Technological Laboratory of Pedagogical Innovation and Learning - (LaTIPA)

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Abstract

This article addresses the theoretical conceptions and purposes of creating the Technological Laboratory of Pedagogical Innovation and Learning (LaTIPA). From a theoretical review of technological innovation concepts in learning processes, the laboratory was systematized to create pedagogical innovations through innovative actions and projects involving applied technology. In this work, we present the theoretical conceptions that substantiate this proposal. The results of this project are expected to come to consolidate the exposed motivations.

Keywords: Pedagogical Innovation, Laboratory, Maker

Introduction

Maker laboratories significantly impact the institutions in which they are installed, as shown by the examples in the Amazon[1] and Ceará[2]. We consider that an installation at the São Francisco do Sul campus will provide various improvements, such as in the permanence and success policies, the recruiting and engagement of entrants, the awakening of students to verticalization, entrepreneurship, the approximation of the institution to local productive arrangements, and the promotion of a free and quality educational institution guided by teaching, research, innovation, and extension.

The emergence of new information and communication technologies has brought about considerable transformations to society and conceptual demands in the teaching and learning process. Such demands range from scientific training that allows development and application through studies to innovation strategies in classroom teaching for technological production, to the empowering of youths in using the technologies.

The education model in which the student only listens to the teacher and copies the content is more and more obsolete. To dynamize classes and amplify the possibilities of acquiring knowledge, some international and Brazilian educational institutions have been gradually implementing alternatives to this methodology, with one of the proposals being maker laboratories.

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[1]https://porvir.org/projeto-leva-laboratorio-maker-para-3-escolas-do-amazonas/
[2]https://www.sct.ce.gov.br/2018/01/09/fablab/

The first maker laboratory, which also inspired fab labs[2], was founded at the Massachusetts Institute of Technology (MIT). Its creation derived from a course taught there in 1998 called "How to do (almost) anything", offered by professor Neil Gershenfeld to the institute students. The idea emerged from the need of people to build, modify, and produce objects on their own. The professor created an environment with a pedagogical purpose that allowed people to solve problems by creating their own tools.

Although the movement may foster the exchange of knowledge, nowadays potentialized by the Internet, the impossibility for many users to acquire the material for building their own prototypes is a reality. This stimulates an important principle in a group of makers: sharing a common interest and wanting to work together on the same project. This proposal caused the emergence of the first maker workshops (Hackerspaces[3] and Fab Labs[4]), all experienced in a process denominated learning by doing. In such workshops, different people, especially youths, join efforts and resources to work together on the same project. At this point, one may say that the maker movement would have shifted from "do it yourself (DIY)" to "do it with others (DIWO)".

Laboratories previously used to transform theory into practice became sites where creations and ideas may be built quickly and cheaply due to the versatility and potential of multidisciplinary joint work, a channeler and booster of creativity. These may be toys, robots, applications, whatever the students want. This environment is intended to support such accomplishments.

That said, this project will support itself on the premise that educational maker spaces, articulated methodologically from the inseparability among teaching, research, innovation, and extension, will effectively contribute to the education of innovative, protagonistic, and collaborative youths. Hence, we present the proposal for creating the Technological Laboratory of Pedagogical Innovation and Learning (LaTIPA) of the São Francisco do Sul campus. The laboratory will be founded on the mission of building a relationship of participation and education of innovative, protagonistic, and collaborative students over the course of the process (learning by doing), from the inseparability among teaching, research, innovation, and extension.

The LaTIPA activities will be structured on three axes:

a) Experimentation;

b) Prospection;

c) Dissemination.

All these items will be discussed in the following section. In this sense, it becomes necessary to contextualize the theoretical aspects that substantiate this reflection.

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[3] Is a real site with the format of a community laboratory that follows hacker ethics, having an aggregating, converging, and inspiring spirit.

[4] Is a small workshop offering digital fabrication. A fab lab is generally equipped with a set of flexible tools that cover various size scales and several different materials with the purpose of doing "almost everything".

Inseparability as an educational principle for maker spaces

The inseparability among teaching, research, innovation, and extension is a principle that may operationalize and provide opportunities for educational spaces (formal or not) in the construction of a maker space. Theoretically, the inseparability bases the argument of quality education, enabling the establishment and development of the universal scientific spirit, which is a condition for permanent education and is "[...] *the necessary response to the challenges of the project of developing a nation that requires from its children a solid scientific education, technical competence, and political lucidity associated with an ethical commitment*" (FORGRAD, 2004, p. 229).

