

STATISTICS EDUCATION IN BRAZILIAN BASIC EDUCATION¹: NEW PERSPECTIVES INDICATED BY THE TEACHING ACTIVITY

EDUCAÇÃO ESTATÍSTICA NA EDUCAÇÃO BÁSICA BRASILEIRA: NOVAS
PERSPECTIVAS INDICADAS PELA ATIVIDADE DE ENSINO

Luzinete de Oliveira Mendonça
Universidade Cruzeiro do Sul, Brazil
luza.oliveira7@gmail.com

Celi Espasandin Lopes
Universidade Cruzeiro do Sul, Universidade de São Paulo, Brazil
celi.espasandin.lopes@gmail.com

ABSTRACT

This article discusses the ongoing education of teachers in collaborative contexts and its influence in the promotion of learning environments in the investigative perspective, for the inclusion of statistics education in elementary education. The objects of analysis are four studies developed by teachers with their basic education students and published in a compilation book. This research is of a bibliographic nature. The analyses indicate the importance of a dialogical and collaborative space where teachers can rely on the pursuit of professional knowledge development for the adoption of a pedagogical practice with which they were previously unfamiliar.

Keywords: Ongoing education of teachers, collaborative context, statistics education, basic education, elementary education

RESUMO

Este artigo discute a formação permanente de professores em contextos colaborativos e sua influência na promoção de ambientes de aprendizagem na perspectiva investigativa, para a inclusão da educação estatística no ensino fundamental. Os objetos de análise são quatro estudos desenvolvidos por professores com seus alunos do ensino fundamental e publicados em um livro de compilação. Esta pesquisa é de natureza bibliográfica. As análises indicam a importância de um espaço dialógico e colaborativo no qual os professores possam contar com o apoio de seus pares na busca do conhecimento profissional para a adoção de uma prática pedagógica com a qual não estavam familiarizados anteriormente.

¹ Basic Education includes the following age groups:
- From 6 to 14 years old - elementary school.
- From 15 to 17 years old - high school.

Palavras-chave: Educação permanente de professores, contexto colaborativo, educação estatística, educação básica, ensino fundamental

1. Introduction

The teaching and the learning processes of basic education students are always present in the current discussions on statistics education. Among other aspects, the adequacy of these processes to the students' needs is questioned. Teacher education is viewed with suspicion in this context and is often considered insufficient in promoting promising learning environments for pupils' education. (P. N. P. Souza, 2013). As a result, there is some consensus on the idea that, for the students' integral development, teacher education must be rethought.

The initial education of mathematics teachers working at this level of education is considered as not having met expectations regarding conceptual, didactic and pedagogical aspects. This situation is even more problematic when it comes to statistics education, since this area is included in the basic education curriculum as part of mathematics, despite the different cognitive and methodological demands of these two fields (Batanero, 2009; Lopes, 1998). Faced with this issue, ongoing education is an indispensable way for teachers to build professional knowledge in these areas.

Several Brazilian researchers have focused on the study of teacher education in collaborative contexts. The results of these investigations point to the understanding that these spaces provide conditions for teachers to engage in a process of action and reflection and to socialize the knowledge they produce in their daily school life. In an educational space of this nature, teachers position themselves as subjects of their own education and producers of practical knowledge (Nacarato, 2011).

The proposition of collaborative groups as conducive spaces to professional teacher development has been defended by several researchers in the field of mathematics education from different perspectives. Fiorentini (2004), for example, understands that a group is collaborative when it is organized according to two fundamental principles: wanting to work with other teachers and longing to be part of a certain group. Hence, being in a group of this nature, participants negotiate the responsibilities to be assumed by each in the project—a task which implies defining in what terms the collaboration will be understood.

This idea has been spreading considerably, as shown by Coelho's (2017) study. The author mapped the understandings about the collaborative group and its potentialities and limits for the mathematics teacher's education. She took research on this subject published from 2001 to 2012 as the corpus of her analysis. The author concluded, from this investigation, that the collaborative group has the potential to promote the teacher's professional development, admitting that this context is relevant to ongoing education.

