

# Northeast Mathematical Education Network: professional development and statistical teaching from a critical and equity perspective

## ABSTRACT

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The paper aims to discuss the professional development of teachers who teach mathematics who participated in an online formative process, carried out within a professional learning community, which addressed equity in the teaching of statistical concepts. Research was based on theoretical references of Professional Development, principles and dimensions of equity for learning in mathematics and characteristics of professional learning community. The research was developed by the Northeast Mathematics Education Network (REM-NE), composed of eight universities located in four states in the Brazilian Northeast and one in the Southeast. The formative process took place in 2020, during the COVID-19 pandemic, with 51 teachers from eight REM-NE elementary and middle partner schools, being completed by 38. The RePARE spiral (reflection-planning-action-reflection) was used for the formative actions distributed in the Large Group with all teachers and researchers and Small Groups composed of approximately six teachers and one researcher (former). The entire process took place online, using Telegram or WhatsApp and the tools from the G-suite package: Google Classroom, Drive, Meet and Google Forms. To achieve the objective of this article, we analyzed data collected in the Large Group meetings: the recordings; journals of nine training meetings; profile instrument; diagnosis of specific knowledge; questionnaire about the perspective on equity and journals from the Small Groups. Research data were analyzed and the results indicate that teacher education needs to value and enhance the professional development of teachers, in order to address: specific knowledge (in this research, statistical concepts); knowledge about teaching practices that enable working with the student; involvement of the school community addressing themes, difficulties and phenomena inherent to the noosphere in which the teacher is inserted; participation of the university in formative processes, constituting professional learning communities; having critical education as a training scenario and valuing work with equity; provide the use of technological tools; value the processes of reflection and collaborative planning. The results indicate that these are inherent and necessary points to be considered in a training process aimed at professional development.

**KEYWORDS:** Network REM-NE. Training process. Equity. Statistics teaching.

## INTRODUCTION

The perspective of Education in the 21st Century for the formation of the student (citizen) has been the subject of several questions. Studies such as Morin (2002), D'Ambrosio (2014) and Harari (2018) point to the (re)thinking about skills and competencies that permeate the student's action and doing in their own life and in their community, considering local and global problems, having knowledge as a complex and not as separate bodies. Within this context, the question is how and what to do, in the school environment and within the classroom, so that the actions of the educational system can approach the reality of the student.

In relation to the teaching of mathematics, it is observed that, in this field, the formation of scientific knowledge, the way in which the abstraction of reality is conceived to consider the regularities and generalized patterns in rules, properties, relationships, theorems and axioms, makes it difficult for its condition to be reviewed from a disciplinary perspective in order to start encompassing and not dissociating the contexts from reality. For phenomena that occur in contexts of the reality of society do not bring dissociated knowledge, but rather in a complex. This difficulty is reflected by the training of professionals working in the classroom, since

The current teacher is prepared to present and charge students for a cast of content that will often have little to do with the teacher's work when entering a classroom. There is an excessive concern to pass content that is not justified, unless by its presence in classical texts, some dated up to 300 years ago. (D'AMBROSIO, 2014, p. 13).

For the author, the pre-service professional development of the teacher who teaches mathematics is being based on charges of memorization of contents, application of formulas, repetitions of texts and classical problems that distance themselves from the teaching practice to be assumed in the reality of the classroom. It is pertinent to expand research on professional development, in order to seek formative mechanisms based on the real needs of student learning to work in the 21st century. In addition, studies and preparation of activities should be opportunistic to professionals in service, to be developed with students in order to overcome such difficulties.

With regard to problems in pre-service and in-service professional development, one should focus on the process of construction of professional experiences that are built along the professional path, since the pre-service professional development. Santana and Cazorla (2018), Santana, Serrazina and Nunes (2019), Santana, Ponte and Serrazina (2020) and Santana, Nascimento and Couto (2021) point to difficulties and possibilities to promote the professional development of teachers who teach mathematics, opportunities for learning experiences in the school environment in partnership with universities. This partnership can contribute to the promotion and maintenance of a continuous formative process carried out within a professional learning community (PLC), here understood as a group of people, sharing and critically questioning their practices in a continuous, collaborative, inclusive and learning-oriented way (BOLAM *et al.*, 2005).

In education, PLC may include groups outside the school (e.g., research group from the university), principals, supervisors and teachers of a school who

continually seek, share and act for their learning. The closest relationship between the school and the university is characterized in this research as University-School Leadership (Usl) which influences:

... in the planning of the classes of mathematics teachers at school, to teach the contents of Statistics, following the practice of these teachers and encouraging them to go further and reflect on the practice of teaching. [...] The teaching of Statistics began to be reflected, from its planning, evolving to the diagnosis of students' learning, as well as the teaching practice performed in the classrooms. Thus, the movement that was developed between the university and the school showed that the actions are not fixed. [...], but they create formative and professional development possibilities considering their context, their students and the trajectory of their teachers. (SANTANA; COUTO; PAULA, 2021, p. 23).