Despite the principle of inseparability among teaching, research, and extension being often in the statutes of academic institutions, it is usually more theoretical than effectively practical, even because coexistence (teaching, research, and extension) may not mean inseparability. Also, only one-third or a little more of Brazilian universities present conditions and infrastructure necessary for the actual practice of this principle (NEHRING; KOLTERMANN BATTISTI; CEZAR POZZOBON, 2018). Hence, a select group of educational institutions and their respective students would actually live this highly enriching experience in their academic education. The authors also suggested that this principle should be present in the pedagogical political projects and institutional development plans of all educational institutions. Unfortunately, this statement has two obstacles to its full operationalization. These are of legal and social order.

Historically, two legal frameworks are important to contextualize. The first is the action of the Brazilian National Forum on Education in the Constituent Assembly, which led the approval of the popular amendment that formulated the inseparability principle still in the terms "teaching, research, and extension" as a paradigm of a socially referenced "university", becoming article 207 of the Constitution of 1988. The second was the approval of the Law on National Education Guidelines and Framework (Law No. 9394 of 1994), also known as the acronym LDB. The laws were emblematic because they materialized an education with strategies of universalization, autonomy, democracy, articulation between science and society, and social commitment.

Hence, both the Brazilian Constitution and the LDB, by force of the clashes and syntheses of the legislative process itself, express the inseparability principle ambiguously. In the LDB, for example, several critics pointed out that the legal provision approved in 1994 did not restate the fundamental requirement of the organization of educational institutions based on the inseparability principle contained in article 207 of the Brazilian Constitution. According to them, the LDB allowed inseparability actions to be, in truth, juxtaposed actions instead of articulated, joined ones (the essence of this theory). Criticism was presented by Mancebo (1997), Saviani (1998), Muranaka and Minto (1998), and Segenreich (1997). At the time, the authors indicated that this flexibilization would bring effects such as the valorization of market mechanisms and the appeal to the private sector and non-governmental organizations in detriment to the place and role of the State and public sector initiatives, with the consequent reduction of the actions and public investments in education. The reality does not show the opposite.

The social aspect that prevents the operationalization of the principle is in the possibility of identifying researchers that despise extension and teaching (high school and undergraduate education). These argue that research is the main engine for developing science. Generally, they point out that the actions are inseparable in research and stricto sensu graduate education - master's and doctoral programs; however, there is no vertical inseparability. As we see it, the complexity of inseparability "that is not separable into parts" is in the operationalization. Traditionally, extension has connections with teaching and rarely with research in any academic organization. It is necessary to advance.

In this sense, inseparability is advocated by the pedagogical political project and institutional development plan of the Instituto Federal Catarinense. There is a very propitious environment for the application of this principle within the maker space. Article 6 of Law 11892 of 2008, the law that creates the Brazilian federal network of scientific and technological professional education, points out that its institutional purpose is to promote the integration and verticalization from basic education to professional education and higher education.

Moreover, there is a fertile educational space for this initiative. We stress that, besides the articulation among the teaching, research, and extension activities and the verticalization of teaching (high school, higher education, and post-graduate studies), innovation is incorporated, which reflects the institutional mission according to its creator law. Hence, hereinafter, we will adopt innovation within the inseparability principle. To not corroborate the arguments that generate the obstacles, the inseparability principle shall guide all projects to be developed at the LaTIPA.

Given the above, we glimpse a path to overcome the challenge posed: capacitate protagonistic, collaborative, **and** innovative youths. In her doctoral dissertation entitled "O princípio da indissociabilidade universitária: um olhar transdisciplinar nas atividades de ensino, de pesquisa e de extensão", Gionara Tauchen (2009) recognized the complexity of this proposal. According to Tauchen (2009, p. 93), (...) *the inseparability concept refers to something that does not exist without the presence of the other, i.e., the whole is no longer whole when it separates*. The fundamentals of teaching, research, and extension are, therefore, altered; for this reason, it is a paradigmatic and epistemologically complex principle. We expect to contribute.

The LaTIPA as a space and connection of the maker culture

The learning by doing process is one of the pillars that define the maker culture. According to Manuel Tóran (2016), the maker culture may be defined as a chain of inventors and creators who treat knowledge as a basis for a new model of doing, creating, and implementing. According to the author, an important aspect is that this concept is very well assimilated among youths (TÓRAN, 2016, p. 2). This knowledge management model of doing offers the opportunity of integrating the broad range of technologies and solutions to promote, implement, and disseminate technologies and knowledge for greater development of society, without the abusive patent costs, without knowledge monopoly, without technological dependency, favoring the collective and collaboration, decreasing technological dependency.

