The hybrid and multimodal training of graduate students in education

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ABSTRACT

This study is an excerpt from the research project entitled "STEAM Education: A Collaborative Construction with Sustainable Educational Robotics", under development with the support of CNPq and presents the experience of offering a discipline, developed, in a hybrid and multimodal way, with a STEAM approach and with a focus on Project-Based Learning. It was offered in the second semester of 2023 to master's and doctoral students in the Graduate Programs in Education linked to a private university in São Paulo. In this perspective, synchronous meetings were used, via Google Meet, asynchronous activities via Moodle/WhatsApp and face-to-face meetings.

Keywords: STEAM Education, Projects, Hybrid and multimodal teaching, Post-graduation, Training.

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INTRODUCTION

This work, reported here, is part of an excerpt from the research project entitled "STEAM Education: A Collaborative Construction with Sustainable Educational Robotics", ongoing since March 2023, with support from the National Council for Scientific and Technological Development (CNPq), according to CNPq Call No. 09/2022 - Research Productivity, in partnership with Universidade Nove de Julho (Uninove/SP/BRASIL). This project aims to analyze how Brazilian public schools, especially those that offer Basic Education, especially in high school courses integrated with technical education, can implement a pedagogical architecture oriented to Project-Based Learning (PBL), integrated with a STEAM (Science, Technology, Engineering, Arts and Mathematics) approach, aiming at the insertion of sustainable educational robotics in pedagogical practices. In this context, a hybrid and multimodal perspective was adopted to promote the training of master's and doctoral students linked to the disciplines entitled: Distance Education in the Digital Age: Fundamentals, Technologies and Online Practices and Culture, Education and *e-Learning*, offered in the second semester of 2023 in the Graduate Programs (*Stricto Sensu*) in Education at the aforementioned university located in the municipality of São Paulo, Brazil.

As both disciplines discussed learning and teaching in the online modality, as well as the use of digital technologies and the impacts of digital culture on Education, it was thought that the best way to lead students to actually experience this new way of teaching and learning, would be to offer part of the discipline in virtual mode and another part in the *face-to-face* classroom, in the hybrid format. In addition, these disciplines proposed to be supported by a STEAM approach and Project-Based Learning (PBL).

It was expected that throughout the semester, graduate students would be able to acquire enough knowledge to reflect on ways to resignify teaching and learning, using digital technological tools, in a STEAM approach. To this end, they were allowed to carry out readings, various individual and group activities, as well as to participate in moments of dialogue about the studies carried out on the topics addressed.

In this sense, the objective of this article was to highlight the formative action within the scope of the disciplines mentioned above. To this end, the theoretical framework that supports the reported experience is addressed, the methodological path adopted for the feasibility of this experience and data collection, the analysis and discussion of the results achieved with this research excerpt and, finally, the final considerations.

THEORETICAL FRAMEWORK

As we faced the consequences of the global covid-19 pandemic, one of the realities we had to experience was the need to offer remote education at all levels and modalities of education. The use of digital technologies as a means of mediation between teachers and students has become almost

mandatory. Today, many of those who were against teaching mediated by digital technologies are able to better accept the possibilities of using the tools offered to offer remote education.

These possibilities and technological tools can be combined with the virtues of face-to-face teaching in the methodology known as hybrid teaching. According to Moran (2015), hybrid teaching integrates face-to-face activities with virtual ones and allows personalized paths for the needs of students. For Valente (2015), in addition to combining face-to-face activities with activities mediated by digital technologies, hybrid teaching places the focus of learning on the student and no longer on the teacher. The student studies in different situations and environments. The face-to-face classroom becomes the space for debate and collective activities. For Bacich, Tanzi Neto and Trevisani (2015), in general, the definitions for hybrid teaching indicate the convergence of the face-to-face learning model with the online model, *where the face-to-face classroom and the virtual space gradually complement each other.*

About hybrid teaching, it is worth noting that it was mentioned as one of the examples for new pedagogical architectures, by Thuinie Daros in an interview for the Education Challenges Portal (2023). On the occasion, Daros listed in January 2023 five pedagogical trends to monitor throughout the year, namely: (1) ubiquitous learning; (2) learning objects and resources based on the attention economy; (3) cohort-based courses; (4) new pedagogical architectures and (5) new certification models[9]. These trends were reaffirmed in December of the same year, when asked again about these five trends that she had indicated to follow in 2023. According to Daros, hybrid models, by promoting the "integration of face-to-face activities with advanced digital technologies, create a richer and more engaging learning experience." (Education Challenges Portal, 2023).

