

6-2022

Agency and criticality in statistics teaching practices: the account of a teacher

Celi Espasandin Lopes

Nathalia Tornisiello Scarlassari

Follow this and additional works at: <https://scholarworks.umt.edu/tme>

Let us know how access to this document benefits you.

Recommended Citation

Espasandin Lopes, Celi and Tornisiello Scarlassari, Nathalia (2022) "Agency and criticality in statistics teaching practices: the account of a teacher," *The Mathematics Enthusiast*. Vol. 19 : No. 2 , Article 5. Available at: <https://scholarworks.umt.edu/tme/vol19/iss2/5>

This Article is brought to you for free and open access by ScholarWorks at University of Montana. It has been accepted for inclusion in The Mathematics Enthusiast by an authorized editor of ScholarWorks at University of Montana. For more information, please contact scholarworks@mso.umt.edu.

Agency and criticality in statistics teaching practices: the account of a teacher

Celi Espasandin Lopes¹
Universidade Cruzeiro do Sul – São Paulo – Brasil

Nathalia Tornisiello Scarlassari²
Universidade Cruzeiro do Sul – São Paulo – Brasil

Abstract: The objective of this article is to discuss actions of agency by analyzing the practices and conceptions of a mathematics teacher working in the municipal school system of Valinhos, state of São Paulo, while teaching statistics and probability to students in the final years of elementary school. The concept of agency is related to transformative capacity and refers to the power of the individual over the context in which they are inserted. The concept of agency is significant for teacher education and is linked to critical professional development, as criticality is essential for people's transformation processes. This study adopted principles of (auto) biographical research, which view narratives as training and self-training practices. Through spoken and written narratives given by a teacher who participated in a collaborative study group, discussions about the way she develops her practices and the factors that most influence her decision-making are examined.

Keywords: Statistic education, Agency, Continuing Teacher Education, Collaborative group, Narratives.

Agência e criticidade nas práticas docentes em estatística e probabilidade narradas por uma professora

Resumo: Este artigo tem como objetivo discutir ações de agência, tomando como análise as práticas e as concepções de uma professora de matemática da rede escolar municipal de Valinhos, estado de São Paulo, ao ensinar Estatística e Probabilidade para alunos dos anos finais do Ensino Fundamental. Agência é um conceito que tem relação com a capacidade transformadora e se refere ao poder que o sujeito tem relativo ao contexto em que está inserido. Entende-se que o conceito de agência é significativo para a formação de professores e está vinculado ao desenvolvimento profissional crítico, uma vez que a criticidade é essencial para os processos de transformação das pessoas. Neste estudo adotam-se os princípios da pesquisa (auto)biográfica que toma as narrativas de si como práticas de formação e autoformação. A partir de narrativas orais e escritas construídas pela professora participante de um grupo de estudos colaborativo, trazem-se à tona discussões sobre a forma como desenvolve suas práticas e os fatores que mais influenciam nas tomadas de decisões.

Palavras-chaves: Educação Estatística, Agência, Formação Contínua de professores, Grupo Colaborativo, Narrativas.

¹ celi.espasandin.lopes@gmail.com

² ts.nathalia@gmail.com

Introduction

Teaching has been the objective of studies such as those of Freire (1998), Passos et al. (2006), Lopes (2008), Lopes & D'Ambrosio (2016), Cyrino (2016), Nacarato (2018), among others. However, this field remains full of mysteries to be revealed, as teachers are human beings routinely immersed in human relations. Each class is the result of the interplay of the particularities inherent to teachers, students, curricula, and several materials. Therefore, each teacher has a unique and individual relationship with the work they develop, which becomes a fertile ground for academic research.

Such particularities cannot be generalized, because, as even in classes of students in the same school and with same teacher, actions are certainly not the same. Therefore, it is important to think of a research methodology that considers the reality of each classroom. We found this sort of support in (auto)biographical research (Passeggi & Souza, 2013), in which the teacher is heard, and their practice is analyzed based on their experiences as well as educational and professional trajectory, which are reported in spoken and written narratives. By examining in teachers' accounts, our intention is to find evidence of agency in their practices and work.

Originating in Giddens (1979), the concept of agency has evolved between the 1980s and 1990s. Agency is related to individual in action theory, and must situate the action in time and space, as a continuous flow of conduct, and does not refer to a series of discrete and isolated acts combined. Agency is related to the individual's ability to transform the social environment in which they are inserted, with the power of action. According to Passeggi and Cunha (2013, p. 46), "agency entails self-knowledge, self-esteem and self-regulation in determining actions." Thus, some of the characteristics arising from the criticality achieved, which point towards agency by teachers who are members of the group, are the pursuit of research, the furthering of theoretical knowledge of contents dealt with in the classroom, and practices focused on student learning.

Research by Lopes and D'Ambrosio (2016, p. 1088) shows that "the notion of agency not only shapes the characteristics of teachers' decision-making process in relation to their own professional development

but is also quite beneficial for students to learn mathematics". Teaching is a dynamic profession and to fulfill well their role in the classroom, teachers must be attuned with the needs and realities of their students. The process of reflecting on their actions becomes fundamental for the elaboration and development of activities under the perspective of statistical research.

The self-formative process present in teachers' relationship with their professional practices is revealed in the elaboration of statistical and probabilistic activities, as well as in their experience with students. Thus, when writing about themselves and their practice, teachers reshape their role as agents in society, and reflect on their own actions. It is not about finding immutable truths in narratives, but analyzing how teachers place themselves as producers of knowledge and how they see and analyze their actions. Moreover, individual life trajectories and formative paths are also brought centerstage, as they influence teachers' actions and decision-making.

Data that support discussions contained in this text are an integral part of a doctoral research project and allow us to reflect on narratives written by teachers about their actions in the classroom. In addition, the narrative interviews afforded a panorama of the trajectories of teachers, and the perception about how they develop investigative activities in statistics, based on what is discussed in the collaborative group in which we participate. Under the perspective of Bolívar, Segovia and Fernández Cruz (2001), we see narrative interviews as a strategy for the construction of data. To interfere as little as possible in the teachers' account, the researcher introduces and explains the objective, clarifying what the interviewee should speak about.

Our objective in this article is the analysis of the practices and conceptions of a mathematics teacher working in the municipal school system³ of Valinhos – SP⁴, participating in a group that evolved into being

³ In Brazil there are public and private school networks. Public schools can be managed by municipal, state and federal governments. In Valinhos, the municipal public school system includes 3 thousand students attending junior high in 13 schools.

