Theme choice in a Project-Based Learning: an interdisciplinary perspective

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Abstract: This article discusses interdisciplinarity in the teaching of Statistics through a Project-Based Learning. We´re sharing the discussion aroused by the publishing of the Common National Curriculum Base in 2018, that suggests learning projects, whose level of complexity and broadness increases gradually throughout the entire basic education (from six to seventeen years old). Our goal is to highlight the initial moment, which is paramount to the success of this approach: the selection of the theme to be investigated. Initially, it is a qualitative research study that analyses official documents, recent studies in the area, as well as recordings of the sessions in which teachers and students discuss the theme to be chosen. In the end, a few considerations that may contribute to promoting Statistics Literacy are presented.

Keywords: Statistical Literacy. Learning Projects. Interdisciplinarity. BNCC.

A escolha do tema em uma Aprendizagem Baseada em Projetos: uma perspectiva interdisciplinar

Resumo: Este artigo discute a interdisciplinaridade no ensino de Estatística por meio da Aprendizagem Baseada em Projetos. Compartilhamos a discussão suscitada pela publicação da Base Nacional Comum Curricular, em 2018, que sugere projetos de aprendizagem cujo grau de complexidade e amplitude aumenta gradativamente, ao longo de toda a Educação Básica (dos seis aos dezessete anos de idade). Nosso objetivo é destacar o momento inicial, primordial para o sucesso dessa abordagem: a seleção do tema a ser investigado. Inicialmente, trata-se de uma pesquisa qualitativa, que analisa documentos oficiais, estudos recentes na área, bem como gravações das sessões em que professores e estudantes discutem o tema a ser escolhido. Ao final, são apresentadas algumas considerações que podem contribuir para a promoção do letramento estatístico.

Palavras-chave: Letramento Estatístico. Projetos de Aprendizagem. Interdisciplinaridade. BNCC.

Elección de temas en un Aprendizaje Basado en Proyectos: una perspectiva

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interdisciplinaria

Resumen: Este artículo discute la interdisciplinariedad en la enseñanza de la Estadística a través del Aprendizaje Basado en Proyectos. Compartimos la discusión suscitada por la publicación de la Base Común Curricular Nacional, en 2018, que sugiere proyectos de aprendizaje cuyo grado de complejidad y amplitud aumenta paulatinamente a lo largo de la Educación Básica (de los seis a los diecisiete años). Nuestro objetivo es resaltar el momento inicial, esencial para el éxito de este enfoque: la selección del tema a investigar. Inicialmente, se trata de una investigación cualitativa, que analiza documentos oficiales, estudios recientes en el área, así como grabaciones de sesiones en las que profesores y alumnos discuten el tema a elegir. Al final, se presentan algunas consideraciones que pueden contribuir a la promoción de la alfabetización estadística.
Palabras-Clave: Alfabetización Estadística. Proyectos de Aprendizaje. Interdisciplinariedad. BNCC.

Introduction

Active participation of basic education students, from Primary to Upper secondary levels (from six to seventeen years old), is determinant to Statistics Literacy success (Giordano, 2018). According to Batanero & Díaz (2011), students' level of motivation and engagement is directly connected to the project theme chosen, which must be part of their list of interests.

The said authors go even further, saying that students must be part of all the stages of development of the scientific investigation, from planning to the disclosure of the results. They continue claiming that students should also work with real data, being closely involved with data collection.

In this qualitative study, following Creswell's (2010) perspective, it is highlighted the role of the initial moments, in which the relevance of the theme to the society, the decision of the guiding question, objectives of the research, and initial hypothesis are discussed. This article is organized into five sections, starting from the Introduction.

In the first, suggestions from official guidelines for Brazilian basic education are presented. In the second, results from studies in the area are shown. In the following section, the teachers' perspective regarding the choice of the project theme is discussed. In the fourth section, a brief discussion about the theme, now from the student's angle, is approached. At the end, we present our conclusions about the present study.

