



Statistics education that promotes creativity and criticality in childhood

Educação Estatística propulsora da criatividade e da criticidade na infância

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Abstract

The objective of this article is to discuss the approach of statistics education in the early years of elementary school, which favors the development of children's creativity and critical thinking through the resolution of real-world problems. It is argued that the teacher has a fundamental role in the education of students regarding methodologies that highlight their protagonism and promote collective and collaborative production of knowledge. The results indicate that the formation of creative and critical thinking is directly linked to a school with democratic principles, where respect for diversity, collaborative work and dialogue are considered in the resolution of real problem situations.

Keywords: Statistical Education, creative thinking, critical thinking, teaching practice.

Resumo

O objetivo deste artigo, decorrente de uma dissertação de mestrado, é discutir a abordagem da Educação Estatística nos anos iniciais do Ensino Fundamental, a qual favorece o desenvolvimento da criatividade e da criticidade das crianças a partir da resolução de problemas reais. Argumenta-se que o professor tem um papel fundamental na formação dos estudantes, no que diz respeito a metodologias que destaquem o protagonismo deles e promovam a produção coletiva e colaborativa de conhecimento. Os resultados nos indicam que a formação do pensamento criativo e crítico está diretamente ligada a uma escola com princípios democráticos, em que o respeito à diversidade, o trabalho colaborativo e o diálogo sejam considerados na resolução de situações problemas reais.

Palavras-chave: Educação Estatística, pensamento criativo, pensamento crítico, prática docente.

1. Introduction

In the world we currently inhabit, we are frequently confronted with inconsistencies, conundrums, and difficult choices that affect both our personal and professional lives.

When faced with such a diverse settings, one must adopt positions based on ethical principles that allow them to overcome exclusion and discrimination through ethical values

Submetido em: 20/12/2022 – **Aceito em:** 01/08/2023 – **Publicado em:** 20/12/2023

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acquired through education as a practice of freedom, which fosters social transformation based on social justice and equity.

The current global social, political, and economic crises point to the need to rebuild our society, which calls for an anti-fascist pedagogy that views education as a form of political intervention in the world, which has the potential to drive social change. Rather than being regarded as a technical activity, education must be seen as a moral and political act in support of human rights, freedom, and solidarity, with the goal of creating a better, more equitable society (Díez Gutiérrez, 2022).

This contemporary social scenario is impacted by technological complexity, which, while improving human existence, also leads to difficulties, some of which are disconcerting. Carbonell (2022) declares his indignation at our daily exposure to fake news, which spread prejudice, disrespect and disingenuousness, compromising information.

We believe that the educational process contributes to overcoming this issue. According to Gontijo (2023), the creative and critical spirit that enables people to choose what is correct and true and oppose that which has no scientific basis or support from the standpoint of social facts.

Recently, Burrill, Souza and Reston (2023) organized a collection, based on the discussions on studies presented during the 14th International Congress on Mathematics Education (ICME 14), held in July 2021, in the Topics Study Group (TSG 12) titled Statistics Teaching and Learning. That book presents syntheses of research conducted in various countries around the world, which face challenges in educating their citizens. The editors consider that new digital technologies are improving the quality of life, health, education, access to information and communication in many aspects. There is an improvement in the speed of communication, due to the increased capacity of technological devices, software, applications, and social media. This changes our lives, generates interactions, alters our discourse, and has led to a change in the concept of democracy. Thus, statistics can be an important tool to investigate, argue, inform, convince and guide social rules of conduct.

We already have an unambiguous comprehension of statistics as a data analysis science and mathematics as socially-historically constructed knowledge. These two sciences are interconnected and, can foster curiosity when approached through an investigative and problematizing mindset.

Faced with such considerations, we contemplate a statistics education that provides students with broad and diverse capabilities to analyze their realities and be able to seek ways to improve themselves and their quality of life.

Due to the scarce scientific production regarding the early years of elementary school, as pointed out by Buehring and Grando (2019), this article will consider the teaching of statistics and probability at that level of education. It will discuss the actions of the second author of this article, who is teaches in the early years of elementary school. While working on the research for her master's thesis (Corrêa, 2019), she conducted activities involving real-

world problem-solving, whose aim was to foster the development of creative and critical thinking in second-year elementary school students, as a result of mathematics and statistics education.

2. Critical thinking

Due to the speed in which information circulates nowadays society is rapidly changing. This leads individuals to make decisions in tune with this social urgency and requires them to mobilize critical thinking to solve emerging problems in this context.

Given its significance for managing uncertainty and understanding technical and scientific, environmental, biodiversity, and sustainability issues, critical thinking has been pointed out as germane in modern existence.

Among other aspects brought about by investigation, critical thinking involves asking questions, formulating hypotheses, searching for evidence, analyzing data and information, systematizing and communicating results with procedural rigor. It is important to highlight that teaching this manner of thinking enables the development of abilities to innovate and create, in addition to increasing motivation for self-learning. In general, critical thinking enables discerning and establishing a position based on arguments, which is essential for lifelong decision-making. (Vieira & Tenreiro Vieira, 2021a; 2021b).

Complementing and expanding such ideas, we consider Halpern (2006), who pointed out that specific knowledge about a content area is fundamental for critical thinking, as no one can think critically about any subject without the necessary information. However, reiterating that facts alone are not enough

For Halpern (2006) critical thinking

is used to describe thinking that is intentional, reasoned, and goal-oriented; the kind of thinking involved in solving problems, formulating inferences, calculating probabilities, and making decisions, when the individual uses skills that are reflective and effective in the specific context and type of thinking task. (p. 6)

Thus, in addition to inciting reflection regarding our own thinking, as well as solving problems, critical thinking suggests expanded views on experience. Therefore, according to Lopes (2021) a methodological approach based on calculations and rules does not contribute to the development of critical thinking, which requires the study of “real contexts, marked by complex issues and complicated and chaotic problems” (p. 68), as reaching a solution will demand the mobilization of multiple understanding and decision-making skills

An educational process that aims to encourage the development of critical and creative thinking calls for teaching activities in which skills that include creating, discovering, inventing, imagining, assuming and hypothesizing are explored.

Hooks (2020) considers that critical thinking is an interaction process among students and between teacher and students. For that author, this manner of thinking is empowering. However, for such interactions to occur, it is necessary to share the pleasure of working with

ideas, keep an open mind, use the imagination, examine perspectives different from our own and be able to foresee consequences for one's positions.

Thus, we can see the importance of creating educational scenarios, with spaces for debating ideas about real-world problems, in which each student can explain possibilities for resolution and suggest procedures to reach a conclusion. In such a space, through dialogue with classmates and the teacher, students learn to reason based on the collective analysis of possibilities, as well as and share their doubts and understandings.

3. Creative thought

Under a Vygotskian perspective, imagination is the foundation of creative activity, which is a human achievement and generator of what is original, and is also “openness to artistic, scientific and technical creation” (Fróis, 2014, p. X). Vygotsky (2014) points out that educators need to be aware that children's imagination is neither poorer nor richer than that of adolescents or adults, it expands throughout its development, until it reaches a certain degree of maturity. For that author, creativity has a social origin, it is historically determined and transmitted through interactions among individuals.