⁴ Valinhos is a city in the interior of the state of São Paulo, Brazil, with a population of approximately 130 thousand inhabitants. It is a center of economic development, aimed at companies operating multiple industrial, trade and services activities. High-tech productive activities in several areas of expertise, such as plastics, paper and cardboard

collaborative over time (Lopes & Mendonça, 2018) and who was willing to narrate their practices regarding statistics and probability. The fact that the teacher had been an active member for nine years shows that she is always in search of new experiences, aiming to improve and reshape her practices. In connection with this object of study, we intend to show possible work conducted in municipal public school classrooms, guided by a teacher concerned with the education of critical citizens who use mathematics and statistics for decision-making and will apply the concepts learned, in their professional lives in the future.

Context of the collaborative group

In 2012, a universal project of the National Council for Scientific and Technological Development (*Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq*), was conducted and coordinated by the second author of the present article. It provided for the creation of the Research and Training Group in Mathematics Education (*Grupo de Investigação e Formação em Educação Matemática – GIFEM*), whose main objective was "to promote investigations about the professional development of teachers on topics related to probability and statistics, in view of the need for working with statistics education in their classes", as reported by Lopes and Mendonça (2018). The mathematics teachers at the Valinhos municipal school system were invited to participate in the only six meetings originally planned. Initially, only three teachers accepted the invitation. Later, a new hire and two other teachers working in the early years of elementary school also joined the group.

The studies carried out during the six meetings inspired participants to continue because they saw potential for learning about teaching practices in the group, and for bettering teachers' classroom practice. In 2014, a new theme emerged with the participation of a new member. A doctoral student, supervised by Dr. Celi Lopes, conducted a two-year project researching teaching activities based on mathematical

packaging, metallurgy, computer science, microelectronics are present in the city which also displays a significant vocation for the development of the logistics sector.

modeling principles applied to statistics. Readings and studies within the group enabled participants to become more autonomous. The need to change the focus of the studies emerged from demands of the educational system. The development of projects had become a demand on the part of the municipal education department, which led us to further our investigative studies in statistics and probability. Due to the complexity and numerous possibilities of the work involving such a theme, the studies persist to this day. This necessary change in approach opened the door for the group to become collaborative, as described by Hargreaves (1998) and Fiorentini (2004). The group's work dynamics enabled participants to identify themselves with the issues discussed in such a way that they gradually became authors of their own practices.

That led us to consider that the group was configured through the professional identity and interactions of each member, as the development of teachers' professional identity can be understood as a movement that "takes place considering a set of beliefs and conceptions linked to self-knowledge and knowledge about their profession, associated with autonomy (vulnerability and sense of agency) and political commitment." (Cyrino, 2016, p. 168). Therefore, each teacher, as a member of the group, when sharing their beliefs and conceptions leads colleagues who are listening to reflect on their own professional actions and reshape their professional identity, as connections between ways of thinking and acting are unveiled. Thus, there is a willingness to listen to colleagues, as well as share ideas and positions when facing dilemmas, conflicts, and challenges. In the group, professional collaboration is supported, based on respect, solidarity, criticality, and ethics.

Nowadays, being a member of GIFEM means accepting and being aware of the need for professional growth; heeding feelings and concerns about behaving differently in the classroom and changing one's views about what it means to be a mathematics teacher (Luehmann, 2007). Participation in a collaborative group offers a safe space, where we gain confidence that allows us to experiment and develop our identities as mathematics teachers and capitalize on unique opportunities for creative practices that dialogue with our reality in the different contexts we inhabit. We feel recognized for the work done and socialized in a structured and theoretically supported process of continuous reflection.

GIFEM consists of 8 members, four teachers who teach mathematics in the final years of elementary school, two who teach mathematics in the early years of elementary school and two researchers. We meet biweekly with the teachers who work in different schools and whose participation in the group is voluntary. It is interesting to observe the process teachers undergo within the group. At the beginning, we had only two master's degrees; currently, all members of the group have already completed their dissertations. This movement characterizes a yearning for furthering continuous education; an individual need emerging from our studies. Nowadays, we can say that GIFEM is a research group because we are searching for answers and publishing what we have produced in the classroom.

In the group, teachers examine and debate scientific texts on statistics education, analyze pedagogical and technological materials and are encouraged to observe, reflect, and narrate their own practice, so that they can gather elements for discussions at meetings. In addition, they constantly debate socio-cultural, political, and economic issues that mark the educational context in which they practice their work. During such discussions there is often disagreement but also respect among group members, underpinned by the receptiveness to different worldviews. This leads to constant learning about diversity and equity. Thus, the members feel free to share their anxieties, fears, dilemmas, and challenges. They socialize their practices, reporting successes and setbacks. This attitude promotes reflexivity for all involved and expands possibilities for reshaping teaching actions. Thus, they feel empowered, augment their autonomy and dare to investigate and recreate their professional practice, so that collaborative work becomes a strength, revealed in the narratives, when teachers claim to be more confident to develop the content proposed for group discussion.

GIFEM is organized as a training space where participants feel comfortable and confident to discuss concepts, share ideas, doubts and anxieties, as well as make suggestions. It has become collaborative over the years due to the increasingly active participation of all members, as each one felt comfortable to detail their classroom practices. According to the teacher's (auto) biographical narratives, she believes that the intense productivity of the group results from being composed of fewer members and not having a significant turnover. What moves us to do it differently is the theoretical study and the exchange among

peers, placing ourselves in a movement of listening to students in the classroom, and discussing both teachers' and students' learning. All that leads to the actions of teacher-researchers who are reflective, protagonists and, therefore, agents of their practices.

Through the narratives, it is possible to notice that the posture of GIFEM's leading teacher⁵ was essential for the group to evolve into being collaborative, as she respects the work of each teacher within their reality and values the ideas presented by everyone. All members share the coordination of the group, as well as responsibility for the activities developed; there is no hierarchy, which means that each member is responsible for their own learning - characterizing self-training - and for the learning of their peers.

In this context of a collaborative group, it is not the facts themselves that matter, but the interpretation given to them, and the transformation of teachers and their practices based on such interpretation. As a result of such movement, the teacher abandons a technicist paradigm that tends to reproduce the curriculum imposed by the system, according to which they were trained, and becomes a professional who produces knowledge, acts and changes based on reflection. Thus, at GIFEM, we produce knowledge together, with people, not about them.