According to Mattar (2022):

> [...] It can be predicted that hybrid teaching and learning may even become a requisition [...] at least in some specific situations. A theoretical (and practical) awareness may have developed that (and how) it is possible to properly combine face-to-face and online in the teaching and learning process. Perhaps it is no longer possible to defend a content-based and decontextualized distance education; But it may not be possible to defend a 100% face-to-face education, with little use of technologies and without "mixing" the online, more and more, in its practice. (Mattar, 2022, p. 14).

It is in this interaction and complementarity of teaching forms that the definitions of hybrid and multimodality teaching are connected. According to Schlemmer and Moreira (2020), multimodality is the educational modality that hybridizes different teaching modalities. The use of multimodality in teaching enables the integration of a variety of resources and technologies that transcend mere verbal exposure, incorporating different tools in learning environments; synchronous and asynchronous. This implies the diversified use of technologies, such as videos, *podcasts*, images

[9] For further information, see: https://desafiosdaeducacao.com.br/tendencias-pedagogicas-2023/.

and *online* meetings, among other possibilities. When considering education in its entirety, including its technological infrastructure, it becomes crucial, perhaps indispensable, to adopt new strategies capable of engaging teachers and, consequently, their students, encouraging them to actively participate in the learning process and making it more conducive to educational development.

In these different ways of making training processes viable, the STEAM approach is included. By opting for the STEAM approach, it was defined what kind of knowledge could be brought to the classroom, as a way to enrich the pedagogical work. This approach integrates Science, Technology, Engineering, Arts and Mathematics and is understood by Bacich and Holanda (2020), as follows:

> STEAM is not considered a methodology [...]. The STEAM that we defend is the one based on the realization of projects, which has project-based learning (PBL) as a methodology, and which will promote in students a sense of relevance of the scientific knowledge developed in basic education. (Bacich; Netherlands, 2020, p. 5).

Corroborating Bacich and Holanda (2020), the authors Maia, Carvalho and Appelt (2021), in one of their studies, also recognize STEAM Education as an approach to "pedagogical work", which contributes to the development of an "active" and "creative" learning process, favoring students in situations in which they are instigated to make choices, analyze and issue *feedback*, based on interdisciplinary projects, triggered to the search for the resolution of emerging real-world problems. "Experiences like these provide opportunities for higher cognitive processes such as perception, reflection, reasoning, generalization and reelaboration of concepts and procedures" (Maia; Oak; Appelt, 2021, p. 70). In this scenario, the way chosen to create a more conducive environment for the construction of this "active" and "creative" learning was the methodology known as Project-Based Learning (PBL).

According to Bacich and Moran (2018, p. 60), PBL:

> [...] It is a methodology in which students engage with tasks and challenges to solve a problem or develop a project that meets the needs of life. It is important to emphasize that in PBL the issues to be solved require interdisciplinary work, with students acting both alone and in groups. In these activities, critical thinking skills are exercised, as well as creative thinking.

PBL requires focusing on a real need. According to Bender (2014, p.15) "[...] PBL can be defined as the use of authentic and realistic projects, based on a highly motivating and engaging question, task, or problem, to teach academic content to students in the context of cooperative work for problem solving." In this way, the work in the STEAM approach and from the perspective of Project-Based Learning are articulated to build an educational environment that fosters autonomous work and that privileges the protagonism of students.