Thus, the present research was carried out in a formative process that prioritized the elaboration of teaching sequences for work in the classroom with statistical concepts. The sequences were planned from a scientific research perspective, aiming at the development of the student in their skills of argumentation, communication, critical thinking and skills to solve problems involving statistical knowledge.

In this context, the Northeast Mathematical Education Network (REM-NE) initiated the actions of the project entitled "Professional development of mathematics teachers and the teaching of statistics in elementary school" funded by the Lemann Foundation and Teachers College, Columbia University, New York, USA. This project aims to understand how a formative intervention collaborates with the professional development of mathematics teachers in elementary and middle school (their knowledge and teaching of statistics) and affects the knowledge of their students about statistical concepts. Currently, REM-NE is formed by a team of researchers from eight Brazilian universities located in four states of the Northeast region and one in the Southeast region, in partnership with eight elementary schools distributed in these states.

With this intention is that this article aims to problematize about the professional development of teachers who teach mathematics when participating in an online formative process, carried out within a professional learning community, which aims to address equity in the teaching of statistical concepts.

Thus, this article presents results of online training performed with teachers from partner schools. In the next section, we discuss the theoretical framework of the study, focused on Professional Development, Communities of Practice and Equity.

## **PROFESSIONAL DEVELOPMENT, PROFESSIONAL LEARNING AND EQUITY COMMUNITIES**

Studies that problematize professional development draw attention to the fact that this concept is not synonymous with training (PASSOS *et al.*, 2006, LIBÂNEO; PEPPER, 2011;). Continuous and reflective teacher training contributes to the professional development of teachers (GATTI, 2015; GUSKEY, 2002; IMBERNÓN, 2011; BRIDGE, 1994).

The development of Professional Learning Communities (PLC) have been seen as a considerable promise of empowerment for the sustainable improvement of education.

Bolam *et al.* (2005) emphasize five characteristics of PLC: (i) shared values and vision; (ii) collective responsibility; (iii) reflective research of the profession; (iv) collaboration and (v) promotion of group learning (and also individual). In addition to these characteristics, there are others: mutual trust, respect and support among community members.

In this sense, the creation and development of PLC seems to depend on working inside and outside schools in various directions: focusing on learning processes, making the best of human and social resources, managing structural resources, and interacting with and using external agents. Building CPA within schools requires the training of leaders who support and feed meaningful collaboration with teachers. This will only be achieved with leadership models that do not delimit the possibilities of teachers to deal with the work to be done in schools.

To develop a PLC in a school, it is necessary to plan the possibilities of actions for the learning of teachers, their professional development and the learning of students, since the teaching and learning processes have inherent connections to their constitution. A key aspect in the professional development of mathematics teachers is the specialized knowledge needed to teach. The present study focused on the professional development of teachers who teach mathematics (and statistics) in elementary and middle school.

A model based on statistical education practices was adopted with the, called the Research Curriculum (WALSH JUNIOR, 2017) and the Investigative Cycle called PPDAC (WILD, PFANNKUCH, 1999). The PPDAC method is composed of five phases: **P**roblem (problem definition), **P**lan (measurement system, data collection instruments, sampling, data, etc.); **D**ata (data collection), **A**nalysis (data analysis) and **C**onclusion (interpretation and conclusion on the results). Statistical thinking is understood as a complete process involved in solving real-world problems, which use statistics to improve a solution.

According to Groth (2017), statistical knowledge for teaching is not equal to statistical knowledge. Teachers need to know how to make Statistics understandable to others and understand the subject. This double demand of teachers requires the development of viable models of teacher training. The author presents a model based on the involvement of teachers in *design-based* research. It is a collaboration-based model in which teachers plan, implement and analyze teaching to achieve the statistical results desired for their students. The researcher gives teachers enough autonomy to make and learn from mistakes during the process. Analyzing and solving errors has value as a means of learning for teachers.

The statistical literacy postulated by Gal (2002) distinguishes readers (data consumers), who deal with statistical information in reading contexts and data producers, who carry out statistical investigations and position themselves on the results and the PPDAC proposed by Wild and Pfannkuch (1999). According to Cazorla and Santana (2010), the development of statistical literacy in Basic Education cannot be limited to the context of reading, but the activities should provide a context of research.

However, the elements posed by statistical literacy, whose mission is to prepare people to deal with statistical data and information, do not yet contribute to the formation of a critical citizen. Research on the contributions of statistics aiming at statistical literacy is very promising, but there are few studies that investigate, in Basic Education, the potential to teach statistics from a perspective of equity and social justice.

It is not easy to conceptualize the term equity. In common sense, many relate the term to equality and justice. However, for Silva (2016), often in Mathematics Education, it is believed that by leveling the knowledge of students, offering the same opportunities for teaching and treatment seems to be fair and in many situations, equality may not be enough. For NCTM (2008, p. 12): "[...] equity does not mean that each student should receive an identical education; on the contrary, it requires reasonable and appropriate adaptation, where necessary, in order to promote access to content acquisition for all students."