The opportunity to elaborate class narratives that marked the group's work arose when we set out to write a book to publicize our work. At that moment, each group member thought about an investigative activity involving statistics and/or probability to develop with students. In the movement between group discussion, classroom work and individual reflections, the narratives were outlined and culminated in the book organized by Lopes and Mendonça (2017), which became a source of studies and reflection by the group. Moreover, narration became a habit.

Through the narratives, teachers become increasingly more autonomous, feel safe to develop activities that break paradigms and requirements imposed by the traditional school, and stop being mere repeaters of activities proposed by textbooks, seeking to diversify their practices. The reflexivity that

⁵ GIFEM is a research group registered before CNPQ, linked to Studies and Research in Mathematics and Statistics Education (*Centro de Estudos e Pesquisas em Educação Matemática e Estatística - CEPEME*) of *Universidade Cruzeiro do Sul* and whose lead researcher is the first author of this text, which means she is institutionally responsible for the group.

writing a class narrative requires allows teachers to further develop their criticality. As a result, they strive to do better, which implies, among several factors, studying concepts more thoroughly. This quest for knowledge and more appropriate practices reveals the concept of agency ingrained in the teaching practices of such teachers.

In this article we adhere to the perception as Lopes and D'Ambrosio (2016), with regard to the way we analyze narratives: each story told is a second order interpretation of the facts, as we insert ourselves in the stories of our research subjects, interpreting them through our own lenses, which are shaped by our life stories, worldviews, beliefs and values.

Every narrative, including those presented here, affords multiple interpretations. This text shows our vision, which allows us to create a new history from our life trajectory, presented here through the standpoint of the work with statistics education.

Statistics education – Brazilian scenario

This study was conducted in the context of Brazilian statistics education, therefore it is necessary to highlight some aspects, such as official documents and factors that influence the practice of mathematics teachers who teach statistics.

Brazil is a reference with regard to research in statistics education, driven by the pioneering researchers, professors Celi Lopes, Cileda Coutinho and Lisbeth Cordani (Araújo, 2016), renowned for the quality and amount of work conducted, as well as for their significant work supervising other researchers in the field. However, there is still a lot to be investigated, especially by establishing a significant dialogue with schools. The Work Group on statistics education (WG 12) was created in 2000 during the 1st International Research Seminar in Mathematics Education (*Seminário Internacional de Pesquisa em Educação Matemática - SIPEM*) organized by the Brazilian Society of Mathematics Education (*Sociedade Brasileira de Educação Matemática - SBEM*), and has been furthering discussions about teaching and learning statistics and probability ever since. Samá (2019, p. 2) states that the aim was “to study the

processes related to teaching and learning statistics, which, according to WG 12, involve cognitive and affective aspects, in addition to the epistemology of statistical concepts, and development of didactic strategies to foster statistical literacy”.

In recent years, with the implementation of the National Common Core Curriculum (*Base Nacional Comum Curricular - BNCC*) (Brazil, 2018), the mathematics educators community has turned their attention to changes in the so-called “Information treatment” block, within the National Curriculum Parameters (*Parâmetros Curriculares Nacionais - PCN*) (Brasil, 1997), and the “probability and statistics” thematic unit, in BNCC. As a result of such changes, content that involves those themes gained more space in the curricula, however, uncertainty permeated many teachers’ classroom work. That was just one of the changes which caused this feeling, especially for teachers in the early years of elementary school, who, in addition to statistics and probability, among several others, had to make adjustments to develop algebraic thinking in the algebra unit. Despite the need to establish what should be worked on in classrooms throughout the Brazilian territory, it is clear that the implementation of the BNCC served political interests.

We agree with Bôas and Conti (2018), who reflected on the content teachers develop in classrooms and considered that the fact that statistics and probability have been present in the curricula since the implementation of the PCN does not guarantee that they are being covered within Brazilian classrooms. Encouraging work with such content and showing the need to pay them special attention is essential, as initial teacher education is often based on traditional teaching methods, which are meaningless for learners. Continuing training courses, study groups, and other proposals to develop this content in classrooms are quite valuable.

This aspect also emerges in the narratives about their initial education: courses in statistics aimed at the construction of graphs, without considering a context, using only mock data, which are of little significance for students do not incorporate important aspects to the work of the teacher. This fact constitutes one of the motivators for teachers to remain in continuing education, in search of training that will enable them to develop classroom work which is different from what they have experienced.

Statistics evolved very quickly in the last century, since it was structured, at the end of the 19th century. Rade (1966) points to the Cambridge Conference (Massachusetts), in 1963, one of the first scientific gatherings where the integration of statistics to the mathematics content in elementary education was proposed.

According to Bôas and Conti (2018), “the speed with which studies on statistics were developed provoked an intensive search on the part of institutions that sought to take advantage of the new methodology to advance their activities” (p. 986). To keep up with the development of statistics within institutions, it was necessary to develop statistical content in schools. In Brazil, this occurred in 1997 with the implementation of the PCN (Brazil, 1997). Nowadays, “the omnipresence of statistics in the modern world became a reality in the lives of citizens, requiring statistics to be taught to an increasing number of people ”(Lopes, 2010, p. 47).

In addition to the need for using statistical and probabilistic content to develop pedagogical practices, in mathematics, and as a problem-solving tool in other disciplines, citizens need to make every day-life decisions, and many of them will need to use statistics for work, such as in market analysis or research in biological and social sciences. It is important that people are not only capable of reading graphs and percentages, but also perform critical readings, linking data shown by surveys to reality. This can and should be done from the early years of schooling, combined with the use of technology, whether it be simple calculators or more elaborate software.

As indicated by Lopes (2008), critical statistics education must consider students' experiences, their actions in society and develop, with them, themes from newspapers headlines, or their interests, related to their daily life.

In view of curricular changes and the growing need for critical education geared to the reality of learners, teacher education has been an ever expanding focus of research. However, there is still no practical evidence that such studies have contributed to the learning of students who complete elementary education (Lopes, 2008). It is important to enable students to develop critical thinking through probabilistic and statistical concepts that entail uncertainty, very present in our lives, the ability to make inferences, establish

relationships and draw conclusions. However, planning and developing activities with this intention is not typically easy, as it requires effort, especially when the teacher was not prepared to work that way.

We believe in pedagogical practice in which students are protagonists, carry out activities that are pertinent to their own context and “can observe and build possible events through concrete experimentation, data collection and organization” (Lopes, 2008, p. 58).