Mendonça (2015) corroborates this idea based on the undertaking of a systematic study about the reflections and actions of a group of teachers whose focus of study and research is statistics education in basic education. The study highlights the relevance of the collaborative context for supporting the actions of teachers in their contexts of action, as well as for conceptual, pedagogical and procedural issues involving statistics education and its approach from an investigative perspective. It is important to highlight the trust and harmony existing among the participants of the

group, enabling them to share the experiences they had in their professional contexts, as well as their doubts, their difficulties and their frustrations. This circumstance favored the reflection on and the construction of professional knowledge in general and statistics education knowledge in particular.

2. Statistics Education in Basic Education

The current discussions about the inclusion of statistics education in basic education converges to on the idea that the teaching and learning process in this area requires an investigative dynamics with the active participation of students in projects or situations dealing with real issues which are significant for the students. From this perspective, this process is mediated by statistical and probabilistic reasoning, to enable the attribution of meaning to these areas' concepts (Lopes, 1998). Despite this evidence, studies show that working with real data, as well as with investigative activities, is not an easy task for many teachers (Batanero, 2009; Chick & Pierce, 2010). Even with a significant movement in this direction, as observed in the different perspectives of IBME (Inquiry-Based Mathematics Education), few teachers have ventured to adopt pedagogical perspectives of this nature in their professional practice

Inquiry-based education centers on the idea that the teaching and learning process in science must be grounded in thinking, reflection, and experimentation (Artigue & Blomhøj, 2013). This movement covers the methodological frameworks already established in mathematics education, such as: problem solving, didactic situations theory, and realistic mathematics education program as well as a mathematical modeling perspective, an anthropological theory of didactics, and a critical dialogic approach.

Some characteristics are common to all the perspectives that are part of the IBME, for example, research, intervention, student autonomy, and use of real data. However, these aspects' level of priority differs in each of these perspectives. These different ways of seeing the investigative approach allow us to attend to the diversity of contexts and interests present in schools.

Nevertheless, teachers' tensions and insecurities are observed in the development of activities of this nature, as A. M. P. Oliveira (2010) observes to be the case with mathematical modeling. These situations may be related to the institutional and social barriers that hinder the insertion of investigative approaches in the daily practice of schools, as observed by Mendonça (2015). However, of course, they are also influenced by the initial teacher education, which, to a significant extent, is based on technical rationality. In this conception, the teacher is seen as a specialist technician who uses the rigorous application of scientific theories and techniques to solve practical problems. This view does not converge with an investigative perspective, which deters its adoption as a professional practice.

Based on these premises, we indicate the need for teachers to have opportunities to know, act, and reflect on teaching and learning methodologies which privilege the use of authentic research situations. We also highlight, specifically, the convergence of this way of conceiving the teaching and learning process with statistics education, considering the contextual and interdisciplinary character that approximates them.

Mendonça (2015) considers that adopting a pedagogical practice in the investigative perspective can help teachers mobilize their professional knowledge

involving concepts related to this field and its insertion in the classroom, especially if they take their practice as a locus of reflection and action. Some current research has sought to observe how these dynamics impacts the professional development of teachers (A. C. Souza, 2013, D. Oliveira, 2013, Estevam, 2015, L. O. Souza, 2013, and Mendonça, 2015).

3. Methodology

This work is constituted as what Fonseca (2002) calls a bibliographic research. Therefore, this is a documentary research based on the analysis of and the reflection on a collection of theoretical data and references which were already analyzed and published by written and electronic means such as books, scientific articles, website pages.

Our object of analysis is several theoretical productions by four teachers who participated in a study and research group. These participants' practice was observed during the construction of Mendonça's (2015) research data. The process of analysis was centered on an in-depth and exhaustive study of the texts elaborated by the teachers regarding the professional experiences developed in their participation in Gifem², a study and research group focusing on statistics education.

