TEACHING KNOWLEDGE IN THE CONTEXT OF A PRACTICE DEVELOPED UNDER THE INTERDISCIPLINARY BIAS: STATISTICS IN FOCUS

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This text aims to analyze the teacher knowledge mobilized in the context of an interdisciplinary practice that approached statistical, Portuguese, and English language concepts and that was socialized in a teachers' collaborative group. The teacher's practice was carried out with Brazilian students in the final years of elementary school. In our results, we highlight the mobilization of statistical, contextual, and horizontal curricular knowledge that is fundamental to the construction of a learning environment. Therefore, statistical training for all teachers is recommended because statistics provides an opportunity and context for interdisciplinary and collaborative practices. For this to happen, however, the teacher must have professional knowledge in the area of statistics to contribute to the learning process and to overcome the fragmentation of teaching.

INTRODUCTION

This study aims to understand the teaching knowledge mobilized in the context of an interdisciplinary practice carried out with students enrolled in a municipal school of basic education in a city in the extreme south of Brazil. The practice articulates concepts of statistics as well as Portuguese and English language concepts. This case study analyzed the narrative shared by one of the teachers responsible for the teaching activity during one of the meetings of a collaborative group.

Although there is no consensus on the conceptualization of such an interdisciplinary practice, we use the work of Fazenda (2011) to theoretically frame the work. Interdisciplinary practice can be thought about as a process in which there is reciprocity in exchanges and dialogue and integration among the different disciplinary areas that make up the curriculum when seeking to promote mutual learning and the creation of a collaborative work environment. Teaching guided by interdisciplinarity can contribute to the training of students in statistics because such a proposal "provokes students' interest in the subjects studied in other school subjects at the same time that these subjects facilitate the understanding of statistical concepts," so there is "a feedback learning between concepts from other disciplines and statistical concepts" (Pagan & Magina, 2011, p. 736).

Shulman (1986, 1987) provides theoretical support to investigate teacher knowledge in the context of statistics education, which in this case can be seen as an axis integrator between the different areas involved in the socialized activity. Studies investigating the understanding and professional development of teachers became prevalent in the 1990s after Shulman's work was published and as researchers sought to determine basic knowledge categories associated with successful teaching (Watson et al., 2008) that aims to promote student learning (Shulman, 1987). In general, the important knowledge base for teachers is a "body of understandings, knowledge, skills and dispositions that are necessary for the teacher to be able to provide teaching and learning processes, in different areas of knowledge, levels, contexts and teaching modalities" (Mizukami, 2004, p. 38). Studies that aim to analyze the practical experiences of teachers and systematize conceptual categories of knowledge and teaching skills have contributed, in particular, to inform and guide the pedagogical process. Considerable work has been completed in the context of statistics education (Burgess, 2011; Godino et al., 2011; Groth, 2007; Ponte, 2011; Schreiber & Porciúncula, 2021), but more studies are still needed to investigate how teachers' understandings and professional skills are produced and how they influence the teachers' practices when approaching concepts related to statistics and from the perspective of interdisciplinary education.

After analyzing the practices of beginning and experienced teachers, Shulman (1987) named seven categories of teacher knowledge: (a) content knowledge; (b) general pedagogical knowledge; (c) curriculum knowledge; (d) pedagogical content knowledge (PCK); (e) knowledge of learners and their characteristics; (f) knowledge of educational contexts; and (g) knowledge of educational ends, purposes, and values, and their philosophical and historical grounds. Among these, the relevance of PCK stands out. Shulman defined PCK as the "blending of content and pedagogy into understanding

of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8).

The purpose of this study, as part of a broader project to investigate student and teacher training in the context of statistics education, is to contribute to the systematization of specific professional knowledge for the teaching of statistics. This field of knowledge remains largely unexplored and yet is relevant for the development of teachers and students in this field. To contribute to the research in this area, we analyze teacher knowledge from the verbal records produced by the Collaborative Group for Teacher Training in Statistical Education (MoSaiCo Edu Group). This group stands out for providing a context of teacher education from a collaborative perspective (Fiorentini, 2004). Therefore, we next describe the methodology used in this investigation and then present and discuss the results as well as considerations about the scientific findings highlighted in this research.

METHODOLOGY

The investigation was developed from a qualitative perspective of a descriptive and analytical nature (Bogdan & Biklen, 1994). We sought to answer the question: What teacher knowledge was mobilized in the context of an interdisciplinary practice (concepts of statistics, English, and Portuguese)? Because we did not seek to generalize the results but rather to contribute to theory, qualitative methods were appropriate for the present investigation.

