ANALYSIS OF THE CONCEPTIONS OF TEACHERS ENGAGED IN STATISTICAL LEARNING PROJECTS

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Teachers' conceptions about teaching and learning guide their beliefs, knowledge, and attitudes that impact their understanding of the proposed curriculum. Studying their origins, functions, and changes makes it possible to rethink teaching practices more effectively, to answer: (a) what conceptions do teachers mobilise when managing and developing a statistical learning project from the perspective of exploratory data analysis? (b) what changes in conceptions might result from this experience? We structured a case study with recordings of six elementary Brazilian school teachers, members of a collaborative group of continuing education, analysed with the technological support of the NVIVO software. The data were collected in a focus group after teachers' experience in development of learning projects. We identify changes between the teachers' conceptions of statistics that allows us to suggest that the learning project can favor changes their statistical conceptions, which, in the light of our theoretical framework, are signs of learning.

INTRODUCTION

The homologation of the definitive version of the National Common Curricular Base, henceforth named simply BNCC (Brasil, 2018), has unchained curricular changes in all the Brazilian learning systems, more specifically in Probability and Statistics thematic unit. One of the news was the explicit orientation to the development of statistical research with real data, collected by students themselves, from the 1st year of Elementary School (6 years old) until the end of High School (17 years old), not as a learning strategy, but as an object of knowledge. To contemplate this proposition, the teacher could make use of active methodologies, some of which are well acquainted not only by the teaching staff but all the researchers: the Project Based Learning (PBL), the Problem Based Learning and Mathematical Modeling. In this way, still in the end of 2021, we collected data from in a proposal of continued collaborative training of six teachers of Basic Education in three public Brazilian schools, of different curricular components, with promoting the Statistical Multimedia Learning through PBL in mind. The weekly meeting happened in the second semester of that year with this group, such as the recording of a focal group which took place in December 2021 after the showing of the results of the statistical research made by the students of these school units, were material of our analysis. We look into identifying the teaching conceptions mobilized in the implementation and statistical project learning development, such as eventual changes in their conceptions. We tried to answer: (a) what conceptions do teachers mobilise when managing and developing a statistical learning project from the perspective of exploratory data analysis? (b) what changes in conceptions might result from this experience?

In the next section, our methodological proceedings will be presented.

METHOD

This is qualitative research, under the perspective of Creswell & Creswell (2021), a case study type, according to Yin (2015). The data were collected during the second half of 2021, under the emergency remote learning, with six teachers of Portuguese, Science, Geography, Math, History and Pedagogy, teaching a 2nd grade group (7 years old) and two groups from the 7th and 8th grades (12-13 years old) from Elementary school in three Brazilian public schools. These teachers initiated a PBL project in their classrooms and they claimed to be their first experience with statistical projects. They were invited to take part of a statistical literacy multimedia learning group, created ten years ago by researchers from a local federal university. In 2021, this program was financially and strategically sponsored by two Brazilian research funding institutions: Carlos Chagas Foundation and Itaú Social Institute, whose main goal is the promotion of social transformation through playful and contextualized pedagogical practices. Its main goal is to promote statistical learning among students from Elementary grades, being assisted by digital information and communication technology, enabling them more capable of reading in a more autonomous and critical way the statistical

information shown throughout several types of media, especially in times filled with fake news. Our source of information used in this study consists of audiovisual recordings of weekly meetings which took place in the second half of 2021, with the presence of researchers and teachers in a collaborative group, via Google Meet. The meetings of this collaborative group have been held for years in this project, with a high member turnover, due to the fact that researchers, except the group leader, conclude their own graduation, masters and doctors' studies and therefore must leave the program. Besides, the active schools change every year, because the central idea is that the teachers support the PBL methodology and act as a multiplier in their respective schools. In such a manner, other schools can be catered for. A particular factor in these last two years was social distancing, allowing meetings to be held in videoconferences platforms, such as Google Meet. Another important adaptation was the one which provided the second source of material to be analyzed: two mentoring groups on WhatsApp, with researchers, teachers and students. Simultaneously happening with these mentoring programs, periodical meetings were held in those two schools in which the final grades of Secondary school are taught, also by Google Meet, weekly in one school and twice a week in another. Our last material source for analysis consisted of the recordings of a focal group, done at the end of the project in the first quarter of December. Within it, teachers and everyone involved answered ten questions about the development and management of the statistical learning project: 1. How did you feel throughout the project? Tell us briefly how the development was made (challenges, hits, adaptations) 2. Did you observe interdisciplinary aspects during the development of the statistical learning project? Were there any relations to Math, Portuguese, History, Geography, Arts, Religion, Physical Education or any other subjects? 3. In your opinion, how did the students feel? Was it a playful experience for them? 4. Regarding the experiences lived in the collaborative group, which teaching knowledge do you consider having been used and/or produced in the process? 5. Which elements of knowledge do you consider in need of development, regarding its continuity of the PAE project in the school, in other moments? 6. Which statistical abilities do you think students developed? After all this time reading, participating in workshops, dynamics and sharing experiences, can you tell if it was possible to build a statistical knowledge (requirements)? 7. Were the theme choices made by students themselves enabling them to bring teenage and youth culture closer to school culture? Within these themes, was there a deepening in learning and constructing students' autonomy/protagonism? 8. What has changed in your own way of seeing Statistics after your collaborative experience? 9. Do you believe that project-based learning can contribute positively in optimizing time and resources, even in articulating different subjects? 10. If you were to start this research now, taking the interdisciplinary experience into account, what type of partnership would you look for, in terms of subjects and co-workers? Would you look for an outside partnership? The session in which these answers were taken lasted for about two hours and was made with the presence of the researchers from the federal university who originally proposed continuous training, just as the statistical learning project implementation and development.