We sought for evidence, in this corpus, of how teachers manifest and apply, in their professional contexts, the knowledge developed in the collaborative group for the insertion of statistics education in education. This reflection can contribute to the discussion on teacher education in general and on statistics education in particular.

4. The Data Collection Context

This article, as previously noted, analyzes the work of four teachers who participated in the Gifem. This group was built with the voluntary participation of teachers of the municipal education network of Valinhos, in the countryside of the state of São Paulo, in 2012. The group was created aiming to study the integration of statistics education in elementary education. In 2013, the focus of action and reflection of the group was an investigative perspective for the approach of statistics education, namely, mathematical modeling. These dynamics were formulated into the data for the doctoral research of one of the participants, Mendonça (2015).

In Lopes and Mendonça (2018) there is an extensive discussion about the trajectory of Gifem and the evidence of its constitution in a group of collaborative nature. In the present analysis, we can confirm such evidence based on the actions and reflections present in the teachers' narratives, as well as from their own publications.

The collaborative aspect of the group was a decisive factor enabling teachers to face the challenge of planning and implementing pedagogical actions from the point of view of mathematical modeling, although the education of all the participants had until then been based on the traditional perspective. This perception was made explicit in

² *Gifem* stands for *Grupo de Pesquisa e Formação em Educação Matemática* [Education and Research Group in Mathematics Education].

Mendonça (2015), however, in the present work, we seek to collect information that confirms this result, based on the narratives of the teachers themselves.

During the first semester of 2013, Gifem participating teachers experienced some activities which literature considers pertinent for the adoption of mathematical modeling as a pedagogical perspective in mathematics classes (Barbosa, 2001, 2004; Bassanezi, 2004). These activities were:

- Experience in activity modeling as students.
- Analysis of ready-made models.
- Evaluation and reflection on modeling activities published in periodicals and congresses (teaching cases).
- Planning activities to be done with their students, sharing them later with the group.
- Interventions in the classroom, followed by group discussions.

These activities were experienced by teachers during a semester, in weekly three-hour meetings, and were the object of reflection in several scientific publications (Mendonça, 2015, Mendonça & Lopes, 2015, Mendonça & Lopes, 2017a, 2017b).

We can verify that the involvement of teachers in the activities of planning and intervention in the classroom was relevant to them, since the results of these activities were discussed by the teachers in events and journals in the area of mathematics education (Toledo, 2015, 2017, Augusto, 2017, Socha, 2017, Scarlassari, 2017). Thus, the teachers were inserted in the field of research, sharing and discussing their professional knowledge. Lopes and Mendonça (2017) present some of these teachers' reports describing their classroom experiences with their students. These are the texts we analyze in this paper. It is possible to observe in them the point of view of each teacher in relation to the pedagogical practice undertaken for the implementation of statistics education with investigative perspectives, be it in the form of projects or in more structured activities.

The activities narrated by the teachers in the texts analyzed herein apply the teaching of statistics to short- and medium-term projects, during which students were invited to act and become protagonists in investigations on topics relevant to them. During this process, students' difficulties and discoveries served as support for new reflections and actions resulting from the intentional intervention of the teacher, who sought to provide conditions which favor students' learning and involvement in problem solving.

The dynamics of such lessons come from an interest in acquiring deeper knowledge about a topic, which requires students to search for data, to develop action strategies, and to establish relationships between data through concepts, techniques, and theory procedures in an ongoing process of reflection and action. This way of seeking understandings on a theme resembles the scientific activity, which, in this case, is guided by the reasoning and by the statistical and probabilistic thoughts arising from the teachers' intervention.

Working in this perspective was a challenge for the teachers. The study and research group, then, became a stage for discussion and reflection and gave theoretical and methodological support for this enterprise.

In the following section, we present brief descriptions of the teachers' reports on the activities developed in the context of their classrooms, based on the experiences of

the study and research group on the approach of statistics education in the perspective of mathematical modeling. Each summary will be referenced so that the reader can consult the work in full for a more comprehensive knowledge about these works.