Human activity is not restricted to the “reproduction of facts and impressions of experiences” as the brain is a combinatorial and creative organ, capable of re-elaborating and creating new principles and approaches. Thus, creative activity “makes man a being that projects the future, a being that creates and modifies their present” (Vygotsky, 2014, p. 3).

Freire (2015) outlines a fundamental point regarding curiosity and creativity.

My point of view is that the mission of education is to foster critical awareness, and such responsibility is manifested when the educator encourages students' curiosity and creativity at the same time. How can a person have a critical conscience if they are unable to create and recreate? For me there cannot be evolution absent a powerful desire and a willingness to try new things. (p. 74, authors translation)

Vygotsky (2014) views imagination and creativity as intrinsically linked and real perspectives for the cognitive and emotional development of individuals. The author considers

imagination as the foundation of all creative activity, equally manifested in all aspects of cultural life, enabling artistic, scientific and technological creation. In this sense, absolutely everything that surrounds us and that was created by the hand of man, the entire cultural universe, unlike the natural universe, is a product of human imagination and creation. (p. 4, authors translation)

Creative thinking is provoked by non-acceptance of a certain standard; individuals are attracted to the unknown and uncertain and take an exploratory and adventurous journey, in which risk and uncertainty are essential stimuli (Kneller, 1978). Therefore, the resolution of real problems enables the development of creative thinking. It is important for teachers to encourage students' curiosity, and it is essential not to inhibit the diversity of strategies for

solutions, in addition to stimulating the flexibility of thought to seek new and different procedures, reflect on mistakes, and learn from them.

Torrance (1970; 1992), cited by Alencar and Fleith (2008), considers that the teacher who seeks to develop students' creative thinking must stimulate them by promoting: involvement; motivation; persistence; determination; encouragement; curiosity; spirit of adventure; independence; self-confidence; and drive to experiment and attempt difficult tasks.

To reiterate what Fisher (2013), Freire, Freire and Oliveira (2014), Freire (2015), Fonseca and Gontijo (2021), Gontijo (2023), Lopes (2008), Vygotsky (2014) and Woods (1999), discussed regarding creativity, and to complement it with some factors to promote it, we will refer to the table in Figure 1.

FACTORS PROMOTING CREATIVITY
1. Give students time to think and develop their ideas.
2. Value students' work and ideas.
3. Consider mistakes as a step in the learning process.
4. Encourage students to contemplate different points of view.
5. Create opportunities for students to choose according to their interests and abilities.
6. Create opportunities for students to realize their creative potential and develop positive self-awareness.
7. Foster humor in the classroom.
8. Present creative role-models as examples.
9. Give students feedback on their performance.
10. Show enthusiasm for teaching and the content being taught.
11. Engage in a variety of teaching activities, specific work instructions, and evaluation procedures.
12. Encourage students to learn independently.
13. Promote students' self-evaluation.

Figure 1: Factors that foster creativity in the classroom

Source: Adapted from Alonso Herrera and Campirán Salazar (2021, p. 291, as cited in Fleith, 2011).

Such factors indicate the importance of having an educational space, where students find an environment conducive to debate and have the necessary time to think and develop their ideas. Valuing children's production implies considering mistakes as part of the learning process. Motivating them to ponder other points of view, so that they become aware of the creative potential they have and giving them opportunities to make choices according to their interests and abilities. This requires teachers to be enthusiastic about their work and the content they are teaching, demonstrating a good disposition, identifying creative ideas, providing students with feedback regarding the group's performance and looking for strategies to foster individual self-assessment of students. Furthermore, it is important that the teacher not only encourages students to learn independently, but also thinks about different tasks, topics of interest to students and different ways of evaluating the process.

Reflecting about creative thinking reminds us of how crucial the role of the teacher and their education are for collective work. The reflections that teachers make while devising activities provide clues regarding the direction of their teaching plans; and exchanging such ideas with peers can make them think of other innovations.

“School is a truly privileged setting to stimulate creativity, not only because it is a place where students acquire a wealth of knowledge, but also because they develop as individuals” (Alonso Herrera & Campirán Salazar, 2021, p. 289). Thus, the school environment must be equipped to foster ethical values in students, to form critical citizens who, while developing as individuals need to know that they can use creativity for the common good, taking into consideration the well-being of others.

4. Statistics education and perspectives to encourage critical and creative thinking

According to Fonseca and Gontijo (2021), various nations have made significant efforts to find ways to foster young people's creative abilities in order to promote the formation of citizens capable of coping with uncertainty in professional, academic, and social settings. For those authors,

those who finish basic education are expected to be able to apply the mathematical knowledge acquired in their daily lives, as well as in academic activities, to further their studies. This approach presumes that it is the responsibility of schools to propose a mathematical curriculum which is consistent with the daily needs of students; focused on the practice of civic virtues and the continuity of studies (at higher level or in vocational courses). Such education should also strive to arouse students' motivation and creativity, regarding mathematics, to solve real problems in a diversified, original way, critically reading the world which they navigate. (p. 21)

We consider the contributions of statistics education in elementary school under the same light. Although mathematics and statistics are distinct sciences, it is recommended they be studied together from the onset of schooling, as the former uses numbers, their operations, generalizations and abstractions, spatial configurations, transformations and measurements, while the latter highlights numbers, in context, conformed as data derived from investigative processes in which variables, distributions and variations are analyzed, as well as the role of randomness in the design of studies and interpretation of results (Lopes & D' Ambrosio, 2015).

The National Common Core Curriculum [(*Base Nacional Comum Curricular – BNCC* – Ministério da Educação, 2018)] proposes beginning the study of uncertainty and data analysis in mathematics in the early years of schooling, as part of the thematic unit titled Probability and Statistics. The document recommends starting from day-to-day problem situations, science, technology, and states that all citizens need to develop skills to collect, organize, represent, interpret, and analyze data in a variety of contexts, in order to make well-founded judgments and appropriate decisions.

We believe that working with statistics education fosters meaningful and creative activities, as after the assessment of data acquired, it encourages decision-making autonomy when exploring real-world circumstances.

In this study, we consider an approach to statistics education that encourages democratic education in which respect for diversity, teamwork and dialogue is considered in the resolution of real-world problems. The teacher must strive to create an atmosphere wherein group discussions and thoughts may foster innovation and creativity to emerge from the exchanges and considerations of the group. “The beauty of the process is exactly this possibility of relearning and changing. This is the essence of democratic education” (Freire, Freire & Oliveira, 2014, p. 30).

The more diverse viewpoints are considered, the more possibilities students will have to ponder on them and learn that coexisting, paying close attention to what others think or observe, can contribute with new ideas. The active participation of everyone involved should be viewed as necessary for students to be prepared to devise different solutions for the same problem situation.

