EXPLORING INTERDISCIPLINARITY IN PROJECT-BASED LEARNING: CHOOSING THE RESEARCH THEME

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This article discusses interdisciplinarity in the teaching of statistics through Project-Based Learning. We share the discussion that arose after publication of the Common National Curriculum Base in 2018, which suggests the inclusion of projects whose level of complexity and broadness increases gradually throughout basic education (from six to seventeen years old). Our goal is to highlight the initial moment that is paramount to the success of this approach: the selection of the theme to be investigated. We describe a qualitative research study that analyses official documents, recent studies in the area, and recordings of the sessions in which teachers and students discuss the theme to be chosen before presenting a few considerations that may contribute to promoting statistics literacy.

INTRODUCTION

Active participation of basic education students from primary to upper secondary levels (six to seventeen years old) is needed for students to achieve statistical literacy (Giordano, 2018). According to Batanero and Díaz (2011), students' level of motivation and engagement is directly connected to the project theme chosen, which must be of interest to them. The authors go further by saying that students must be part of all the stages scientific investigation development, from planning to the disclosure of results. The authors also indicate that students should work with real data and be closely involved with data collection. We follow Creswell's (2010) perspective in this qualitative study and highlight the role of initial moments, in which the relevance of the theme to the society, decision about the guiding question, objectives of the research, and initial hypothesis are discussed. We first present suggestions from official guidelines for Brazilian basic education and then present results from studies in the area. Subsequent sections present teachers' perspectives regarding the choice of the project theme, a brief discussion about the theme from the students' perspective, and our conclusions about the present study.

METHOD AND METHODOLOGICAL PROCEDURES

We carried out a qualitative research study from the perspective of Creswell (2010). In the first stage, we analyzed normative documents and studies that consider the potential of project-based learning through projects in statistical education. In the second stage, we present the perspective from Brazilian teachers directly involved in this didactic approach and then focus on the beginning of the development of their students' research. Our objective is to highlight the importance of ta project-based approach, especially at a point that we consider crucial for its success: the choice of topic by groups of students, as recommended by Batanero and Díaz (2011) and Garfield (1993, 2013).

WHAT DO OFFICIAL DOCUMENTS SAY?

The Common National Curriculum Base–BNCC (Ministério da Educação, 2018) is a normative document for Brazilian basic education curriculum that brought new demands to educators and mathematics teachers, especially in the field of probability and statistics, for developing and managing statistical projects. The use of this methodology in class is recommended because the school "must favor meaningfulness to its learning process by connecting it to real-life challenges and by eliciting the contexts of knowledge production and distribution" in order to promote collaborative learning (p. 465). To construct personal and collective projects based on freedom, social justice, solidarity, cooperation, and sustainability is part of the school's role. Discoursing specifically about probability and statistics, BNCC asserts that:

> In order to develop abilities related to statistics, students must have opportunities not only to interpret statistical data broadcasted by the media but also, above all, to plan and execute sample research studies, interpreting the measures of central tendency, and opportunities to communicate the obtained results through reports, including adequate graphic representations. (p. 528)

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This research contemplates ideas defended by Batanero and Diaz (2011), who declare that "projects reinforce student's interest, especially if the theme is chosen by them. People learn best from real data. It is shown that statistics cannot be reduced to mathematical subjects" (p. 22). In a complementary document to BNCC, the Brazilian Culture and Education Ministry (MEC) defines the Contemporary Transversal Themes (TCT) that should be articulated with curriculum subjects, including mathematics, and be explored using active methodology such as problem resolution, gamification, mathematical modeling, and Project-Based Learning (PBL) (Ministério da Educação, 2019). The TCT are organized by six macro areas: (a) civics and citizenship, which includes children's and teenagers' rights, human rights education, traffic education, aging, respect and valorization of the elderly, and social and family life; (b) science and technology; (c) economy, which includes financial education, work, and fiscal education; (d) the environment, which includes environmental education and consumer education; € multiculturalism, which includes cultural diversity and the valorization of multiculturalism in the cultural and historic matrices of Brazil; and (f) health, which includes health and food and nutritional education. According to Cazorla and Giordano (2021), statistics teaching and learning can successfully use an interdisciplinary and transdisciplinary perspective associated with the implementation of TCT, which presupposes integrated work among the teacher, their peers, and the school management team. This methodology offers great potential to promote statistics literacy (e.g., Gal, 2019).

