Elements of articulation between innovation and technology in professional and technological education

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ABSTRACT
Vocational and Technological Education (EFA) is a modality capable of combining professional training with the context to be applied, covering different aspects of education, work, science, technology, and innovation. In this context, a question arises: what elements, perceived by the students of an EFA FIC course, promote the articulation of technologies with innovation? To problematize this issue, the text on stage aims to verify which elements express the aforementioned articulation in the context of EFA. To this end, its materialization took place from the participation of 22 students of the FIC course, using as an instrument a semi-structured questionnaire applied from Google Forms carried out in November 2022. After the construction of the data, they were structured and verified through Content Analysis (Bardin, 2016). As a result, it was observed the identification of two elements that match the perception of the participants and seek to reverberate their understandings around the experience of the course: the articulation of the content with pedagogical practices and the realization of experiences that simulate the world of work.

Keywords: Professional and Technological Education, Training, Technologies, Innovation.

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INTRODUCTION

Education is an open and continuous process that includes personal, social and cultural aspects throughout the human trajectory. It involves the acquisition of knowledge, the formation of values and attitudes, and the preparation to act in numerous demands that weave the lived context. Furthermore, education focuses on the way each person interacts with the world and how they perceive the various conditions that act on daily life (Freire, 2014).

As a process, education manifests itself both directly in people's lives and in the structures that order a way of doing it, such as educational institutions, for example. Therefore, it is important that educational institutions seek strategies to become increasingly accessible to all and that there are public policies that guarantee equal opportunities, access, permanence and success in the space indicated for formal education.

Immersed in this assumption, Professional and Technological Education (EPT) cannot escape this perspective. Its teleology, the training of workers, envisions a modality capable of combining professional training with the context to be applied, encompassing different aspects of education, work, science, technology and innovation (Vinholi Junior; Mello, 2022). Such aspects find relevance in EFA as they can foster learning strategies and professional training through different levels of education (Souza; Nunes, 2019; Brandão, 2020) and with the aim of collaborating in the necessary transformations brought about in the world of work (Castaman; Scallop; Pasqualli, 2019).

As a work-oriented modality, EFA is not reduced to mere technical-professional improvement. EFA involves training, integrated and human, in a dialogue with the various areas (Flores, Cardoso, and Denardi, 2023) and with the urgencies of its time, such as the innovation proclaimed in the contemporary. Thus, one of the activities developed by EPT, in the context of the Federal Institute of Education, Science and Technology *Manaus Industrial District campus* (IFAM/CMDI), which are attentive to this perspective is the articulation, through resources from the Research, Development and Innovation (RD&I) Informatics Law, of Initial and Continuing Education (FIC) courses that promote the approximation of technologies with innovation.

One tool used for this articulation is Project-Based Learning (PBL). In general, PBL is a methodological approach developed in the field of education, where students are at the center of the problem-solving process. In this context, a question arises: what elements, perceived by students of EFA FIC courses, promote the articulation of technologies with innovation?

In order to problematize this issue, the text on stage aims to verify which elements express the aforementioned articulation in the context of EFA. Thus, the text is materialized in 03 (three) topics: theoretical articulation between EFA and PBL, methodological strategies and results. Thus, this problematization is relevant by highlighting the students' perception of the integration of an

education that combines the context of technological advances with strategies to generate innovations.

THEORETICAL ARTICULATION BETWEEN EFA AND PBL

The formation of a federal network for EFA and the establishment of its purposes (Brasil, 2008), such as training and qualification in view of professional performance, affect expectations of dealing with social dilemmas and promoting, through education, a process of inclusion of those who were outside or on the social margins (Souza; Nunes, 2019). In this sense, EFA has demonstrated the ability to impact at economic and social levels, although it has not been able to expand such capacity on a significant scale (Brandão, 2020).

Innovative strategies are essential since EFA needs to enhance its work, including promoting professional training that can problematize the current world of work (Souza; Nunes, 2019). On the other hand, EFA should prioritize specific skills that focus on the consolidation of theories pertinent to the professional scenario and, at the same time, encompass a qualification that recognizes the application in real and meaningful situations to the subjects (Vinholi Júnior; Mello, 2022).

The preparation of professionals responsible for professional and technological training must encompass theoretical, practical, and ethical principles, which enable them not only to improve their professional skills, but for life in general (Flores, Cardoso, Denardi, 2023). EFA focuses on the development of competencies and skills aimed at a critical and reflective experience, especially with regard to the world of work (Teodoro, 2022). It can be seen, therefore, that this modality can promote transformations in the student's perspective in relation to the globalized world, providing instruments to face current adversities (Parente; Lima, 2023).

