The Freirean Legacy in Innovative Educational Practices: Maker Culture, Active Methodologies, Digital Technologies and Transdisciplinarity

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Abstract

Currently, the challenges of contemporaneity impose a new social contract for a fairer, more democratic and inclusive society. This idea implies a new vision of education and, consequently, a re(think) and innovation of school curricular practices with the purpose of contributing to the education of all citizens in this new era. In this context, we highlight the visionary Paulo Freire and the Maker culture, since the study presented here is part of a project to be developed in the scope of initial teacher training. Based on a reflection on the presence of Freirean thought in contemporary school curriculum proposals, which values inclusion, trans-disciplinarity and the natural integration of digital technologies supported by active methodologies, in this specific case the "hands-on" culture, this article aims to understand the concept of Maker Culture from the perspective of future teachers who will integrate the project. A questionnaire was applied to 23 students doing Supervised Educational Practice, integrated in two professional master's degrees. Two open questions were considered in this paper. The results show that most future teachers associate the concept with the constructivist paradigm in the sense of knowing how to do and create by the student using digital technologies, but also attribute an innovative nature that trains students capable of solving problems in an attitude of predisposition to the task with predominance of a collaborative environment and human value. We hope to contribute to a reflection on the training of future teachers in this new social framework of education.

Keywords: Maker Culture, Supervised Educational Practice, Initial Teacher Training

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Introduction

We live in a globalized world and a networked society (Castells, 1999) characterized by the interactivity of semiotic resources directly influenced by the social context (Hodge & Kress, 1988; Kress, 2003) and by technological development. The integration of Information and Communication Technologies promotes new dynamics and identity strategies that promote a renewed teaching professionalism in the digital age (Nóvoa, 2013; Quadros-Flores, Peres, & Escola, 2013). From Moran's (2019) perspective, schools around the world are reinventing themselves and this is the time to develop educational practices that are aligned with the connected world we live in. To this end, it is necessary to break with pedagogical models that reproduce knowledge and with traditional disciplinary and fragmented curricula to move forward with proposals in which the curriculum connects with the world through digital technologies (Gonzaga, 2022). Thus, in this digital age, teachers are required not only the technical and pedagogical knowledge of the use of digital technologies, but also the creativity needed in the construction of educational practices that combine active methodologies and analog and digital resources, valuing transdisciplinarity and the development of knowledge, know-how, being and being indispensable for the critical awareness of students in solving everyday problems in a dialogical and humanized relationship with the world (Freire, 1983). The development of skills and competences in a motivating environment are fundamental factors for the success of the teaching and learning process, as advocated by Paulo Freire (1998), with the value of leaving no one behind (inclusion of all), and by Papert (1995), the result of a concrete action that results in a tangible product and that is of interest to those who produce it. Freire was an enthusiast for the use of technology in education, but pointed out, in a dialogue with Papert (Catholic University of São Paulo, 1995) that it should have the character of technological praxis since, in his view, technology humanizes men and makes them able to transform the world, and it is up to teachers to think of new ways to teach and learn, promoting opportunities for development and growth of students in different educational environments.

In this sense, it is necessary to institutionalize the actions for change, building systematic and conscious practices for the development of skills, abilities and attitudes in their students so that they can implement them, to be the protagonists, in the perspective of the three formative processes proposed by Pineau (1988, 2006a; 2006b): the self-training (formative action of the subject on himself), the hetero-training (formative action of other people in the subject's training) and the eco-training (formative action of the environment on the subject). The educator Paulo Freire believes, like Papert, that in this way technology can not improve the school, but it can destroy the oppressive school model, which unfortunately still remains in most of the reality, because considering that:

> (...) we have tools at hand that amplify, facilitate, and stimulate the human cognitive faculties, so why not use them to amplify and/or modify the ways of teaching and learning? The educational processes can and must be contextualized in the information society, using the various resources that new technologies make possible in the educational field, whether in formal education represented by the school, or in education in the socio-community environment. Regardless of the place where learning takes place, whether in the formal or non-formal environment, we believe that this construction of knowledge mediated by the educator can and must rely on technologies to expand the possibilities of communication and interaction. (...) Modern technology serves as a mediator in the construction of the new teaching and

the new learning, but access to them must be guaranteed, and its use must be ensured within the concept of praxis, as proposed by Freire (...) (Soffner, 2019, p. 148-162)