In this context, educational robotics has been understood as one of the technologies, demonstrating that it has progressed to a comprehensively educational and pedagogical proposal, discussed as a learning tool in the classroom, as well as the science and technique of designing and building robots. Santos, Moura and Araújo (2017) believe that educational robotics emerges as a didactic resource that can contribute to teaching and learning processes. The authors point out that educational robotics has been incorporated into teaching practices, allowing students to apply concepts learned in theoretical classes, favoring the development of skills such as logical reasoning, creativity, responsibility and cooperation. The Educa Brasil portal[10] defines educational robotics as a learning environment that brings together materials from scrap metal to *assembly kits*, with motors and sensors programmed through *software*, such as Arduino, which is a platform that enables the development of electronic projects, that is, it is an electronic prototyping platform. The Arduino is made up of *hardware* and *software*, thus making it possible to carry out various technological projects, which explain its operation (Menezes; Santos, 2015).

It is also worth considering, according to Chitolina, Noronha and Backes (2016, p. 57 *apud* Moala; Nunes; Custódio, 2022, p. 98-99), that:

> [...] Educational robotics, when applied in an articulated way to curricular content in the teaching and learning process in Brazilian schools, is managing to cultivate logical reasoning, a taste for scientific investigation and group work from a very early age. In addition, it can and becomes a space rich in possibilities for the development of creativity and support in the development of skills such as problem-solving skills, mutual collaboration, initiative, good oral and written communication, information analysis, problem-solving skills, creativity, curiosity and imagination of the student, the teacher and the institution in general.

Moala, Nunes, and Custódio (2022, p. 100) also emphasize that "robotics provides practical learning articulated with theory, and can be used as an attractive didactic-pedagogical resource, which makes sense and difference in the students' routine, as well as in the continuous training and development of teachers [...]". Thus, in the development of the experience portrayed in this study, it was expected to contribute to the training of trainers (master's and doctoral students) based on the STEAM approach and Project-Based Learning (PBL), aiming to promote a pedagogical practice that stimulates the exploration of new ways of developing projects in the context of Basic Education, including educational robotics.

METHODOLOGICAL PATH

The activities linked to the disciplines were carried out in 15 weekly meetings, in the second half of 2023. In this context, synchronous meetings were held through the *Google Meet platform,*

[10] Portal Educa Brasil: *Online portal* that offers continuing education courses, in distance education and with certification. Learn more: https://educa-brasil.com/.

asynchronous meetings using the Moodle Virtual Learning Environment and a group created on *WhatsApp, as well as face-to-face meetings in the format of* workshops at the university's facilities.

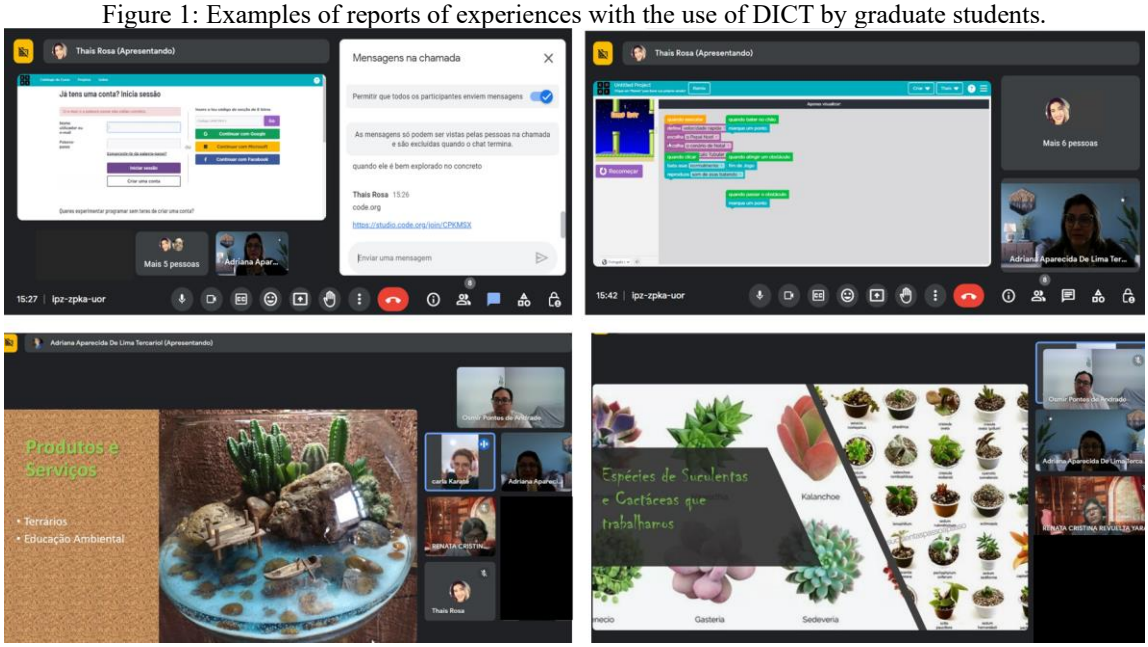
The following is a brief characterization of the direction of this formative process in the different modalities mentioned:

SYNCHRONOUS AND ASSYNCHRONOUS ENCOUNTERS

To carry out the *online* meetings that could allow a meaningful debate among the graduate students, as well as the interventions of the mediator professor, the videoconferencing platform *Google Meet* was used. *Google Meet* is an online meeting tool, which allows audio and video, instant communicator, and screen sharing. In this way, synchronous interaction was made possible in the meetings scheduled weekly on this platform. The university offers faculty and students full access to *Google* tools, which include videoconferencing services, without limitations on time and number of participants. In synchronous virtual meetings, an initial *brainstorming* was done , guided by the mediator teacher. It sought to support graduate students to understand the highlighted concepts, based on readings carried out in the week prior to synchronous classes, opening spaces for dialogue, criticism and reports of experiences, in line with the theme that was being addressed in each meeting, reaching the sharing of ideas to use this knowledge in favor of their pedagogical practices.

Next, the figure presented brings examples of images that exemplify the dynamics adopted online to provide graduate students with space to socialize research or classroom practices, since most were teachers in Basic Education. In these reports, they evidenced the use of DICT, in a STEAM approach, as tools that enhance a more active and creative learning, as mentioned earlier.

Figure 1: Examples of reports of experiences with the use of DICT by graduate students.



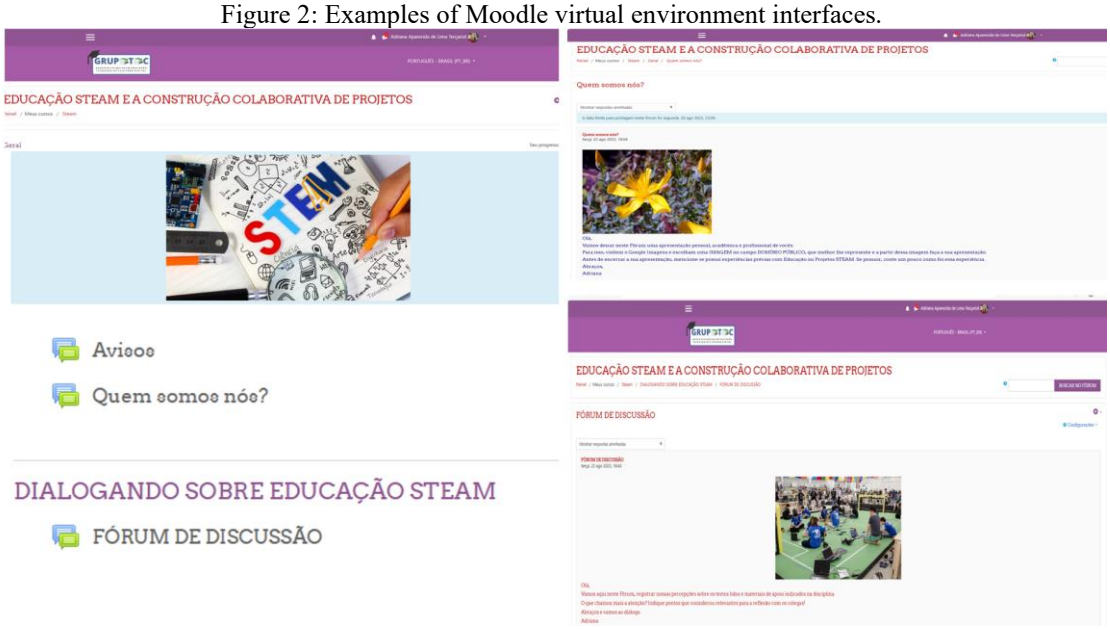
Source: Personal Collection of the Authors.