5. Summaries of the Teachers' Narratives in the Works Analyzed

Teacher Adriana reports the development of a project carried out with a ninth-grade class to study the theme "athletics". She considers that, in this process, students went through all the stages of statistical practice, using both already consolidated knowledge and new knowledge built from the research needs. In this context, measures of central tendency, graphical representations, and calculation procedures acquired meaning for the students, since they provided elements for pupils' decision making during the investigative process, from which conclusions were drawn based on the data collected. Adriana considers that communicating the results of the experiment was a means of valuing, on the one hand, statistics as the science of data analysis and, on the other hand, the capacity of each student to build statistical knowledge. Moreover, for her, this activity favored the development of statistical literacy in a singular way (Augusto, 2017). The author also notes other benefits generated by the development of this activity : "With this project, my students and I became even closer as our classes became more 'open', 'lighter', and there was room for dialogue, everything was not standardized, we were building something together and that changed our relationship"³ (Augusto, 2017, p. 37).

It was from the context of football, a subject particularly relevant to his students, that teacher Rogério developed an investigative activity with a group of eighth-grade students. In his report, the teacher presents the trajectory of this group of students during the investigation of probabilistic (subjective probability) and frequentist ideas based on a common situation in this sport, the penalty kick. He considers that the investigation has started from the following question: "Are penalty kicks a matter of luck?".

Students were asked to investigate the subject, to make conjectures, to experiment with a simulation, and to reflect on the produced results. In this process, the idea of a priori probability (guessing) was scrutinized and was verified based on the evidences observed in a process of experimentation for the data collection, organization, and analysis. The social and cooperative aspect of this activity was highlighted by the teacher as an important contribution to the development of the work: "Making use of the school's other environments and of strategies which are different from the traditional ones stimulates more interaction between the students and between them and the teacher and motivates teamwork cooperation among all" (Socha, 2017, p. 60).

Teacher Sezília described, in her report, the involvement of her fifth-grade students in the development of a statistical research project in a public school. The collectively chosen theme was "games". The objective of the research was to find out the favorite game of the school's fifth-grade students (a group of four classes). The children participated in the entire process of statistical research, from elaborating the questions to forming a questionnaire, from data collection, organization and analysis of

³ In this paper, we have translated the quotations from Portuguese into English.

the to the communication of the results. In this process, some ideas, procedures, and graphical representations were used for the organization and description of the data. From this data, conclusions were drawn and later shared at an event organized by the municipal network.

The report shows that teacher Sezília created the conditions for the students to elaborate specific reasonings for each situation that arose. She also stimulated the search for action strategies and for the use of procedures, without, however, directing the students excessively, as can be observed in Toledo (2017). Among several benefits that the work has brought to the students, the teacher pinpoints the knowledge students acquired about the importance of writing and about collaboration:

The knowledge that became most visible in the final reflections of children is the social function of writing. Students have recognized that it is necessary to write clearly when others will read. They also became aware that listening to and respecting each other's opinions lead to making new friends. Another contribution of the project involved the discipline of the room, considered as difficult. The research counted with the participation of all, generated a collaborative group, among many other learnings. (Toledo, 2017, p, 126).

This report indicates the incorporation of the idea of collaboration as an important factor in the process of teaching and learning.

As her report evidences, it was particularly important for teacher Nathália the fact that, during the investigative process, the project led students to the level of graphic interpretation, with a critical look at the use of these representations and the ability to connect the information present in the graph with the context. Moreover, for her, the possibility of establishing initial hypotheses and of confirming or refuting them at the end of the investigation was a key factor for students to understand the random nature of the phenomena with which statistics deals. According to her, this understanding became evident when students found, in their investigations, results that contradicted their initial ideas about people's behavior. This type of reflection is favored by the application of the investigative process as a whole. We can observe, in the following passage, the teacher's impression of the relevance of the work for the students: "Overall, the work was very significant. The students performed an activity involving mathematics and statistics which was very different from the practices they were accustomed with. Because of this, they learned concepts and developed strategies of group work" (Scarlassari, 2017, p, 82).