In Freire's (1980, p. 82) line of thought "the educational process is the result of the communion of men, mediated by the world. As technology is part of this world, it can favor collaboration and interaction among men, as a praxis, generating a process of innovation in educational practices". And for this, it is necessary to prepare teachers, so that they can train the younger generations, and for this they must also develop digital literacy skills so that they can be in line with a school integrated in the digital society (Quadros-Flores & Raposo-Rivas, 2017; Raposo-Rivas et al., 2020; Graça et. al, 2021), so that they can develop values and attitudes of inclusion and sustainability in a heterogeneous environment of responsibility, equity and social justice. Involving humanity in the joint creation of futures, the new proposal of education today, according to UNESCO (2022), traces transformative lines of human societies and raises the student in the joint creation of knowledge, making him a thinking, responsible and autonomous producer. This perspective, also advocated by Freire (1983), emphasizes the idea that "nobody educates anybody, just as nobody educates himself: men educate themselves in communion, mediated by the world" (Freire, 1983, p. 79). As the subject of the learning process, the student assumes a central role and an effective posture, problematizing knowledge. In this sense, Japiassú (1979), Fazenda (1991), Klaassen (2018) refer potentialities of inter and transdisciplinary practices that favor dialogue, inter-help, epistemological curiosity, reciprocity, humility, involvement and commitment to projects and people, among others. Moran (2019) mentions that innovative schools combine three processes in a balanced way: personalized learning (learning the basics by oneself - prior learning, resulting in the flipped classroom); learning with different groups (peer-to-peer, networked) and learning mediated by more experienced people (teachers, counselors, mentors).

The concept of Maker Culture is associated with the idea advocated by Paulo Freire (1998), that education is a constant process of creating knowledge and seeking the transformation-reinvention of reality, by human action-reflection, which arises from the importance of the contextualization of knowledge and the student "putting his hand in the dough," which moves from "searching for the place to manufacture" to "one who manufactures anywhere" (Husinga, 2012). Students develop projects in which they use digital artifacts and other available materials to solve problems or produce significant knowledge for the community, adopting an interdisciplinary or transdisciplinary approach, propitiating dialogue between fields of knowledge, transforming the teacher into a learning designer (Bullock & Sator, 2015; Blikstein & Worsley, 2016; Rossi et. al., 2019; Sang & Simpson, 2019). Currently, the FabLab movement has created networks, such as the World Fab Foundation Network, in order to democratize access to the tools for technical invention and democratizing access to its benefits (Blikstein, 2017). In turn, the maker culture values creative learning, which goes through the construction of learning environments centered on 4 P's, based on the theory of Creative Learning developed at MIT Lifelong Kindergarten, linked to the Massachusetts Institute of Technology: (1) Projects (activities with problematization); (2) Playful thinking (free exploration, thinking playfully, with pleasure); (3) Passion (personal meaning, meaningful learning); (4) Peers (collaboration and respect, building teamwork, where the result tends to be much better, with exchanges, than if it were individually). He also guarantees four steps in learning: feeling, imagining, doing, and sharing, in a perspective of educational innovation. Freire also proposed two perspectives on innovation: as a regulatory action or as an emancipatory action:

That is why I reject banking pedagogy and propose and defend a critical-dialogical pedagogy, a pedagogy of the question. The public school that I want is the school where the critical apprehension of significant knowledge through dialogical relations has a prominent place. It is the school that stimulates the student to ask, to criticize, to create; where the construction of collective knowledge is proposed, articulating popular knowledge and critical, scientific knowledge, mediated by experiences in the world. (Freire, 2001, p.83).