In the figure, above, specifically, the images presented at the top show the presentation of the Code.org platform[11], adopted by one of the graduate students for the elaboration of games in the early years of Elementary School within the scope of her Master's research, entitled: "The STEAM Approach and Project-Based Learning: the development of Computational Thinking in the early years of Elementary School" (Rosa, 2022). Through this presentation, her peers were able to learn about the methodological direction of her study, as well as understand some of the possibilities offered by this platform to the teaching and learning process about the curriculum to be addressed with the audience involved. In this same set of images, it is also possible to note the presentation made by another graduate student, who brought as her theme "Terrariums and Environmental Education". In her presentation, she showed how she led the development of a project with this theme in high school classes, where she works as a teacher. With this, the other graduate students were able to reflect on the importance of the theme in the context of Basic Education, as well as had the chance to identify numerous actions that can be broken down with the PBL methodology, in conjunction with STEAM, to stimulate student engagement in the development of artifacts, using reusable and technological materials.

The asynchronous activities, on the other hand, were carried out through the Moodle virtual environment. Moodle is a *free software*, to support learning, running in a virtual environment considered a "*Learning Management System*" (LMS), a Learning Management System, which provides a series of resources, synchronous and asynchronous, that support the learning process, allowing its planning, implementation and evaluation (Cefor, 2018). The dynamics used in asynchronous classes, via Moodle, usually began through contact with videos and texts. Then, questions and reflections were proposed, motivating interaction between participants in forums of the platform, created by the mediator teacher. These activities allowed students to learn about the theories covered in the course and discuss STEAM and PBL education. Below, the figure exemplifies interfaces adopted for the organization of this virtual environment, as well as illustrates the calls of two forums, one of which is dedicated to the personal, academic and professional presentation of graduate students, while the other was created for dialogue and exchange of impressions on the proposed readings that brought "STEAM Education" and "Collaborative Construction of Projects" as central themes.

[11] For further information, see: https://code.org/

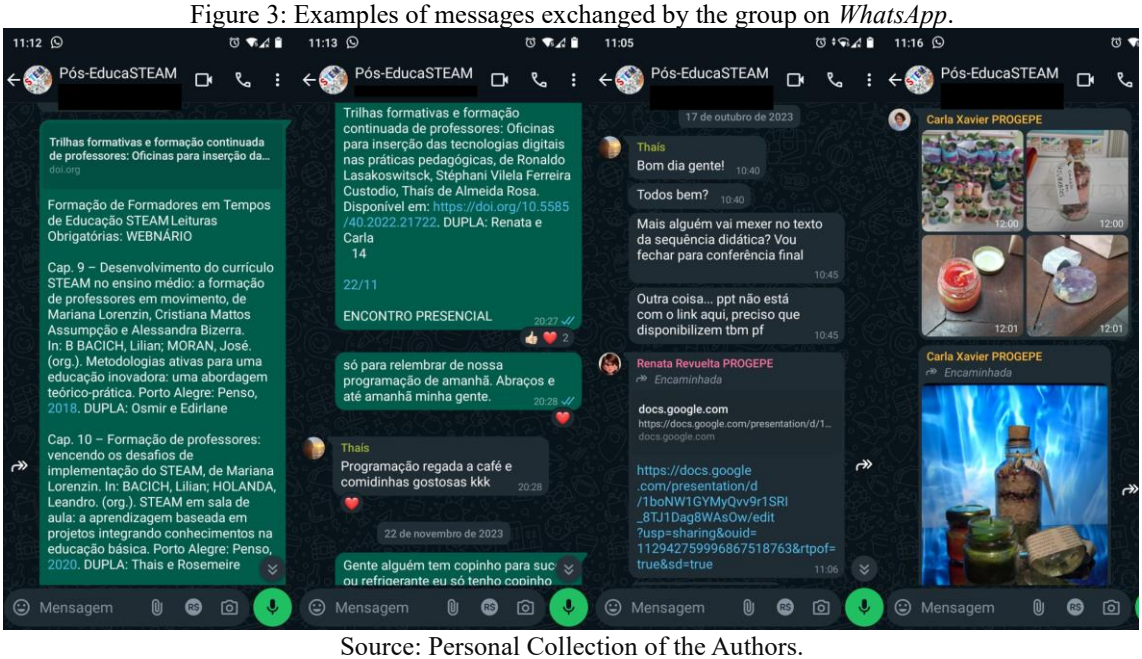
Figure 2: Examples of Moodle virtual environment interfaces.