In this context, autonomy, humanism, and critical capacity are key skills for EFA (Flores; Cardoso; Denardi, 2023). Its concreteness outlines challenges in integrating an increasingly necessary professional training as this modality is recognized as a comprehensive education, that is, preparing beyond a content-based teaching (Brandão, 2020). And yet, it can be a catalyst for innovation in the numerous changes in the world of work.

An example of this is the innovations arising from the technological context, which is increasingly continuous and dynamic. Innovation in EFA plays a crucial role in the development of activities that make sense in students' daily lives, more precisely, that meet individual demands. To this end, it requires different approaches in the elaboration of actions aligned with the reality of each student (Souza; Nunes, 2019). In addition, financial incentives aimed at changes in the EFA curriculum are important to support future research activities (Pereira, 2022). It is in this perspective that PBL emerges as a proposal that can enhance the results and practices developed by EFA.

PBL is a teaching methodology that focuses on active learning and problem-solving through the realization of practical projects related to everyday life (Costa Junior *et.al*., 2021). This approach seeks to provide a more meaningful education for students, promoting essential competencies and skills for the 21st century, such as the development of critical thinking, improved communication, and encouragement of collaboration (Cavallo; Luck, 2022).

Unlike the approach employed in traditional teaching, in which information and knowledge are passively transmitted, PBL provides students with an active position to assume a differentiated role in their own learning (Richardt, 2021). In other words, teaching is based on the investigation of real problems, to which students have the freedom to try to develop alternatives and expose their own learning through a material solution (Cavallo; Luck, 2022).

The PBL application considers a teaching performance based on mediation, usually introducing students to a problem or challenging issue. Students, in turn, play an active role in addressing real problems through research, planning, and the execution of projects aimed at solving these issues (Costa Junior *et al*., 2021). During the process, they are encouraged to seek relevant information, collaborate with each other, make decisions, and reflect on their own learning (Hora; Carvalho, 2022).

PBL has several characteristics that make it an effective methodology for student learning. It is certainly highly engaging and motivating, as it allows students to feel more connected to the subject and see a real purpose in their work (Castro, 2021). This is because PBL is not restricted to theory, on the contrary, it stimulates the cognitive as well as personal characteristics, allowing the student to develop their skills beyond the proposed content (Januário; Gomes, 2022).

Another positive aspect of PBL is that it is highly adaptable to different subjects and levels of education (Born; Maia, 2023). Therefore, it can be used in areas such as science, mathematics, history, literature, among others, and can be adapted for different ages and abilities. However, to be successful, PBL requires significant commitment on the part of teachers and students, and a structured and thoughtful approach to project planning and execution (Richardt, 2021).

During the application of the method, the individuality of the students becomes present, making them responsible for their own learning and, in the midst of mistakes and successes, they reap the desired results. Thus, through their choices, they shape their project and, consequently, their way of thinking (Cavallo; Luck, 2022). However, not everyone has a level of motivation to reconcile high demands and responsibilities, and it is important to alternate PBL with other methodological proposals (Almeida, 2020).

By using PBL in experimental activities and with the support of the teacher, students are encouraged to reflect on the relevance of work, of collectivity, in the debate of issues and in the development of research. In addition, they explore the contributions of scientific activities to society

(Aguiar, 2019). It is very similar to the problem-based learning model, which also emphasizes teamwork, always trying to articulate the concept with practice (Magalhães, 2021).

Furthermore, it can be affirmed that relating concepts experienced in everyday life with the PBL method transfers to the student the ability to perceive aspects that are not commonly identified. This process involves relationships between different knowledge, decision-making, collaboration, criticality, and creativity (Costa Junior *et al*., 2021). As a result, it promotes active learning and transforms the way educators work, as it enables students to be protagonists in the construction of knowledge (Richardt, 2021).

Considering the integration between EFA and PBL, the training courses emerge as an opportunity to implement an innovative project. PBL, with a focus on active learning and problem solving through practical projects, presents itself as a methodology capable of enhancing the results of EFA. In this scenario, it is envisaged the development of a project that promotes meaningful learning, considering this methodology, together with the important skills of the twenty-first century in the process of knowledge construction.

