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Teaching practices in a context of adapting to Emergency Remote Teaching: contributions from Cybereducation with digital videos

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Abstract: The post-pandemic context has shed light on the urgency of continuing education actions that are concerned with teaching with digital technologies (TD) and fundamentally provide a critical reflection on teaching experiences in this context. The objective of this article is to reflect on the teaching practices of the participants of a training course in the process of adaptation to Emergency Remote Teaching (ERE) and on the contributions of Cybereducation in this process. The course took place at IFSP/Hortolândia (SP) and was adapted to ERE. Narrative research was adopted and focused on the participation of three teachers in a task that involved the production of a mathematical activity with video. Data analysis was anchored in the assumptions of Cybereducation and cultural practices, in the light of complexity. The training actions based on Cybereducation contributed to the organic dynamics of a complex system and to the process of (re)constitution of the participants' teaching cultural practices.

Keywords: Teaching Learning. Complexity. Digital Technologies. Financial Education. Geometric Progression.

Prácticas docentes en un contexto de adaptación a la Enseñanza Remota de Emergencia: aportes desde la Ciberformación con videos digitales

Resumen: El contexto pospandemia vislumbró la urgencia de acciones de educación permanente que se preocupen por la enseñanza con tecnologías, siendo fundamental proporcionar una reflexión crítica sobre las experiencias docentes en este contexto. El objetivo de este artículo es reflexionar sobre las prácticas docentes de los participantes de un curso de formacion en proceso de adaptación a la Enseñanza a Distancia de Emergencia (ERE) y sobre las aportaciones de la Ciberformación. El curso tuvo lugar en IFSP/Hortolândia(SP) y fue adaptado a la ERE. La investigación narrativa se centró en la participación de tres profesores en una tarea de producción de una actividad-con-video. El análisis de datos se ancló en los supuestos de la Ciberformación y las prácticas culturales a la luz de la complejidad. Las acciones formativas contribuyeron a la dinámica orgánica de un sistema complejo y en el proceso de (re)constitución de las prácticas culturales de enseñanza de los participantes.

Palabras clave: Enseñanza Aprendizaje. Complejidad. Tecnologías Digitales. Educación Financiera. Progresión Geométrica

Práticas docentes em um contexto de adaptação ao Ensino Remoto Emergencial: contribuições da Cyberformação com vídeos digitais

Resumo: O contexto pós-pandêmico jogou luz na urgência de ações de formação continuada

que se preocupem com o ensino com tecnologias digitais (TD) e fundamentalmente proporcionem uma reflexão crítica sobre as experiências docentes nesse contexto. O objetivo deste artigo é refletir sobre as práticas docentes dos(as) participantes de um curso de formação no processo de adaptação ao Ensino Remoto Emergencial (ERE) e sobre as contribuições da Cyberformação nesse processo. O curso ocorreu no IFSP/Hortolândia (SP) e foi adaptado ao ERE. Adotou-se a pesquisa narrativa e focou-se na participação de três docentes em uma tarefa que envolvia a produção de uma atividade-matemática-com-vídeo. A análise dos dados foi ancorada nos pressupostos da Cyberformação e das práticas culturais, à luz da complexidade. As ações formativas baseadas na Cyberformação contribuíram para a dinâmica orgânica de um sistema complexo e para o processo de (re)constituição das práticas culturais docentes dos(as) participantes.

Palavras-chave: Aprendizagem Docente. Complexidade. Tecnologias Digitais. Educação Financeira. Progressão Geométrica.

1 Introduction

In recent years, all sectors of society have been transformed to combat the COVID-19 pandemic caused by the SARS-Cov-2 virus. Especially in 2020 and 2021, with the implementation of Emergency Remote Teaching (ERE), teachers had to deal with disparities, since practically all teaching practices were permeated by technologies. *The COVID-19 Edition of the TIC Education 2020 report*, by the Internet Steering Committee of Brazil [CGI] (2020), shows that most of the measures adopted in schools to continue carrying out pedagogical activities during the pandemic relied on the use of applications, social networks, videoconferencing platforms, video recording of classes, Virtual Learning Environments (AVA) and virtual educational resources.

In this scenario, continuing education actions with technologies have become more urgent. Research on training actions with technologies, carried out before the pandemic scenario, already highlighted the valorization of the practice of participating teachers in the incorporation of digital technologies (TD) and the way in which reflections and shared experiences enrich the training processes. Among these studies, Zampieri (2018) highlights the importance of the flexible dynamics of the training actions, according to the needs and context of each teacher, Chinellatto (2019) highlights the articulation between activities with contents of interest to the participating teachers and the stimulus to the elaboration of their own activities with TD, which can encourage them to take activities with different technological resources to their classrooms, as stated by Andrade (2017). In addition, Barros (2019) reveals that collaborative work with the teacher in the classroom is a way for the teacher to reflect on their teaching learning with TD in the process. Thus, training actions can enable not only knowledge about technologies, but also their potential in mathematics teaching processes, so that teachers understand the actions with TD in their own training processes and can perceive the way in which mathematical knowledge is produced with this resource (Souza, 2022).

In this direction, Cybereducation is shown as a conception of teacher training that seeks to provide reflections and problematizations of teaching action with TD, as it composes a training *with* teachers and *with* TD, these being means for the constitution of mathematical knowledge. Souza (2020, 2021, 2022), Souza and Rosa (2021), Pinheiro (2020) and Schuster (2020) present results that show how formative actions based on Cybereducation can enable teachers to be trained beyond the simple use of TD, as the formative process provokes them to reflect on teaching practices with TD.

We also understand that Emergency Remote Teaching (ERE) implied the

(re)constitution of teaching and learning practices (Barros, 2019). In a research on ERE, developed in a period of seven months in 2020, Santos and Barros (2022) sought to reflect on the evidence of appropriation of TD by teachers, based on the reports of a group of Basic Education teachers from public and private schools about their practices in that period. The authors identified that the teachers' choices of TD reverberated the meaning produced by them in their teaching practices prior to the ERE (in face-to-face teaching), the offers of TD in the ERE and the institutional impositions of that period, among other factors. We agree with Barros (2023) that, just as the experiences prior to ERE influenced teaching practices during this period, the intense practical experiences with technologies in ERE generated learning and teaching learning (Honorato & Fiorentini, 2021) that cannot be ignored in the training and teaching contexts in the post-pandemic period.