Finally, we emphasize that this article is an expanded version of a study presented by the authors at the 11th ICOTS - International Conference on. Teaching Statistics, in September 2022, entitled "Exploring Interdisciplinary in a Project-Based Learning: choosing the research theme"

Method and methodological procedures

We carried out a qualitative research, from the perspective of Creswell (2010), in the methodological approach of the bibliographic documentary study, analyzing the Common National Curriculum Base – BNCC (Brasil, 2018) and some recently published works in the area, which explore interdisciplinarity and leaning projects in Statistical Education. Our objective is to highlight the importance of this approach, especially at a time that we consider crucial for its success: topic's choice by the groups of students, as recommended by Batanero & Díaz (2011) and Garfield (1993, 2013).

What do official documents say?

The BNCC (Brasil, 2018) is a normative document for the new Brazilian basic education curriculums that brought new demands to educators and Mathematics teachers, especially in the field of Probability and Statistics, by predicting the development and management of statistical projects.

The use of this methodology in class is recommended in this document, for 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 (Brasil, p. 465). To construct personal and collective projects based on freedom, social justice, solidarity, cooperation, and sustainability is part of the school's role (Brasil p. 467).

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 (Brasil, 2018, p. 528).

The said proposal contemplates ideas defended by Batanero & Diaz (2011, p.22) who declare that "projects reinforce student's interest, especially if the theme is chosen by him. People learn best from real data. It is shown that Statistics cannot be reduced to mathematical subjects". In a complementary document to BNCC, Brazilian Culture and Education Ministry

(MEC) defines the Contemporary Transversal Themes (TCT) which should be articulated with curriculum subjects, Mathematics among them, and be explored using an active methodology, as in problems resolution, gamification, mathematical modeling and Project-Based Learning approach (PBL).

The TCT (Brasil, 2019) are organized in six macro areas: civics and citizenship (children and teenagers rights, human rights education, traffic education, aging, respect and valorization of the elder, social and family life); science and technology; economy (financial education, work, fiscal education); the environment (environmental education; consume education); multiculturalism (cultural diversity, valorization of multiculturalism in the cultural and historic matrices of Brazil); health (food and nutritional education, health).

According to Cazorla & Giordano (2021), Statistics teaching and learning process success, in an interdisciplinary and transdisciplinary perspective associated with the implementation of TCT, presupposes an integrated work among the teacher, his peers, and the school management team. This methodology proposal carries in its bosom a great potential to promote Statistics literacy in Gal's (2019) viewpoint.

What do studies in the area say?

The previous suggestions related to Probability and Statistics expose the necessity of pedagogical practices that engage the students through interdisciplinary topics. Some methodologies attempt to accomplish that, among them, the 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, allowing the students to become protagonists in their own learning process.

As themes connected to the students' reality emerge, interdisciplinarity becomes viable since real-life problems are not limited by the concepts of a single study area, but they can also involve historical, geographic, and physical elements, among others.

We emphasize that, in this study, interdisciplinarity is understood in accordance to Fazenda (2002, p.11) as "a new attitude face the matter of knowledge, of being open to comprehend concealed and expressed aspects of the act of learning by putting them into

question". Interdisciplinarity allows the development of new knowledge from different areas of knowledge, favors new ways of approaching social reality and interactions between different communities. For an interdisciplinary practice, it is essential to know the place from which one speaks in order to investigate how to proceed or how to develop. Thus, an interdisciplinary project is born from a well-defined *locus* and, for Fazenda (2011), it is essential to contextualize in order to know. And contextualizing implies bringing to memory elements of everyday life related to the time and space in which one learns.