CONTEXT OF THE METHODOLOGICAL STRATEGY

The context for the construction of the data for this text was the extension course called Training and Entrepreneurship 4.0 developed in a period of 07 (seven) months, between May and November, 2022. Its implementation was based on the completion of 04 (four) modules: i) Digital Literacy; ii) Entrepreneurship and Innovation; iii) Application Development and Programming; iv) Additive Manufacturing (3D Printing). Concomitant with the study of the modules, the students developed a Viable Product – MVP with the help of advisors and monitors, having PBL as a methodological foundation.

The course had the participation of 25 (twenty-five) high school students from the state public network, selected in a public call that considered the grades of Portuguese Language and Mathematics in Elementary School and the receipt of some social assistance benefit (IFAM, 2022). To this end, those selected received a scholarship in the amount of R$ 400.00 during the execution of the course. This perspective accentuates a concern to provide opportunities for a segment that sometimes does not have access to technological resources due to belonging to a certain social stratification.

The activities took place in a space with equipment and materials that provide the development of creative, innovation and problem-solving skills. The main idea was to bring together students of different age groups and without specific technical knowledge in the planning, creation and construction of the most varied types of projects with technological equipment. The course in

question is, therefore, a training that articulates technological elements with entrepreneurship for students enrolled in social assistance programs.

The participation of the subjects of the FIC, according to their perceptions, is associated with the opportunity to take a free course involving technologies, the importance of receiving a scholarship to help with studies and the reputation of the Federal Institute in society. Such interests were basically based on the dissemination carried out in the various communication channels, in the schools surrounding the campus.

Inserted in this context, it is possible to indicate that 22 students participated in this study based on a semi-structured questionnaire applied from *google forms* carried out in November 2022. Participants cover the following age groups: 15 years (13.6%); 16 years old (45.5%); 17 years old (31.8%) and 18 years old or older (4.5%). Regarding gender, the majority of participants are female (68.2%), while 27.3% are male and 4.5% chose not to declare their gender. The analysis of the ethnic composition revealed an urgency of browns (63.6%), followed by whites (31.8%) and indigenous (4.5%), with no indication of participants self-declared as black.

A significant observation deduced from this characterization concerns the prevalence of women in training activities in EFA. Historically, the image of a male academic-scientific education has stigmatized the presence of women/girls in technical-scientific training (Tabak, 2002). This situation has spread to the interface with technology, where there is a male predominance (Louzada *et al.*, 2019). The presence of women in this FIC course signals the relevance of paying attention to gender relations that cross the scope of EFA.

Another relevant aspect about the participants concerns the location of the participants' neighborhoods. Mostly, because it is a course offered within the scope of the extension, the FIC course in question was able to connect students who lived in the following neighborhoods of Manaus: Mauazinho, Crespo, Lagoa Verde, São Lázaro, Japiim, Morro da Liberdade, Betânia, Distrito Industrial and São Lázaro. All of them are related to IFAM-CMDI.

It is also worth noting that these neighborhoods were forged, especially from the 80s of the last century, by the dynamics guided by the Industrial Pole. This condition is expressed in the indication that 50% of the participants had a family member who worked/works in one of the factories that house the Free Trade Zone and that with projects articulated with such companies, in this case LG *Electronics*, another formative relationship is forged with their children/relatives. If in the past work moves to companies based on the need for employment/work, now it is the company that moves, via RD&I, in the training offered.

Hence the opportunity to aggregate students from other networks in this type of training, such as the state education network, which represented almost all of the participants' school origin (90.9%). And also, to provide opportunities for the participation of students in situations of

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socioeconomic vulnerability. With regard to salary income, most of the participants were allocated to households of up to one (1) minimum wage (63.6%) and in relation to social programs or benefits, it was observed that the majority (72.7%) were beneficiaries of Auxílio Brasil

In fact, after the construction of the data, they were structured and verified through Content Analysis (Bardin, 2016). In general, this technique is articulated from three (03) stages: a) Pre-analysis: the material is systematized and "floating reading" is performed; b) Analytical Description: carried out through codification through the search for a synthesis of congruent or divergent ideas and the selection of registration units; c) Inferential interpretation: transcends the surface of the data and guides categorization (Bardin, 2016).

Therefore, based on the verified data, it was possible to organize 02 (two) categories that match the perception of the participants and seek to reverberate their understandings around the experience of the course: the articulation of the content with pedagogical practices and the realization of experiences that simulate the world of work.

RESULTS AND DISCUSSION
ARTICULATION OF CONTENT WITH PRACTICES

By verifying the participants' satisfaction with the FIC course (100%), it can be seen that its development not only faced these challenges, but also successfully overcame them. This satisfaction is mainly linked to the positive experience among the students of the articulation of the contents taught, such as the experimentation of practical activities, as highlighted:

> "The structure in general was very well thought out [...] Study and practice" (S. 21).
> "It was to make me feel more secure and confident in what I was studying" (S.15).