Fisher and Spiker (2000) point out that the development of critical thinking includes reasoning, judgment, metacognition, reflection, questioning, and mental processes. It involves formulating questions and hypotheses, searching for evidence, analyzing data and information, procedural rigor, systematization and communication of results, among other aspects favored by investigation.

For statistical and probabilistic reasoning, linked to flexibility and reflexivity, the development of critical and creative thinking may stem from the approach to solving real problems, as shown in Figure 2.

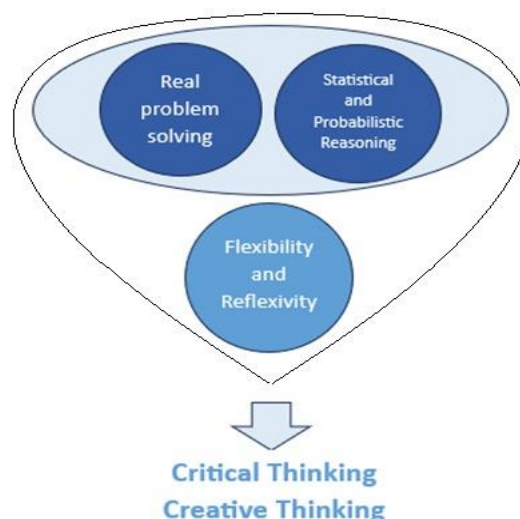


Figure 2: *Movement for the development of critical and creative thinking*

Source: elaborated by the authors (2023)

It is important to emphasize that teaching this manner of thinking helps students become more innovative and creative while also boosting their enthusiasm for independent learning. In general, critical thinking skills enable individuals to evaluate arguments and form viewpoints based on them, which is crucial for decision-making throughout life.

Curiosity is necessary in the teaching process in order for creativity to emerge.

Curiosity as an inquiring restlessness, as an inclination to reveal something, as a question, whether verbalized or not, as a quest for clarity, as a sign of attention that suggests alertness, is an integral part of the vital phenomenon. There would be no creativity without the curiosity that moves us and makes us patiently impatient in face of a world we did not create, adding to it something we have created. (Freire, 2015, p. 32).

In addition to curiosity, we believe that accepting and respecting mistakes as an essential component of the construction of knowledge is another crucial factor in fostering creativity.

From the standpoint of an education that promotes the creation of knowledge, I cannot be afraid of making mistakes, as mistakes are the consequence of taking risks, and taking risks is a crucial step in the process of overcoming the challenges of a technological society. So, another important quality of 21st century educator is the awareness that risks must be encouraged and are an inevitable consequence of risk taking is making mistakes. Therefore, educators must be ready to deal with risk and mistakes and in a positive, encouraging and challenging way. (Freire, Freire & Oliveira, 2014, p.75)

Therefore, solidarity is essential for an environment free of imposition, devoid of the desire to be a *know-it-all*, which fosters respectful listening, and enables reformulation through consideration of different opinions.

Figure 3 shows the main objectives to be achieved by students based on the dialogue among peers and interventions by the teacher.

Assess if content learned is useful for one's daily life and according to their interests.
Take responsibility for one's learning and play an active role in the classroom.
Learn through a variety of procedures and concepts.
Assess if the teacher's approach starts at students' level and ability to understand.
Take on challenges, feel emotions and interest, be motivated.
Work in a team, learn from others and respect different opinions.
Write in order to systematize studies conducted and memorize ideas.
Conduct projects focused on solving real problems.
Conduct oral presentations and debates, learning to question and inquire.

Get frequent feedback from the teacher, as directed.
Enjoy an atmosphere of acceptance and organization in the classroom.
Internalize social interactions and resolve disputes using a model of respect and communication based on social skills.

Figure 3: *Common methodological aspects of the development of critical and creative thinking through statistics education*

Source: adapted from Carvalho [2021, p. 286]

5. Context of the research

The setting for the research object of the present study, conducted with children aged 6 to 7, in the second year of elementary school, during the first semester of 2018, is *Escola Comunitária de Campinas*, a private school, located in the city of Campinas, which serves students from kindergarten through high school. The results were used in the dissertation by Corrêa (2019).

The school was devised and founded 45 years ago by Amélia Pires Palermo, who, as she declared, viewed teaching as a profession to be taken seriously. For her, the classroom is a sacred place, which demands from teachers, on a daily basis, a ritual of preparation, work and concern for the students' learning.

According to Palermo (2000):

Nowadays, another challenge arises for us: how to transmit to parents, and even teachers, that the great lesson in democracy is not learned by choosing a principal, course coordinator, student representatives; or allowing the student to speak in the classroom, often refraining from saying no in order not to appear authoritarian, but this is done, mainly, by not giving students everything ready, putting them in a situation of work, of constant search, allowing them to choose a path to approach any proposal, or problem, encouraging them to commit to finding the solution for each situation.

I believe this is the only way we will be forming critical-creative students and preparing them to resolve situations they encounter throughout life in the world, discovering new solutions for the crises that arise. And, maybe, that is the only way we will have, in the future, more original and effective proposals to surpass the great impasse that national education and politics are experiencing today. (p. 61) *Speech delivered on the school's tenth anniversary on 11/07/87 and published on "O Comunitário" - Nov/87*³.

When considering what Amélia Palermo proposed 35 years ago, teachers realize that they are researchers as well as the students. Thus, the mediation of the educator regarding what the children say or propose about the various problem situations is crucial. In a cooperative way, students and teachers are supported by several information sources and,

³ "*O Comunitário*" was the newspaper published by the school with articles on various topics of interest to the community

together, ask questions, seek answers, teach and learn. Knowledge is created, and no longer passively accepted by the school, as it is the result of elaboration and construction processes.

The proposals for work become more challenging: they encourage creativity, create opportunities for conscious decision-making and form autonomous and participative citizens.

We agree with Woods (1999) that:

In such an environment, the teacher takes on a role as a facilitator, as someone who is aware of the sudden changes in students' thinking and encourages them to trust their abilities. This requires adjustment, flexibility and experimentation. It also entails a certain autonomy for the teacher; mastery of various pedagogical and cultural forms of knowledge, control of educational processes, and freedom to organize and negotiate. (p. 129)

Therefore, we consider that every teaching situation in every classroom is unique: the same group of students will follow different paths, as the interest depends on what emerges from the discussions with the students. In this approach, the inherent complexity of the classroom places the teacher in a constant state of ambiguity and variability. As a result, students feel encouraged to be creative to solve the problem situations that arise.

In this scenario, we highlight the teaching strategy employed in the early years of elementary school, at that *Escola Comunitária*, at the time: working with class projects, which promote the development of integrated knowledge based on a significant problem to be investigated and a context to be known and/or modified.

The pedagogical team selects the topic to be covered in the class project with the children, based on a subject or issue defined in the Universal Declaration of Human Rights (UDHR). Established on December 10, 1948 by the United Nations (UN), the UDHR is a legislation that protects the fundamental rights of every human being.

The data selected for this study were collected from the activities development under the topic "Right to Play." The work included class projects completed by all second-year students. When children comprehend and realize the significance of this topic, they feel supported and protected by their rights.