In the next section, our main theoretical references will be presented.

THEORETICAL BACKGROUND

The term conception is polysemic, often times associated with ideas and beliefs. It was applied in this sense, for example, by Azcárate (1996) in a study about teacher training and professional knowledge. This author implied that one's ideas, beliefs and knowledge directly affect their comprehension regarding the proposed curriculum, becoming fundamental agents of their teaching practices. In many researches, the idea of present conception is of a local construct associated with knowledge and the different problems to which it's applied, as observed by Artigue (1989), making evident the intrinsic nature of teaching and student practices in learning situations. The recognition of a conception highlights the plurality of perspectives on a determined Mathematical object, of representations and ways to deal with it altogether, adaptation and tooling adequacy and strategies used in problem solving emerging from Mathematical activities. Such knowledge contributes, yet, to demystify a supposedly transparency in learning communication, common in empiricist models of teaching and learning, particularizing the relationship in the teacher-student-learn triad. Many conceptions are mobilized in the cognitive processes which conducted to building a certain knowledge. Knowledge, on one hand, is articulated in concept elaboration. The resolution of a Mathematical problem, on the other hand, involves a large sorting of conceptions, knowledge and

concepts, according to Balacheff (2001, 2002). Artigue (1989) affirms that a conception assumes a local character in the interaction between the subject and the problem at hand. The multiplicity of possible conceptions in a local and personal scope and it still takes on importance to the researcher, in the sense which it is representative of an educational context, common to other students and teachers. What interest this researcher the most is not the theoretical comprehension of a possible hypothetical genetical structure, but the identification of local conceptions which manifest themselves in a situation of analyzing the condition of passing from a certain local conception to another. According to the Theory of Conceptions (Balacheff, 1995, 2001, 2002; Balacheff & Gaudin, 2002; Balacheff & Margolinas, 2005) it is the changing in conceptions where the cognitive gain can be seen, the learning. Artigue (1991, 1993, 1994) returns to the discussion about the importance of understanding better the conceptions, for students and teachers, for they are determinant in the learning and teaching processes. The conceptions work as lenses, which make every learning experience unique, but studying their origins, their functions and, above all, their transformation in learning contexts, it's possible to rethink the teaching practices in a effective way. Balacheff and Gaudin (2002) highlight that the knowledge must not be reduced to behavior, but it can't be taught in their absence. In the teaching and learning processes, each action mobilizes a great amount of knowledge and, in order to develop new pieces of knowledge or deepen previous ones, the mobilization of conceptions associated with the problem faced makes itself needed.