However, changing practice or adapting to new demands of society is not an easy process. With that in mind, our studies focused on the role of the teacher, actively participating in a collaborative group, in a continuing education process. Based on the assumption that the teacher is a creator of knowledge, we chose (auto)biographical research methodology to better understand the reality experienced by teachers who revealed their practices, what happens in the classroom, their anxieties and insecurities regarding the process.

Methodological paths: the meaning of narratives in (auto)biographical research

Throughout the research process, readings by Passeggi and Cunha (2013), Bolívar, Segovia and Fernández Cruz (2001), Ferrarotti (2014) and Nacarato (2018) helped ensure that we had chosen the ideal methodology for the type of analyses intended. In general, teachers' voices are silenced by their exhausting routine, school management, and the political system. However, with the present work, we intend to amplify some of these voices so that everyone can have access to the richness of the transformation going on in teaching practice, since the first contact with students, and intensified by some practices that we will discuss subsequently in this article. The narrative enables the conduction of a more intimate and profound analysis of the way teachers see themselves as professionals.

According to Passeggi and Souza (2017), this form of research in the field of education in Brazil is very recent, and the first work of this kind was developed in the 1990s by the Teaching, Memory and Gender Study Group (*Grupo de Estudos Docência, Memória e Gênero*) of the Faculty of Education of the University of São Paulo. In the same text, the authors stated that “in this permanent process of interpretation

and reinterpretation of events, in order to give meaning to experiences, the person who narrates re-elaborates the historical process of their learning and reinvents themselves” (p. 14). Only from the 2000s onwards a more consistent and diversified trend in the (auto) biographical movement can be detected. A key component of this type of research is respect for the narrator's words, when analyzing how they reinvent themselves based on the narratives, as, in this movement of reinvention, we can “see autobiographical narratives as a teacher education process” (p. 14).

The main objective of (auto)biographical research that views individuals’ narratives as training and self-training practices is “to contribute to the construction of new ways of understanding humans” (Passeggi & Souza, 2017, p. 9). Teachers’ narratives are essential, as teachers are immersed in context, experiencing reality with both potential and setbacks.

The process that a person uses to organize and narrate experiences is called biographizing. Passeggi and Souza (2017, p. 9) define it as follows: “Therefore, biographizing is this permanent process of learning and socio-historical constitution of the person who narrates. (Auto)biographical research favors such biographizing processes aiming to understand how individuals become who they are”.

This definition is in line with what Freire (2018) proposed about us being “indeterminate, unfinished, incomplete” beings (p. 26). As human, we are aware of our incompleteness and as unfinished beings we can always seek improvement. “It is the conscience of the world that creates my conscience... Curiosity drives us, motivates us, leads us to reveal reality through action” (p. 27); this curiosity which drives us thrusts the development of teaching agency and actions on behalf of our students.

Teachers' narratives enable an approximation between research and teacher education; in this case, continuous education. Our work at GIFEM, which helps bring the university closer to schools, makes it possible to reflect on the needs of teachers and students regarding pedagogical practices. In this sense, the teacher becomes an author. Passeggi and Cunha (2013) reflect on the narrative authorship process, which takes place “through language operations and comprises cognitive and socio-historical processes through which the person who writes appropriates their experiences and through this writing act is constituted as an author, while reinventing their human condition” (pp. 45-46).

As Passeggi e Souza (2017), we believe that

the subject, in all stages of life, appropriates semiotic instruments (language, graphics, drawing, gestures, images, etc.) to retell their experiences in the form of autobiographical narratives that did not exist before. And through this biographizing process, even though the person who narrates, cannot change events, they can reinterpret them within a new plot, reinventing themselves with it [original emphasis]. (p.8)

Through our experience in the collaborative study group we realized that writing about themselves and their practices is a fundamental aspect for reframing teachers' pedagogical practice. When writing about themselves and their actions, and reflecting on students' learning, teachers interpret the experience reported, reshape their actions and assign meaning to them. With this in mind, we sought the words of Freire (2018) regarding the inconclusion of human beings: because of it "human beings become educable" (p. 29). And, in this movement of understanding as unfinished and incomplete, and while feeling that way, humans "begin a permanent quest" (p. 27).

Practices are being reshaped in the reflexive movement of self-knowledge and of understanding the reasons that lead us to act in one way or another, as there is a need to reorganize the pedagogical posture adopted and, consequently, theoretically augment what is taught. In this path postgraduate courses, study groups, and continuing education are found. This direction is only possible through criticality, acquired over time, and with agency built through the search for more appropriate practices.

Listening to the teacher means allowing them to reflect on several aspects that are often hidden which end up surfacing; and letting them realize how much they are responsible for their own education. And these paths make all the difference in the final product, which is student learning. Giving space and opportunity to teachers' voices means allowing individuals realize how the process of becoming a teacher takes place, as no one is born a teacher, people constitute themselves, in a movement of both personal and professional improvement, which gives rise to the narratives and highlights their voices. We consider teachers as authors of their practices, and not mere enforcers of curricular determinations and / or transmitters of public policies, often instituted without their participation.

Passeggi and Souza (2017) concluded that “the construction of knowledge in (auto)biographical research is only achieved with the other and with respect for the other, never by the researcher in isolation” (p. 12). This was gratifying and moved us to research using this methodology. Under this perspective, academic research will never be solitary, as it only happens through the relationships established, in the respect that, in our case, we have for the work of colleagues, for the relationships it establishes with knowledge.

We value the potential of narratives in academic research and, as teachers and researchers in the field of education, recognize their importance, as while narrating, individuals reveal their perception of the world, their perspective about how things happened, and there is not one single truth, but points of view. Our role as researchers is to analyze the narratives as they are presented to us. Bertaux (2010) cites a lot of research that compared data obtained in closed questionnaires, subjected to quantitative analysis, with data obtained by reading narratives. The conclusions were that “the information contained in the reports was not only richer, but also more reliable than that collected through questionnaires”, which is not surprising, but “it is good that it has been verified” (Bertaux, 2010 , p. 32). This happens because, when the person trusts the interviewer and feels more comfortable to speak; they end up describing their actions and, often, their feelings in more detail, due to the open character of the narrative interview, which allows them to explain their actions. Bertaux (2010) states that “during the interview, the experience of reality takes on human form, life and voice; its power of persuasion increases considerably ”(p. 69).

In view of such assumptions, we pored over the narratives of a teacher called Adriana.