5.1 Methodological procedures and analyses process

This text stems from the qualitative research developed by Corrêa (2019) who viewed her classroom as a research space. She conducted an autobiographical research when she used the (oral and written) narratives of students as a qualitative research tool in education interfaced with research-training.

Class activities were recorded, then narratives were transcribed from oral to written form. The transcription produced data that were used in the present study whose aim is to discuss the approach of statistics education in the early years of elementary school, which favors the development of children's creativity and critical thinking through the resolution of real problems.

The activities conducted with the children based on the description of the teacher, the second author of this text, were analyzed considering the narratives made in the classroom, often with the whole group. One child's speech complemented the others', thus breaking with the pattern of narratives told by a single source, and considering these sequences as collective, polyphonic narratives, harmonically constituted by the multiple participating voices.

Below, we will present some of the activities conducted with the children: the elaboration of proposals, conduction and completion.

5.2 A world without play

The first activity we will describe in the class project is called "A world without play". The children participated in a playful activity about the importance of play, in which they could prepare oral and written records. After tabulating individual data, they were able to analyze the answers and reached a probable conclusion for the entire class.

The activity was adapted from Alencar, Braga and Marinho (2017). The aim was to foster the development of creative thinking skills. The proposal was to collectively develop an imaginary scenario with the children, in which they could fantasize about a world in which there was no play. How would they feel about the possibility that they could no longer play anywhere, not even at school?

To start the activity, the researcher prepared a peaceful, calm and relaxed environment, where desks were arranged in a circle, the lights turned off, and children were instructed to close their eyes and rest their heads on the desk. The researcher spoke in a low voice and asked everyone to use their imagination and think about the following question: "Imagine a world without play or, a school where no one could play anymore. How would you feel... if you could not play at all?"

This environment favored listening and attention. For Fisher (2013)

Good listening is a skill to be learned. Active listening engages the mind. To listen well, children need to learn to focus and pay attention... Listening is one of the most important skills for effective learning (pg. 27).

This attitude of knowing how to listen prepares children for a dialogue considering different stances, without the need to agree on such differences.

After conducting this activity for some time, with the researcher speaking and the children listening silently, using their full imaginative potential, the researcher asked each child individually to draw and write what they had felt and thought at that time. We consider that "imaginative activities depends on the experiences, needs and interests on which they are based." (Vygotsky, 2014, p. 31).

Subsequently, based on the narratives written and developed by the children, the researcher conducted another activity in which (with permission) the children would disclose who had written each record, so they could understand how the whole class felt about the idea of "not playing" and the group's reaction to that.

The fact that they would not be able to play brought about feelings to fear in the children, such as, for example, visions of being in the dark, the absence of color (everything black and white), having nightmares, being weak, feeling sadness, loneliness, longing for loved ones, indignation. One child even thought she was being held in the principal's office, where she would be "tortured" or "drowned."

We knew that play is part of the interests of most children. However, we did not anticipate that the absence of play could arouse feelings so fraught with suffering and dread. For this reason, we believe that it is increasingly essential to listen to all children and design leaning environments that welcome their interests in reality.

Figure 4 shows the records of some children after the experience of not being able to play.

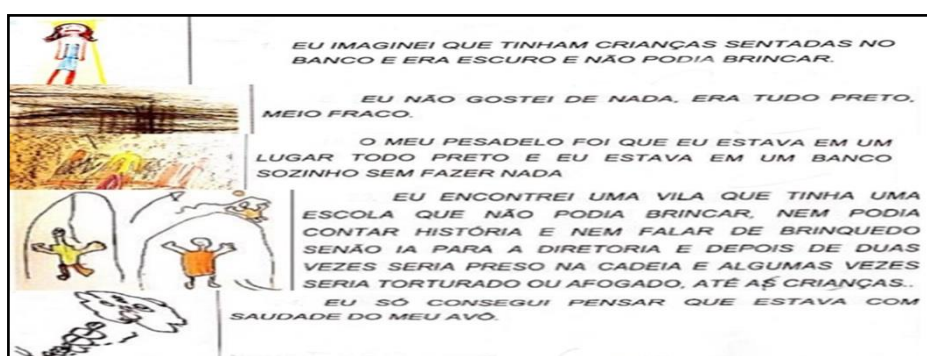


Figure 4: Children's records

Source: Corrêa (2019)

The fact that they could not play caused a wide range of reactions from the children related to fear, such as darkness, weakness, loneliness, being tortured or drowned, missing loved ones. Play is part of the interests of children, but we did not imagine that not playing could lead to feelings so full of suffering and unhappiness. That is why we increasingly believe in the importance of listening to all children and promoting didactic situations that protect their interests and realities.

Figures 5 and 6 show the graph and the conclusion of the group, ensuring effective participation of all children in the class.

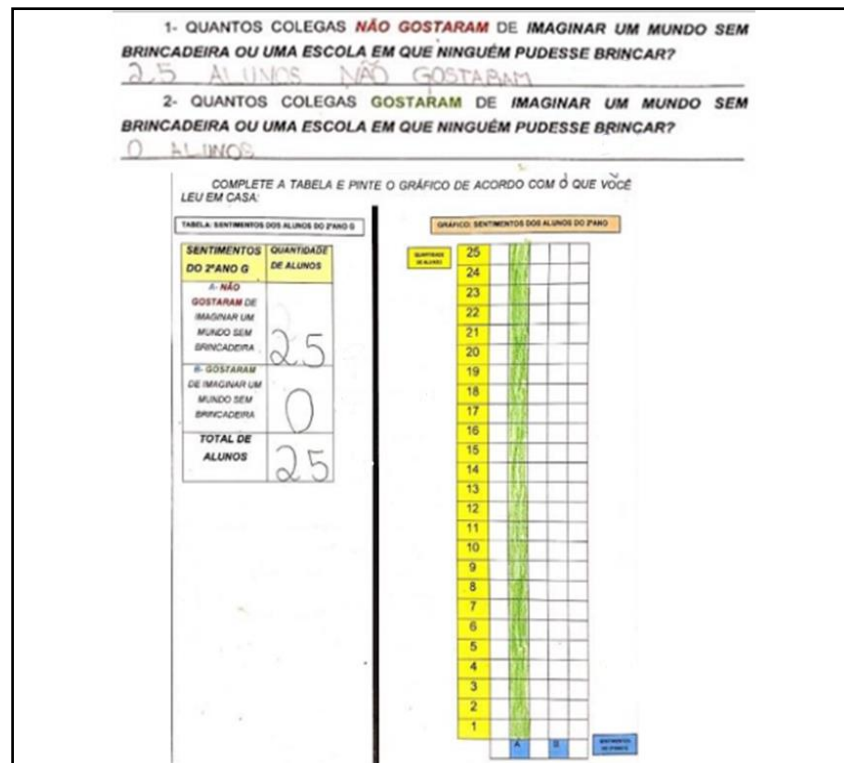


Figure 5: Bar graph
Source: Corrêa (2019)

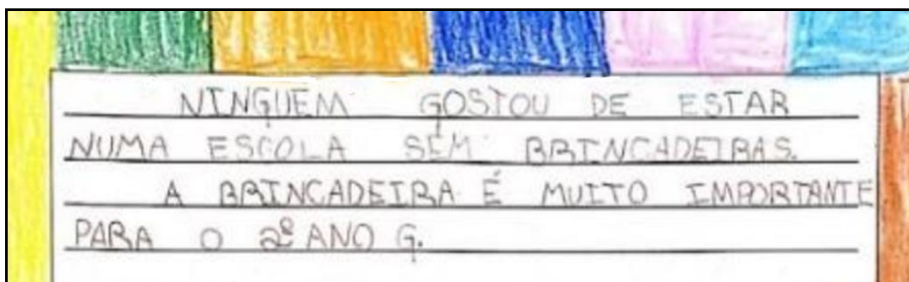


Figure 6: Collective conclusion of the chart
Source: Corrêa (2019)

The data analyzed derived from a significant problem for children: the right to play.