Understanding that all students can learn mathematics allows teachers and students to promote rich experiences rather than impoverished learning. In this process, appropriate environments should be offered for the development of mathematical knowledge connected to or outside other areas of mathematics. In this sense, Jorgensen and Niesche (2008) propose resources to promote a more inclusive pedagogy that can work towards a more equitable outcome for all students, especially those who are less favored. They are: (i) group work (through collaboration); (ii) defined functions; (iii) teacher as facilitator; (iv) rich mathematical tasks and (v) multiple representations. Thus, the authors believe that when teachers are predisposed to change their practices to favor equity, students benefit.

The Principle of Equity (NCTM, 2008) requires that, in order to acquire mathematics learning, schools must ensure that all students have a robust curriculum by stimulating teaching programs that help students understand the importance and usefulness of learning and continuing their mathematical studies in the future. In addition, all students should have access to "a curriculum of excellence and equitable that provides solid support for their learning and responds to their prior knowledge, intellectual and personal potentials"(NCTM, 2008, p.13).

However, when talking about equity, one cannot underestimate the elements that permeate the educational system. Considering equity only in the effectiveness of teaching and learning processes tends to fail, since, in this way, there are no complete measures to realize equity in society. For this to happen, in addition to performing mathematical literacy, it is necessary to implement social policies.

There are pedagogical strategies that promote education with equity, but also important are the approaches to modify systems at the school, municipal, state and national levels that maintain unequal structures. Equitable practices focused on skills-based approaches must be comprehensively implemented so that all student experiences are devoid of labels, prejudice, and unequal access to learning opportunities.

In this sense, it is assumed that equity requires a significant supply of material and human resources to schools and classrooms. That pedagogical tools, curricular disciplines, complementary special programs and the competent use of

community resources undoubtedly play an important role in the development of equity.

However, another relevant component is the professional development of teachers. Teachers need to understand the strengths and needs of their students, who come from diverse linguistic, social and cultural backgrounds, have special difficulties or specific talents and interests in mathematics. Discussing these points in a formative process built in collaboration with teachers will enable the production of knowledge that can improve student communities and help advance their learning in the search for a more just and egalitarian society.

Concerned about the issues of improving the learning of mathematics in schools, the REM-NE conducted a series of studies focusing on the professional development of mathematics teachers in the context of the Education Observatory Program<sup>1</sup> (SANTANA; CAZORLA, 2018). In general, professional teacher development programs in Brazil are based on pre-formatted *courses or workshops* outside schools and focused mainly on mathematics content. In these programs, issues such as school context, teachers' beliefs about student learning and strategies for learning students with a focus on equity are rarely addressed (DAY, 2001, 2019).

Santana, Serrazina and Nunes (2021) point out that professional development should take into account the more effective participation of teachers in decision-making processes on what knowledge should be taught and address issues of equity in student learning.

## **THE FORMATIVE PROCESS**

This session is intended to describe the formative model used by REM-NE.

The approach to research in the REM-NE Project is qualitative in nature, based on elements of an action research "[...] developed with the purpose of transforming schools into critical communities of teachers who problematize, think and reformulate practices, with a view to professional emancipation" (IBIAPINA, 2008, p. 9), with collaborative research bias. The author points out that "[...] collaboratively investigating means involvement between researchers and teachers in common projects that benefit the school and teacher professional development" (IBIAPINA, 2008, p.22), that is, the focus is on the search for knowledge aimed at improving school culture and teacher professional development.

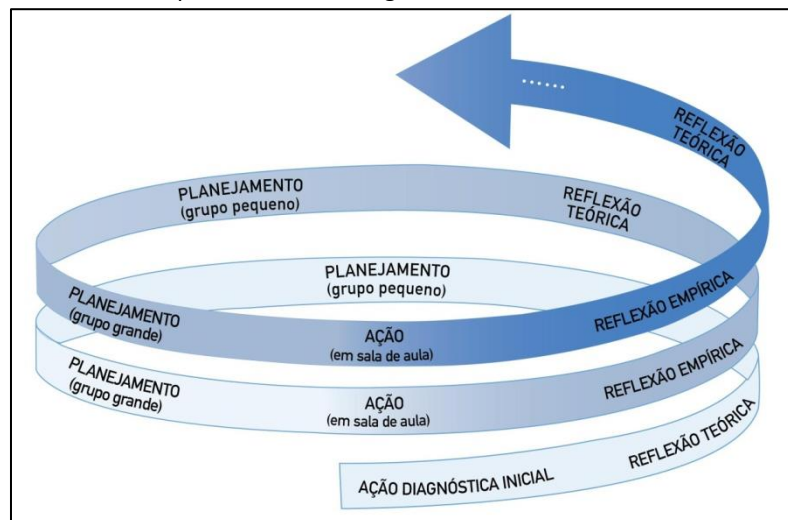
The REM-NE Mathematical Education Network consists of a team of researchers from eight Brazilian universities, located in Bahia, Ceará, Pernambuco, Rio Grande do Norte and São Paulo, including: Universidade Estadual de Santa Cruz (UESC), Universidade de Estado da Bahia (UNEB), Universidade Federal do Ceará (UFC), Universidade Federal do Cariri (UFCA), Universidade Federal de Pernambuco (UFPE), Universidade de Pernambuco (UPE), Universidade Federal do Rio Grande do Norte (UFRN) and Universidade de Campinas (UNICAMP). Teachers and coordinators of the eight public schools partner schools of elementary and middle schools, higher education teachers, undergraduate and graduate students also participate in the Network.