A teacher with agency

Adriana was born in Valinhos, state of São Paulo, in 1978. She is one of the three teachers who take part in the ongoing research project that grounds this article. Since 2003, the year she first graduated, Adriana has been a tenured teacher of the final years of elementary school, in the municipal educational system of the city of Valinhos - SP. She has been participating of GIFEM since its inception. She gave

spoken narrative interview about her life and professional trajectory and wrote narratives regarding her practices with statistics that were discussed in the group.

The individual narrative interview brings elements about her educational trajectory, beginning with her schooling, as an elementary education student, going through the process of choosing a profession, initial teacher training course, postgraduate and continuing education. The interview was conducted according to the theoretical basis suggested by Bolívar, Segovia and Fernández Cruz (2001), regarding narrative interviews, in which the interviewer (researcher) only explains its purpose and interferes as little as possible in the narrator's (teacher) account.

As Bolívar et al. (2001) stated, the individual who narrates, assumes their identity within the community they partake. In their accounts, teachers talk about what they do, feel and the consequences of actions, always placing themselves in context in relation to others, and not as a lonely or impersonal self. The signs of the route chosen by each teacher are evident.

Since elementary school, Adriana always knew she wanted to be a teacher. She liked mathematics, got good results in evaluations. In the first minutes of her narrative, she stated that the demands at her school, a public school, were not remarkably high, thus she believed that she performed well because it was "easy" to get good grades. This was confirmed when, while working towards a bachelor's degree in mathematics, she failed to pass some courses because - as she came to realize - she had not learned the concepts necessary for further learning. As usual, she was critical in relation to her learning, and towards former teachers who dwell in her thoughts. Immersed in a reflective process, she did not settle when evaluating the work that her teachers did and realized the need to be a better teacher and do things differently for her students. Considering that, she sought further education that could provide subsidies for innovation in the classroom. This is an attitude that characterizes her agency: going in search of something to improve her actions and reframe what she has learned. She has a teaching degree in mathematics from the Pontifical Catholic University of Campinas (*Pontifícia Universidade Católica de Campinas* - PUCCamp), a master's in mathematics education and a specialist degree in teaching mathematics from the State University of Campinas (*Universidade Estadual de Campinas* - Unicamp).

The municipal school where Adriana works is located in a rural area and has very few classrooms, with students who have limited or no access to technology, magazines, newspapers, and even to the center of the city, due to the considerable distance. Students spend a large part of their time in the neighborhood where they live, which, in this case, translates into a lack of access to social and cultural facilities. This gives them a worldview restricted to the environment where they live.

Such aspects have gradually constituted Adriana's professional identity by allowing her to reflect on her actions and believe that she can do better; do differently.

Professional agency in teaching: analysis of a statistical project

As we analyzed Adriana's spoken and written narratives, the concept of agency was revealed by her considerations. Instigated by the common practice of the group of promoting critical reflections regarding the system, training courses and even about their own classes, she seeks to improve her learning, with the objective of breaking away from the established curriculum, in the textbook, which does not allow the students' reality to be considered. This quest gave rise to opportunities. It is important to point out that these reflections which emerge from discussions among peers, in the collaborative group environment, transform both teachers and the environment where they work.

Exercising professional agency means striving to maximize the potential for development and growth. This movement allows individuals to take a stand, resisting what is imposed onto them, which they believe is not desirable for their practice.

The narratives analyzed dialogue with Lopes and Grando (2019), as they make it clear that the more mathematical or statistical content teachers master, the greater the possibility to reshape their practices in favor of their students' learning. This generates confidence in their daily pedagogical activities because the constant reflection about practice and focus on the answers given by students, enables them to make prompt decisions during the teaching process.

In fact, when narrating their formative trajectories, teachers reflect on their present actions, comparing them to those at the beginning of their careers. This reflection is inevitable for those who remain in continuing education. As we have observed, from the views of Passos et al. (2006) teacher education takes place as follows:

as a personal, permanent, continuous and never-ending process that involves multiple stages and formative instances. In addition to personal growth throughout life, it also includes professional education (theoretical-practical) during initial training — focused on teaching, which involves conceptual, didactic-pedagogical and curricular aspects — as well as the development and updating of professional activity in continuing education processes after graduation. Therefore, continuing education is a phenomenon that occurs throughout life and is ingrained in the social practices and daily professional life of each individual, gaining momentum and relevance for some. (p. 195)

During the narrative interview, Adriana said that she was disappointed with the college she attended, as she had expected to learn the content she would teach, however, calculations prevailed. She was frustrated when she realized her shortcomings regarding mathematics and that her good performance as a public school student resulted from the shallow treatment given to concepts taught. On the other hand, she recalled having good teachers, who actually taught the content and linked it to the pedagogical issues. She had fond memories of two of them and stated that they had influenced her practices as a teacher.

She analyzed her early teaching career: she prepared "little summaries at home and, when I arrived at school, copied them onto the board and the students copied... I felt sorry for those poor children." As a result of such reflection, she took the initiative of seeking specialization courses and, since then, has been in continuous education, either by attending such courses or participating in study groups. Through this search she learned much of the content she felt necessary to improve her classes, and what she considered the best part: learned to use games, manipulative materials, and investigative activities. As a result, nowadays, her classes are completely different, she feels confident because she knows the content better and of all the pedagogical knowledge acquired through training.

Adriana stated that ever since she started participating in GIFEM, she has developed projects involving statistics every year. For her, the most striking were the projects "Athletics" and "Teen

Pregnancy". The "Athletics" project was included in the first book of the group (Lopes & Mendonça, 2017) and will be discussed below.

In that narrative, Adriana stated that she usually let students choose the theme to be studied. However, she had been noting that students at school were not involved with the student games promoted by the city of Valinhos, and, while talking to 9th graders, she realized that they had no knowledge about individual sports. Team sports were not feasible at that school, as the number of students rendered it impossible to form teams and reserves as required by the rules. Thus, she proposed an investigative activity with the students involving statistics with the theme "Athletics" which would include the whole school, from year 6th to 9th. Her teaching agency was revealed in the action of choosing an important theme in the lives of students with a greater goal - practicing sports - related to a healthier life, as well as participating in an important city event, embodied by the annual student games.

Thus, she organized the project in several steps, starting with planning and research about athletics and its modalities. Adriana reported that not only groups of students conducted research, but she also conducted an in-depth research so that she would be more confident to develop a topic she had never explored in her classes. She pointed out that the planning of her projects is not always followed strictly because their conduction is tailored to the actions and needs of students. Characteristics of teaching agency can be seen when she elaborates a flexible project, which meets needs as they arise and when she puts herself in the learner's shoes.