Batanero & Diaz's (2011) suggestion of an approach through projects is considered a way to accomplish the goals set in the national official documents related to statistical education, and an ally 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 since they become more confident in their ability to critically analyze hypotheses, thus, contributing to the following stages of the statistical study, based on Wild and Pfannkuch (1999):
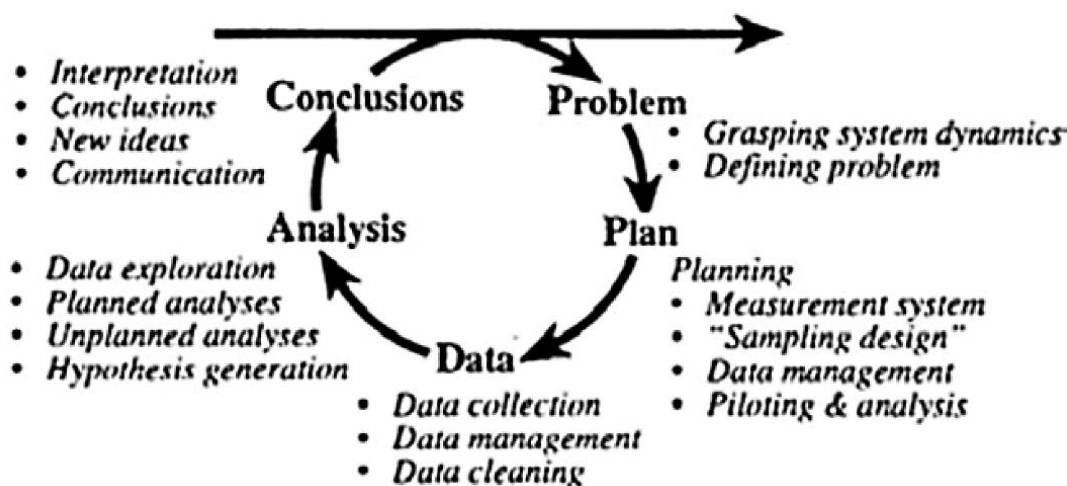
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Figure 1: Investigative Cycle (Wild; Pfannkuch, 1999, p. 226)

Likewise, Bender (2014) disserts about the students' voice and opportunity of choosing the topic of research. The author, referring to other studies, brings the choice of the theme as a component that may be the most important in a project, for 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 solve problems became a necessary motivation.
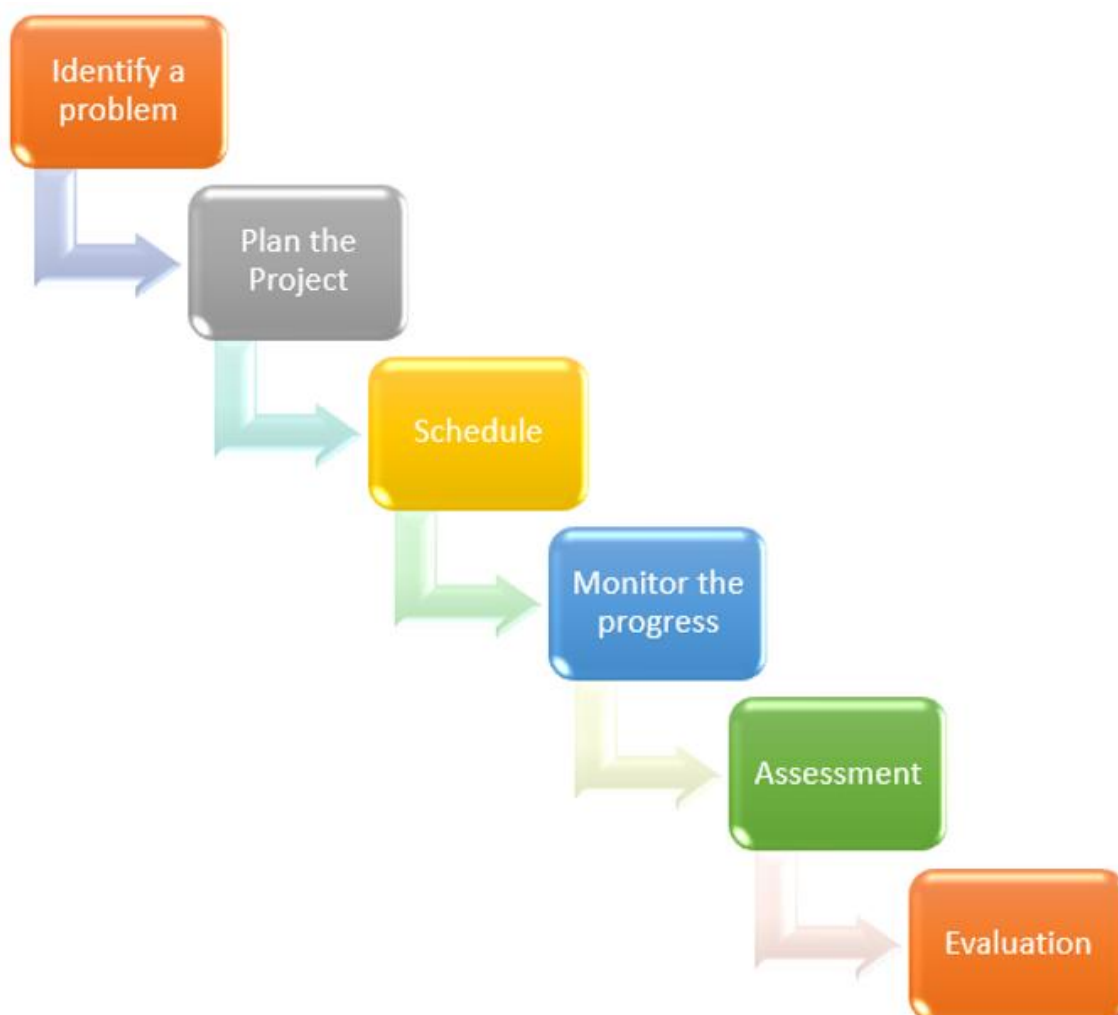