The online formative process, called Mathematics #COMVIDa<sup>2</sup> was carried out in 2020, from September to December and had the participation of 51 teachers in total, of which 38 (74.5%) completed the course. The main objective of this process was to plan teaching sequences to be developed in mathematics classes, in order to discuss local and global elements linked to the Covid-19 pandemic. The specific objectives were:

- motivate and guide teachers to develop their teaching practices in the perspective in which students are protagonists of the learning process, in a context that enhances equity;
- discuss mathematical contents (statistical concepts) that allow working in elementary school classrooms with problem situations related to Covid-19;
- (re)cognize methodological elements that allow to enhance the practice of teaching in the classroom of elementary and middle school, through problem situations located in the context of Covid-19;
- enable the use of digital technologies that can enhance the teaching practice and, consequently, the learning of students.

The formation was based on the RePARE Spiral (MAGINA *et al.*, 2018), a movement anchored in actions of the type reflection, planning, action, reflection, with increasing shape and that becomes wider, in terms of knowledge, in each turn traveled (Figure 1).

Figure 1 – The RePARE spiral - a methodological model aimed at teacher education



Source: Magina *et al.* (2018, p. 247).

The operational definition of the spiral as proposed by Magina *et al.* (2018, p. 11-12) comprises:

- **Action (ação)** - activities carried out by teachers or researchers (according to the moment of training) with students. It comprises the initial and final diagnostic actions and related to the teacher's making in his/her classroom.
- **Initial Diagnostic Action (Ação Diagnóstica Inicial)** - starting point, carried out together with the participants of the formative process

collaboratively. It aims to collect diagnostic data about the competence and conceptions of the students. This action provides elements for carrying out theoretical reflections during the formative process.

- **Final Diagnostic Action** (Ação Diagnóstica Final) – final point, optional, identified mainly with scientific research, since it allows evaluating the effect of the formative process for student learning.
- **Reflection** (Reflexão) - is related to thinking and rethinking the actions performed and comprises two types: theoretical and empirical.
- **Theoretical Reflection** (Reflexão Teórica) - carried out based on the results of the diagnostic action gradually throughout the formative process.
- **Empirical Reflection** (Reflexão Empírica) – held, together with colleagues, on the action in the classroom and the observation of its effect on students' learning.
- **Planning** (Planejamento) – carried out during training in moments of collective work and comprises the planning of actions, being divided into small groups and large groups.
- **Small group planning** (Planejamento em grupo pequeno) – after theoretical reflection, teachers, divided into small groups according to the school year in which they present, elaborate activities about the content discussed in **theoretical reflection**. The activities are recorded in report form so that they can be discussed collectively in the large group.
- **Big group Planning** (Planejamento no grupo grande) – happens at the time of presentation of the plans by the small groups with collective discussion both from the structural point of view (logic, grammar and semantics) and from the didactic-pedagogical point of view (work in the classroom).

Because it is a follow-up training to the teacher, which takes place in the partner school throughout the school year, these actions are being developed with each cycle that is completed and thus we are going around the spiral, thus making a very strong link between the University and the School.

The next section details how the RePARE spiral was used in the Mathematical and #COMVIDa.

### **METHODOLOGY: THE REPARE SPIRAL IN THE CONTEXT OF THE FORMATIVE PROCESS MATHEMATICS #COMViDa**

With the advent of the pandemic caused by COVID 19 (SARS-CoV-2), changes had to be made, especially with regard to the methodological procedures of the research considering the RePARE spiral. The formative process that was thought to be carried out in face to face format gains a new structure with an adaptation to the online environment, mediated by digital information and communication technologies (DICT).

In the realization of the formative meetings, applications of the G Suite for Education<sup>3</sup> were used, mainly Classroom, Chat, Meet, Groups, Drive and Forms. Classroom was used to store all the material used in the training and provide



activities to be performed by teachers. Drive tools were made available for teachers to edit texts and presentations. Meet was used to conduct synchronous meetings. In addition, instant communication applications were used, as well as groups on Whatsapp<sup>4</sup> and Telegram, the first being used for communication between researchers and the second with groups formed by teachers and researchers. The choice of these tools was also a way to expand the technological knowledge of teachers, necessary due to the adoption of emergency remote education (HODGES *et al.*, 2020) by many schools.

The activities were developed in the following aspects: (i) statistical content; (ii) equity and research in mathematics classes and (iii) elaboration of teaching sequences, in a permanent movement of dialogue between these three strands, distributed in four modules, as illustrated in Chart 1.