A significant factor for the group was the appropriation of statistical skills regarding the treatment of information: the tabulation of data and the organization in tables and graphs (Figure 5). The acquisition of statistical knowledge can help individuals analyze data arising from the problematization of information, enabling them to understand their reality ridden with complexity (Lopes, 2008).

Learning to listen to the different emotions expressed by classmates and realizing that the researcher values each and everyone in the group shows students that they can act without fear of being accepted or rejected, as all are considered part of the group.

The second activity described in this article derived from the following question developed by the children for investigation in the class project: Why do we like to play? The plan devised by the children to arrive at a possible answer was to conduct interviews in which

they themselves would be the interviewees.

Considering the age group (6-7 years), and to make the tabulation of the data easier, the researcher proposed that the children themselves develop possible answers to the question. Here are the suggested answers proposed by the children: () It's good for the kids; () it's fun; () we learn many new things freely; () it's creative; () learning through play is a goal that children have; () others.

At this point dialogue was employed so that the children felt respected and represented by their responses in the activity record. According to Fisher (2013, pp. 27-28), creative dialogue presupposes that questioning be done by the children themselves; the action plan is shared, the different points of view for the same problem are welcomed, without considering correct answers, but rather possible answers. There is no competition, but cooperative research.

As there were numerous possible responses, it was suggested to the children that they each chose three answers, ranking them according to their personal priority. They should consider the first option as the most important and the third option as the least important. See below the activity sheet the children received in order to conduct the interview:

PROJETO DE CLASSE: BRINCAR E APRENDER

Utilizaremos a entrevista para responder a seguinte questão do nosso projeto: *Por que a gente gosta de brincar?* Os entrevistados serão os próprios alunos do 2º ano G. Para respondê-la, cada um de vocês vai responder as perguntas abaixo escolhendo somente 3 respostas. Coloque 1º, 2º e 3º de acordo com a importância da resposta para você.

1- Por que a gente gosta de brincar?

(2º) Faz bem para as crianças.

(1º) É gostoso.

() Aprendemos muitas coisas novas de maneira livre.

(3º) É criativo.

() É um objetivo das crianças aprender brincando.

() outros.

Figure 7: Interview activities

Source: Corrêa (2019)

When contemplating possible answers to the interview question, the children were encouraged to create their own records in groups. There was a moment of collective debate during discussions and decision-making.

The time for sharing the record the group had elaborated with the class demonstrated that the children operated on the data and with the data, as well as concentrated on reasoning processes.

After the interview questions had been answered, the researcher coordinated the

groups of children so that they could organize their answers according to the number of votes. The researcher suggested that each group make records of the first option as they wished, provided that the participants agreed on the choice, as shown in Figure 8.

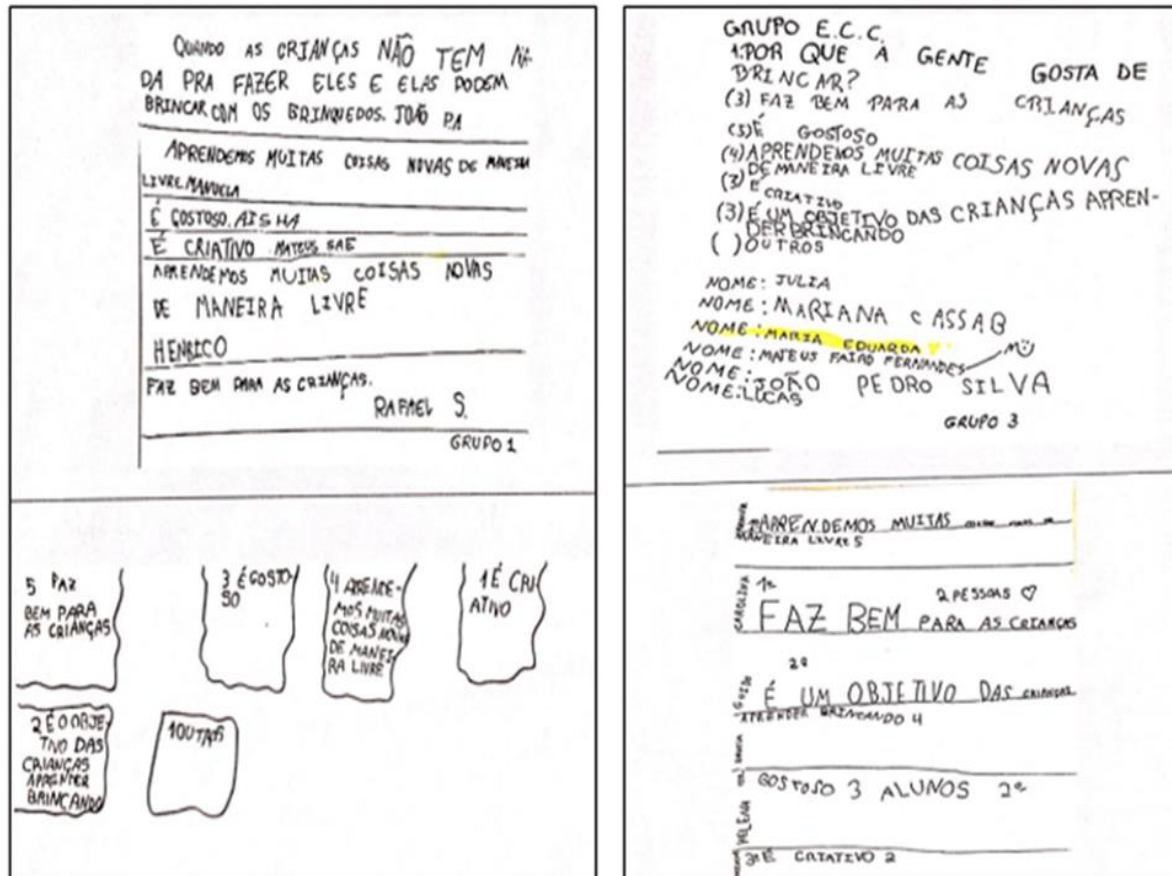


Figure 8: Record of data tabulation made by four groups of children.