Figure 2: Stages of a Learning Project (adapted from Bender, 2014)

The PBL can also be considered, according to Bender (2014), a teaching model that allows students to confront real-world issues and problems that have meaning for them, determining an approach and actions in the search for solutions. Through this methodology, students can develop skills related to technology, problem solving and cooperation (Bender, 2014). Such skills are recommended according to the BNCC (2018), in addition to being necessary for life in society today, in the exercise of citizenship.

> PBL can be defined by the use of authentic and realistic projects, based on a highly motivating and engaging question, task or problem, to teach academic

content to students in the context of cooperative work to solve problems (Bender, 2014, p. 15).

The possibility of working with PBL on topics of interest to the student, in addition to helping to produce the meaning of the concepts and contents necessary throughout the development of the project, for Batanero and Díaz (2011), requires students to think about issues of the like:

What's my problem?

Do I need to collect data?

Which? How many?

When and how to collect them?

What does this result mean in practice?

In this way, the student problematizes the theme chosen for his research, being able to go beyond technical knowledge, exercising his strategic and critical awareness. PBL allows students to work with real problems in their own context. It can promote discussions based on real data and not invented by the teacher, taking into account data variability, sample reliability, measurability, bias and other characteristics of statistics, realizing that this science is not limited to mathematical content.

In the context of this research, the PBL is adapted for the implementation of the Statistical Learning Projects (PAE, in Portuguese) of the Statistical Multimedia Literacy Program (LeME) (Porciúncula, 2022) of the Federal University of Rio Grande (FURG), to be developed from a project to promote the statistical literacy of students and teachers in the Final Years of Elementary School in two public schools in Rio Grande do Sul.

The PAE is based on learning from the theme chosen by the student to carry out a statistical survey, developed during their participation in LeME. Students are invited to organize and apply a survey (opinion survey), becoming researchers and protagonists of their own learning. In this sense, the learning process can become relevant, in addition to

opportunities for Statistical Literacy to develop, empowering students and teachers in the educational context (Porciúncula, Schreiber, Giordano, 2022).