Thus, we assume in this article that the transformations of the classroom that have occurred in the ERE have increased the need for continuing education actions that are concerned with teaching with TD. However, it is not just a matter of promoting a course, but of offering training that enables teachers to reflect on pedagogical practices with TD, in order to problematize the use of TD beyond a simple support, aid or fad. We believe that this is possible in a process that includes learning situations in which teachers enter the risk zone provided by the use of TD, full of uncertainties and limitations, but full of possibilities that emerge with TD. In it, it is possible to look at new paths, which perhaps would not appear without TD, and thus detach from situations in which everything is predictable, known and controllable in the classroom.

In this perspective, this article was conceived as an unfolding of the first author's doctoral thesis and expanded the discussions about the reflections on teaching practices experienced during the course "Youtube Videos in Mathematics Teaching", which took place in the first semester of 2020, at the Federal Institute of Education, Science and Technology (IFSP), Hortolândia campus (HTO). This course, configured as Initial and Continuing Training (FIC) and coordinated[1] by the first author, was planned to occur in a semi-presential way with the use of the Virtual Learning Environment (AVA) Moodle, but it had to be reorganized for the ERE. Therefore, our objective in this article is to *reflect on the teaching practices of the course participants in the process of adaptation to the ERE and on the contributions of Cybereducation in this process.*

To this end, anchored in the assumptions of the narrative research methodology (Clandinin & Connelly, 2011), we will present a section of the experience lived by three teachers participating in the course. To expose and discuss the data, we rely on the perspective of Cybereducation and cultural practices understood in the light of complexity. Due to the co-authorship, we will use the third person to refer to the actions of the first author, who also worked in the course as coordinator.

2 Cybereducation

We understand teacher training as something continuous, which is never finished and is configured as a totality of actions that constitute the figure of the teacher who, in turn, depends on lived experiences, conceptions and sociocultural aspects. Thus, the teacher is in constant training, in search of what Bicudo (2003) calls "ideal form", that is, the direction to be followed to reach this "ideal", which will never be achieved, this being a process called form/action. It is this conception of teacher training that underlies Cybereducation with *professories*[2] who teach

[1] The coordinator of an FIC course is responsible for its creation and development.
[2] The conception of Cybereducation presents the neutral gender in the spelling of the term *professories*, bringing

mathematics, “a conception of training that understands Digital Technologies (TD) as participants in the constitution of mathematical knowledge, not using them as a tool to speed up the teaching and learning processes or as motivation for such” (Souza & Rosa, 2021, p. 77).

In this sense, the term Cybereducation refers to the two main ideas of its conception: the first, through the term "cyber", related to the aspects of technologies; and the second, to the idea of teacher "training/action", in the sense of using digital technologies as the main factor of this training (Rosa, 2018). Cybereducation is therefore configured as a teacher-training-with-TD (Rosa, 2018), which defends a teacher's intentionality when being with technology, believing in the role of TD as a means of transforming society, teachers, teaching and learning (Souza, 2022). In this sense, we understand the insertion of TD in the classroom no longer as the use of technologies, as they are not auxiliary to learning, nor as tools for it (Rosa, 2018). We are talking about an experience, an experience with TD (Rosa, 2022), understood here as media, in the sense of means. Means that enable the constitution of knowledge and act on it. Therefore, they are part of the process or even the process itself, because they are involved in the act of thinking (Rosa, 2020).

In order to provide this understanding of TD, it is important that teachers in Cybereducation experience the role of students with TD, so that they are formed by experimenting and discovering numerous possibilities with them, and not just reproduce old practices with new resources. In this way, teachers can come to understand in practice not only the role of technologies as participants in teaching and learning processes, but also the pedagogical implications that working with TD can bring. Thus, it is "possible to rethink the mathematics we teach and want to teach, through new and different looks at mathematics, through [the experience] with TD" (Souza, 2022, p. 8).

In addition to mathematical training, Cybereducation involves a constant personal, social, cultural, cognitive evolution, among others, that is, it is not just about technologies, because the teacher is connected to the world (Rosa, 2015). This makes Cybereducation constitute a complexity of dimensions that permeate the teacher, understood here as directions/movements/flows in the midst of which various actions can be carried out. These are the philosophical, social, temporal, cultural, pedagogical, specific - mathematical, in our case - , technological, political dimensions, among others, which make up the desired image of those who teach mathematics, and which move and connect mutually, mixing with each other, as if they were paints of different colors (Vanini, 2015). We highlight the *specific (mathematical), pedagogical and technological dimensions* here, not because they are more important than others, but because they are the ones that will be evidenced in the analytical narrative presented in this article.

The *specific (mathematical) dimension* is understood as the doing of mathematics that happens when TDs participate in the teaching processes, which may occur in a different way from that in which they do not participate. This can occur when we analyze mathematical-activities-with-TD[3], when we socialize our own practices with TD and develop materials-with-TD. These actions can allow the understanding of the multiple connections of mathematics in practice, whether in the mundane reality or in the digital environment, "which expands the range

with it a political position to confront gender discrimination and "the social conception that heterosexuality can be adopted independently of the possible sexual orientations of each person" (Souza & Rosa, 2021, p. 77). Although we agree with this position, we have chosen, in writing this article, to use only the terms masculine and feminine (in parentheses), but we have not forgotten that there are other possibilities beyond feminine and masculine.

[3] The use of the hyphen in these terms is necessary to show that these activities and/or materials do not exist without TDs, as they only make sense with them.

of possibilities of meaning for [constituted] mathematics" (Rosa & Mussato, 2015, p. 41).

The *pedagogical dimension* seeks to promote reflections and discussions on the transformations that teaching processes undergo when TD are incorporated. Marked by dialog, questioning, reflection, these actions may include different mathematical educational processes, such as analysis of mathematical-activities-with-TD, elaboration of activities and work with resources that occur with cyberspace. Here, one of the main points is to provide situations for teachers to develop teaching materials or activities that take technological resources as means to expand, transform and/or enhance mathematical knowledge.