WHAT DO STUDIES IN THE AREA SAY?

The previous suggestions related to probability and statistics expose the necessity of pedagogical practices that engage students through interdisciplinary topics. Some methodologies attempt to accomplish that, among them, PBL. Projects have the potential of creating opportunities for students to conduct investigations about themes of their interest, therefore, fomenting an environment for questioning, interpretation, and criticism and allowing the students to become protagonists in their own learning process. As themes connected to the students' reality emerge, interdisciplinarity becomes viable because real-life problems are not limited by the concepts of a single study area. They can also involve historical, geographic, and physical elements, among others. We emphasize that, in this study, interdisciplinarity is understood in accordance with Fazenda (2002) as "a new attitude faces the matter of knowledge, of being open to comprehend concealed and expressed aspects of the act of learning by putting them into question" (p. 11).

Batanero and Diaz's (2011) suggestion of an approach through projects is considered one way to accomplish the goals set in the national official documents related to statistical education and to increase student's motivation. The authors highlight the higher level of engagement that this pedagogical practice achieves with students, mainly when they choose a theme they sympathize with. Moreover, because the topic attracts students' interest, they become actively involved in the project and become more confident in their ability to critically analyze hypotheses, thus, contributing to the stages of statistical study.

Likewise, Bender (2014) discusses student voice and the opportunity for students to choose the topic of research. The author, referring to other studies, identifies the choice of the theme as a component that may be the most important in a project. Bender believes that students' active participation and involvement is crucial during all stages of PBL. Similarly, the use of real-life situations and the attempt of understanding and solving problems became a necessary motivation.

TEACHERS' PERSPECTIVE IN THE CHOICE OF THE THEME

Before the Multimedia Statistic Literacy project (LeME) developed by the Federal University of Rio Grande (FURG) could be implemented in schools using PBL, it was considered important that the teachers involved in the project participate in all stages of this statistic study. In particular, the teachers should propose the themes, discuss and determine the research subjects (i.e., the sample and sampling procedures), develop data collection instruments, collect and analyze data, report research findings, and evaluate all processes by doing what would be proposed to the students. The idea was that involving the teachers would contribute to promoting safety, agility, and a sense of ownership in the development and management of the projects.

The teacher project was developed in three moments. At first, the teachers debated the research topic. Teachers were grouped according to their level of affinity (professionals from the same school).

One group had a mathematics teacher and a Portuguese teacher, and another group had only one Portuguese teacher from lower secondary school years. In each group, there were three researchers who were members of the Statistics Education Interdisciplinary Research Group (GIIPEE) from FURG. The meetings were held in virtual classrooms, using the Jamboard technological resource to record the teachers' brainstormed ideas. Themes that emerged from one group's brainstorm were sports, physical activities, hybrid learning, plants, hobbies during the pandemic, and educational applications. The themes from the other group were inclusive education in distance learning, democracy, education, technology, respect and diversity, and interconnections between the city and the countryside. The chosen topic was "respect and diversity" because it is a theme within "democracy" and is related to "inclusive education in distance learning," which is part of "education and technology." It also characterizes relations between "the city and the countryside" because the teacher who suggested this theme thought about diversity among students from different regions and the respect that is necessary for these relationships.

The themes of "educational applications" and "respect and diversity" would be better outlined, but they had already aroused common interests from both groups. We noticed that both themes meet the interdisciplinary requirements suggested in the BNCC. In the theme of "educational applications," the influence of technological science, mathematics among them, was clear. Furthermore, depending on the application's target subjects (biology, history, physics, chemistry, etc.), different statistical concepts could be explored not only in Portuguese but also in English and Spanish. With the theme of "respect and diversity," the researchers could address concepts related to history, geography, sociology, biology, and mathematical sciences, depending on the subject to be investigated or the way the data would be analyzed and presented.