Source: Personal Collection of the Authors.

Another resource used as an asynchronous space was the WhatsApp communication application. As everyone involved had access to the application by *smartphone* or *desktop* computer (or *notebook*), a messaging group was created on *WhatsApp.* In this environment, the mediator teacher shared documents and *links*, proposing and monitoring tasks and communicated with the group, both collectively and individually.

Figure 3: Examples of messages exchanged by the group on *WhatsApp*.



Source: Personal Collection of the Authors.

There was also the exchange of complementary materials between the graduate students in this space, other reports of experiences they were developing in their classrooms, in addition to those

shared on *Google Meet* and requests for support from colleagues for the development of some proposed activities.

Finally, the *online meetings* sometimes took place synchronously and sometimes asynchronously, taking place through different environments – *Google Meet*, *Moodle* and *WhatsApp*, which expanded the opportunities for dialogue, as well as the construction of new knowledge, skills and abilities, essential for teacher training in times of STEAM Education.

FACE-TO-FACE MEETINGS

In the time allocated to face-to-face meetings, preference was given to practical activities, such as the face-to-face workshops entitled "Basics of Educational Robotics" and "The construction of terrariums in a perspective of STEAM projects", carried out as part of the graduate program. They were conceived with the purpose of providing the participants of the disciplines with the construction of new knowledge, especially with regard to the design and implementation of STEAM projects in the context of Basic Education. This initiative aimed to allow teachers in training a practical experience of the principles they wish to apply in their pedagogical practices with their students.

It was expected that graduate students could experience, in their own training process, what they want to apply to their students in the future. For the dissemination of the STEAM approach to be effective in educational institutions, it is believed to be essential that teachers ponder these concepts, promote dialogues among peers and experience, in a practical way, the planning and development of STEAM activities. In this way, they will be able to acquire, in a more significant way, theoretical and practical subsidies to conceive and implement new practices capable of positively impacting the educational environment, mobilizing their inventiveness, previous baggage of knowledge and establishing partnerships, both internal and external to the school.

In this sense, the focus is not restricted to the mere transmission of content, but encompasses methodological and didactic aspects. It is crucial to understand that the integration of the STEAM approach to pedagogical practices, through active methodologies such as Project-Based Learning (PBL), requires a deep understanding and experience of these methodologies throughout the training process. This implies recognizing a continuous process of knowledge construction that goes beyond the mere assimilation of concepts in the classroom, training professionals to deal with emerging challenges, based on everyday situations in the school context, transcending the traditional boundaries of school disciplines.