The *technological dimension*, in turn, is configured by the "understanding of the use of technological resources as part of the cognitive process" (Rosa, 2015, p. 70), as it understands that mathematics teachers will act in (and with) virtual learning environments and / or digital resources in order *to be-with-TD, think-with-TD and know-how-to-do-with-TD*, in which the constitution of knowledge happens with these resources.

To be-with-TD is the intentional action that occurs when we are connected to the technological resource(s) as means for the constitution of mathematical knowledge. *To think-with-TD* means perceiving oneself with TD, in such a way that they reflect the way of thinking, promoting thinking, which is shaped by them. And to *know-how-to-do-with*-TD is acting with TD itself, so that, when performing the action, I perceive myself doing and reflecting on it, constituting mathematical knowledge. Thus, this acting with TD makes me *be-with-TD*, that world made possible by the computer (or any other TD), from *to think-with-TD*, and it is in this situation that we have *to know-how-to-do-with-TD*.

Thus, from Cybereducation it is possible to think about the (re)constitution of teaching and learning practices with TD, since we are formed in a structured culture, in cyberspaces, by technologies as participants in the constitution of knowledge of teaching practice.

These considerations presided over the elaboration of the course proposal explained here, whose cultural practices were developed based on the considerations of the following section.

3 Cultural practices in the light of complexity

The growing study of Complexity Science is an interdisciplinary work concerned with collective phenomena that demonstrate emergence, self-organization and adaptation (Davis & Sumara, 2014). In this perspective, emergence is understood as something not predictable, something new, random (Almeida, 2010). Thus, the focus of complexity studies is on *complex systems*, which emerge from the relationships and interactions between the parts that, added together, are not the whole (Davis & Sumara, 2014). According to these authors, a complex system can also be called a *learning system*, as it self-organizes for adaptive behaviors that co-emerge with the interactions between the components of the systems and with the environment. Precisely because we need to be concerned with the union of notions that normally repel each other logically, such as unity and diversity or plurality, Morin (2007) conceives the idea of organizing complex systems as autoeco-organization, which means living organization.

In this sense, Barros, Simmt and Maltempi (2017) and Barros (2019) interpret the classroom as a complex system, that is, a learning system, in which the culturally emerging practices there are the system's own learning, characterizing the classroom as organic and dynamic. Therefore, we assume that the classroom "is a community characterized by its complexity, given the emergence of practices that reverberate from (and are produced by) different cultures" (Barros & Maltempi, 2022, p. 604). Thus, it is coherent to understand the

need for actions designed in/on/for the classroom not to ignore the real demands emerging there (Barros, 2019; Barros et al., 2017).

Thus, according to Davis and Simmt (2003), it is important that teacher education actions try to go beyond descriptions of learning and recommendations for teaching. For this, the complexity of the classroom cannot be ignored in these training spaces. Therefore, we consider that reflections on teaching practices in a training course that was self-organized to adapt to the emerging needs of the pandemic can reveal a lot about the practice of teachers with TD in their respective classrooms, since the course in question was transformed to meet the demands of the teachers themselves who worked in the classroom.

Barros and Maltempi (2022) present cultural practices as those characterized by cultures from other contexts and produced in dialogical relationships with the diversity of expressions manifested in the classroom. Thus, we understand that the manifestation of teaching and learning practices with technology by teachers participating in a continuing education course reveals teacher learning (Honorato & Fiorentini, 2021) that can contribute to the teacher's performance with TD in the classroom and about it. In this perspective, pedagogical actions can consider different domains of knowledge in the classroom, the emergence of intelligent collectives (learning collectives), the care with external interferences, the balance between prescriptive and proscriptive actions, and the interactions between different agents in the classroom (Davis & Renert, 2014; Davis & Simmt, 2003).

Thus, we understand, with Barros and Maltempi (2022), the importance that the analysis of the teacher's practices with TDs does not intend to establish some teaching methodology with TDs, but that it considers the organic, living classroom - that is, a place where teaching and learning practices are culturally constituted.

4 Methodology

The qualitative research approach (Bogdan & Biklen, 1994) was chosen because of the objective, which is to *to reflect on the teaching practices of the course participants in the process of adaptation to the ERE and on the contributions of Cybereducation in this process.* And because of our interest in the experiences of the course participants and collaborative interactions, narrative research was adopted (Clandinin & Connelly, 2011). According to Cristóvão (2015, p. 73), it is "a way of understanding the experience, lived in collaboration between researcher and participants over time, in a place and in interaction with all their own of each person".

The course, entitled "YouTube Videos in Mathematics Teaching", took place in the first semester of 2020, at IFSP/HTO, and aimed to promote training with TD in an integrated manner; enable moments of discussion among peers regarding pedagogical practice with TD, especially YouTube videos; and enable situations in which teachers could understand the potential of videos in the process of constituting mathematical knowledge. The meetings, which would be face-to-face, took place via Google Meet, due to the COVID-19 pandemic. The course was attended by nine teachers who teach mathematics in the São Paulo state school system, both in high school and in the final years of elementary school.

According to the Cybereducation conception, theoretical and practical activities were developed in the course through readings and discussions of texts; analysis of activities with YouTube videos from various sources; realization of activities with videos; and elaboration and development of mathematical-activities-with-videos by the participants in their classrooms. The field texts produced, as the data in narrative research are called, were composed of questionnaires applied during the course; transcripts of the recordings of the meetings; records

of the activities carried out; reports written by the teachers during the course; and notes in the research field diary.

In this article, we present an analytical narrative about the experience lived by three teachers participating in the course: André, Carina and Daniel. The narrative was built from a section of the course, which considered a task consisting of three proposals (1, 2 and 3), carried out by the participants so that they produced a mathematical-activity-with-video, developed it in the classroom and socialized the results with the course class. Proposals 1 and 2 were important so that, in proposal 3, the objective of the task was achieved. Chart 1 presents the details of these proposals:

Chart 1: Proposals for a task carried out in the course

Proposals	**Description**	**Date it was carried out**	Tools for producing field texts
Proposal 1 — Getting to know Youtube videos	The participants visited some channels and videos that could be used in their classes. Then, they answered some questions related to these videos and proposed a lesson/activity with one of these videos. After that, they made a socialization with the group.	03/14/2020	Recording of the activity in text; Transcription of the recording of the discussions; Researcher's field diary.
Proposal 2 — Analyzing two activities with videos	The participants should analyze and discuss two activities, shared by the coordinator, on the concept of Function from an excerpt of the movie Os Normais 2.	03/21 to 03/28/2020	Recording of the activity in text; Transcription of the recording of the discussions; Researcher's field diary; Reports written by teachers during the course.
Proposal 3 — Elaboration of an activity-with-video	In groups, the participants produced a video activity, whose theme and video were chosen by them. The objective was that such an activity was designed to be developed in their classes, in the schools where they worked. After that, the groups socialized the experience of producing an activity and taking it to school.	04/18 to 07/04/2020	Recording of the activity in text; Transcription of the recording of the discussions; Researcher's field diary; Questionnaires applied during the course; Reports written by teachers during the course.