Source: Corrêa (2019)

The remaining answers (second and third place) were tabulated orally and collectively in the classroom together with the researcher. Then, each student individually completed bar charts including the three options, as shown in Figure 9.

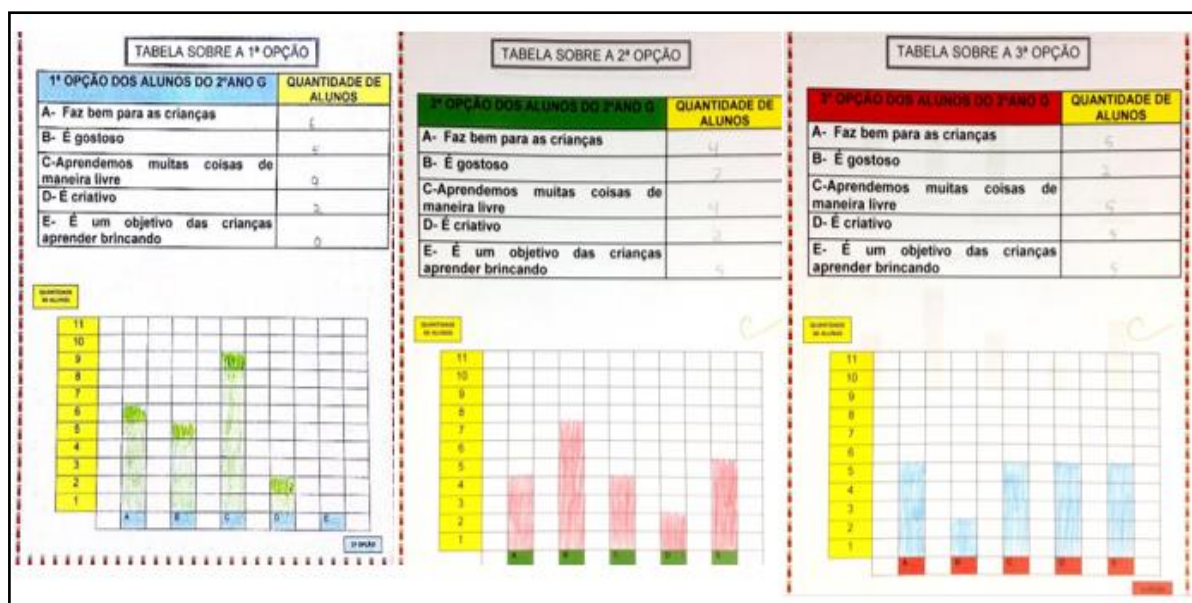


Figure 9: Bar graph showing three answer options

Source: Corrêa (2019)

After the tables and graphs were completed by the students, the researcher proposed the creation of graphs using Excel®. Students agreed with the idea and accepted the challenge, as shown in Figure 10.

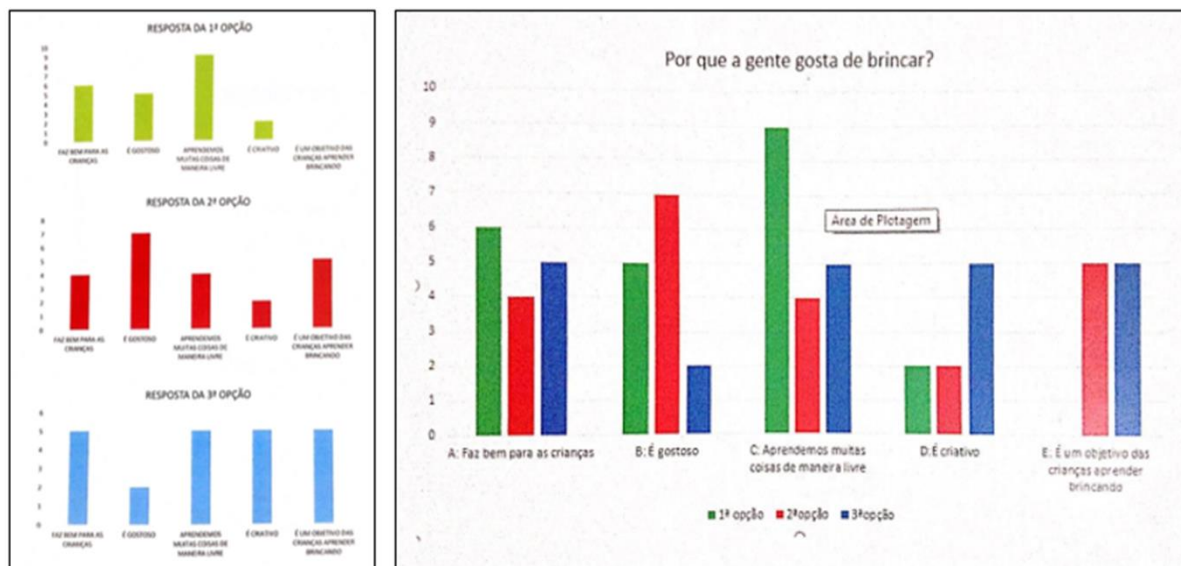


Figure 10: Single and triple bar graphs

Source: Corrêa (2019)

In order to determine how many people voted for each of the three possibilities the children organized the information obtained from the records into smaller groups and then into tables. They observed options that got the most votes, thus exercising statistical reasoning. The use and comprehension of the graphs enabled reading the data provided by the tables for making decisions.

Mathematical and statistical learning is effected and gains significance by imparting meaning to the information collected, as the students engaged in the development of the questions, the survey of possible answers and even the solution of problems, which arose from a real context. Figure 11 shows the conclusions drawn by the children.

Figure 11: Collective record of the answer that got the most votes.

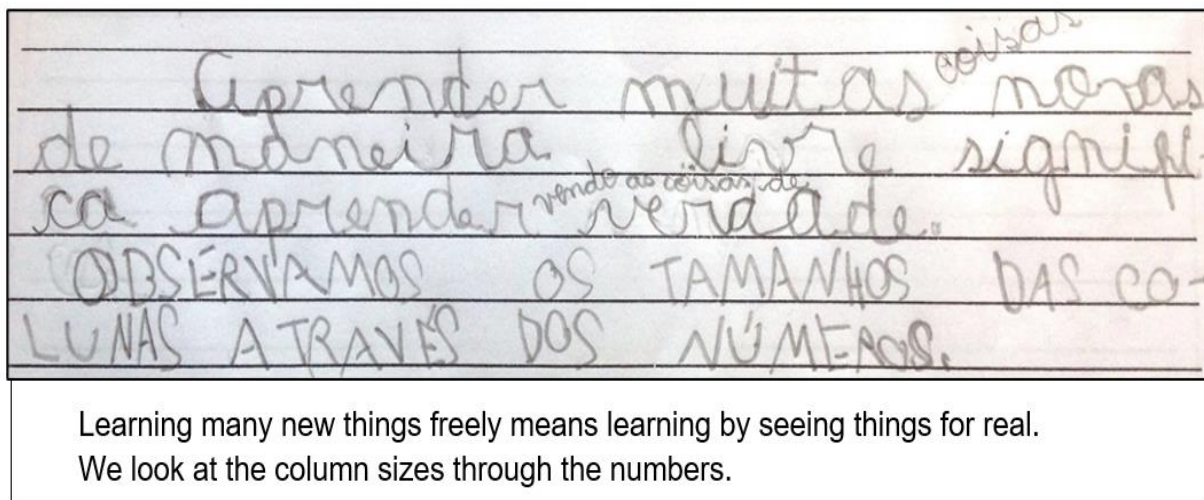


Figure 11: Collective record of the answer that got the most votes

Source: Corrêa (2019)

We will close the presentation of the activities with the following question developed by the children: Why don't adults play much with their children in their daily lives?