Chart 1 – Structure of the Mathematics #COMVIDa Methodological Process

Modules	Strands	Themes	Total Hours	Number of Synchronous Meetings
1	Statistical content	Statistical concepts (considering the indications of statistical content according to the Common National Curriculum Base (BNCC) for Basic Education, mainly the elaboration, analysis and interpretation of different types of graphs).	25	4
2	Equity and research in mathematics classes	Studies on Equity from the perspective of mathematical learning, taking into account the four dimensions proposed by Gutiérrez (2012) for the promotion of equity in the educational context: access, achievement, identity and power.	3	1
3	Theoretical study of didactic and methodological elements	Study of the assumptions for an investigative class and the methodology of the PPDAC Investigative Cycle (Problem, Planning, Data, Analysis and Conclusions) for the elaboration of the teaching sequence (WILD; PFANNKUCH, 1999).	8	2

4	Development of teaching sequences	Teaching sequence - its elaboration (content, activities, duration time and evaluation of the activities carried out with the students). Reflection about and of on and pedagogical practice, considering the perspective of possibilities of development of collaborative work in school.	8	2
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Source: REM-NE (2020).

The planning for structuring the course was carried out through bi-weekly online meetings, via Google Meet by the REM-NE research team, in addition to participating in all phases of the course. This process was necessary, since there was no certainty about the return of the periods of face-to-face classes.

In view of the proposal of the formative process, it was necessary to support the research instruments for the structure of a remote formative process. The purpose, type and purpose of each instrument adopted in the training are specified in Chart 2.

Chart 2 – Research instruments

Purpose	Guy	Objectives
Follow-up of Big Group	<ul style="list-style-type: none"> <li>-Field journal</li> <li>-Recording and transcription of meetings</li> <li>- Empirical reflection with generating questions</li> </ul>	Identify the reflections, exchanges of experiences and learning that are presented by teachers during the meetings of the professional learning community
Follow-up of Small Group	<ul style="list-style-type: none"> <li>- Field journal wrote by an instructor</li> <li>-Record of resolutions of the proposed activities</li> <li>- Report to record the development of a Teaching Sequence</li> </ul>	Identify the interaction and exchanges of experiences of the small group that enable the professional development of teachers

<p>Follow-up of the teacher individually</p>	<ul style="list-style-type: none"> <li>-Profile instrument with questions on formative and pedagogical practice</li> <li>- Instrument to assess teacher statistical knowledge before starting the course.</li> <li>-Instrument of perception about equity, social justice, socioeconomic and racial issues</li> <li>- Instrument to evaluate the formative process.</li> </ul>	<p>To analyze the knowledge of statistical concepts, pedagogical practices, teachers' perspectives about equity and the formative process.</p>
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Source: REM-NE (2020).

As previously scored, the collaborative formative process was implemented in four modules, and the empirical data were constructed based on the instruments presented in Chart 2. The results of the study are presented in the following section.

## RESULTS

The results are presented from a synthesis of the modules developed in the course, illustrating them with extracts of protocols from teachers who participated in the course.

### MODULE 1: STATISTICAL CONTENTS

The first module began with a synchronous meeting, in which we presented the course proposal and held an initial conversation with all teachers. In this same meeting, we gave instructions for installation or use of the aforementioned applications to be used in the course. Participants were asked to answer an online form about their statistical knowledge prior to the course, via Google Forms, as well as to sign the Consent Form required by the Ethical Committee.

In the following, the meeting addressed some statistical concepts from the analysis of a bar chart that presented the percentage of confirmed cases and deaths due to COVID-19 by gender. Continuing, we proposed the problematization for the development of a teaching sequence experiencing Steps 1 and 2 of the PPDAC, respectively Problem and Plan.

In the end, the teachers received instructions about the next activities, which should be carried out in small groups. Nine diverse groups were formed with participants from different states. Throughout the module, these groups carried out study and research activities. Each of the groups had an instructor who assisted in problematization and reflection, interacting in synchronous meetings with, at most, six teachers. Google Meet was used for synchronous and Telegram for asynchronous conversations.

The next two meetings of Module 1 continued the reflections on statistical concepts discussing the difference between sample and population, types of variables, tables and graphs, absolute and relative frequency, based on the

material available to teachers. The second meeting highlights the comment of the teacher named Cia (pseudonym), indicating the importance of having a training that deals with statistical concepts:

[...] of the things that we have observed, that I have analyzed in the question of the proposal of the course, I was talking to Celia [instructor] and the staff of this core, that some terms, some proposals, it is not common for us to see in elementary school, at least, not from the 1st to the 4th grade, it is not common! Or we hardly see. I was even talking, even a question of who did pedagogy, practically. What you see in pedagogy, at least where I studied, the question of mathematics is well simplified and also does not add this range of knowledge, you know?..., so it is not common these terms, this proposal, as statistics are put... So we have a hard time with some things, what is this? What does this term mean? You have to be researching, you have to be studying. It is so much that Celia [instructor] formed another group in zap [Whatsapp] precisely to, when a doubt arises, one is contributing to the other, perhaps even in a faster way (Extract from the Protocol of the 2nd Meeting comment by teacher Cia).