Students were instructed to elaborate questions for the questionnaire to be answered by other students at school and questions that would be used to elaborate explanatory material which would be presented at the end of the project. She pointed out that allowing students to elaborate questions is a time of significant learning and systematization of the research conducted. She added that the choice of questions that allow the analysis of qualitative and quantitative answers (discrete and continuous) was discussed. This is quite different from practices in which the teacher comes with a ready-made questionnaire to be used.

To finish this first step of the project, students created a written text contemplating the aspects researched and an oral presentation.

The second step consisted of measurements and data collection in the school court, for statistical analysis. At this stage, it is important to highlight the fact that Adriana promoted the experience of students on the court, which allowed them to come in contact with different track sports and realize the meaning of the data obtained (Lopes, 2008). To do this, she elaborated a form with personal information such as the student's name, gender, age, whether they liked physical activity or not, and information that was collected by the students themselves such as the distance jumped (long and high jump), shot put, and 100 meter sprint. It must be observed that qualitative (such as gender) and discrete quantitative (age - discretizing the continuous) and continuous quantitative (height, for example) variables were contemplated.

While collecting data, Adriana realized that few students knew their own measurements such as height and weight, a fact she emphasized, and that showed concern for the student's personal life, showing them the importance of self-knowledge. This demonstrates another instance of agency of a teacher who cares about students as human beings, enabling them to transform their reality through knowledge.

Data were collected first by the 9th graders; then by other classes. With the data for each modality in hand, in groups, students organized the data and Adriana created a table with the best results obtained, per grade.

<i>Grade</i>	<i>Long jump</i>	<i>Shot put</i>	<i>High jump</i>	<i>Sprint</i>
<i>6th</i>	<i>2,72 m</i>	<i>9,50 m</i>	<i>3,03 m</i>	<i>9,88 s</i>
<i>7th</i>	<i>2,95 m</i>	<i>12 m</i>	<i>2,56 m</i>	<i>9,65 s</i>
<i>8th</i>	<i>2,85 m</i>	<i>10,27 m</i>	<i>2,70 m</i>	<i>10,09 s</i>
<i>9th</i>	<i>3,16 m</i>	<i>10,40 m</i>	<i>2,82 m</i>	<i>9,50 s</i>

Figure 1: table with the best results organized by Adriana's students.

When analyzing the data, students found that boys achieved the best results, which led to the discussion of why modalities were separated per gender, due to differences in physical characteristics. This moment (among others) shows the importance of developing investigative projects of this nature; as they reach far beyond the confines of the school and teaching statistics.

After that, with the data organized and the help of a calculator, students learned measures of central tendency (mean, mode and median). The need to use software to assist in these calculations was clear due to the significant amount of data. This led to a session in the computer lab, using Excel. As a result, the following table was created:

	Sprint				High Jump				Long Jump				Shot Put			
	6º	7º	8º	9º	6º	7º	8º	9º	6º	7º	8º	9º	6º	7º	8º	9º
Mean per class	11,7	12,7	19,9	13,2	2,16	2,53	2,44	2,21	2,33	2,25	1,96	2,46	7,39	7,06	7,15	6,8
General Mean	14,36				2,33				2,25				7,1			
Mode per class	não	não	não	não	não	não	não	não	2,33	não	não	2,98	não	não	não	não
General Mode	10,72/10,34/11,47/11,66				2,33				2,33				7,22/6,17/8,64/5,4			
Median per class	11,2	11,6	15,6	12,3	2,11	2,34	2,39	2,48	2,33	2,24	1,89	2,02	6,15	7,22	6,37	6,17
General Median	11,72				1,99				2,2				6,37			

Figure 2: Table with measures of central tendency created with *Excel*.

As a result of that, Adriana discussed the importance of each measure, what they meant, and which best represents a given set of data. The question of which measure of central tendency is best suited to represent data is fundamental, as well as the interpretation of each of them from the data obtained. Separately, they are meaningless numbers and, according to our concept of statistics, numbers only make sense when taken in context (Lopes, 2008).

In the last step of the project, the objective was to investigate the preferences of students of other classes (grades 6th, 7th, and 8th), 9th graders acted as interviewers as well as treated the data. Allowing each group to record data in the way they deem most pertinent is important for learning and, even more important is the socialization of ways of constructing meaning. During this time, students usually identify with the elaborations of colleagues and appropriate new ideas. Moreover, by systematizing thought to expose their ideas, students reflect and produce meaning for what they say. This tabulation and analysis stage is important for the development of statistical reasoning (Garfield, 2002).

Within this movement it was possible to decide, with the students, the most appropriate type of chart for each situation or type of variable (Garfield & Gal, 1999); sectors and column graphs were created.

The elaboration of the sector graph enabled the learning of arithmetic, algebraic and geometric concepts such as percentage, proportion, and measurement of circumference sector angles. When eliciting comments on the charts, the teacher asked students for their analyses of the graph, transposed into words to communicate it in a language understandable to all. To ensure that the graphs produced by students were correct, Adriana took them back to the computer lab so they could be reproduced in Excel and compared. The teacher fostered the protagonism of students by asking them to share what they know with others. Garfield and Gal (1999) point out that teachers do not specifically teach statistical reasoning; they teach concepts and procedures through real data, with the help of calculators and software, and the result of such process is the development of statistical reasoning.

To complete the project, students prepared information posters with the initial research and graphs resulting from statistical treatment, as seen in Figure 3, as well as an oral presentation:

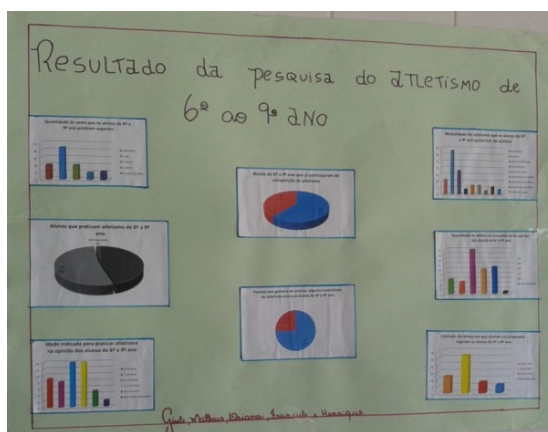


Figure 3: Poster created by students for presenting results⁶.