The PAE can be developed and implemented from the following steps:

1. The student's choice of theme;

2. Problematization (hypothesis survey);

3. Choice of research subjects;

4. Creation of a data collection instrument;

5. Data collection;

6. Organization and analysis of collected data;

7. Disclosure of data;

8. Activity evaluation.

The proposed path refers to a dialogic teaching approach, which can alleviate emotional inhibitions and fears of mathematics involved in statistics, in addition to promoting interactions between students through teamwork. For Porciúncula (2022), the PAE has the potential to promote interdisciplinary, intradisciplinary, contextualization and to trace new paths for the transformation of data into information based on statistical analysis, in favor of human development, citizenship and social justice.

The teachers' perspective in the choice of the theme

Before the LeME, be implemented in schools using PBL, more specifically the PAE, it was considered important that the teachers involved in the project participate in all stages of this statistic study, proposing the themes, discussing and determining the research subjects (what would be the sample, and sampling procedures), developing data collection instruments, collecting and analyzing data, reporting research findings, evaluating all process, living 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.

This experience took place in the context of the participation of these teachers in the meetings of the Collaborative Group for Teacher Training in Statistical Education (MoSaiCo Edu). The group's meetings, at the time, took place remotely in view of the effects of the

COVID-19 Pandemic. In addition to the teachers, postgraduate students from the Research Group on Statistics Education (EduEst), Basic Education teachers and graduates also participated in the meetings, who socialized and discussed practices for the teaching and learning of Statistics.

The development of the PAE was proposed to the group of professors in order to make them aware of this methodology that they had not yet worked on. When experiencing the PAE, teachers had the opportunity to develop statistical literacy themselves, to perceive the nuances of each of the phases and the possible challenges that students could face, to appropriate the statistical concepts and contents that could be approached throughout the development. of research, explore the resources and technological tools that enable statistical analysis, problematize everyday themes, contextualize the research, perceive the interdisciplinary nature of the methodology and the role of the student in assuming the role of researcher.

The project with the teacher 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 another of Portuguese, another group had only one Portuguese teacher, from lower secondary school years. In each group, there were three researchers, members of Statistics Education Interdisciplinary Research Group (GIIPEE), from FURG.

The meetings were held in virtual classrooms, using also a technological resource called Jamboard, to register the teachers' brainstormed ideas. The 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, the city and the countryside – interconnections. The chosen topic was "respect and diversity", since it is a theme within "democracy" and it is related to "inclusive education in distance learning", which is part of "education and technology" and it also characterizes relations between "the city and the countryside", since the teacher who suggested this theme thought about the diversity among students from different regions, and the respect that is necessary for these relationships. The themes, "educational applications", and "respect and diversity" would be better outlined, but they had already started to arouse common interests from both groups.

We noticed that both themes meet the interdisciplinary requirements suggested in the BNCC (Brasil, 2018). In the theme "educational applications", the influence of technological science, Mathematics among them, was clear. Furthermore, depending on the applications target subjects (education for Biology, History, Physics, Chemistry, etc.) different statistical concepts could be explored not only in Portuguese but also in English and Spanish.

On the other hand, with the theme "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.

The interesting thing was that to reach these themes, several ideas emerged from the experiences of the teachers themselves in a context of remote teaching, pandemic, social distancing. And for the themes to be chosen, the teachers had to "defend" their themes and the reasons for their choices, in order to convince the rest of the group to embrace the theme. Curiosities and the desire to want to research, to know more about the topics were decisive for the suggestions. In this way, we can see that the themes of the PAE arise from contexts that have meaning for the researcher, which can promote the subject's engagement and commitment to the research and to its future results.

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As the themes chosen are, in a way, very broad, that is, there are several "sub-themes" that could be raised from them, teachers were encouraged to think about more specific themes from the first choice. Teachers were asked about their doubts and curiosities about the themes chosen in order to delimit the problems within the themes "educational applications" and "respect and diversity".