Managing interdisciplinary curriculum, Maker educational spaces, emancipatory pedagogical practices, valuing student autonomy, their protagonism and the use of active methodologies, seems to us a necessary and viable alternative for educational innovation, in the perspective of praxis, recommended by Freire. In addition to Freire's idea of innovation in education, we consider Carbonell's (2002) perspective, defining it as:

> A set of interventions, decisions, and processes, with intentionality and systematization that tries to modify attitudes, ideas, cultures, contents, models, and pedagogical practices and to introduce new curricular materials, teaching and learning strategies, didactic models, and other ways of organizing and managing the curriculum, the school, and class dynamics. (Carbonell, 2002, p.19)

In the context of teacher training, an intervention design was launched for Supervised Educational Practice, the EDUMAKER project - "Maker Culture in initial teacher training: a contribution to professional development", whose starting question aims to understand, from practices implemented in real contexts in the 1st and 2nd Cycles of Basic Education by future teachers, the impact on teaching professionalism: What is the contribution of Maker Culture, one of the pillars of Education 5.0, for professional development in initial teacher training? To answer this question the study aims to:

- Conduct a literature review in the context of Maker Culture;
- Investigate the theoretical basis of future teachers regarding the concept of Maker Culture including the bibliographic references on which they are based;
- Understand the methodological design used in the educational practice;
- To create a Maker Laboratory, supported by the Technical Scientific Unit of Mathematics, Natural Sciences and Technologies in order to promote the dialogue between future teachers and the use of fundamental technologies for educational practice;
- Foster the development of an interaction network between future teachers using different professional master's degrees and, therefore, enhance interdisciplinary dialogue and multiculturalism;
- To experience and analyze the projects created in the Maker lab for the change of educational practices;
- To verify the impacts of Maker practices on students from the 1st and 2nd Cycles of Basic Education;
- Understand Maker Culture as a transformer of the educational reality towards the common good;
- To identify the abilities, skills and attitudes developed by future teachers to understand Maker Culture as a transformer of the teaching professionalism;
- To encourage the participants to extrapolate the learning methodology experienced to other performance spaces, making them multipliers, researchers and evaluators of it;

- To encourage the production of scientific research in the field/area of the project;
- Produce scientific articles from reflective reports about the experiences provided by the project;
- Encourage future teachers to commit to the Sustainable Development Goals (ODS), developing, from them, investigative themes from interdisciplinary curriculum projects, at different grade levels, using the Maker methodology and different technologies.

We assume that transformative teaching practices necessarily involve a combination of active methodologies and digital technologies and are meaningful to the actors in education. In this context, teachers become facilitators of personal and group learning itineraries, true designers of collective learning with their students and educational agents. Methodologies emphasize the leading role of the student, enriched by a hybrid model, responding to all students and circumstances in an environment of flexibility, sharing spaces, times, activities, materials, techniques and technologies (Moran, 2015). The project aims for the future teacher to become more empowered, a digital citizen, builder and facilitator of knowledge, environments and interactions. That they become a researcher of reality, an innovative designer of their educational practices, a computational thinker, a creative communicator and a global collaborator, assuming a unique responsibility in the training of new generations: no teacher will be able to develop experiences that they have never experienced, so it is important to develop these practices from initial teacher training.

This article is part of the reflections and investigations of three researchers and teacher educators, seeking to contribute to a project for the initial training of elementary school teachers at a public Portuguese university, the Polytechnic Institute of Porto, by building the proposal of a training curriculum based on innovative curricular practices, aiming to prepare future teachers for an Education 5.0.

We are in its initial stage, and, as part of the initial diagnosis of one of the project's development contexts, we applied the survey by questionnaire to students in initial teacher training of two professional master's degrees about Maker Culture, the methodological basis of the training project we seek to mobilize. Thus, this article aims to understand the concept of Maker Culture and Education for innovation from the perspective of future teachers, and the results will serve as a starting point for the development of the formative process of future teachers.

Methodological options

As mentioned, this article is part of the EDUMAKER project, which aimed to understand how future teachers conceive the concept of maker culture. To this end, the following research question was outlined: What are the conceptions of students in initial teacher training about the concept of maker culture?

Following a quantiqualitative methodology, we applied an online questionnaire survey (Ghiglione & Matalon, 2001), with open and closed questions, to 23 future teachers who attend the Supervised Educational Practice, integrated in two professional master's degrees. The participants were mostly female.