The teacher reported that after completion she asked students to write about their learning and impressions during the development of the project. The following is an excerpt of her narrative:

I would like to point out that, through the students' texts, I realized the importance of changing the stance of the students. They are often spectators, but in this project, and especially in the final presentation, they were on the front line, showing their knowledge while other students and teachers were on the other side, learning from them. We could see this in the account of a student who said

⁶ Athletics survey results grades 6th to 9th.

she thought it was very cool, learning much more than she knew and presenting it; teaching friends what she knew. They learned a lot from each other. That same student said that she felt she was in a 'privileged position', which is traditionally the teachers'. (Adriana Narrative, May 2017)

Placing students at the center of the learning process is also a characteristic that Adriana developed as a teacher with agency. Other accounts from students indicate that many of them decided to devote more time to sports and have healthier lives. This can be observed in the account of another student: "I, for example, after we did this survey, I was interested in playing sports, I'm sure my health will improve even more, I will be more energized for my day-to-day activities. So, practice sports and be healthy!".

As a result of that project, Adriana achieved her objective:

Students who wanted to participate came to school in the morning to practice, ate lunch at school, and stayed for their classes in the afternoon. Some have excelled in state competitions, as is the case of a student named Jessé who, in 2014, ranked 2nd in the State Pre-Teen category for the Dart Throw and 2nd in the Shot Put. In 2015, he got 3rd place in the statewide School Games at regional level in the state of São Paulo and was the Metropolitan Champion. Athletics training at school and Jesse's performance are among my victories. They are not direct results of this project, but the work we did played a role in planting this little seed... (Adriana Narrative, May 2017)

We must point out the potential of project development in mathematics classes for enabling interdisciplinary work, with mobilization of content from different areas of mathematics and other disciplines (in this case, physical education), and positively impacting the behavior of students. With this project, Adriana allowed students to transform reflections from research and experience into actions such as those reported by the students themselves, who incorporated sports into their lives (D'Ambrosio, 2016).

According to Adriana, her participation in GIFEM significantly contributes to the investigative activities she develops. In the group, when discussing activities, she elaborates, and transforms them into practices that appeal to students, allowing everyone to participate enthusiastically and achieve a positive performance. As a result, she was invigorated and assumed ownership of her classes, which allowed her to depart from the textbook, as she understood that the activities proposed did not consider the context and reality experienced by students. This made her the protagonist of her actions and encouraged her to dare even more.

Not only does the issue of criticality appear in her classes, when she is concerned with putting the student at the center of the learning process, but also when she is available to "open the doors of the classroom", that is, discuss her practice. This is not a common experience among colleagues in this profession, as many teachers are afraid of exposing their weaknesses, as well as being criticized.

Therefore, teacher agency is a fundamental tool for teaching which promotes meaningful learning for students. Teachers are responsible for their own education, seeking to improve their practices because they feel the need to be prepared to serve those they teach and educate. This requires actions that "as well as being intentional and deliberate, are in line with the needs and collective interests of the individuals participating in the activity" (Ninin & Magalhães, 2017, p. 627). Moreover, according to those authors, agency displays a hybrid character, that is, it is simultaneously individual and collective; and collaboration is long-lasting and takes place to preserve identities, articulate and coordinate divergences.

A factor related to the issue of teachers' agency and that is evident in the written narratives is the influence of studying theory onto teaching practices. The confidence that deeper theoretical knowledge provides enables the elaboration of new activities, more appropriate interventions during class discussions and the way teachers further the concepts presented.

Final Considerations

Talking about the concept of agency and the protagonism of teachers leads us to think of a different way to create knowledge, starting from what students think and produce, placing them at the center of the educational process. This way of viewing teaching practice requires teachers to seek new educational perspectives. This process becomes necessary, as, in most cases, teachers feel the need to recreate, to take a stance in view of what they find at schools.

In this context of continuing education, teachers criticize their own practice, looking for training that they consider adequate to provoke effective learning of statistics. It is interesting to point out that the

educational system where this teacher with agency works does not offer continuing education supported by a collaborative perspective.

However, such a perspective seems fundamental, as teacher learning happens all the time, it is continuous, encourages the teacher to always study, exchange ideas among peers, get to know the community where they work and their needs thoroughly. And, without the support of adequate public policies, this only happens when teachers are predisposed, open to learning and contributing to society and create such possibilities through their own means.

It is not enough that teachers have knowledge of the content they are teaching, they also need to have pedagogical knowledge, understand how students learn, what their needs are and consider all of it when planning their classes, elaborating activities and evaluations.

We also emphasize the importance of using technology in schools. It is not possible to teach statistics without the use of calculators and/or software that creates graphs, as shown in the activity described.

The quest for educating critical citizens drives educational practices to assume a commitment of fostering equity, social justice, and human respect.

Acknowledgements

We would like to thank all the participants of GIFEM, who are always willing to listen, exchange ideas and collaborate with each other's learning, especially Adriana.

We would also like to thank *Fundação de Amparo à Pesquisa do Estado de São Paulo* (FAPESP), for the grant which funded the research that gave rise to the present study.

References

- Araújo, E. (2016). Concepções de Educação Estatística a partir de narrativas de professores membros do GT 12... In *Anais do Encontro Brasileiro de Estudantes de Pós-Graduação em Educação Matemática*. Curitiba, Brasil. Recuperado em 18 de agosto de 2019 de http://www.ebrapem2016.ufpr.br/wp-content/uploads/2016/04/GD12_ednei_araujo.pdf.
- Bertaux, D. (2010). *Narrativas de vida: a pesquisa e seus métodos*. Natal: EDUFRN; São Paulo: Paulus.
- Bôas, S. G. V., & Conti, K. C. (2018). Base Nacional Comum Curricular: um olhar para Estatística e Probabilidade nos Anos Iniciais do Ensino Fundamental. *Ensino em Re-Vista*, 25, 984-1003. ISSN: 1983-1730
- Bolívar, A., Segovia, D., & Fernández Cruz, M. (2001). *La investigación biográfico-narrativa en educación. Enfoque y metodología*. Madrid: La Muralla.
- Brasil. (1997). Ministério da Educação. *Parâmetros Curriculares Nacionais (5ª a 8ª séries)*. Brasília: MEC/Secretaria de Educação Básica.
- Brasil. (2018). Ministério da Educação. *Base Nacional Comum Curricular: Educação Infantil e Ensino Fundamental*. Brasília: MEC/Secretaria de Educação Básica.
- Cyrino, M. C. de C. T. (2016). Mathematics Teachers' Professional Identity Development in Communities of Practice: Reifications of Proportional Reasoning Teaching. *Bolema: Boletim de Educação Matemática*, 30(54), 165-187. <https://doi.org/10.1590/1980-4415v30n54a08>
- D'Ambrosio, U. (2016). A educação matemática hoje: porquê e como? Palestra de encerramento do Encontro Nacional de Educação Matemática – ENEM. São Paulo. 2016. Available at: <http://www.sbembrasil.org.br/enem2016/anais/pdf/8490_4451_ID.pdf> [Accessed 13 October 2020].
- Ferrarotti, F. (2014). *História e história de vida: o método biográfico nas Ciências Sociais*. (Carlos E. Galvão, & Maria Passeggi, Trads.). Natal: EDUFRN.
- Fiorentini, D. (2004). Pesquisar práticas colaborativas ou pesquisar colaborativamente? In M. C. Borba, & J. L. Araújo (Orgs.), *Pesquisa qualitativa em educação matemática* (pp. 47-76). Belo Horizonte: Autêntica.
- Freire, P. (1998). *Pedagogia do oprimido* (25a ed.). Rio de Janeiro: Paz e Terra.

