts, whose statistics promote reflections in society, based on themes such as violence and demography, contribute to the development of this literacy, given the perspective of studying Statistics through interdisciplinarity.

The usual graphical representation of the students was made up of vertical bars, with the nominal qualitative variables on the horizontal axis, as shown in Graph 2.

Graph 2: Student A's answer[59] from Pilar do Sul-SP



Source: Research data.

On the vertical axis of this graph, the number of students who watched each of the six films mentioned was inserted, and the information was organized in tabular form.

With regard to the level of negative self-efficacy for students in the 9th grade, had 26 manifestations and the presence of 31 incorrect solutions for 'item 4' (third task). The expression of the belief 'I don't like drawing up graphs' compromised the statistical literacy of 9 students, because the set of data arranged inappropriately on the graph distorts the interpretation of the graphical representation. Three of them organized the records obtained collectively between the teacher and the students in the table in the wrong way and, in the conversion to the graphical representation, errors occurred. The remaining six students presented a graph with vertical bars for each of the six films mentioned, but with errors in the construction of the numerical scale on the vertical axis.

Six students chose a vertically stacked Pareto chart. In each bar, the frequency of the two complementary situations (watched/not watched) was associated for each of the films. Technically, this is a correct type of graph for presenting the data, but all of them made mistakes in the distribution of the number of students who watched a movie and those who didn't, as shown in Graph 3.

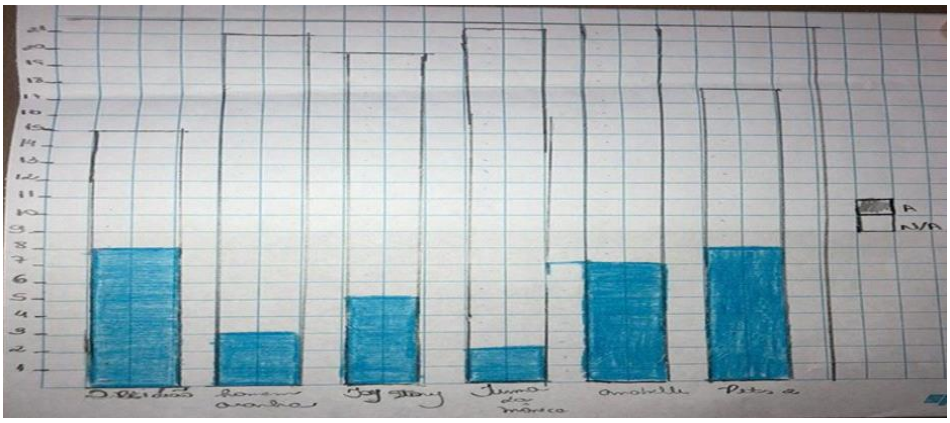
The pie chart was the other graphic representation chosen by 16 students with a weak negative belief (point 3 on the Likert scale), expressed as 'I don't feel motivated'. It is worth noting that the lack of instruments such as a ruler and protractor, as well as conversion calculations between the number of people and the angle of each circular sector, compromised this graphical representation.

Evidence of school failure in terms of the mathematical knowledge base (Gal, 2002, 2019) in the use of scale in graphs, calculation of angles for the geometric construction of the circular sector, as well as conceptual misunderstandings in determining the stacked Pareto Diagram, constituted gaps in the development of statistical literacy. These observations had repercussions on the performance of these 9th graders in solving item 5 (the third task), generating negative self-efficacy for 35 students and a total of 36 wrong solutions.

The literacy skill required in 'item 5' generated short and restricted answers in 126 of the hits from the students at . We understand the term *restricted* to mean that the content of the written records revealed, in most cases, only one possible aspect of the

interpretation of the data. Eighty-five students wrote about the movie most watched by the students in their class. Thirty-eight wrote about the least watched movie in each class. Only three students used contextual knowledge related to the fact that Pilar do Sul does not have a cinema, and because of this, people travel to Sorocaba to watch movies in a shopping mall, covering a distance of at least 53 km. In the exercise of literacy skills, the answers went beyond interpreting the data available on the graph: 'given the number of students in the room, few watched any of these films, because the town doesn't have a cinema and it's difficult to get out of here' (written record by student A_{62}).

Graph 3: Student A's stacked Pareto diagram[10] from Pilar do Sul-SP



Source: Research data.

We went on to analyze the third task using a sample of 165 3rd grade students, in which we counted 129 correct answers for item 4, based on 130 positive statements about the ability to construct a graph. With regard to item 5, there was an increase in positive efficacy (154 responses) and the number of correct answers (135) in graphical interpretation, when compared to item 4. This increase in the number of correct answers shows that some students were able to interpret the data using the tabular representation rather than the inadequately constructed graph, which resulted in success in their school activity.

The least used graphical representation was the pie or sector graph, which was used by eight students, as shown in Graph 4.