Source: Research Collection

In order to reflect on the teaching practices of teachers André and Daniel and teacher Carina and on the contributions of Cybereducation in this process, we follow with an analytical narrative. In addition to the statements and written manifestations of the teachers, the narrative brings interventions by the researcher Marília, who acted as coordinator, actively participating in the development of all proposals. Given the space limit, some excerpts of speeches and manifestations of the participants are presented in italics between double quotation marks in the body of the text, without identification in parentheses. Excerpts longer than three lines are presented followed by the following identification: (Teacher, Activity Identification, Place where it took place, date).

5 The emergence of a mathematical-activity-with-video-and-with-Google-Forms

Teachers André and Daniel and teacher Carina, from the beginning of the course, demonstrated affinities and built a good relationship. Therefore, we will first tell a little about them and her.

André and Carina already knew each other, as they had worked in the same school where Carina was still working at the time. André had 6 years of experience as a teacher and taught in 2 schools, one of which was part of the Comprehensive Education Program (PEI)[4], totaling almost 60 hours of weekly work classes. He was doing the PROFMAT professional master's degree and studying Pedagogy in a Distance Education course. He also acted as pedagogical coordinator when he worked with Carina.

André stated that he liked technologies very much, and this encouraged him to use them in his classes, as he wanted to *"provide students with classes that [were] more attractive/interesting"* and he believed that technologies could help with this. When he started the course, he did not usually use videos in his classes, although he indicated some channels to students to complement their studies. As he also taught Physics, he sometimes used a video with experiments, because, according to him: *"it is often not possible to carry out experiments in public schools due to lack of laboratories and materials"*. For the teacher, the lack of structure in schools was a hindrance to the use of technologies, *"because many* [schools] *have only one projector or one laptop to share among all teachers/students"*.

Teacher Carina had more than ten years of classroom experience and had taken specialization courses and also the PROFMAT professional master's degree. In addition, she served as a supervising teacher in PIBID from October 2018 to March 2020, with students from the IFSP/HTO Mathematics Degree course. During the COVID-19 pandemic, she tried to reconcile remote school work, course activities, her tasks as a housewife and mother. It was a very stressful time for her, who often vented to her course mates, stating that she was *"feeling a little bit of difficulty at this point [reconciling all activities]"*.

Carina said she was a teacher focused on traditional teaching practices, with expository classes and focused on the exercise paradigm (Skovsmose, 2000), but felt the need to start using technologies. She saw technologies as an aid for the teacher, or as a way to motivate students, believing that they *"serve to assist us, enrich the classes, make them more attractive to students"*, which led her to emphasize that TDs *"should not replace the traditional (blackboard, chalk, exercise lists)"*. In addition to not having ease with the use of technologies, she said it was very difficult to use them at school, because, as there were few resources, they were very disputed. In addition, in the few times she had tried to use some technological resource, her experiences had been frustrating: *"It seems that technology runs away when I want to use it, it doesn't go"*, said Carina.

The third member of the group, Daniel, had a background in Physics and Mathematics, and had already completed a Master's degree with a focus on Field Theory in Cosmology. In general, he was interested in science and technology, which led him to use different technological resources in his classes, although he had never had specific training for this. He was also a teacher at a PEI school, having already taught some specific subjects with technologies, as he reported in the initial questionnaire: *"an elective course at PEI on Digital*

[4] The Comprehensive Education Program (PEI) offers students a daily day of up to nine and a half hours, with study guidance, preparation for the working world and assistance in developing a life project, in addition to elective subjects, which are chosen according to their objective (São Paulo, 2019).

Media, video recording and editing, Stop Motion, Application Creation, and another with Arduino for Robotics, and unusual devices". The videos were already part of Daniel's practices, who said he used them *"for greater understanding of the students [...] to introduce, exemplify and clarify topics in Physics and Mathematics in Experimental Practices classes"*. In other words, the practical experiences with video made by the teacher were to introduce or exemplify physical and mathematical content, but not necessarily as part of a lesson thought-with-video.

5.1 The first and second proposals of the course

The first proposal of the course was to search for any video on Youtube and propose a math lesson with that video. In this context, Daniel, André and Carina expressed their first impressions about the use of videos. Daniel suggested the use of videos to *"facilitate the understanding"* of mathematical concepts, André considered the function of the media *"only as a support"* in his classes, presenting *"techniques and tricks"* for solving exercises. Carina, in turn, stated that she would use the video as a resource capable of solving students' doubts about *"why they have to learn mathematics"*. Although Carina, André and Daniel had different experiences with technologies in the classroom, their conceptions about the use of TD in teaching and learning processes were related to attraction, entertainment, motivation and/or assistance, which is not in line with the conception defended in Cybereducation (Rosa, 2015, 2018, 2022). We also observed that the initial decisions of teachers Daniel and André reflected learning from their practical experiences with videos, prior to the ERE, and Carina's choice seemed to be linked to the expectation she had about the videos, based on a probable prior knowledge of their pedagogical use. The choice fell on Os Normais 2 (Alvarenga Junior, 2002).

The second proposal of the course asked teachers to analyze and discuss two activities, presented in Seidel (2013). The activities involved the concept of Function through the use of the same video, an excerpt from the movie *Os Normais 2*[5]. In one of these activities, the video was used as a data source to construct a graph with an electronic spreadsheet (Excel) and, in the other, the same video served as a trigger for a discussion that was not only mathematical: students were asked to read and interpret other reports that addressed the subject covered in the video from different points of view and, thus, answer questions that enabled reflection and interpretation of the mathematical concepts involved (Souza, 2020). Upon having contact with such activities, André stated that they *"present*[ed] *to students a better contextualization, because the choice of the video was of rare happiness, being able to deal with a subject, somewhat delicate for some, in a funny way"*, and that they would not be treated in a mathematics class without that video. For André, the activities presented gave *"students the opportunity to exercise their protagonism"* and to engage and learn from these activities, because *"the teacher [should] act as a mediator/facilitator of the process by preparing/choosing activities and videos that [provided] students with a desire to know the new, with an interaction between them [...]"*.