Between September 04, 2020 and December 07, 2021, teachers who worked in municipal schools of basic education (in the areas of mathematics, Portuguese language, history, and pedagogy) and undergraduate and graduate students from different areas of knowledge (members of the Innovation Center of Statistics Education) met every two weeks as part of the MoSaiCo Edu Group to share personal and professional experiences in statistics education. To achieve the objective of this investigation, we analyzed the transcript of an online meeting of the MoSaiCo Edu Group that took place on March 25, 2021 and lasted approximately one and a half hours (from 7:30 PM to 9:00 PM). This meeting was part of a Project developed by the Multimedia Statistical Literacy Program (LeME), in partnership with the Carlos Chagas Foundation, the Municipal Secretary of Education, and two municipal public schools of Rio Grande, Brazil.

In the March 25 group meetings, one of the teachers, a Portuguese language teacher narrated her pedagogical experience with a lesson called "promoting gender equality." The lesson involved discussions about the space of women in different contexts of society and was carried out with students enrolled in the final years of elementary school. The lesson integrated elementary mathematics and statistics (descriptive statistical measures, percentages, and graphic and tabular representations), Portuguese, and English content through the production and dissemination of texts (in a digital magazine) of different textual genres, with this interdisciplinary integration being the focus of analysis of this text.

We analyzed the transcription of the MoSaiCo Edu Group's meeting by selecting clippings from the Portuguese language teacher that were related to statistics, including excerpts that mentioned "statistics," "graphs," or similar expressions and included the context in which these words were included. This selection was necessary for us to maintain the focus of the present research. The analysis occurred in stages: (a) reading the transcript from the MoSaiCo Edu Group meeting; (b) selecting excerpts from the teacher's narrative that were related to statistics; and (c) identifying the teacher knowledge that anchored the selected transcript excerpts. For this, we consider teacher knowledge as proposed by Shulman (1986, 1987) as our theoretical reference. We highlight that, in general, the meeting was dedicated to the narrative of this educator, who described the developed activity in detail. Thus, the excerpts focused on aspects of her practice and her reflections on the statistics in the lesson and the role of statistics in discussions. In this meeting, other participants shared their understandings, questions, and contributions to the narrated activity, but these statements were analyzed as part of a separate study.

RESULTS AND DISCUSSIONS

Statistics concepts are used to communicate information in books, magazines, an, newspapers and thus are part of the school curriculum (Batanero, 2001; Cazorla & Castro, 2008). The activity discussed here was based on information published in the media that included statistics, as described and shared by the teacher: "I worked with textual genres"; "always asking myself, where does

statistics enter in these spaces?"; "[...] The work of the English language area, which the professor also worked with graphs about to violence against women."

> I noticed that the texts that I took to the students that statistics were in the report, were in advertising, were in the autobiography, were in the news, appeared in the cinema, appeared in large volume like this in the opinion article. As the objective was to develop the argumentative skill, within these texts statistics worked, as an argument, mainly in the report text and the opinion article. (Transcript clippings)

In these transcript excerpts, one can evidence the teacher's recognition of the importance of statistical concepts as a way of stimulating argumentation when students worked with different textual genres. In addition to specific understandings associated with writing and textual interpretation of the Portuguese language, this pedagogical proposal led to the mobilization of knowledge underlying statistical concepts and associated mathematical issues. These skills are necessary to discuss the percentages, graphs, tables, and statistical data normally included in these texts (reports, opinion articles, etc.). Implementation of such activities characterize an interdisciplinary practice in which statistics presents itself as a catalyst for the non-compartmentalized formation of students' knowledge.

The teacher's narrative allows us to understand that statistics training is necessary for teachers regardless of their area of professional activity (Pagan & Magina, 2011) because, for example, a number of sciences use these concepts and procedures in addition to mathematics. This situation corroborates Batanero's (2001) expressed concern about how topics and subjects associated with notions of statistics can be addressed in other curricular areas, something that is inevitable due to the interdisciplinary nature of statistics. Teachers not trained in mathematics might present conflicting definitions and properties of statistical concepts that would normally be addressed by mathematics teachers.

The teacher's dialogue makes it possible to extrapolate the teachers' development of skills related to statistical literacy, because in addition to professional attributions and knowledge, the lesson's development and enactment requires knowledge of a citizen immersed in a society full of information. It is expected that this teacher understands statistical concepts and can critically analyze textual, graphic, and tabular information, considering problem solving and decision making in addition to arguing about the quality and reliability of these data. Such competence also requires mastery of certain mathematical procedures (Gal, 2002) generally developed during basic education or complemented in initial and continuing teacher training.

Against this background, we can agree with Cazorla and Castro (2008) who point out the importance of statistical literacy for the formation of citizens because this information is inserted in everyday life, such as speeches, advertisements, texts, and news. Such information brings ideas of scientificity, exemption, and neutrality that are sometimes questioned rarely by ordinary citizens. Thus, as explained in the excerpt from the teacher's narrative, "a reading experience will not be complete without understanding the logic of mathematical and statistical information," because these discourses can contain 'traps' or be misinterpreted if there is no basic knowledge of statistics (Cazorla & Castro, 2008, p. 47). In the educational process in the classroom, when the teacher presents "failures" or difficulties related to statistics, the teacher may miss learning opportunities during pedagogical interactions, especially in moments that demand the evaluation of students' statements or doubts (Burgess, 2011).