Some children in that class miss playing with their parents, but even though some classmates in the group said they did not experience that situation in their homes, the majority decided to investigate the issue. In the same way as previously detailed in this article, the children themselves also developed hypotheses for possible answers to the question, considering their experience with each of their families.

The answers developed by the children were as follows: () Adults have many commitments; () they are preoccupied with doing their things; () they have a lot of work and sometimes forget to play; () they are watching a movie; () they are on the cell phone or computer; () they are tired; () they lack time. Or: they don't have time; () they work hard to make money; () others.

The children decided that their own parents would be the interviewees in the investigation of this issue. Due to the large number of answers, the same strategy was used through which they chose three answers according to priority criteria: the first option was the most important, and the third was the least important.

At this stage, due to limitations of the school calendar, the children were able to partially organize the data collected, elaborating their records in small groups as shown in Figure 12.

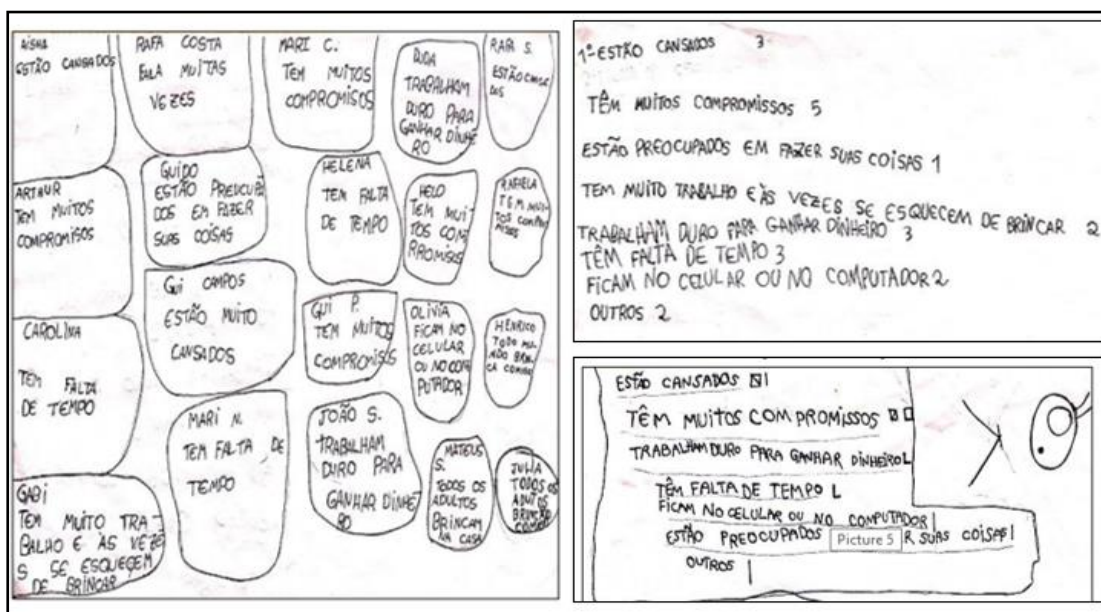


Figure 12: Collective record made by children

Source: Corrêa (2019)

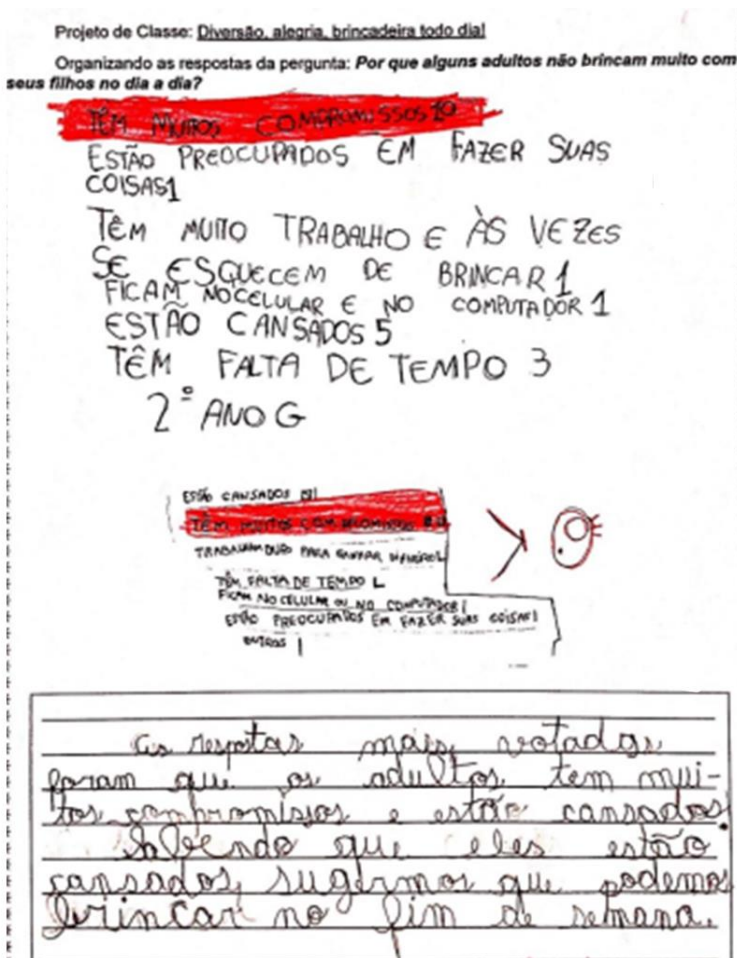


Figure 13: Collective record of the conclusion of the class

Source: Corrêa (2019)

The need to organize data, first into group records, then in tables, offering a method of identifying the most popular answers to each question, promotes the development of statistical thinking. Reading the data provided in the table for decision-making was facilitated by comprehension of how graphs are used. The students were able to attribute meaning to the information gathered through data collection, organization and analysis.

The children were able to read the data obtained as shown by their comparison of the data and creation of triple bar graphs with technological tools (EXCEL®).

Thus, the learning of mathematics and statistics is enriched when children engage in the development and resolution of problems that emerge from their own reality.

When comparing the data obtained, the children observed similarities and differences. They also noted that the most voted option was "children like to play because they learn many things freely".