Another approach that addresses the maker culture is that considered "experimental game", given that the makers are enthusiasts and play (seriously) with new technologies to learn how things work and develop new products and ideas. An example is the CEO of the Maker Magazine[5], Dale Dougherty. The magazine is a reference in the maker concept; besides tutorials, it also provides content, projects, targeted events, and marketplace (sales market of its own or third-party products). In his TED (Technology, Entertainment, Design) talk in 2016, he emphasized: "We are all makers"[6]. From this statement, one may highlight the following arguments:

a) Interest in doing things on their own (Do It Yourself, DIY) and in collaboration with others (Do It With Others, DIWO);

b) Use of digital desktop tools to create new products and develop prototypes;

c) Culture of sharing projects online and collaboration in online communities so that anyone may access information and create products using corresponding manuals;

d) Use of standard project files that allow anyone to send projects to fabrication services to produce in any quantity.

All presented arguments share a common aspect, even considering that there are different areas of knowledge: communication. Paulo Freire (2005) stated that to educate is to communicate. He contested the communication that takes place outside dialogic premises, especially regarding the supposed conversations the purpose of which was the imposition of the idea of a group, which did not allow the more in-depth reflection aimed at overcoming what he called "false awareness of the world" (FREIRE, 2005, p. 86).

The professor fosters students to cope with their realities in the classroom from what he called problem-situations, which would develop and be solved from joint reflexive, collaborative exchanges established among participants - educators and pupils - for real liberation and humanization for true mastery of culture and history. Such reflexive and creative processes are responsible for the praxis as a structure fostering the teaching, research, innovation, and extension actions; hence, a methodological proposal to operationalize inseparability.

The laboratory innovation will be in providing opportunity, preferably for integrated high school students, to have experiences with different collaborators at distinct phases of knowledge (undergraduate students, graduate students, and professionals already inserted in the work market) in an environment based on learning by projects, applying the contents of various subjects present in the school curriculum. This project proposes to mediate the use of technology as a pedagogical tool, not for the students to end up being computer literate but rather conscious users of technological tools. Hence, the LaTIPA proposes to approximate the fab lab essence so that its participants may complement or develop teaching, research, innovation, and extension activities using the available equipment. Hence, the professors will also be able to generate didactic materials to complement their courses.

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[5]Https://makezine com/
[6]Https://www ted com/talks/dale_dougherty_we_are_makers

Expectations

Nowadays, maker laboratories are the last word relative to learning science and technology in the school environment at any level. Several countries have already understood that the development of the local and international society will be guided by the transfer of experience and technology, in the consortium between universities and the industry, for the innovation, generation, and circulation of wealth.

The LaTIPA will be an IF Maker laboratory in essence: a place focused on the students, professors, and administrative technicians, not on machines, to thus provide a possibility of comprehensive and innovative learning. The presence of people of different ages and backgrounds contributing to projects that are being carried out or bringing their own demands. Ensuring some principles, such as freedom of creation, innovation, project sharing, and teamwork.

In this environment, no imposing demand that a given project "has to work out" may exist. The professor must always be around to pass on the necessary theoretical basis to the students, never undermining creativity but rather encouraging them to innovate more and more.

Propitiate multidisciplinary learning that stimulates a more personal approach to problems and, hence, introduce the maker practice in everyday life, awakening in the students the pleasure for work, the search for knowledge, autonomy, collaboration, the development of technical skills, the improvement of socioemotional competencies, and the emergence of the initiative to investigate. Essential skills to form citizens committed to the environment they live in and professionals with skills that meet the new demands of society.

The experience in this environment will be of utmost importance for the continued training of the professors: the development of scientific knowledge, the emergence of new didactics, and the approximation with the local needs within the social and technological scopes will provide better understanding for contributions in the most diverse areas of knowledge present on the campus, strengthening and integrating the institution with society.

The stimulus to educational administrative technicians regarding teaching, research, innovation, and extension, approximating them to students and professors for the integration and consolidation of their role in institutional processes.

According to the data from a study carried out by Saunders and Kingsley (2016) with 93 maker laboratories in China:
- 32%   of people are there for a hobby,
- 30%   go with the purpose of learning,
- 21%   have the intention of starting a company,
- 17%   go for other reasons, such as official visits from the government and business people.