The contents of these narratives show the relevance attributed by the teachers to the work developed in their contexts of professional activity based on the experiences had in the study and research group. They also allow us to observe evidences of individuals assuming the role of producers of professional knowledge.

6. A Brief Discussion on the Teachers' Reports

Regarding the approach to statistics education based on mathematical modeling, the reports show teachers' enthusiasm and satisfaction with the work done. On the topic of students' learning, there is a unanimous idea that the applied pedagogical approach

was accepted by the students and that it produced the attribution of meanings to the statistical and probabilistic ideas that the projects had as their focus of study.

In relation to the study and research group support, this research makes it possible to notice the teachers' perception about the importance of this space for the development of projects. All reports indicate the importance of peer discussions in the collaborative group to support their actions in their professional contexts. This is due to this group becoming a stage for critical discussions about the experienced practices and about the conceptual, pedagogical, and didactic issues that arose during the planning and from the analysis of the records produced by the students during the investigations. This way, the sharing of the experiences each teacher had in their professional contexts contributed to the reflections and actions of all the participants.

This understanding is presented, both directly and indirectly, in the various works analyzed, as observed in Scarlassari's (2017) account:

Gifem was responsible for the success of this activity. In our meetings, I was instigated to do an innovative work in the classroom. I was able to talk to the members of the group, who gave me several suggestions on how to develop the task, as well as on reading material to better understand the students' learning process. (p.84)

The encouragement of the group to undertake changes in pedagogical practice was also highlighted by Toledo (2017):

The biggest incentive for the activity was my participation in Gifem, a group of which I am a member since 2013. This group conducts studies, research works and projects focused not only on mathematics and statistics, but also on interdisciplinarity issues. (p.111)

In each case reported, we find evidences of teacher learning related to the subjects of the studies and the discussions carried out in Gifem's context. They report, for example that their students experienced the whole process of statistical research: starting from the elaboration of a questionnaire or from an experimentation; going through the collection, organization, and analysis of data; and, finally, communicating the results. We have, therefore, an indication of the value of working from the investigative perspective when approaching statistics education, an idea widely discussed and stimulated in the education space provided by Gifem. We can observe that the study and research group constituted a meaningful form of teacher learning, thus providing professional development.

7. Final Considerations

The reports analyzed and the discussions held demonstrate that investigative environments favored the implementation of statistics education and motivated both students and teachers. It is possible to observe a deeper understanding, by the teachers, about teaching and learning regarding statistics education. This can be seen, for example, in the unanimity of participants' understandings about the relevance of providing a learning environment that favors a broad, deep, and autonomous education for the students and of a strategic pedagogical intervention that allows these students to develop their skills related to oral expression, to questioning themselves, to relishing the sense of discovery, and to becoming involved as active subjects in the learning process.

The participation in the study group, moreover, was a crucial factor for the implementation of these projects by the teachers, since they engaged in the development of activities from a pedagogical perspective which had not yet been used in their previous professional practices. The participating teachers recognized that a teaching context with these characteristics favors the implementation of statistics education, an area that uses research as the means to build knowledge about phenomena that cannot be predicted a priori, requiring a systematic treatment in the analysis process. This is important considering that, despite the evidence of the relevance of the investigative practice for the approach to statistics education in basic education, as well as in initial and ongoing teacher education, it has not been given its due importance (Mendonça, 2015).

In this work, the need to provide a collaborative learning environment is emphasized, considering that this space can foster confidence and security so that teachers can exchange experiences, ask questions, and feel encouraged to face the challenges of their profession. This is especially true in cases where the focus is on adopting a form of pedagogical action that requires a radical change in teachers' and students' roles, as has also been observed here.

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