When the children were encouraged to draw their own conclusions and share their ideas with others, they started to reason in favor of their views. The joy of the children when realize they are effective participants in a proposed activity shows the level of significance of respecting and considering their views. All peers, as well as the teacher who facilitates the activity, are stimulated by the happiness of the group when they realize the suggestion made by a colleague is validated.

Intentionally working with this type of thinking – involved in solving problems and formulating inferences – contemplating probabilities, possibilities and making decisions contributes to the outset of critical thinking (Halpern, 1989). We consider creative thinking similarly, as it is also mobilized when children, as a group, experience an environment favorable to the participation of all in the opinions and construction of knowledge.

Figure 14 shows the importance of considering democratic dialogue so that all the steps planned can occur, and individuals can make decisions and are aware of their rights and needs.

Through statistics education that promotes resolution of real-world problems students can learn concepts and procedures, which generate capabilities that develop critical and creative thinking. This way, one acquires knowledge founded on actions and values, which enable decision-making based on plausible arguments.

DOI: 10.20396/zet.v31i00.8672080

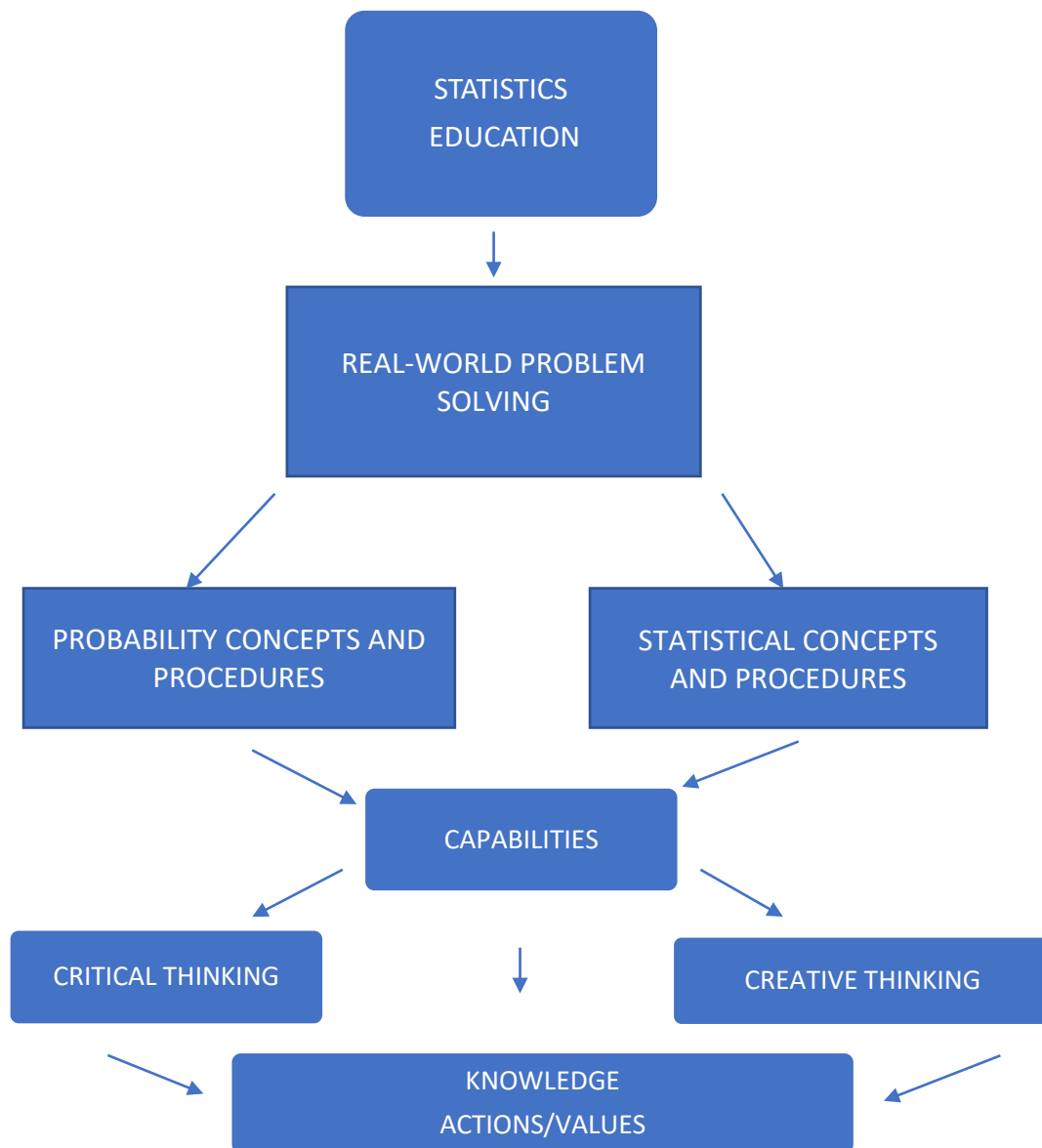


Figure 14: Statistical Education, critical and creative thinking
Source: elaborated by the authors (2023)

Final considerations

The purpose of the discussion in this work is to highlight the relevance in statistics education of an approach which considers education as a practice of freedom, pursuing the democratic construction of society every day, in each classroom, helping students realize the value of sharing their ideas and the significance of listening to others, thus understanding that knowledge is constructed collectively and socially, as indicated by Paulo Freire.

Considering everything stated above, we believe it is necessary to link the process of teaching and learning mathematics and statistics in elementary school to the real social and political issues of society, as education cannot be severed from life and requires a critical

praxis that democratically transforms society.

When we analyze the work developed with second-year elementary school students through the description of teaching activities conducted by the second author of this article, we realize that the proposals made by the students provide them with a mathematical and statistical learning that fosters the development of critical and creative thoughts.

Achieving that required a formative space in which children could learn the value of dialoguing, listening and being listened to when discussing issues related to their reality, allowing them to activate their creative imagination, which Vygotsky (2014) considers very complex and dependent on the stage of development of a child and the relationship of the child with their environment, stimulating and guiding the process of creativity. The process of teaching and learning creativity requires educational contexts in which mistakes, possibilities, chances and risks are discussed, and from which, understandings can be established, producing arguments for decision-making. This didactic path also converges to critical thinking, as Carvalho (2021) states, when considering the confluence of such modes of thinking in the school context.

Research conducted by Lopes, Augusto and Toledo (2023) also converges to considerations analogous to the findings of the present work when they indicate that the opportunities to develop statistical and probabilistic reasoning in childhood, relating social sciences, mathematics and statistics content and procedures, provide students with an approximation to statistical and probabilistic ideas that enables them to reexamine habits and beliefs. Similarly, the investigation by Corrêa (2019) concluded that working with data collection, organization and interpretation was fundamental for children to deal with numbers, within a context derived from real problems, cultivate ethical values, developing a creative and critical stance.

To educators who will work with the next generations, we can state that it is imperative that their work encourages students to develop a creative and critical view of the information that emerges and changes so rapidly.

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