- Freire, P. (2018). *Pedagogia do compromisso: América Latina e Educação Popular* (Ana Maria Araújo Freire, Org.). Rio de Janeiro; São Paulo, Brasil: Paz e Terra.
- Garfield, J. & Gal, I. (1999). Teaching and assessing statistical reasoning. In: Stiff, L; Curcio, F. (Org.). *Developing mathematical reasoning in grades K-12*. (pp. 207-219). Reston, VA: National Council Teachers of Mathematics.
- Garfield, J. (2002). *The Challenge of Developing Statistical Reasoning*. *Journal of Statistics Education* 10(3). Available at: <<http://www.amstat.org/publications/jse/v10n3/garfield.html>> [Accessed 13 October 2020].
- Giddens, A. (1979). *Central problems in social theory: action, structure and contradiction in social analysis*. Berkeley: University of California Press.
- Hargreaves, A. (1998). *Os professores em tempos de mudança. O trabalho e a cultura dos professores na Idade Pós-Moderna*. Lisboa: Mc Graw-Hill.
- Lopes, C. E. (2008). O ensino da estatística e da probabilidade na educação básica e a formação dos professores. *Cadernos Cedes*, 28(74), 57-73. Recuperado em 20 de junho de 2020 de <http://www.cedes.unicamp.br>.
- Lopes, C. E. (2010). Os desafios para Educação Estatística no currículo de Matemática. In C. E. Lopes, C. Q. S. Coutinho, & S. A. Almouloud, *Estudos e reflexões em Educação Estatística* (pp. 47-64). Campinas: Mercado de Letras.
- Lopes, C. E., & D'Ambrosio, B. S. (2016). Professional development shaping teacher agency and creative insubordination. *Revista Ciências & Educação*, 22(4), 1085-1095.
- Lopes, C. E., & Grando, R. C. (2019). Teacher's responsible subversion when promoting Statistics education. In T. J. Møller (Ed.), *Teacher development: perspectives, opportunities and challenges* (pp.43-66). New York: Nova Science Publishers.
- Lopes, C. E., & Mendonça, L. O. (2017). *Trilhas investigativas em Educação Estatística narradas por professores que ensinam matemática*. Campinas: Mercado de Letras.

- Lopes, C. E., & Mendonça, L. O. (2018). O percurso de um grupo que se tornou colaborativo. In *Anais eletrônicos do V Simpósio Nacional de Grupos Colaborativos e de Aprendizagem do Professor que Ensina Matemática, IV Jornada de Estudos do GEEM*, Vitória da Conquista, Brasil. Campinas, SP: GALOÁ, 2018. Recuperado em 08 de julho de 2020 de <https://proceedings.science/geem/geem-2018/papers/o-percurso-de-grupo-que-se-tornou-colaborativo>.
- Luehmann, A. L. (2007, September). Identity development as a lens to science teacher preparation. *Science Education*, 91(5), 822 - 839. Recuperado em 25 de maio 2020 de <https://onlinelibrary.wiley.com/doi/epdf/10.1002/sce.20209>.
- Nacarato, A. M. (2018). Uma caminhada pela pesquisa (com)narrativa: a construção colaborativa de um percurso teórico e metodológico por um grupo de pesquisa. In: A. M. Nacarato (org.). *Pesquisas (com)narrativas: A produção de sentidos para experiências discentes e docentes*. São Paulo, SP: Editora Livraria da Física.
- Ninin, M. O. G., & Magalhães, M. C. C. (2017). A linguagem da colaboração crítica no desenvolvimento da agência de professores de ensino médio em serviço. *Alfa Rev. Linguíst.* 61(3), 625-652. ISSN 0002-5216. [Online: <http://dx.doi.org/10.1590/1981-5794-1711-7>].
- Passeggi, M. C., & Cunha, L. M. (2013). Narrativas autobiográficas: a imersão no processo de autoria. In P. P. Vicentini, E. C. Souza, E. C., & M. C. Passeggi, *Pesquisa (auto) biográfica: questões de ensino e formação* (pp.43-57). Curitiba: CRV.
- Passeggi, M. C., & Souza, E. C. de (2017). O movimento (auto)biográfico no Brasil: esboço de suas configurações no campo educacional. *Investigación Cualitativa*, 2(1), 6-26.
- Passos, C. L. B, Nacarato, A. M., Fiorentini, D., Miskulin, R. G. S., Grando, R. C., Gama, R. P., ... Melo, M. V. (2006). Desenvolvimento profissional do professor que ensina Matemática: uma meta-análise de estudos brasileiros. *Quadrante*, 15(1-2), 193-219.
- Rade, L. (1986). La Statistique. In: R. Morris (ed.). *Etudes sur l'enseignement des mathématiques*. Paris: Unesco, vol. 4, pp. 123-134.

Samá, S. (2019). *Caminhos trilhados pelo GT12 nas pesquisas em Educação Estatística no Brasil, no período de 2016 a 2018*. Revista Eletrônica de Educação Matemática, [online] (14), pp.1-18. Available at: <<https://periodicos.ufsc.br/index.php/revemat/article/view/1981-1322.2019.e62755/40938>> [Accessed 13 October 2020].