ARTICLE

SYSTEMATIC MAPPING OF SOCIAL TECHNOLOGIES IN BRAZIL: SUBSIDY FOR TEACHER EDUCATION AT THE INSTITUTO FEDERAL DE SERGIPE

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ABSTRACT: The debate on Social Technologies (ST) has reached various sectors of society, including educational and research institutions. However, there are still few projects of this type produced in these contexts and training aimed at the practical development of this type of intervention in Brazilian communities is still lacking, which makes feasibility, especially in educational contexts, in which it is necessary to plan and evaluate actions educational.

In this article, the ST are analyzed from the perspective of their application to Professional and Technological Education, specifically at Federal Institutes. The results of a Systematic Mapping Study are presented, which selected primary studies indicative of methodological aspects of the development of concrete ST projects implemented in Brazilian communities. At the end of the mapping, 186 articles (only 5.9% of the sample analyzed) showed the methodology applied to the development of ST. From the discussion of the results of the mapping, a Thematic Analysis was conducted to qualitatively analyze significant patterns of the data set that revealed methods and processes of ST production to systematize an educational product of teacher training. The product proposed collaborative trails for the development of ST appropriate to local specificities with the goal of developing a project in ST applicable to their fields of activity at the Instituto Federal de Sergipe (IFS). As a way of applying and evaluating the educational product, a Case Study was developed with teachers and technicians from IFS - Campus Lagarto, which resulted in good prognoses of wider application.

Keywords: Professional and Technological Education, Social Technologies, Educational product, Teacher training.

MAPEAMENTO SISTEMÁTICO DE TECNOLOGIAS SOCIAIS NO BRASIL: SUBSÍDIO PARA FORMAÇÃO DOCENTE NO INSTITUTO FEDERAL DE SERGIPE

RESUMO: O debate sobre as Tecnologias Sociais tem chegado a vários setores da sociedade, incluindo as instituições de ensino e pesquisa. Entretanto, ainda são poucos os projetos desse tipo produzidos nesses contextos e há carência na formação voltada para o desenvolvimento prático desse tipo de

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intervenção em comunidades brasileiras, o que dificulta sua viabilização, sobretudo em contextos educacionais, nos quais é preciso planejar e avaliar as ações educativas.

Neste artigo, as TS são analisadas sob a perspectiva de sua aplicação à Educação Profissional e Tecnológica, especificamente nos Institutos Federais. São apresentados os resultados de um Estudo de Mapeamento Sistemático que selecionou estudos primários indicativos de aspectos metodológicos de desenvolvimento de projetos concretos de TS implementados em comunidades brasileiras. Ao final do mapeamento, 186 artigos, i.e. apenas 5,9% da amostra analisada, evidenciaram a metodologia aplicada ao desenvolvimento da TS. A partir da discussão dos resultados do mapeamento, foi conduzida uma Análise Temática para analisar qualitativamente padrões significativos do conjunto de dados que revelassem métodos e processos de produção de TS, no sentido de sistematizar um produto educacional de formação docente. O produto propôs trilhas colaborativas de desenvolvimento de TS adequadas às especificidades locais com a meta de elaborar um projeto em TS aplicável a seus Campi de atuação no Instituto Federal de Sergipe (IFS). Como forma de aplicação e avaliação do produto educacional, foi desenvolvido um Estudo de Caso com docentes e técnicos do IFS – Campus Lagarto que resultou em bons prognósticos de aplicação mais ampla.

Palavras-chave: Educação Profissional e Tecnológica, Tecnologias Sociais, Produto educacional, Formação docente.

MAPEO SISTEMÁTICO DE TECNOLOGÍAS SOCIALES EN BRASIL: FUNDACIÓN PARA LA FORMACIÓN DE PROFESORES EN EL INSTITUTO FEDERAL DE SERGIPE

RESÚMEN: El debate sobre las tecnologías sociales ha llegado a diversos sectores de la sociedad, incluidas las instituciones educativas y de investigación. Sin embargo, todavía son pocos los proyectos de este tipo producidos en estos contextos y hay una falta de formación dirigida al desarrollo práctico de este tipo de intervención en las comunidades brasileñas, lo que hace que su viabilidad, especialmente en contextos educativos, en los que es necesario planificar y evaluar acciones educativo.