It is noted that the teacher points out her ignorance and that of some colleagues with the concepts addressed, but shows a confidence that she will learn in the formative process and with the help of one of the trainers.

The 3rd formative meeting, with the large grupo, began with one of the trainers bringing examples of tables built by teachers, in which they lacked elements or brought some wrong information in order to analyze these elements together with the group. The strategy allowed teachers to review what they had done and contribute to the doubts of other colleagues.

At the 4th and last meeting of Module 1, each of the nine small groups presented their answer on the research question proposed at the previous meeting, namely: "What are the conditions of teachers in the REM-NE formative process to develop their professional activities in the period of social isolation?" . Although all worked with the same data, it was observed that the groups analyzed different aspects of the data, such as: amount of hours worked (in all schools), per week, equipment they have to perform remote work, such as dividing remote work equipment with someone, internet connection and satisfaction with the space they have to perform the work remotely. Also, there was diversity in the types of charts used, comprising rod, sector, bar and histogram charts.

In general, it was possible to verify, at the end of Module 1, an evolution of teachers in relation to the appropriation of statistical concepts, especially in relation to expressing their conceptions, whether they are appropriate or not. This is due to the fact that the course provided the teacher with learning, as can be observed in the comments of teacher Mar (pseudonym).

It's great to be here sharing experiences and learning from you. I would like to thank Professor Sintria and Luana [instructors] for the discussion of the activity, for the suggestions and for the learning that occurred together with the two [small group]. This is the activity of Module 1, we made the representation there through two graphs, answering the question posed there at the beginning of the formative process #COMVIDa in Module 1. (Extract from the Protocol of the 4th Meeting comment teacher Mar).

The comments of the teacher Mar highlight the importance of exchanging experiences with the instructors, when accompanied by the researchers in the

small group. Follow-up that was prioritized during the formative process and that supports the teacher in his studies and learnings.

## **MODULE 2: THEORETICAL STUDIES ON EQUITY**

A week before the start of Module 2, teachers answered a questionnaire, through Google Forms, with the aim of understanding their perspectives on equity, social justice, cultural, economic, and racial issues, and relationships with mathematics teaching and learning. The results of this questionnaire are presented in Santana *et al.* (2020) and point out that before starting the module, teachers' perspectives approach the principles of equity. However, few perceptions were identified for support and opportunities that can be offered to students considering socio economic issues, cultural, racial and social justice issues.

At the beginning of the module, the teachers were divided into groups, and each group read and discussed Carrijo's paper (2014). The nine groups reflected on how to take what they learned from reading to their teaching practice, as a teacher who teaches mathematics.

In the only synchronous meeting of this module, teachers presented their reflections with the instructors and with professor Mariana Souto-Manning (professor and researcher at Teachers College/Columbia University) who participated as a guest. During the discussion, the teachers addressed many aspects related to Carrijo's paper (2014), such as: the social power of Mathematics, mathematics as a political act, mathematics as a tool of social transformation and criticism of the vision of mathematics as exclusive to intelligent people, as an instrument of the market and as a purely cognitive view. In addition, they related the reflections of the paper with personal experiences, such as family and school experiences and with their pedagogical practice. We highlight the understanding of the difference between equity and equality, indicated in the comment of teacher Júa (pseudonym):

One thing that we put was, for example, equity, it aims precisely to think about the needs of each individual, this is the difference of equality, it is not only to really provide equal conditions but to think even in the needs of each individual. (Extract from the Protocol of the 5th Meeting comment by teacher Júa).

It is noticed, therefore, that the module provided teachers with reflecting on how to exercise their practice in a context of equity and advances in relation to the answers given in the form answered at the beginning of the module.

## **MODULE 3: THEORETICAL STUDY OF DIDACTIC AND METHODOLOGICAL ELEMENTS**

Module 3 began with a discussion with teachers about their understanding of what an investigative lesson means from a word cloud activity using the interactive presentations site mentimeter.com. The most common words pointed out by teachers were "knowledge", "reflection", "learning", "challenging", "participatory", "action". After this moment, the trainers invited a teacher and a teacher who had already experienced the PPDAC Investigative Cycle in 2018 and

2019 to report their experiences. The teacher reported the development of an investigation to know if students from other classrooms had already suffered some kind of Bullying. The teacher reported the research conducted with 9th grade students on how the immunization situation was through vaccination of students. At the end of the meeting, the teachers were instructed to perform an activity in the small groups, which consisted of elaborating the first part of the teaching sequence, which described the theme and problem of research to be developed.

During the following week, in the small groups with the guidance of the instructor, each teacher chose a theme and elaborated a research problem. These themes and problems were discussed among them, with only one theme being chosen by each group and a problem for the elaboration of a teaching sequence, considering what is proposed in the PPDAC.