In addition, the participants expressed how significant the different and varied areas studied were. Many highlighted learning in technology, entrepreneurship, application development, and additive manufacturing. Emphasizing programming languages such as *Python and* Javascript*, as well as mastery of software such as* Fusion 360 *and* Cura. These answers corroborate the need for relevant knowledge for professional careers.

By addressing topics such as entrepreneurship, programming and application development, 3D printing, the student-participants travel in possibilities and knowledge that may be unprecedented for them. From this perspective, the use of methodological strategies that integrate and foster education not only enhances cognitive abilities but also integrates solutions in the midst of social adversities (Castaman; Scallop; Pasqualli, 2019).

Access to technologies is not always possible for a portion of the population, especially those who live in areas or zones of social vulnerability. This condition, lack of access, is also present in

several areas of the social fabric, including education. This condition is even more notorious when understood in the context of the state of Amazonas, where logistical barriers integrated with low investment in public policies lead to low access to technological artifacts (IBGE, 2018).

In this way, the use of PBL aligns well with the objectives of a professional education that contemplates an innovative practice. It is necessary to assume that, based on a problem, the educational process can unfold into a challenge of integration, relationship and problematization. The articulation stimulates situations that signal the participants' satisfaction with the classes. This positive perception reflects the quality of the project and the positive impact it has had on the learning experience of the participants.

CONDUCTING EXPERIMENTS THAT SIMULATE THE WORLD OF WORK

When addressing the participants' perceptions about the FIC course, another highlight was the impact on personal and professional training when glimpsed from the realization of experiences that simulate the world of work. The answers reveal that the course contributed to the improvement of training, providing relevant knowledge for the job market. In addition, there was a lot of mention in the acquisition of practical skills, in the development of the ability to work in groups and in the encouragement of professional responsibility, as can be seen in the answers below:

"Teaching how to work professionally with social groups of people" (S.8).
"The course was a help to prepare us, to face the reality of the job market" (S.18).
"The course prepares us to show how the labor market really works" (S.19).

Participants pointed out that the training not only enhanced their technical skills but also expanded their communication capabilities. Many emphasized that the course adds value to their resumes, offering potential for employment opportunities in a variety of industries. Some participants mentioned that they feel more prepared to face the challenges of the labour market, while others highlighted the role of the project in providing a clearer understanding of how the market works.

The development of simulations, such as presentations and advocacy of ideas, for example, included a favorable approach to the development of interpersonal skills and the construction of a solid foundation in preparing participants for entry into the job market. This experience proclaims a feeling that the course was important for the job market, highlighting its importance in training.

Participants see the course as an effective way for companies to offer professional opportunities to young people, emphasizing the effectiveness of the program in connecting participants with the job market. Methodological integration as an experience is a stimulus for continuing education. The spark of curiosity and permanent training are at the basis of the professional profile so demanded by the intense technological change.

The desire to continue their professional training in a higher education course was signaled by

all participants. In addition, all participants also affirmed their willingness to recommend the project to other young people, evidencing a positive experience when sharing with others the search for training opportunities.

Despite the positive emphasis on the way in which there was an articulation between technological tools and innovation from the course, there were also some challenges that need to be better explored, such as: the availability of materials and tools for training at home, handling of terms in technical English and personal access to the internet. These suggestions and observations are of great relevance for the continued evolution and effectiveness of future projects.

FINAL THOUGHTS

The study sought to investigate students' perceptions regarding the articulation of elements that promote innovation and technology within an EFA FIC course. The results obtained from the analysis of the participants' responses indicate a positive overall satisfaction with the project. The theoretical articulation between EFA and PBL was explored, highlighting the importance of EFA in the integral formation of students, preparing them not only for the job market, but also for life in general.

PBL was presented as an effective methodology, promoting active learning and developing essential skills for the 21st century. The analysis of the perceptions about the courses offered highlighted the positive impact on the personal and professional training of the participants. Participant satisfaction and positive feedback reinforce the importance of innovative and integrative strategies in EFA, preparing students in a comprehensive way that is aligned with contemporary demands.

Thus, education is a fundamental process for individual and collective development and is essential for the construction of a more just and democratic society. Therefore, it is important to ensure that all individuals have access to quality education and that the education system is constantly improved to meet the demands of modern society.

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