En este artículo, los TS son analizados desde la perspectiva de su aplicación a la Educación Profesional y Tecnológica, específicamente en los Institutos Federales. Se presentan los resultados de un Estudio de Mapeo Sistemático, que seleccionó estudios primarios indicativos de aspectos metodológicos del desarrollo de proyectos concretos de TS implementados en comunidades brasileñas. Al final del mapeo, 186 artículos, es decir, solo el 5,9% de la muestra analizada, mostraron la metodología aplicada al desarrollo de TS. A partir de la discusión de los resultados del mapeo, se realizó un Análisis Temático para analizar cualitativamente patrones significativos del conjunto de datos que revelaron métodos y procesos de producción de TS, con el fin de sistematizar un producto educativo de la formación docente. El producto propuso senderos colaborativos para el desarrollo de TS adecuados a las especificidades locales con el objetivo de desarrollar un proyecto en TS aplicable a sus campos de actividad en el Instituto Federal de Sergipe (IFS). Como forma de aplicar y evaluar el producto educativo, se desarrolló un Caso de Estudio con profesores y técnicos de IFS - Campus Lagarto, que resultó en buenos pronósticos de aplicación más amplia.

Palabras clave: Educación profesional y tecnológica, Tecnologías Sociales, Producto educativo, Formación del profesorado.

INTRODUCTION

In the context of a dispute between society projects, characteristic of the period of re-democratization in Brazil, in which, under the prism of national education, the construction of a more progressive path, committed to the working class, was sought, we can identify among the conceptions more debated the defense of a unitary high school, with work as an educational principle (SAVIANI, 1989), embodied in the integrated high school proposal (RAMOS, 2008, p. 2).

This proposal is opposed to the traditional dual vision of teaching that reproduces inequalities and provides young people from the lower classes with a professional education that is functional to the productive requirements (CIAVATTA; RAMOS, 2011, p. 28). It points to a technical high school incorporating science, work, technology, and culture as inseparable axes (FRIGOTTO; CIAVATTA; RAMOS, 2005, p. 43-45), overcoming curricular fragmentation and promoting integrated education from the knowledge point of view and integrating from the human point of view.

For Ciavatta (2008, p. 3), the terms "integrated education," "polytechnic education," and, more recently, "technological education," all associated with the integrated high school proposal, seek to respond to the needs of a world of work run through by science and technology. On the one hand, they are productive forces and generators of values and wealth; on the other, through their private appropriation, they are the source of exclusion, precariousness, underemployment, unemployment, loss of community bonds, and identity.

The objective of this education proposal is, therefore, to ensure to young people a complete formation for the critical reading of the world, for the understanding of the social relationships underlying all the phenomena, and for the effective intervention in the social reality (CIAVATTA; FRIGOTTO; RAMOS, 2005, p. 85), as Simões explains(2007, p. 84):

> Technical education linked to high school, preferably integrated, represents for youth a possibility that not only contributes to economic [...] survival and social insertion, but also an educational proposal, which in the integration of fields of knowledge, becomes fundamental for young people from the perspective of personal development and the transformation of the social reality in which they are inserted.

The proposition is based, in a broader way, to a perspective of studies on Science, Technology, and Society (CTS) that defends the integration of the technoscientific process to the social context and the democratic participation of the population, both in the development of such process and in the fruition of its benefits, seeking local development under new rationality linked to social and economic inclusion, sustainability, and solidarity relationships.

We can recognize, in several aspects, the attempt to concretely apply these ideas to the process of creation and implantation of the Federal Network of Professional, Scientific and Technological Education (RFEPCT) and the creation of the Federal Institutes of Education, Science and Technology (IFs) in Brazil, through Law No. 11,892/2008. The text of this Law presents the defense of an education aimed at absorbing concepts as a system of relationships of a concrete totality; the promotion of a non-deterministic view of science and technology; a conception of socio-economic development oriented towards the construction of a more just and egalitarian society; training for active intervention in the social reality experienced by the communities surrounding the IFs.

According to Silva *et al*. (2009), IFs were created to promote and encourage social justice, sustainable development, social inclusion, technical solutions, and new technologies, meeting the EPT and supporting productive arrangements locations. In line with this understanding, Law No. 11,892/2008, which created the IFs, among the purposes of these institutions, the provision of EPT as an educational and investigative process for generating and adapting technical and technological solutions

to social demands and regional peculiarities and the promotion of the production, development, and transfer of Social Technologies (BRASIL, 2008).