At the second meeting of Module 3, each group presented the chosen theme and the problem. The themes were: access to remote classes; carrying out school activities during the pandemic period; use of social networks by students; entertainment in the pandemic period; connectivity as a booster of education; impact of agglomerations on political rallies during the pandemic; functioning of classes during the pandemic. All themes focused on phenomena related to the pandemic period and ranging from personal issues to collective community issues.

The teachers demonstrated that they were able to expand their knowledge about the Investigative Cycle and the teaching of statistical concepts, as we can see in the words of teacher Ete (pseudonym).

I want to thank the instructor team, professor Elizabeth who did the mediation that was very significant. We learned a lot. I asked questions in this course with professor Elizabete. I also thank the colleagues who participated and in a collaborative way we built this first phase of work. Thanks to the whole team, I am delighted. In the year 2018 when this Investigative Cycle was presented, I even talked about another course, I was delighted with this work proposal. (Extract from the Protocol of the 7th Meeting comment teacher Ete).

The learning that is recognized by the teacher is mentioned as a result of the support she received from the instructor. This follow-up becomes important to boost actions in the formative process. In module 3, the discussion was provided about how to choose a relevant theme to enable the student's citizen education and how to conduct the phases of the PPDAC ensuring work with investigative thinking.

#### **MODULE 4: ELABORATION OF TEACHING SEQUENCES**

In the two meetings related to Module 4, the objective was to experience the PPDAC investigative cycle. Asynchronously, the teachers watched a video that addressed the planning phase of the investigative cycle. They then met with the instructors in the small groups to carry out the sequence planning. In the subsequent synchronous meeting, the teachers presented the planning and all participants were suggesting points to be improved. Thus, each small group took the suggestions for adjusting the planning.

After the meeting, the teachers, in the small groups, elaborated the data phases, analysis and conclusion. Then, the sequences were developed with

students from their respective classes. It is important to point out that the activities were all performed remotely due to the pandemic context. Applications such as WhatsApp and Google Forms were used for data collection and Google Meet for contact with the students.

At the next formative meeting, teachers presented the sequence and the results obtained. All reported good experiences with regard to their own learning and student learning and highlighted the difficulties with the activities performed remotely. Such aspects can be noticed in the comments of teacher Mar (pseudonym).

We did and realized that families can not keep up with these activities, we asked these questions, whether it was daily, two to three times a week, or if weekends, or if they could not follow, to our surprise, I think the same families, that we crossed the data of the children who did not do the activities. (Extract from the Protocol of the 9th Meeting comment by teacher Mar).

The report indicates that the non-performance of the activities is related to the lack of frequent follow-up of the children by the family. This observation made teachers reflect on the family's support for the development and engagement of children.

Overall, the teachers made a positive evaluation of the activities developed with their students and highlighted the difficulty of remote work with their students and how much they were able to learn from the development of the teaching sequence.

## **FINAL CONSIDERATIONS**

The online formative context, provoked by the impossibility of face-to-face meetings, brought, at the same time, opportunities and challenges. One of the opportunities was the possibility of integrating teachers and researchers from all states and cities participating in the REM-NE Network, which allowed integration, knowledge of different realities and exchange of diverse experiences. A major challenge stems from the little experience of many teachers with the use of Learning Management Systems, web conferencing systems and the instant messages apps adopted, such as Telegram and Google forms. This challenge has become an opportunity for teachers to become familiar with these tools, as well as for the team that had to (re)build and give meaning to what was previously planned for the course. Having a team with undergraduate and graduate students, who can be considered digital natives, contributed greatly to the success of the actions developed by the REM-NE Network.

In this sense, we highlight the diversity of possibilities constructed during the formative process with a view to the exchange of experiences, whether in synchronous or asynchronous format, which enables possibilities of interactions with different digital genres and, above all, provides participants with dialogical spaces that are characteristic of a virtual environment. However, we found difficulties regarding the frequency of synchronous and asynchronous activities by teachers. About 17% abandoned the formative process. Among teachers' reasons for drop-out was the high demand for school activities that were being developed in the remote format and the double working day performed in their homes due to the context of the pandemic.

In summary, what empirical evidence brought through the formative process can help to reflect on the Professional Development of teachers who teaches Mathematics and Statistics in a critical and equity perspective? First, it needs to bring, to the school context, discussions such as those that were woven in the course so that teachers can appropriate the statistical knowledge, considering that these report gaps in their preparation. Second, to provide challenging situations that involve collaborative work and that lead teachers to explain their ways of thinking anchored in action models such as the RePARE methodology and the PPDAC Investigative Cycle, proposed in this work. Third, it is necessary to problematize with teachers what their conceptions of equity are and how they have been developed in the school context in which they operate. Last, but not least, it brings to the focus of discussions, the reflection on thought and mathematical relations as discussed by Spinillo, Lautert and Borba (2021).