What did you want to know about?

What did they want to know from others about these topics?

Do you think of some hypotheses?

Are there any guiding questions for the research?

Such questions served to direct the groups to types of applications used in pedagogical practice, which are easy to use (in relation to the theme "educational applications") and in the diversity of local communities, such as *quilombolas* and also in relation to different ethnicities and races (in relation to the theme "respect and diversity").

During the decision-making process regarding the respective themes, the teachers reflected on how this process could happen with their students, the doubts that could arise from their own questions and what the best attitude to take to guide students and groups in choosing their themes. They also realized that, as it is an opinion poll, the theme and the problematization should be directed to what one wants to know about what people think about the subject.

Regardless of which topic the researchers decide to approach, it is possible to see the potential of the projects in the promotion of interdisciplinarity, since 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.

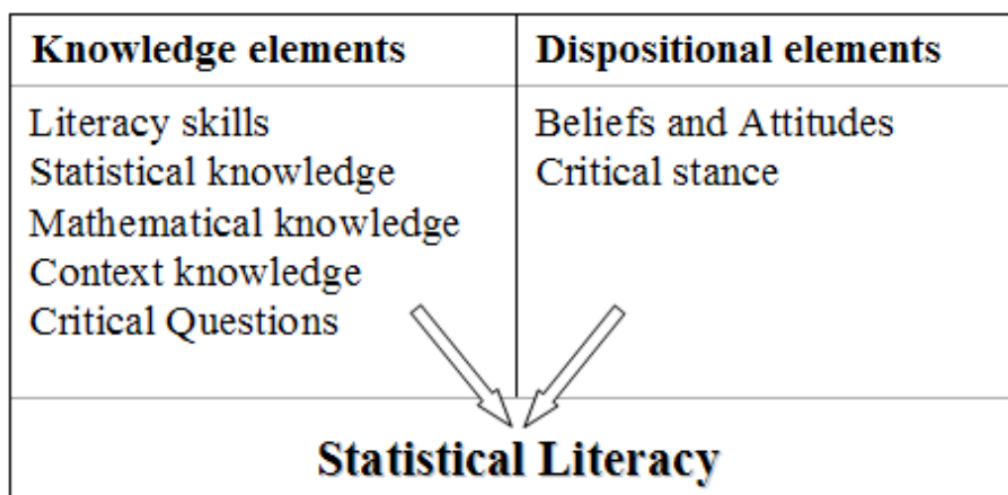| Knowledge elements	Dispositional elements
Literacy skills Statistical knowledge Mathematical knowledge Context knowledge Critical Questions	Beliefs and Attitudes Critical stance
Statistical Literacy	

Figure 3: A model of statistical literacy (Gal, 2019, p. 2)

Projects furnish opportunities for collaboration among teachers, from subjects other than Mathematics, and students, which is essential in an interdisciplinary assignment, because, 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.

The 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 the year seven (Lower Secondary education) from one of the participating schools, under the guidance of the class' teachers of History, Portuguese, and Mathematics.

In order to choose the theme to be studied by the students, it was necessary three encounters. 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 to arouse were: ways that pollution may affect birds; animals; whales; how to improve the local environment; extinct animals; extinct civilizations; the universe; binary numbers.

Subsequently, students reflected upon the possibilities during data collection and pondered on the significance of the 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 delimitate 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.

It is possible to observe that the chosen topics allow different interdisciplinary possibilities, being intertwined with the graduation fields of the teachers from that class, as well as with other areas of knowledge. In the end, the teachers asked students to deliberate on the

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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 a project-based learning approach both for the statistical literacy of the students 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 this perspective, the mentioned author highlights that, 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" (Fazenda, 2011 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, attached to different subjects, offering resources for the planning and execution of studies, facilitating 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, but becomes even more relevant to foster Statistical Literacy in the distance learning model adopted in Brazil during the COVID-19 pandemic.

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