Notably, the presence of machines and tools stimulates individuals to create and be protagonistic. In this process, the approximation with the learning of the technological practice focused on doing, allowing room for mistakes, always with a transdisciplinary and collaborative approach, will bring the entrepreneurial spirit closer. Responding to questions and local problems of the community surrounding the institution, hence integrating it with society. Thus, it is not uncommon for them to be viewed favorably by business people and academia, because their versatility allows it to be both a learning environment and a prototyping and creation environment.

Institutions with maker laboratories are where science and technology originate; they generate a highly qualified workforce for potential research, development, and innovation investments. Cultivating high-level scientific talents to promote scientific development and economic prosperity through stimulating the creative learning of students of humanities and exact sciences, putting different programs to talk to each other, and planting the seeds for the

communication and interaction among different areas of human knowledge, being a differential for providing consistent services of public interest.

Incubators and startups are often created in maker laboratories, boosted from a development methodology known as Minimum Viable Product (MVP); the principle of this methodology is the idea of collecting the maximum of validated information with the minimum effort and cost, enabling a correction and a new test quickly. Learning is taken to a new product stage, ending at the due patent registration guided by the laboratory and institutions such as NIT and INPI.

The LaTIPA is expected to propitiate a complement to teaching with the use of the available equipment for development using technology as a pedagogical tool. Generating opportunities for integrated high school, undergraduate, and graduate students to have experiences with different collaborators at different phases of knowledge in an environment based on learning by projects, applying and integrating the contents of various subjects present in the school curriculum, maximizing creativity and innovation.

References

CEPE, P.-G. ([s.d.]). Poíticas e diretrizes do ensino de graduação. Pontifícia Universidade Católica de Goiás. https://sistemas.pucgoias.edu.br/sistemas/concursos/editais/0252020-prograd/1596661586650_politica-e -diretrizes-ultima-versao-10-de-julho-1.docx

Demo, P. (2004). Aprendizagem no Brasil: Ainda muito por fazer (2a). Mediação.

Fazenda, I. (1978). Integração e interdisciplinaridade no ensino brasileiro: Efetividade ou ideologia(6o). Loyola.Freire, P. (2019). Pedagogia do Oprimido(69a). Paz e Terra.

Gavassa, R. (2017). Cultura Maker, Aprendizagem Investigativapor Desafios e Resolução de Problemasna SME-SP (Brasil). In Educomunicação e suas áreas de intervenção: Novos paradigmas para o diálogo intercultural (Vol. 1, p. 662–668). ABPEducom. https://abpeducom.org.br/publicacoes/index.php/portal/catalog/view/1/1/93-1

Morin, E. (2015). Introdução ao pensamento complexo(5a). Editora Sulina. Nehring, C. M., Battisti, I. K., & Pozzobon, M. C. C. (2018). Entendimento de professores universitários sobre o seu fazer: Ensino como atividade preponderante e extensão como atividade ainda periférica. Revista Espaço Pedagógico, 25(3), 647–664. https://doi.org/10.5335/rep.v25i3.8569

Pinheiro, F. A. (2010). Indústria, agricultura e serviços na economia catarinense: Do desenvolvimento regional a formação de arranjos produtivos locais. http://tede2.pucrs.br:80/tede2/handle/tede/3879

Silva, P. R., Ribeiro, E., Serpe, B., Matallana, G., Meira, E., Mattedi, M., Gaia, C., Spiess, M., Ludwing, L., Castro, C., Guimarães, P., & Martins, A. (2020). Transferência de tecnologia para monitoramento ambiental por drone em aterros sanitários regulados e recursos hídricos no vale do Itajaí – SC. Metodologias e Aprendizado, 2, 52–57. https://doi.org/10.21166/metapre.v2i0.1310

Tauchen, G. (2009). O princípio da indissociabilidade universitária: Um olhar transdisciplinar nas atividades de ensino, pesquisa e extensão (p. 147) [Tese de doutorado]. Pontifícia Universidade Católica do Rio Grande do Sul. http://tede2.pucrs.br:80/tede2/handle/tede/3624

Tom, S., & Kingsley, J. (2016). Made in China: Makerspaces and the search for mass innovation(p. 1–36) [Pesquisa]. British Council. https://media.nesta.org.uk/documents/made_in_china-_makerspaces_report.pdf

Torán, M. M. (2016). ¿Por qué tienen tanta aceptación los espacios maker entre los jóvenes? Cuadernos de Investigación en Juventud, 1, 28–45. https://dialnet.unirioja.es/servlet/articulo?codigo=5698516