Knowing those activity proposals also led Daniel and Carina to rethink their practices, specifically those with videos. Daniel showed that the videos enabled *"better contextualization; creativity and presentation resources; better elaboration of mathematical activities; more interactive, exemplary and active pedagogical methods in the construction of knowledge for students"*. Carina evidenced the reflection on how *"the activities presented through the video can give the student a sense in what he is learning, because when he associates the content with an everyday situation, the assimilation is more effective"*. However, it would not be any activity capable of providing this meaning, but an activity in which *"the teacher works with videos using*

[5] Avaiable on https://youtu.be/30W8sqcQ_Ek. Last access: 02/28/2023.

a script, whose objective is to make students put their hands in the dough, giving them the role of protagonist, promoting debates, exchange of ideas and giving feedback".

Thus, the group began to demonstrate more reflections about their own practices, enabling much more than just knowing new and different tools. Carina highlighted that the course was *"bringing [her] another view on the use of technology"*. For André, the course was offering *"the opportunity to analyze why to use videos or any other technological tool in the classroom"*, and how they could *"choose or even produce, why not?"*.

We can observe a movement in which the participation of teachers was marked by transformations in the meaning they had previously had about teaching with technologies. These are indications that teaching practices were being rethought, that within that complex community of the course a new look at the role of video was emerging and that the lessons learned from previous experiences were being reframed (Barros, 2023; Honorato & Fiorentini, 2021). We realized, then, that the teachers began to glimpse different ways of thinking about TD in mathematics teaching, meeting the conception of Cybereducation, which was fundamental for them to be able to develop a mathematical-activity-with-video of their own, as we will see below.

5.2 The elaboration of the mathematical-activity-with-video

To start planning the activity, the first group meeting was marked by intense negotiation about the contents and themes that would be addressed, in which the group was able to expose their points of view, their demands, their wishes and their expectations to reach a definition that best suited their teaching contexts. Therefore, they decided to produce an activity focused on Financial Education, involving the concepts of progressions, to be applied in the first grades of high school, in an asynchronous and remote format.

It should be mentioned that the school year of the state public network of the São Paulo State Department of Education had resumed approximately one month ago (after the emergency recess due to the pandemic), remotely, through the application of the São Paulo Education Media Center (CMSP). Many changes and improvements were made both to the app and to the way schools organized and managed teaching activities. Teachers had to adapt daily to emerging phenomena in society as a whole and in the school community — for example, they had to use the educational content management platform Google Classroom to share activities with students.

It is also important to note that, at this point, teachers in the state network were not yet using videoconferencing for their classes, i.e., they were not conducting synchronous classes. The CMSP was in charge of the lectures, and the teaching staff of each school prepared activities, based on the lessons recorded by the CMSP, for the students to carry out at home. These activities were made available in different ways: in AVA; in text format sent by email, via chat applications (WhatsApp) or even in printed form to be picked up at schools by students and/or their guardians. Teachers had to consider the needs of students' families, while in some cases they had to use specific platforms such as Google classroom and CMSP. The rules varied according to schools and sometimes the challenge of meeting students' demands was fostered by external rules, which disregarded the reality of the classroom (Barros, 2019). Thus, a frequent concern was to be able to "reach" all students, leaving no one behind.

In the second meeting held to discuss the activity, the group presented a first idea and thus many reflections could be made on the planning and execution process. The group chose

to work with the video *Huguinho e Zezinho*[6], which tells the story of two twin brothers who only looked alike. Huguinho managed to save a thousand reals and decided to invest the money in savings, but as he did not understand how this application worked, he went to the bank, where the manager clarified his doubts about the income from savings. With this, the concept of compound interest is defined and how it is calculated is presented. Unlike his brother, Zezinho had a debt and decided to go to the bank to ask for a loan, also of a thousand reals. There he was received by the same manager who attended his brother, who clarified that the loan followed a pre-fixed rate at 8% per month. Without reflecting on the consequences of the loan, Zezinho closed the deal and, after six months, found himself in a situation where he would not be able to pay off the debt made because of the loan. This situation led Zezinho to ask for help from his brother, Huguinho, who was willing to help him with the money he had invested. At that moment, the brothers were surprised by the difference between the savings income and the interest charged on the loan.

The group understood that the students would have difficulties with the topic, because, for André, they *"have no idea what interest is... if they see a credit card, they think the limit is the money they have"*. Here we realize that the knowledge about the students implied in the reflections and decisions of the teacher(s) about the activity. The initial idea of the activity presented by the group was, from the situation brought by the chosen video, to work on the concepts of compound interest and the implications when making loans and applications. With this, they would also discuss a credit card account, as well as different ways of saving money, for example, capitalization bonds.

The story presented in the video led Carina to think that *"I could question them* [students] *so they can see the difference when we want and need money, how difficult it is, the interest is much higher than when we want to apply"*. This could lead to important discussions about Financial Education and, for Carina, more important than knowing how to do the calculations was to get students to critically reflect on bank transactions and charges.

Carina, André and Daniel identified with the problem presented in the video, due to the fact that it was part of their own daily cultural practices (Barros & Maltempi, 2022), and this contributed *to think-with-the-video* in order to develop a proposal that made sense to such practices and, consequently, could make sense to the students (Rosa & Mussato, 2015). At the time, the video allowed the group to think of an activity with an open characteristic, which invited students to ask questions and seek explanations, allowing them, by *being-with-the-video*, to "live online experiences through images and movements, being able to transform mathematical educational processes from the environment in which it is experienced" (Rosa, 2008), "in an open totality, which allows us to go beyond what is immediately given" (Seidel, 2013, p. 215).