In the first workshop, called **Basics of Educational Robotics,** the construction and programming of small prototypes of simple robots was proposed, using educational robotics kits and scrap electronic components. The objective of this workshop was to lead graduate students to learn about the principles of educational robotics, with basic concepts of Arduino programming, promoting

the reuse of electronic materials that have already been discarded. The trainer presented the available materials, the basic principles of assembly and the initial programming commands. Participants were challenged to create prototypes of simple robots and perform some basic movement commands. During the process of exploration in the construction of robots, the workshop participants experienced sensations and difficulties analogous to those of students when exposed to similar situations. This experience provided graduate students with a reflective opportunity on how they can mitigate certain challenges or facilitate others, in a more didactic and effective way, in the context of training aligned with the STEAM approach and PBL.

In the second workshop, called **The Construction of Terrariums in a STEAM Project Perspective**, the focus was to teach concepts of basic electronics and Biology. With basic gardening materials and remains of electronic devices, the graduate students should set up a terrarium with internal lighting in a glass jar. It was discussed during the assembly how it would be possible to create this environment, the terrarium, so that the vegetation there could stay alive even with the pot closed for months. After the resumption of the basic concepts regarding the maintenance of life indoors, master's and doctoral students were able to set up their own terrarium in the glass jars. Next, they were challenged to develop the electronic circuits that would allow lighting the inside of the pot. The workshop mediator taught the basic concepts of assembling electronic circuits for the installation of a small LED lamp. The activity of building the terrarium, together with the use of technology, fostered a reflection and dialogue among the participants about the adoption of diversified investigative approaches in the classroom, exemplified by the terrarium, and the potential contribution of this approach to the construction of scientific knowledge in the context of Basic Education. In this way, the learning objectives were achieved effectively, establishing throughout this educational experience a connection between different areas of knowledge, such as electronics and Biology.

DISCUSSION OF THE RESULTS

Based on the experience portrayed in this study, the graduate students were asked to prepare a Reflective Memorial at the end of the semester, of six participants, five of whom gave their testimonies about the experience lived. This Memorial was organized in *Google Forms* with 12 essay questions, but the data issued only in the questions indicated in the table below are presented and discussed. It is worth explaining that the testimonies shared in the table were chosen to exemplify the answers of the graduate students issued for each question presented.

Chart 1 – Excerpts from the answers.

Questions	Testimonials
- What have you learned or would you highlight as new in this discipline?	*The very way the discipline was offered was very productive, in the hybrid form. We were able to exercise the various tools for hybrid teaching via the meeting platform and the MOODLE system. In addition, the discussion and practice of the STEAM approach was very enriching. We were able to study the most relevant authors, elaborate and apply a project. It was great.* *We learned a lot about the STEAM approach, about active methodologies and project-based learning.* *The novelty was to have other people collaborating in the activities.*
- Regarding the use of virtual environments: Moodle, WhatsApp and Google Meet in the context of the course, offered this semester, what would you have to say? Any specific suggestions? In your perception, what were the contributions of each of these technologies adopted in the course?	*The combination of WhatsApp, Google Meet and Moodle tools is the perfect combination for hybrid teaching. The Moodle environment is great for creating centred activities, discussions and depositing materials. Google Meet is the best video conferencing system available on the market. It allows meetings in a fast and intuitive way, including the use of presentations, chat and screen sharing. For daily and dynamic communication, WhatsApp is the perfect tool. Enables real-time integration, for any decision-making and urgent notice.* *WhatsApp for me was the most perfect tool, with synchronous and asynchronous interaction and immediate mediation. Google Meet was an efficient facilitator for synchronous meetings.* *Google Meet was a productive tool for collaborative work and it worked well. But WhatsApp was the one that most sustained the group's dynamics.* *I found the participation and interaction of the whole group through WhatsApp and Google Meet fantastic, however Moodle was less used, due to the delay in accessing and writing. The other means were faster and more dynamic and this greatly facilitated our communication and interaction with the group.* *Moodle, in my view, was the most "static" tool in the process, which despite being dynamic did not allow us to interact in real time, it was more "bureaucratic".*
- Regarding the theme PROJECTS and STEAM APPROACH as guiding elements of the discipline this semester, did it make sense to you as a professor and/or researcher?	*Yes. It made a lot of sense to discuss the project theme in the STEAM approach. With the support of the texts of the author Lilian Bacich and other collaborators, we were able to have the basis to better understand the topic of STEAM, with its advantages and challenges. Among several topics, one chapter in particular drew my attention to the need to reflect on the use of technologies in the classroom. By inserting technologies into the class, we cannot act only to meet market demands. We need to use technological resources as a means of emancipating students and not of reproducing practices of unbridled consumption.* *Yes. It made a lot of sense to me to use both the Projects and the STEAM approach, because I do not believe in the effective construction of knowledge from traditional methods, because they do not make the student the protagonist of their learning and in this way, in addition to not achieving the best results, they make learning unattractive to students.*