Regardless of which topic the researchers decided to approach, it is possible to see the potential of the projects in the promotion of interdisciplinarity because it will demand knowledge from different school subjects. Fazenda (2011) considers interdisciplinarity to be an attitude to be embraced as an alternative to understanding knowledge. In this manner, projects contribute not only to the development of statistical literacy (Gal, 2019) but also to the comprehension of other approached subjects. Projects furnish opportunities for collaboration among teachers, from subjects other than mathematics, and students, which is essential in an interdisciplinary assignment. According to Fazenda (2011), co-participation, reciprocity, and mutuality are characteristics of integration. It is this integration along with interaction that furthers an interdisciplinary teaching practice. Projects may be a motivating factor to truly implement interdisciplinarity with all the obstacles and possibilities that come with it.

THEME'S CHOICE FROM THE STUDENTS' PERSPECTIVE

The stage following the formation of the teachers from LeMe consisted in the implementation of the statistics learning project with the students. LeMe was developed with year seven (lower secondary education) from one of the participating schools, under the guidance of history, Portuguese, and mathematics teachers. Three stages were needed to choose the theme to be studied by the students.

Immediately after the proposal of working with projects was presented to the students, the first stage began: the moment of choosing the project theme by the students based on their personal interests. At that moment, the teachers instigated their students to talk about their curiosities, stressing the importance of them choosing a theme of their liking. The first ideas that arose were: ways that pollution may affect birds; animals; whales; how to improve the local environment; extinct animals; extinct civilizations; the universe; and binary numbers. Subsequently, students reflected upon the possibilities during data collection and pondered the significance of themes connected to the environment and society, such as basic sanitation and garbage disposal. It was possible to notice that students were able to correlate their project themes to their local reality, considering ways to ameliorate the problems mentioned by them. Thus, it was possible to establish that interdisciplinary assignments situate students in the world (Fazenda, 2011), encouraging them to reflect and act in response to real issues.

During the second and third encounters, teachers alerted students about the need to limit the themes in order to avoid overly extensive research. It is crucial to mention that after reflecting and researching their curiosities, new and more specific themes emerged. Students, then, formed groups according to their themes' affinity, choosing the following topics: extinct animals, wars, old games, the environment, and outer space—topics that allow different interdisciplinary possibilities that intertwined with class teachers' fields of study as well as with other areas of knowledge. In the end, the teachers

asked students to deliberate on the questions: "What do we want from this theme? What do want to know? Is there something specific about it that we want to know more about?"

Observing this process, we could reflect upon the contributions that interdisciplinarity has to offer in PBL both for students' statistical literacy and for fostering their sense of citizenship. Fazenda (2011) suggests that in order to have a better formation, students must comprehend their role in society, making use of a critical and transformative attitude. Moreover, students need to learn how to learn. In order to achieve this attitude, interdisciplinarity is paramount, for "only it may facilitate identification between what is lived and what is studied, as long as what is lived is a result of the interrelation of multiple and varied experiences" (p. 75). Therefore, whenever a teacher explores interdisciplinarity, he or she overcomes the barriers among school subjects, privileging a view of the whole picture.

CONCLUSIONS

From the brief reports presented in this text, it was possible to identify possibilities to further interdisciplinary through PBL in the development of statistical research. The choice of the themes by the students proved to be a crucial moment among all the investigative stages of the research because after its definition, students are able to see themselves as researchers, trying to find answers to their own questions. The chosen topics are connected to real issues that involve knowledge from different subjects, pointing at an interdisciplinary work as prescribed at the BNCC.

The chosen themes reveal that statistics is present in many places, can be attached to different subjects, offers resources for the planning and execution of studies, and facilitates data interpretation and reflection upon the results found in them. Knowledge and level of interest for the chosen topic determines the level of engagement of the participants, which is necessary for any learning process.

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