In the statistical learning and teaching, we assume the theoretical mark of the Exploratory Data Analysis (EDA) and its proximity to the PBL methodology, for it values the critical investigative posture. Batanero, Estepa and Godino (1991) highlight its potentiality to create learning situations about students' interests themes, basing in graphical representations which favor the variability perception, the evaluation of order measures which minimizes the unusual cases, the use of different scales and the lack of necessity of a complex Mathematical theory, with unnecessary tools for the field learning stage. In this research, our interest lies mainly in the development of statistical projects, and the role played by their teachers, in the EDA perspective. According to Batanero and Díaz (2011), the statistical projects motivate them, differing from the simple resolution of long lists of repetitive and decontextualized exercises. For these authors, the Statistic is the data science, and these aren't just numbers, but numbers in a context. According to them, working with projects, the emphasis is on realistic situations. Batanero and Díaz (2011) say that the project development contributes to the acquisition of the following abilities, fundamental to students, as: communicative linguistic competence, mathematical competence, the competence for recognizing and interacting with the physical word, the competence for dealing with information, digital competence, social competence to exercise their citizenship, "learning to learn" competence, critical questioning competence and the competence for achieving autonomy and personal initiative. Such competences are needed for the development of cognitive and attitudinal components of statistical literacy. The development of statistical learning project makes the exploration of statistical knowledge possible, in significative contexts for the students, such as techniques and strategies of great relevancy for the formation of a critical citizen, in a richer and more complex approach than the one offered by the educational books. Batanero and Díaz (2011) highlight the differences between knowing and the power to apply the knowledge. Applying them is usually much harder than it seems because not only does it require the technical-procedural knowledge (such as preparing a graphic or calculating an average), but also strategic knowledge (knowing to pick the best type of graphic, according to the nature of the variables and what is intended to be highlighted using it). Cazorla and Giordano observe that Statistic contributes exceedingly to the interdisciplinary exploration, for being about a mediatorial science, whose role is to support the other sciences in the apprehension and comprehension of phenomenon, through empiric scientific evidence, grounded in data. Wild, Utts and Horton (2018) affirm that the Statistic is a meta-discipline, capable of transforming data in insights for the real world. To better understand it, the development of statistical literacy makes itself necessary (Gould, 2017; Gal, 2021). For promoting the Statistical learning, Porciúncula (2022) suggest the implementation of statistical learning projects whose development follows the steps: theme definition (according to the interest and restlessness of the researchers), obtaining and organizing data (through a survey); statistical analysis and discussing the results among the members of the group; results submission/disclosure, with the socialization of the information. In this process, the student lives the role of a researcher, of great importance to the appropriation of the scientific knowledge building process, to the enhancing of

criticality and to the exercise of full citizenship, for living in a democratic and enlightened society, in an ambient of social justice. The teacher's support, as a mediator of the interactions in the learning environment, as managing the statistical learning project development, is fundamental.

In the next session, we will present some results of our research.

RESULTS AND DISCUSSION

For the teachers involved in the statistical learning projects implementation and development have brought to light, initially, insecurity, fear of the new and acceptance of a new methodology, but the confidence in the support given by the researchers led them into accepting the challenge. The collaborative group was welcoming and were able to hold back their own angst and anxieties. To be able to see schools reopening, combined with the event when students release their research data, with of all the school community being present, and also being able to register audiovisually and through a book, with teachers' narratives, side by side with the researcher's analysis, was rewarding, in the words of these professionals. Finally, these teachers experienced a sense of relief and gratitude, when they saw the final students' paperworks. In the words of one of the teachers involved "That is the goal, isn't it? It covers everything from a research point of view, and I think this is it, this is the cool thing about it" and, talking about the work done: "sometimes we do, and we don't even realize how interdisciplinary it is, but we research, and research and we need to know minimally about other areas too, right?". This same teacher concluded that "the main goal of the project is to let students be aware they have a collective space of dialogue, discussion and research". Another teacher observed that "in a very traditional teaching environment, everything was very linear, one thing after the other, very little interdisciplinarity". It used to be a safe path, even though it was little motivational for students and even teachers. During the Focal Group, in a two-hour session, the teachers emphasized more advantages than difficulties when adding to their regular teaching practices.

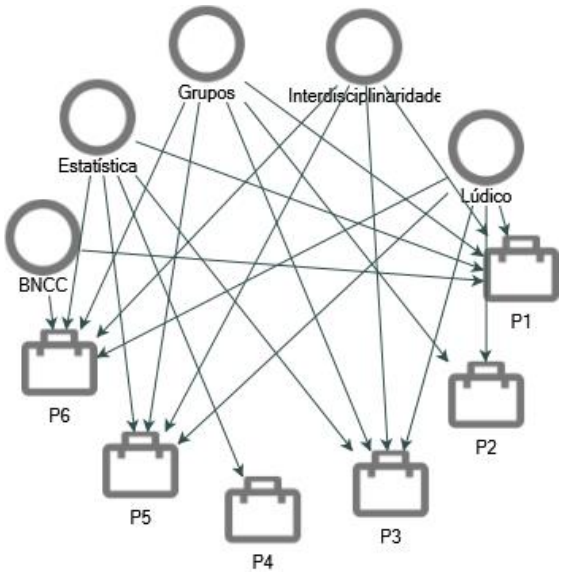

Figure 1. Project map based on teachers' discourse.