> I - Offer EPT, training, and qualifying citizens with a view to professional performance in the various sectors of the economy, with an emphasis on local, regional, and national socio-economic development;
> II - Develop EPT as an educational and investigative process for generating and adapting technical and technological solutions to social demands and regional peculiarities; [...]
> IX - Promote the production, development, and transfer of **social technologies**, notably those aimed at preserving the environment. [emphasis added] (BRASIL, 2008).

Studies on Social Technologies are multidisciplinary and relatively recent; the concept is still the subject of debate and tends to be polysemic, inspired by different theoretical and methodological perspectives, even though its variations maintain essential elements in common. As a starting point, we will adopt the concept of Rodrigues and Barbieri (2008) of TS as the construction of solutions collectively by the social actors who will benefit from these solutions – with external support, if necessary – and act with the autonomy to apply them sustainably. It means they are not only acting as users of technological solutions transferred from other places – technology transfer – or produced exclusively by teams of specialists, but acting to appropriate social technology under the logic of the development of the community itself. (RODRIGUES; BARBIERI, 2008, p. 1075).

In an attempt to characterize the practical experiences in TS in an objective way, Maciel and Fernandes (2011) propose fundamental elements that should integrate the TS projects, which we take as guiding parameters of the research that originated this article: potential for social transformation; direct participation of the population; a sense of social inclusion; improvement of living conditions; socio-environmental and economic sustainability; innovation character; ability to meet specific social needs; organization and systematization of technology; a dialogue between different types of knowledge (academic and popular); accessibility and appropriation of technologies by the target communities; dissemination and educational action; the building of citizenship and democratic processes.

From an educational perspective, one of the ideas under debate, inspired by Latour (1994), is TS as a tool for easing the hierarchy between knowledge under a dialectical and inclusive prism for building collective learning and knowledge.

For Dagnino (2014), the TS seeks inclusion by deconstructing the concept that communities' social problems must be defined and solved according to other actors' cognitive models and not from the communities' model. Therefore, they point to community praxis, supported by dialogue between technical-scientific and popular knowledge, and representing a cognitive platform for alternative forms of development, which are more democratic and solidary.

From the curriculum and educational processes, the TS involves dynamics of non-formal education and dimensions of the production of knowledge related to different types of knowledge: theoretical, conceptual, scientific, technical, technological, and practical. It also involves knowledge obtained through participatory research. It requires discovering and incorporating to TS the dimension of popular, traditional knowledge, often not codified, linked to community practices, which also need to be mobilized to produce and plan innovative solutions to local problems.

Kuenzer (1999) proposes, among the fundamental axes for teachers' training for EPT, the Praxis axis, which must integrate scientific knowledge, tacit knowledge, and social practice. Under the praxis axis, we consider that teacher training in TS should be articulated, which, in turn, demands a methodological foundation and practical guidelines to enable the development of extension projects in TS in the IFs, under the perspective of an integrated EPT and integrator of knowledge.

In the specific context of the IFs, the development of actions and extension projects oriented towards the production of TS can significantly and appliedly integrate the knowledge, methods, and practices related to both the propaedeutic disciplines and those related to the technical and technological disciplines of professional education. It can also contribute to constructing students' autonomy, critical understanding of the totality in which they are inserted, construction of innovation capacities, problem-solving, applying theoretical and practical knowledge to the community's social reality and the world of work.

Based on this panorama, it requires reflecting on the aspects of the practical feasibility of TS projects in the EPT context applied in the IFs and answering some essential questions: Have the IFs systematically developed TS projects effectively on their campuses? How can teacher training for EPT account for the feasibility of this type of project? Are there systematic methodological guidelines on the production of TS applicable to educational processes and the context of the IFs? How is it possible to support teachers in the development of TS in the IFs?

In the EPT scenario predicted for the IFs, supported by the teaching/research/extension tripod, extension actions, such as technological extension projects, appear as an alternative for developing TS projects in the IFs. As advocated by Rios and Lima (2016, p. 95): "This action enables both the creation and the recognition, dissemination, and valorization of collective work embodied in TS," as it helps to mediate the production and application of projects that solve problems of the local population, the recording of steps and their results, and the sharing of the knowledge produced.

Technological Extension should be noted as having distinct characteristics from university extensions, despite sharing the sense of extension as a dialogical relationship with society. The concept of extension in the IFs appears in the document released in 2013 by the National Council for the Federal Network of Vocational, Scientific, and Technological Education Institutions (CONIF):

> The technological extension of the Federal EPCT Network has as a differential the service to the social segments and the world of work with an emphasis on social inclusion, the emancipation of the citizen, favoring local and regional development, the diffusion of scientific and technological knowledge, the production of research applied and socio-economic sustainability [...] extension activities must be articulated with teaching and research meeting the demands of the internal and external community. The aim is to understand and consolidate academic and popular knowledge linked to one or more extension dimensions (CONIF, 2013, p. 20).