Although it is not possible to assess the teachers' capacities related to statistical literacy from the clippings of this teacher's narrative, the excerpts make clear the presence of statistical and mathematical notions as well as the associated context, which enabled the teacher to approach this information in the classroom. As proposed in the activity, making students aware of issues related to women necessitates mobilizing professional understandings (Shulman, 1986, 1987) about: (a) content and pedagogical strategies (Portuguese/English, statistics and, mathematics) in the teacher's ability to identify and use statistical information to teach textual genres; (b) curriculum (interdisciplinary work) in the teacher's ability to teach different areas in an integrative activity; and (c) context in the teacher's ability to facilitate an activity with the theme of "women" and the understandings/reality of the students in this context.

The pedagogical activity, which involved the theme of "gender equality," was also related to the experiences of the students themselves and discussions about the space of women in society. This situation was described by the teacher: "they realized, through research ... the problem of differences,

of inequalities, in the participation of women in the relationship as a whole, it is much smaller, by the statistical data, by the graphs that they searched"; "the research was done by counting, by assembling the graphs about the representation there, of women in politics, in the intention of the municipalities, there is the research about the IBGE (Brazilian Institute of Geography and Statistics) data, and, also, the life experience itself" (Transcript clippings).

This part of the teacher's narrative reveals a mobilization of not only the teacher's statistical knowledge but also contextual knowledge (Shulman, 1986, 1987), especially on issues related to "women" and students' everyday experiences. In addition, mastery of statistical concepts enabled the teacher to identify the concepts in the texts studied (textual genres) and in discussing information entered in the IBGE database. We highlight the necessary domain over the statistical content and the importance of understanding the context, which provides meaning for data analysis (Cobb & Moore, 1997). In this situation, the context provides support so that the teacher can use other professional knowledge to design and implement the lesson within this particular classroom, school. and community space.

Interdisciplinary practices also demand curricular knowledge of horizontal scope, that is, the teacher's familiarity with the contents of other subjects in the curriculum for the same educational period (Shulman, 1986). In the case of this activity, curricular knowledge was required for the areas of Portuguese, English, and statistics, which can be exemplified through the teacher's narrative: "I heard the mathematics teacher that she was working on graphics, and I said 'ah, I'm going to take advantage of her working and I'm going to use this resource.' So, when I asked them to build the graphics, they already had an idea of how it works" (Transcript clippings).

For Pagan (2009), interdisciplinary practices can contribute to the statistical training of students because students will show greater interest and curiosity for the main subject while experiencing gains in learning and development of a broader vision of the role of statistics for the critical citizenship. Integrating concepts of statistics into an activity of Portuguese and English, which then are worked on in mathematics classes, can contribute to dialogue among teachers from the different areas in an interdisciplinary work perspective. Such interdisciplinary work responds to current societal demands while helping to overcome the fragmented structuring of the curriculum. In this way, due to its interdisciplinary nature, statistics presents itself as a catalytic element of an interdisciplinarity process in educational spaces such as elementary schools, if teachers can work together and recognize concepts and skills from other areas of the curriculum.

CONCLUSION

In this paper, evidence of the mobilization of teaching knowledge (Shulman, 1986, 1987) was described and analyzed in the context of a practice developed under an interdisciplinary perspective, which involved the areas of Portuguese, English and, statistics. The discussions resulting from the results presented made it possible to understand the specificities associated with the potential of statistics as a link of interdisciplinarity.

As scientific findings, there is an explanation of the knowledge of the statistics content needed to promote students' learning of students in statistics, a circumstance that does not depend on a particular content area of training and professional teaching practice in light of the interdisciplinary character of statistics. Furthermore, one can describe the mobilization of contextual knowledge and curriculum knowledge that are fundamental for carrying out associated practices that involve the discussion and integration between statistical information and other curricular components.

In addition to students graduating with degrees in mathematics and pedagogy, future teachers from varied disciplinary fields require statistical training to carry out interdisciplinary and collaborative practices and to consider contextual issues in the pedagogical process. With this understanding, therefore, the potential for learning to teach statistics is highlighted from the perspective of interdisciplinarity and integration between the different disciplines of the school curriculum. Teachers need a minimum set of professional knowledge inherent to their major area of study, but even though statistics has been mobilized in basic education, teachers still need some statistics training that might also come about through continuous collaborative interdisciplinary training. Such training can contribute to students' learning and help to overcome the fragmented nature of education.

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