For the analysis of quantitative data, we used descriptive statistics to describe and summarize a set of data. The qualitative data were analyzed using content analysis techniques from

Bardin's (1977) perspective, using the "mileage" procedure, in which the categories of analysis are created as the data are analyzed, and each category is only defined at the end of the operation.

Analysis and discussion of the results

In the present paper, only some questions from this survey will be analyzed: "Have you heard of Maker Culture?"; "In what context have you heard of it?"; "What do you consider to be Maker Culture?"; "What elements do you consider to be necessary for the development of Maker Culture in the classroom?"; "In your opinion, what is an Education for Innovation?".

We asked the prospective teachers if they had ever heard of maker culture (Figure 1).
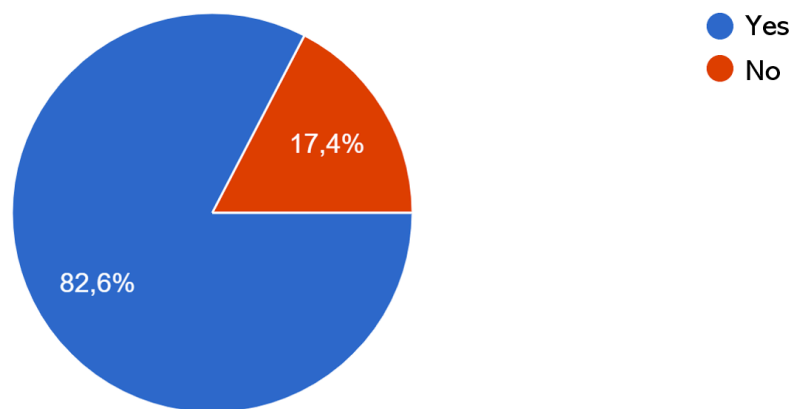

Figure 1: Student responses to the question: "Have you heard of Maker Culture?"

It was found that 82.6% of the students said they already knew the term "Maker Culture", which shows some contact, theoretical or practical, with other ways of teaching and learning. Only 17.4% said they had never heard of the term, a negligible percentage, but which points to a reflection within the scope of initial teacher training.

We wanted to understand in what context they had heard of the term, so we put options to answer and also an option that allowed them to choose freely.

The students' responses are mirrored in the following bar chart (Figure 2).
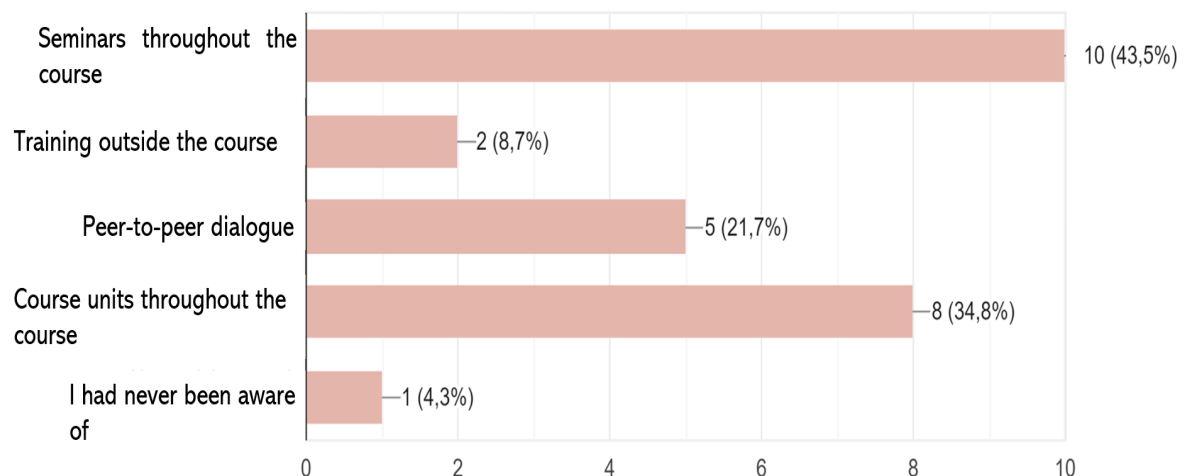

Figure 2: Students' answers to the question: "In what context have you heard of it?"