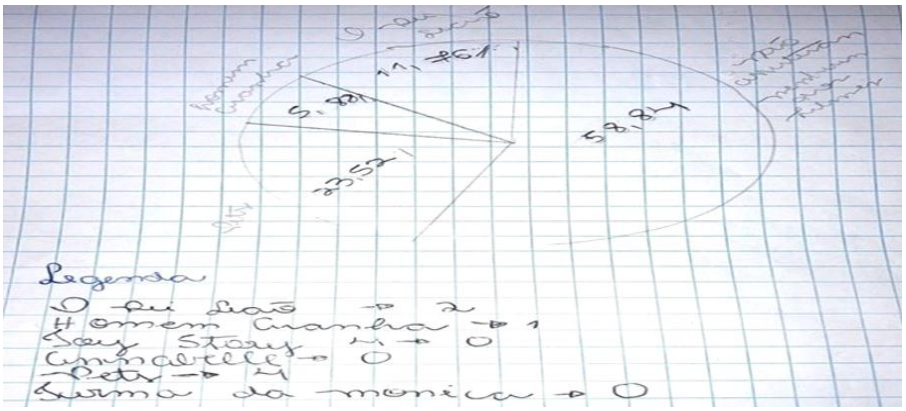
In this graph, we note that two students watched "The Lion King" (11.76%), one watched "Spider-Man: Far From Home" (5.88%) and four students watched "Toy Story 4" (23.52%), which corresponds to 41.16% of the students present in this class at the time of the statistical activity. In constructing the pie chart, these seven students showed mathematical ability and skill, both in calculating the proportion to determine each circular sector and in using geometric drawing tools. With regard to statistical knowledge, we highlight the correct choice of graphical representation, based on its characterization.

The other students who got 'item 4' right, a total of 121 participants from the 3rd grade (HS), chose to construct a vertical bar graph, with the association between the name of each movie and the respective frequency of students. However, in 94 of these written protocols, we found an additional vertical column with the relation 'no movie *versus* number of students'.

The negative beliefs of 3rd grade (HS) students for 'item 4' (35 manifestations)

made it possible to count 36 inappropriate graphical constructions. For 'item 5', there was a significant reduction in negative efficacy (11 manifestations), however, erroneous graphical interpretation generated 30 cases. It is worth noting that the cases of negative self-efficacy did not discourage the students from solving the proposed task. According to Pajares and Olaz (2008), the belief of negative self-efficacy is often correlated with the student's lack of willingness to try to solve school tasks, seeing them as a challenge to be overcome.

Graph 4: Graphical representation produced by student B_{26} from Pilar do Sul-SP



Source: Research data.

The cases of inappropriate graphical constructions were due to the use of the pie chart. The most frequent error (20 cases) was associating this graphical representation with tables in which more than one student had watched at least two films from the list in question. Therefore, the sum of the central angles of the circular sectors exceeded 100% of the circular region.

4 Final considerations

In this research, we wanted to analyze the relationship between students' self-efficacy beliefs and their performance in presenting the solutions to the three statistical tasks proposed. To do this, we first present a comparison of the numerical quantification between the number of manifestations of self-efficacy beliefs and the number of correct answers to the five items that make up the three statistical tasks.

Practically in all three tasks, for both samples of students, the number of correct solutions was lower than the number of manifestations of positive self-efficacy beliefs. The exception was item 3 (second task), where the number of correct solutions was equal to the number of positive self-efficacy beliefs, totaling 122. The results of the empirical phase of the research converge with the Social Cognitive Theory (SCT), which considers that the individual's behavior, personal factors and the environment influence each other. In the school context, the expression of feeling capable of solving statistical tasks or at least expressing a predisposition to challenge what is proposed motivates students to mobilize cognitive actions.

Based on their previous knowledge or school experiences, the externalization of their mental actions occurred through the presentation of written records involving various statistical representations, namely: construction and organization of data in the table; construction of graphs and interpretation of information in tabular and/or graphical representations.

With regard to negative self-efficacy beliefs, there were situations of school

failure due to the absence of written records, which prevented us from understanding why the student hadn't at least tried to solve the proposed task. Overall, the number of inadequate solutions exceeded the number of negative self-efficacy beliefs. In this sense, the numerical quantification shows that the expression of positive self-efficacy does not imply that the student is successful in carrying out the proposed statistical task.

The exception in the relationship between negative self-efficacy beliefs and school failure occurred in 'item 1' (task 1). There were 46 manifestations of negative efficacy in 9th graders, more than the number of incorrect solutions (a total of 39). In this sense, there were cases in which the student was predisposed to identifying statistical variables and succeeded in this purpose at school.

The results of the analysis of the written protocols of the students taking part in the research allowed us to identify gaps in mathematical knowledge, specifically in the use of scales in graphs, calculation of percentages and proportions, as well as skills in constructing pie charts. As far as literacy skills are concerned, there were gaps in interpreting data in graphs or tables, as well as in understanding the content of each task.

The context surrounding the tasks with the theme of *cinema* and *police occurrences enabled* several students to take a critical stance towards the information provided. However, it constituted a gap for statistical literacy in situations where the items involved in the tasks were not solved, due to lack of interest in the topic or negative beliefs about the veracity of the data, even when the reference used to formulate the proposed task was explained.

In order to fulfill the purposes of this research, we considered the methodological approach, from its nature, to the choice and application of the data collection instrument, as well as the way in which the information obtained was analyzed, to be suitable for the discussion and results presented. However, while reading the students' written protocols, we found possibilities for further research on this subject. The diversity of topics that can give rise to statistical discussions is wide-ranging and, depending on the classes in which we have developed such approaches, we can question which contexts are relevant and develop projects or proposals for solving and formulating problems to develop statistical literacy.

The methodological procedures used in this research did not include the teacher's pedagogical intervention. However, the inclusion of interviews or video recordings of classroom conversations could be potential data collection tools for analyzing statistical literacy in relation to the students' critical attitude towards interpreting the statistical information in question.

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