Of the six teachers, only two of them mentioned the BNCC, and they did so only once, which we believe to be significant, since it was mentioned several times in the initial meetings in the context of the teachers' expression of concern about not meeting the demands with the time they could "waste" in the development of projects. Thus, the idea that the SLP allows for optimising time, efforts, and resources in school dynamics prevailed. Teacher P2 was the only one who did not mention the word 'statistics'. With teacher P4, P2 did not think it was significant to mention the word 'interdisciplinarity'. However, by not mentioning interdisciplinarity, they ignored group work, the interaction between peers, and the ludic aspect of the SLP. Playfulness was remembered by half of the participants. One teacher observed that in "very traditional teaching, everything was online, it was this, then, later, that, little interdisciplinarity". It was a safe path, although not very motivating for the students and the teacher. The SLP proved to be challenging, requiring the teacher to accept living with

uncertainty, as the directions of the research were in the students' hands. According to this teacher, "the biggest learning was to allow ourselves not to be in control". A third teacher was delighted with the result, especially with the students' engagement: "how important they feel when they gave us a thousand and one explanations of their research!". The word cloud (Figure 2) elaborated from the focus group represents the importance of learning statistics by doing statistics, from the EDA perspective (Batanero; Díaz, 2011), of doing in the sense of 'doing statistics', as Conti argues (2009) when stating that it is possible to promote literacy and 'do statistic' in a public school, in the periphery, despite all its own difficulties, and that this possibility is not limited to statistical knowledge.

Figure 2. Specialty percentage by extent of use

Emphasising the 'doing', we find highlighted, in Figure 2, 'trabalho/work', 'trabalhar/to work', and 'projeto/project'. The word 'tempo/time' was associated with three different contexts: the time available to carry out the project, without prejudice to the curriculum program, especially at the beginning of the works, the remaining time, with the return to face-to-face classes, to enable the culmination of the project with the disclosure of the research results, and the time optimisation by incorporating objects of knowledge from different curriculum components and transversal themes (Cazorla; Giordano, 2021).

Considering the interdisciplinary perspective, exploring the transversal themes and the formative itineraries in education post-BNCC (Brasil, 2018), it indeed does not revolve around it. Echoing the "making" aspect, we highlighted the words "work" (noun), "work" (verb), project. The word "time" was associated to three different contexts: the time available to develop the project without causing harm to the syllabus, most importantly at the start of the projects, the time left, with the return of students to in-person classes, to make possible the culmination of the project, alongside making the results available, and time optimization, when incorporating knowledge objects from different syllabuses, itineraries and transversal themes, as well as the likelihood of observing the speeches acquired with the help of the NVIVO software. The statistical learning projects posed a challenge, requiring from the teacher the acceptance of living with uncertainty, because the research paths were in the students' hands. According to her, "the biggest learning was to allow us not to be in control". A third teacher said she was fascinated with the final results, mostly with the level of engagement of the students: "they felt so important while giving us numerous explanations about their research!". Next, we will present some of our conclusions.

FINAL CONSIDERATIONS

The BNCC, (Brasil, 2018), in spite of all the criticism it has received, a great part of them was well founded, to our mind, has given a boost to learning active methodologies, making it possible to develop statistical research via projects as a knowledge object. Such changes have required and will continue to require, in the years to come, a big investment of effort and resources in initial and continuous formation. We hope that the collaborative groups participate in these formative proposals. The Covid-19 pandemic, and the emergency remote teaching implementation, just when educational professionals were trying to adapt themselves to the syllabus changes due to the BNCC publication (Brasil, 2018), became one of the most challenging moments for a whole generation of teachers in our country. To guarantee engagement from students during online classes, to bring community and school closer, to participate in collaborative continuous formation, mentoring, strategic technical

support, while keeping an open channel for communication of everyone involved in any educational process was necessary when facing an educational crisis. For the teachers, to develop the statistical learning project in the midst of a pandemic was an opportunity to reinvent, break and rebuild knowledge, establishing partnerships, collaborating, sharing knowledge and feelings, and above all, daring. They started to see Statistics in a different way, getting aware that they knew much more than they had thought when assisting their students in constructing statistic graphs, with technological support of multiple computer resources and even using paper and pencils, reading and interpreting frequency charts, writing and revising students' argumentation based on scientific data, above all in the moments preceding the release of their results. We consider an important advance for these teachers was to acknowledge the need of partnership, of dealing better with opportunities in continuous formation. We hope to have contributed to deepen the reflection about teaching conceptions, when developing the statistical learning and teaching.

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