It was found that 43.5% of the students have been exposed to the term through seminars throughout the course, offered by their teacher training institution. These seminars are mainly focused on Supervised Teaching Practice. Already 34.8% consider in "Curricular units along the course". Note that in the 3rd year of the Degree in Basic Education, in the Initiation to Professional Practice III: Observation and Cooperation in Educational Contexts (IPPIII) students are 80 hours in internship situation in real contexts. It is also noted that only 21.7% selected the option "dialogue among colleagues", which is a fundamental aspect in the training process of future teachers that is based on a paired training process, marked by teamwork, collaboration and cooperation supported by key moments of reflection and action research. In any case, the result shows that the concept is discussed or developed in initial teacher education.

We also questioned the future teachers in initial training about their concept of Maker Culture. As it was an open answer, it was categorized as follows (Table 1).

Analysis Categories	Analysis Descriptors	Total occurrences
Use of digital technologies	Answers that consider the use of digital technologies as maker culture.	2
Educational practices based on constructivist paradigms	Answers that consider the maker culture as the opportunity to put the student at the center of his learning process, making him active in the construction of his learning, through "learning by doing".	15
Learning method/strategy	Answers that consider maker culture a learning strategy and method.	6

Table 1: Students' answers to the question: "What do you consider to be Maker Culture?"

A high number of occurrences, the majority (15), places the concept of Maker Culture in educational practices designed in a constructivist paradigm, and the answers show the opportunity to place the student at the center of his learning process, making him active in the construction of his learning, through "learning by doing": "A creative and proactive methodology that gives body to verbs like experiment, create, think, do." [a6]; "Taking matters into one's own hands. Being a principal party in the knowledge process." [a13]; "The creation of one's own technological objects and resources." [a17]; "I think the maker culture motivates students to build their own knowledge, to set their own goals, and to work autonomously to achieve them." [a3]; "The student learns through practice." [a21].

The six responses that conceive Maker Culture as a Learning Method/strategy show that as a pedagogical strategy it develops skills in the student of creativity, critical and creative thinking: "A way of sharing and creating ideas and knowledge." [a16]. The two responses associate the concept of Maker Culture with the use of digital technologies: "I think it is a culture that is based on the idea of creative construction, meaning people are able to turn their ideas, projects, etc. into reality, through technology among others." [a2]. Although the concept is not limited to the use of digital technological resources these are fundamental in a

global connection and reveal potentialities in prototyping and creating products and in ecological sustainability, besides developing skills inherent to the 21st century.

We sought to better understand what elements students feel are necessary for the development of Maker Culture in the classroom. The responses are mirrored in the word cloud below. In the word cloud, the size of the words is directly proportional to their frequency in the text (Figure 3).

Figure 3: Students' answers to the question: "What elements do you think are necessary for the development of Maker Culture in the classroom?"

The words "Technology", "Creativity", "Other materials", "Critical thinking", "Sharing", "Dialogue" stand out as key elements considered by future teachers to carry out Maker Culture practice in the classroom. It is found that future teachers associate Maker Culture practice with characteristics of the student profile in the 21st century (Oliveira-Martins et al., 2017): "Proactivity, critical thinking, group and individual work." [a7]; "Openness on the part of teachers and creativity on the part of students." [a5]; "Technology, group work, critical spirit." [a10]; "Creativity, commitment, dedication." [a18].

It is expected that future teachers, by acquiring knowledge about the important elements for the implementation of Maker Culture in the classroom, will be able to mobilize them in their educational practice in order to find a methodology capable of embracing ICT in an integrated, critical and, eventually, innovative way (Graça, Quadros-Flores, & Ramos, 2020).

Finally, we questioned the future teachers: In your opinion, what is an Education for Innovation? The answers are categorized in the following table (table 2).

Analysis Categories	Analysis Descriptors	Total occurrences
Use of digital technologies	Answers that consider the use of digital technologies as a fundamental aspect for an innovative education.	5
Active construction of your knowledge	Answers that consider the use of active learning methodologies, which place the student as the active builder of knowledge, as a fundamental aspect for an innovative education.	13
New teaching and learning strategies/methodologies/new conception of education	Answers that refer to the need to adopt new teaching and learning strategies/methodologies for an innovative education. In addition, they refer to a new conception of education aimed at Freirean thinking.	8
21st Century Skills	Answers that consider the development of 21st century skills essential for innovative education.	3

Table 2: Students' answers to the question: "In your opinion, what is
an Education for Innovation?"