During the discussions established by the group, the possibility of using Google Forms to carry out the activity was raised, as it was a technological resource that was being used by them and her in their classroom practices in this new context of ERE. The choice of this technology turned out to be fundamental in the elaboration of the activity. According to Carina, Google Forms was already *"giving more feedback from students"*. Here, we realized that the teachers' practices constituted in the school context were reflected in the course context (Barros, 2023), especially due to the knowledge they had about the format and functionalities of Google Forms, which allow the insertion of digital media, multiple choice questions, open questions, lists, among others. All this implied the group's actions in relation to the questions elaborated,

[6] Video of *M*^{3} – *Multimedia Mathematics.*

helping to define what would be most appropriate for the objectives they were proposing, because, as André stated: *"having the* feedback *from the form you can already know if you are going to the next step, which would be the calculation of the card bill"*.

> André: *[...] we were thinking of sending them* [students] *a form. Some open questions, you can even put some multiple choice questions, with the calculation itself, but the main idea would be* [to elaborate] *some open questions, for them to question exactly that, the interest ... because the video brings some explanations. [...]*
>
> Marilia: *Cool. I'm just thinking about one thing: they're going to watch the video, and it's like a class, right? And thinking that afterwards the teacher won't be there to ask them if they understood and see their doubts. Maybe it would be nice to put, on the form itself, a suggestion of some questions that they have already talked about in the video, just to see if, in fact, they understood...*

As the activities would be carried out asynchronously, during the planning, Marília showed her concern to know *"if, in fact, they [students] understood"*. To this end, Marília suggested that some questions about the ideas discussed in the video be elaborated, pointing out her own doubt: *"don't you need to know first if he [student] understood what was said in the video, and how would we be able to know if the student understood, if we are not there to ask the question?"*. Barros (2019) presents the (re)constitution of the practice of evaluating when students are engaged in an online community, because, in this context, the practice of evaluating involves new challenges, such as the fact that the teacher has no control over what the student is doing behind the screens. In this sense, although the use of Google Forms was a practice that everyone in the course already brought from their respective schools, there in the course, this same practice was (re)constituted (Barros, 2019), because it was a different context from the school context, with different objectives (Barros & Maltempi, 2022).

This theme had already been addressed in the course, and at the time Marília highlighted:

> *[...] when it's distance* [teaching] *we don't have that control* [over the students' actions]. *And there's no way to really have it, you can't guarantee that he did it, you can't guarantee that he saw it and, I don't know, it's a reflection that I even make, I was even talking to my coworkers, that maybe we're going to have to let go of that a little bit too, right? It's another kind of posture that we will have to have and these new times may impose this on us, right?* (Marília, Meeting 8, Google Meet, May 23, 2020).

The reflection made by the coordinator emphasized the *"new times"* we were living in, about how remote teaching or distance learning could change our attitude towards the control of students' actions and learning, so that *"when it is distance, we do not have this control and, perhaps, we will have to let go of this a little too"*. Barros (2023) emphasizes the importance of teaching experiences with TD prior to the ERE, as the learning from such experiences was important for the choices of TD and pedagogical strategies in the ERE. However, the author also points out that in the ERE such learnings reflected in teaching practices were re-signified, since they were (re)constituted in the new context - which, according to Barros and Maltempi (2022), is characterized by specificities and cultures - and will also generate new learnings for the post-pandemic future.

After this discussion, Daniel pointed out his concern about the specific content about AP and GP that should be worked on in the activity, which gave rise to this discussion:

> Daniel: *Just one thing, how would it apply for junior high school, won't it link with AP and GP content?*
>
> Carina: *I think we can make an association later, because it would actually be an application of GP. I*

think there is no need to stay on top, you could just make a link, an observation for them....suddenly a construction... of course, in the classroom it would be possible to enrich much more, to get with them to the formula of compound interest, so that, in this construction, they can see the general term....make them deduce to get there [to the concept of AP term, GP]. *I even looked for some videos that showed it, but I couldn't find it... they already play the direct formula and just say what's what... unfortunately I think this will leave something to be…*

Marilia: *I think this link you want to make, from what I read of the document, would be the closing of this proposal, right? It's like closing this one to start this other one from GP. [...]*

André: *That's why I think this form is important, because it will give us feedback....*

Daniel: *Do as was done on TED[-Ed][7], as I did in COVID* [another activity he had produced], *separate into activities that they will build....*

Carina: *But the idea of this is a single form, a single activity, you won't have to enter several, in the form itself have this question and go on...*

Marilia: *So put the video, it would be the first thing on the form, then a few questions relating to that video, and then the proposed credit card bill questions, is that it?*

Carina: *I don't think the bill will go on the form, will it, André? Will it be afterwards?*

André: *So, like Marilia is raising, we could do as Carina said initially, but we can do the form with the entire initial part, then we have the answers of the form for us to look at and see where the students are, and then, this credit card bill would be a second activity....there is no need to be a form, do an activity via Zoom and end with another video of the importance of financial education, of saving... Then we think about this finalization, maybe even the form with a single open question....for them to answer something ... [...]*

Carina: *Suddenly the closing would be to do these calculations already with the credit card bill, because it is a very interesting activity already... because whether we want it or not, if we had this activity in person, it would be much richer, flow much more..., but we have to think that the student will be alone, and you can't demand so much....* (Second meeting of the final activity, Google Meet, June 3, 2020).

In this discussion, Daniel drew attention to the initial objective they had thought of, which was to work on the contents of AP and GP. However, after the discussions in the group, Carina realized that the main objective would not be this and suggested *"making an association later, because it would actually be an application of GP"*, as she did not see the need to deepen the content. She also pointed out how different and *"richer"* the activity they were planning would be if it were developed in person, which would make it possible to *"get with them* [students] *to the compound interest formula so that, in this construction, they can see the general term, make them deduce to get there [...] unfortunately I think this will leave something to be desired"*. He expressed tensions related to the practices he used to have in person and the new practices that were emerging with the planning of the activity to be developed remotely. Such tensions and challenges reveal to us that, when considering the pedagogical dimension of Cybereducation, it is possible to identify the process of (re)constitution of cultural practices of those teachers involved in the planning of the activities-with-TD.