Source: Personal Collection of the Authors.

In the answers given by the participants, it was evident that the proposal of hybrid format activities was very well received by the graduate students. The interactivity and collaborative nature of the activities were mentioned several times as a positive point.

The use of *Google Meet* in combination with *WhatsApp was also* praised, as they allowed interaction during classes. Especially through *WhatsApp*, the graduate students and the mediator professor were able throughout the week to clarify doubts and share extra materials to support synchronous dialogues. It was also evidenced that the possibilities of immediate interaction and ease of access made the *WhatsApp* environment essential for communication, to the detriment of the

Moodle environment, which was considered "more static and bureaucratic". However, it is important to highlight that *Moodle* has several resources that contribute to the teaching and learning process in the different teaching modalities (distance, hybrid and face-to-face), as it can be used to provide the educational process in its entirety or just be used as a support. In the case of the experience reported in this article, this virtual environment was adopted for asynchronous dialogues between participants about the proposed readings, prior to synchronous and face-to-face meetings, a dynamic that was new to some.

In this scenario, it is important to consider the specificity of each platform adopted, its potentialities and possibilities of contribution to the proposed training process. The integration of various technologies is not so simple, it requires participants to be open to knowing and experimenting with new ways of learning. In addition, it implies the commitment, engagement and time management of all those involved to move between the spaces created, making the most of the resources adopted in the training.

The option for PBL and the STEAM approach, with its practical development, to the detriment of more traditional methods, was praised, as it motivated collaboration and protagonism. According to Bacich and Holanda (2020, p 11): "As a way to stimulate autonomy and protagonism, it is necessary to give space for students to choose what they will produce and how to do it".

These notes indicate that the integrated use of digital technologies, including mobile devices, can increasingly become a great ally of training processes aimed at teachers, due to the ease of access and agility in interaction.

FINAL CONSIDERATIONS

It is believed that the training triggered through multiple teaching modalities may have facilitated the acquisition of theoretical and practical knowledge by teachers in training, enabling them to reproduce, improve and innovate, thus expanding this knowledge beyond what was acquired, incorporating them into playful, diversified and interdisciplinary activities in their respective places of school activity.

From the training made possible in various environments and modalities, it was also possible to contribute to teacher training regarding the STEAM approach and Project-Based Learning (PBL), as a strategy to promote a pedagogical practice that stimulates the exploration of new methodologies for project development in the context of Basic Education. It was evident that PBL has the potential to improve cognitive development, by providing those involved with the opportunity to face real problems and seek multiple solutions to the challenges presented.

It is imperative that the teacher learns to teach in this new paradigm, which requires understanding how his students learn. This implies abandoning outdated conceptions, such as the

idea that the teacher is the only holder of knowledge, and adopting a posture that recognizes the joint construction of knowledge, in a constant process of transformation, adaptation and study, which are fundamental for effective and meaningful learning.

In this way, it seeks to extract from this experience and future practices principles that support the design, planning and implementation of public policies aimed at the creation of specific programs of continuing and in-service training for teachers, considering the introduction of STEAM Projects in Basic Education, including Technical Education Integrated to High School, through innovative methodologies for active learning, creative, sustainable and aligned with the emerging demands of Digital Culture.

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