Of the four categories, the one related to "Active construction of their knowledge" is the one most highlighted by future teachers, considering that educating for innovation requires the use of active learning methodologies relevant to the focus on the student as the active constructor of their knowledge: "It is an education that seeks to provide students with the best learning, allowing them to build their own knowledge, therefore betting on innovation." [a2]; "In my opinion, it is an education that prepares students for change and allows them to build their own knowledge" [a9]; "It's an education where the student feels like the center of learning." [a16].

In their answers, the future teachers also focus on the category "New strategies/methodologies of teaching and learning/new concept of education", which shows that educating for innovation requires changes in pedagogical and organizational renewal, and in the concept of education itself. We emphasize that the new concept of education also goes in the direction of Freirean thought: "It is targeted teaching, where the student has access to innovative tools that bring elements of meaningful learning with new practices." [a7]. "It's about building teaching that is creative, inclusive, and increasingly responsive to students' needs." [a14]; "It is an education that aims to transform and renew." [a17].

The use of digital technologies is also verified in five responses as fundamental to education for innovation: "An education that uses technology and allows the student to be to make decisions regarding their own learning." [a11]; "For me it focuses on developing skills to build a more competent being in society." [a12].

Conclusion

Regardless of how the innovation process is carried out, developing practices of educational innovation implies an attitude of planned change with the purpose of providing capacity to the organization, institution or system and educational actors to meet the objectives that motivate the innovation itself. Thus, educational innovation can be understood as the search for answers to the challenges present in the dynamics of school processes, from the analysis and critical reflection and creative thinking of the sociocultural context, for effective

contributions that such innovations can offer in the process of learning and personal and social formation. We know that the current challenges focus on a humanistic and sustainable paradigm that promotes the education of citizens and professionals for a VUCA world - Volatility, Uncertainty, Complexity and Ambiguity. Paulo Freire, an avant-garde pedagogue who, since the 1960, has been building pedagogical, political, ethical, and epistemological bases for the renewal of the school, considers, according to Carbonell (2002), the need for a curriculum that aims at the transformation of the culture of the collective subject through the awareness of social reality, emancipating those involved and transforming reality.

In this reality Maker Culture, mediated by technologies and by an inter and trans disciplinary knowledge approach, responds to the commitment of Agenda 2030 (UNESCO) with its Sustainable Development Goals (ODS). Note that, education for the common good is a social commitment to shape sustainable futures grounded in social, economic, and environmental justice (UNESCO, 2022), which means that it prepares for future changes by highlighting knowledge, skills, attitudes, and values, as reinforced by the current curriculum (DL nº 55 de 2018). From this perspective, education is a commitment to human capabilities that interact using Science in a cultural environment. Maker Culture responds to private and public interests and includes all citizens, because everyone is capable of putting their hand in the dough by making, according to their curiosities, interests and needs, towards the common good. It integrates the citizen actively, in a pedagogy of autonomy and liberation in the process of construction and sharing that, using technologies, creates products as an answer to common problems and needs, so important in an era of change where innovation takes significant shape in personal and social success. It thus awakens the spirit of meaningful learning in a contextualized, empathetic and entrepreneurial challenge.

The results of this study show that initial teacher education is beginning to respond positively to change. Future teachers know the concept of Maker Culture and associate it with pedagogies that actively center the student in the learning process by developing 21st century skills that use varied and updated technologies, especially digital ones, as a response to the development of personal and social skills towards the common good. Among personal abilities, creativity and critical thinking are relevant in the process of innovation and creation. As far as social skills are concerned, collaborative dialogue with others is equally relevant. These two points underscore the perspective of the public school dreamed of by Paulo Freire. The study also shows that educating for innovation involves three significant dimensions: (1) a constructivist environment in the learning process; (2) pedagogies that develop skills for the 21st century; (3) integration of digital technologies. We hope to contribute to a reflection on the concept of Maker Culture in the training of future teachers in this new social framework of education.

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