In the new teaching scenario, not only with the incorporation of videos, but mainly with the use of Google Forms and the development of the activity remotely and asynchronously, many transformations in teaching and learning occurred. Thus, there was a need for important reflections that implied the understanding that it was not a matter of transferring old practices to the new scenario. The group agreed that this would be an introductory activity for the GP

[7] The TED-Ed is an education initiative of TED, which aims to spark ideas and share knowledge from teachers and students around the world by producing videos and providing an international platform for teachers to create their lessons.

curriculum content, through a real situation - bank applications and loans. They decided

> *make the form with all the initial part, then there are the answers of the form to [...] see where the students are and then, this credit card bill would be a second activity [that] does not need to be a form, make an activity via Zoom.*

From this process of negotiations emerged the mathematical-activity-with-video-and-with-Google-Forms (Souza, 2022), elaborated by the group (Chart 2):

Chart 2: Clipping of the mathematics-with-video-and-Google-Forms activity produced by the teachers

In the following video two brothers go to the bank with different intentions — one to invest and the other to take out a loan. Watch the video and observe how compound interest is used in each of the cases, then answer the proposed questions. If necessary, you can use other available resources, such as internet research and use of the calculator.

1) After watching the video, describe what you understand profit to be?

2) Describe in a few words what you understand about interest?

3) The interest rate that Huguinho will receive by making the investment is different from the interest rate that his brother Zezinho will pay by taking out a loan. Why? Does this always occur?

4) Huguinho invested in savings, are there other types of investments? (Remember that you have many resources at your disposal, feel free to do research or use other resources).

5) Why, after 6 months, was the amount that Zezinho owed after taking out the loan greater than the amount that his brother Huguinho owed after making the investment?

6) At the end of 6 months how much interest will Zezinho pay the bank?

7) At 4 minutes 30 seconds, the video gives an explanation of how the calculation is performed. Use this explanation to calculate how much Zezinho would receive if the amount applied was R$100,00 and the total time was 3 months.

Look at the calculations below to answer the next questions:

Let's analyze Huguinho's application to try to find the formula for compound interest:

Value applied (Capital): R$1.000,00

Interest rate (i): 0,6%=$\frac{0,6}{100} = 0,006$

Time (n): 6 months

Observe what happens with the application month by month:

1º month: $1000 \cdot (1,006) = 1006$

2º month: $1006 \cdot (1,006) = 1000 \cdot (1,006) \cdot (1,006) = 1000 \cdot (1,006)^2 = 1012,04$

3º month: $1012,04 \cdot (1,006) = 1000 \cdot (1,006) \cdot (1,006) \cdot (1,006) = 1000 \cdot (1,006)^3 = 1018,11$

4º month: $1018,11 \cdot (1,006) = 1000 \cdot (1,006) \cdot (1,006) \cdot (1,006) \cdot (1,006) = 1000 \cdot (1,006)^4 = 1024,22$

Note the repeating pattern, thus:

5º month: $1000 \cdot (1,006)^5 = 1030,36$

6º month: $1000 \cdot (1,006)^6 = 1036,54$

⋮

nº month: $1000 \cdot (1,006)^n$

Since 1000 is the capital, we will call it C.

1,006 = (1 + 0,006), lremembering that 0.006 is the interest rate of 0.6%.

Following the reasoning, we have that:

$M = C \cdot (1 + i)^n$, where M is the amount or final capital.

8) Knowing the compound interest formula, how much will Huguinho have after 12 months?

a) R$1273,09

b) R$1345,9

c) R$2073,09

d) R$1074,42

9) And what will Zezinho's debt be after 12 months, assuming he has not made any payments?

a) R$2173,74

b) R$2518,17

c) R$3543,12

d) R$1074,42

10) Analyzing the image above, check what happens to the amount Huguinho put in month by month. What is added to make the calculations?

11) Can you associate the amounts of the sum month by month with a sequence? If yes, which one?

Source: Research Data

The elaborated activity shows how the group appropriated the story presented in the video, as it proposed questions related to it, for example: *"The interest rate that Huguinho will receive when making the investment is different from the interest rate that his brother Zezinho will pay when taking out a loan. Why? Does this always occur?"* and *"Why after 6 months, the value of the loan that Zezinho made was higher than the investment made by his brother Huguinho?"*. These questions dialogue with the video and take students back in the story, enabling critical thinking about financial operations and can make students *think-with-the-characters* and thus attribute meanings to the mathematical concepts involved.

We noticed in the activity the presence of old and new teaching practices of teachers (Seidel, 2013). We realized that in the process in which they and she appropriated the TD, the decisions occurred consistently with the teaching experiences that made sense to them (Santos & Barros, 2022). By inserting a text explaining the compound interest formula in the activity — for example, a reproduction of the textbooks —, we noticed an attempt to do, remotely, the same thing they would do in person, which was *"to get them to the compound interest formula so that, in this construction, they can see the general term"*, that is, *"make them deduce to get there [to the concept of AP, GP term]"*, as Carina said. However, it was not exactly the same old practices, because in the new cultural context of ERE and a course based on Cybereducation, the old experiences with TD were being resignified by those teachers and by that teacher, they were cultural practices that were being (re)constituted (Barros & Maltempi, 2022).

Indeed, the group showed an intentionality with the chosen video and it was clear that this resource acted as a participant in the whole process (Rosa, 2015, 2018). By launching themselves into the story lived by the characters in the video, the teachers transported themselves there, *being-with-the-video* and *thinking-with-it* and with all the problems discussed (Souza, 2022). These movements sharpened the group's creativity and enabled different questions to be raised about the video, which could lead students to interact with that media as well, thus acting in the constitution of mathematical knowledge.

Carina, Daniel and André finalized the activity and developed it with their classes in the schools where they worked. Given the purpose of this article, we do not focus here on the students' productions in carrying out the activity, but we highlight some of the impressions that the teachers and the teacher had with this development and that they shared with the whole

group.

According to the three teachers, the activity developed in the schools allowed them to understand the students' dependence on the teachers and allowed a careful look at their difficulties beyond calculations and mathematical concepts. According to André, students *"cannot interpret the data on a credit card bill"*, but in face-to-face classes this would not happen, because *"if we are there on the side it is easier to guide [...], direct them, give examples"* (André, Meeting 9, Google Meet, 07/04/2020). For André, they *"always want to be together"* with the teachers to carry out the activities, and for Daniel, during the execution of the activity *"dedication* [on the part of the students] *was lacking"* (Daniel, Meeting 9, Google Meet, July 4, 2020).