In this sense, the problematization of the professional development of the teacher that is supposed to theoretically occur in a continuous movement throughout his professional career permeates: specific knowledge of mathematical content; knowledge about teaching practices that enable work with the student; develop formative processes with the entire school community addressing themes, difficulties and phenomena inherent to itself noosphere that teachers are inserted; have the participation of the university in the formative processes constituting communities of practice; having critical education as a formative scenario valuing work with equity; provide the use of technological tools; value the processes of reflection and collaborative planning.

In general, the results of this study indicate that the relationships established between members of the professional learning community composed of teachers, school managers and members of the research group were effective. As well as the dialogue, the exchange of experiences and the union to study, plan and put into action the plans made. If, on the one hand, the professional development of teachers implies dialoguing with the school reality, providing opportunities for teachers' learning experiences.

On the other hand, it showed the fragility of bringing a teacher's work into the classroom, on bases that follow beyond the process of equality that is established naturally in the Brazilian educational system. And, that promotes a teaching practice that guides the opportunities for students to achieve learning according to their needs and difficulties and supports students, so that this learning boosts achievements and accomplishments in their lives.

Professional development should be carried out at the school site, in order to consider the planning time of teachers and emphasize collaboration between teachers, instructors and researchers. Teachers should have more voice in deciding the school contents to be taught from their experiences, have the possibility to be co-authors of learning activities and reflect on the teaching and learning of students. These principles can be considered the cornerstone of a new model of professional development of teachers in Brazil.

Thus, the research proposed sought to contribute to a model of professional development that can reduce the gaps in achievements of disadvantaged students.



# REDE EDUCAÇÃO MATEMÁTICA NORDESTE: DESENVOLVIMENTO PROFISSIONAL E ENSINO DE ESTATÍSTICA EM UMA PERSPECTIVA CRÍTICA E DE EQUIDADE

## RESUMO

Este artigo tem por objetivo principal problematizar o desenvolvimento profissional de professores que ensinam matemática ao participarem de um processo formativo on-line, realizado no âmbito de uma comunidade profissional de aprendizagem, que visa abordar a equidade no ensino de conceitos estatísticos. A pesquisa é apoiada em referenciais teóricos de Desenvolvimento Profissional, princípios e dimensões de equidade para a aprendizagem em matemática e características de uma comunidade profissional de aprendizagem. A pesquisa foi desenvolvida pela Rede Educação Matemática Nordeste (REM-NE), que é composta por oito universidades situadas em quatro estados do Nordeste brasileiro e uma no Sudeste. O processo formativo aconteceu em 2020, com a participação de 51 professores de oito escolas do ensino fundamental, parceiras da REM-NE, durante a pandemia da COVID-19, e concluído por 38 professores. A espiral RePARE (reflexão-planejamento-ação-reflexão) deu sustentabilidade para as ações formativas, distribuídas em Grupo Grande, com todos os professores e pesquisadores, e em Grupos Pequenos, formados por um quantitativo de, no máximo, seis professores e um pesquisador (formador). Todo o processo ocorreu de maneira on-line, fazendo uso do Telegram, do WhatsApp e das aplicações do pacote G-suite: Google Classroom, Drive, Meet e Google Forms. Para alcançar o objetivo deste artigo, analisamos dados coletados nos encontros do Grupo Grande: gravações; diários de bordo de nove encontros formativos; instrumento de perfil; diagnóstico do conhecimento específico; questionário sobre a perspectiva a respeito da equidade, além de diários de bordo dos encontros dos Grupos pequenos. Os protocolos de pesquisa foram analisados, e os resultados indicam que as formações de professores precisam valorizar e potencializar o desenvolvimento profissional de professores, no sentido de abordar: conhecimentos específicos (nesta pesquisa, conceitos da estatística); conhecimentos sobre práticas de ensino que possibilitem o trabalho com o estudante. Além disso, envolver a comunidade escolar abordando temáticas, dificuldades e fenômenos inerentes à própria noosfera em que está inserido o professor; ter a participação da universidade nos processos formativos, constituindo comunidades profissionais de aprendizagem; ter a educação crítica como cenário formativo e valorizar o trabalho com equidade; proporcionar o uso de ferramentas tecnológicas; dar valor aos processos de reflexão e planejamentos colaborativos. Os resultados indicam que esses são pontos inerentes e necessários a serem considerados em um processo formativo que vise ao desenvolvimento profissional.

**PALAVRAS-CHAVE:** Rede REM-NE. Processo Formativo. Equidade. Ensino de Estatística.

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## NOTES

1 The Education Observatory Program, funded by CAPES agency, aimed to provide the articulation between graduate, undergraduate and basic education schools and to stimulate academic production and the formation of postgraduate resources, at the master's and doctoral level.

2 Com Vida means With Life and refers to the Covid-19 pandemic.

3 Available at: [https://edu.google.com/intl/ALL\\_br/products/workspace-for-education/](https://edu.google.com/intl/ALL_br/products/workspace-for-education/).

4 Available at: [https://www.whatsapp.com/?lang=pt\\_br](https://www.whatsapp.com/?lang=pt_br).

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