Upon hearing these considerations, Marília drew attention to the fact that everyone could reflect on their own practices about providing new behaviors to students, instead of blaming them. As observed by Barros (2019), students' practices are also (re)constituted in the face of the challenges of the presence of TD in our classes, especially because they are still very much based on expository practices and repetition exercises, which does not allow the active participation and initiative of students. Pointing out this reflection was important for Carina to realize that students are capable of *"building knowledge on their own"*, since, even without having had an expository class on the GP concepts, she was happy that *"five students were able to see that a single value was always increasing there. And many said: 'It's a sequence, it's a numerical sequence'"* (Carina, Meeting 9, Google Meet, July 4, 2020).

Therefore, the development of this activity revealed to the teachers participating in the course that the traditional classroom model to which they were accustomed does not provide conditions for students to develop autonomy, as they are always waiting for "someone", in this case, the teachers, to show the "right" way. In this sense, when the teacher understands the complexity of a classroom, pedagogical actions can intentionally take advantage of the diversity of ideas and other conditions that maintain the organic dynamics of the classroom (Barros et al., 2017; Davis & Simmt, 2003). Thus, students will have more opportunity to act autonomously and be more productive and less passive in the classroom. We agree with Skovsmose (2000) that moments of protagonism can occur when classroom practices are not only focused on the paradigm of exercise, but stimulate investigation from the activities, engaging students actively in their learning processes.

Therefore, we need to rethink and revisit our practices, in a movement of (re)constitution of the paths of learning and teaching mathematics (Barros & Maltempi, 2012), highlighting the fluidity and constancy of the process of teacher training/action (Bicudo, 2003) of teachers who teach mathematics. We understand that this will only be possible when the characteristics of classrooms and training communities are consistent with the organic dynamics of a complex system, so that the diversity of ideas brought by the members of such communities are not ignored but transformed (Davis & Simmt, 2003). In this sense, the structuring of the course "YouTube Videos in Mathematics Teaching", based on Cybereducation, contributed to the shared knowledge being transformed, in a process in which teachers were learning-with-videos about teaching possibilities.

6 Conclusions and final considerations

In this article we aimed to reflect on the teaching practices of three participants of the course "YouTube Videos in Mathematics Teaching", in the process of adaptation to the ERE and on the contributions of Cybereducation in this process. So, we looked at the development of a task composed of three proposals that aimed to lead participants to critically reflect on their

processes of producing a mathematical-activity-with-video. This took place in a context where the complexity of the school was clearly visible to all, as the school community was also self-organizing and adapting to ERE (Davis & Simmt, 2003).

The three teachers' view of the video in the first proposal reflected the culture and knowledge about videos that they brought from other communities and experiences (Barros, 2023; Barros & Maltempi, 2022). We were able to reflect on the indications that the practices of this group of teachers were being (re)constituted, while their view of the role of technologies in mathematics teaching was modified. We identified that, initially, the participants had a limited understanding of the potential of TD, due to factors such as: lack of structure in school environments for the use of TD; previous experiences seen by them as frustrated; and teaching experiences with TD, limited to the introduction or examples of mathematical or physical content. Thus, the initial decisions about the production of an activity with video were related to their practical experiences with this media in face-to-face teaching, and revealed cultural marks of previous experiences in other communities (Barros & Maltempi, 2022), such as, for example, the idea of using video as a tool, as an aid or as a motivation, which is contrary to what is understood from the perspective of Cybereducation (Rosa, 2015, 2018, 2020).

The task proposals valued the knowledge brought by the participants, as well as fed an organic dynamic of self-organization and adaptation of the course, which allows us to characterize that community as a complex system (Barros et al., 2017). The course was shaped by the adaptation not only to the ERE, but to the shared knowledge and the productions that emerged from them. In fact, we observed that the different ways of thinking about TD in mathematics teaching, manifested by the participants, were moving towards the conception of Cybereducation, when the videos began to be understood by the members of that system as participants in the process (Rosa, 2015, 2018, 2020).

The research showed that, in the training process, what was part of the participants' practices, such as the use of Google Forms, was resignified in the ERE environment. Therefore, the pedagogical, mathematical and technological dimensions of Cybereducation, present in the course proposal, contributed to the teachers negotiating and producing knowledge among themselves and with the videos, so that the mathematical-activity-with-video-with-Google-Forms emerged. If the course did not consider the culture and knowledge brought by the participants, marking that community with its own characteristics and valuing the practices that are culturally constituted in a complex system (Barros & Maltempi, 2022; Davis & Simmt, 2003), Google Forms would possibly not be present or its use would be imposed, in an attempt to "transfer" to the course what they already did. Therefore, we evidenced the presence of the technological dimension when teachers chose and launched themselves into the video and decided to work with Google Forms. This enabled them to *think-with-Google-Forms-and-the-video*. The pedagogical dimension was highlighted in the process of elaborating an activity-with-video that would be developed in their school realities, in which they were able to place an intentionality in *being-with-the-chosen-video*, because it brought a problem that was part of their own daily cultural practices, which contributed to *thinking-with-the-video* a proposal that made sense for such practices and that, consequently, could make sense to the students.

The activity-with-video-and-with-Google-Forms elaborated by the group enabled reflections and connections with real situations, and could allow an enhancement or an expansion of the mathematical knowledge worked on, based on a thinking-with-video. However, it was not the simple presence of this media and the digital form that engaged the students in carrying out the activity, because, according to Barros (2019), the emergence of learning collectives with TD is a very challenging process, since the members of this collective

see more sense in practices that were constituted without TD.

In this sense, we understand that the mathematical dimension was evidenced when teachers reflected on how the practices of teaching progressions through an asynchronous activity with video and Google Forms would be different from those they were used to, with face-to-face practices. These differences could be both mathematical and pedagogical, since the video, Google Forms and the open questions posed by the group would require different attitudes from teachers and students and would enable investigations and new discoveries by students.

Finally, we emphasize that, in this article, only the pedagogical, mathematical and technological dimensions were taken into account, however, we believe that, by considering the different dimensions of Cybereducation, such as social, political, cultural, playful, among others, we can advance with regard to the analysis of the process of (re)constitution of cultural practices of teachers who participate in these training actions.

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