Concerning the development of TS projects in the IFs, within the preliminary bibliographic surveys' scope to the research that gave rise to this study, few characterize effectively as TS among the extension projects concluded and ongoing in IFs (SOUZA; RUFINO, 2017, p. 106-112). This occurs because a significant part of the projects aimed explicitly at TS, developed in federal institutions, do not correspond to the expected criteria for this project type, such as the appropriation and the learning of TS by the community and that of planning, application/systematization, and recording knowledge produced in an organized manner.

From the perspective of teacher training for the development of TS, it is necessary to consider the specificities and complexities of EPT. For Machado (2008, p. 18),

> [...] the profile of the professional education teacher needs to account for three levels of complexity: a) develop skills to use, a more elementary level related to the application of knowledge and the use of instrumental skills; b) develop production capacities, which requires the use of knowledge and skills necessary for the conception and execution of objectives for which technological solutions exist and must be adapted; and c) develop capacities to innovate,

a higher level of complexity related to the requirements of the process of generating new knowledge and new technological solutions (MACHADO, 2008a, p. 18).

Therefore, teacher training at EPT needs to develop the skills to produce and use the knowledge and instruct teachers to develop the ability to generate new knowledge and technical solutions.

The IFs' role is to contribute to professionals' training and produce knowledge compatible with a more just and egalitarian society project, promoting the direct contact of students, teachers, and technicians with popular needs. This occurs through a dialogical practice of knowledge construction and joint struggle against exclusion: "the proposal to strengthen the power of the popular strata is not centered on the transmission of knowledge, but on the creation of a space where popular knowledge can express itself" (GARCIA, 1980, p. 92), which is in line with the teacher training proposal for the development of extension projects in TS in the context of the IFS. However, preliminary surveys have shown that materials, products, courses, or other resources of a methodological or didactic nature are not available to the Ifs' faculty aimed at the production or adaptation of TS applicable to the educational processes of EPT.

From this scenario, the hypothesis was raised that, among the reasons for the scarcity of extension projects in TS in the IFs, the absence of systematic methodological support resources for the teacher in a systematic way, through actions and extension projects, requiring creating educational itineraries and resources to support the continuing education of EPT faculty focused on the mediation of local social intervention practices.

Then, as a research problem that originated this study, the absence of training itineraries and resources to support the production of TS in the context of the IFs was delimited and, as a solution proposal, the investigation of methods and processes of TS development was carried out, applicable to EPT, its systematization and transposition to an educational product of teacher training in TS. We hope to support the elaboration and application of extension projects in TS aimed at sustainable local development and socio-economic inclusion, the dialogical interaction of the academic community with society through the democratic exchange of knowledge , and critical and comprehensive training of students.

THEORETICAL BACKGROUND

The context of debates on the role of Science and Technology in contemporary times and their relationships with society requires considering the phenomenon of technological acceleration and analyzing the different theoretical perspectives elaborated from the intensification of technical-scientific processes and their impacts on social, cultural, and economic dynamics, including the transformations that have been causing in the production and dissemination of knowledge and the nature of teaching and learning processes, both in the formal and informal spheres of Education.

In this scenario, on the one hand, there is the traditional conception that the growing progress of science and technology is decisive for economic and social development. On the other hand, there is the perspective founded on the uncertainty that surrounds the future of society, and questions the determinant and supposedly neutral role of science and technology, pointing to the need to develop alternative technologies to conventional technologies based on more democratic and inclusive principles (ROLLEMBERG, G.; FARIAS, M. F., 2018). To substantiate such questions, we highlight here representative excerpts from the review of scientific production related to the areas supporting the research in which this article originated.

Debates on Technology, Innovation, and Development: a conceptual milestone of the TS

The linear chain model of conventional technological innovation, inspired by the liberal interpretation, which considers innovation and technology as directly related to the market (SHUMPETER, 1985), assumes that scientific research is followed by technological research, which, in turn, produces economic development, and this enables social development (BAUNGARTEN, 2008, p. 5). Innovations, in this sense, would be processes through which new ideas, objects, and practices are created, developed, or reinvented (CROSSAN; APAYDIN, 2010, p. 1.155). This perspective, therefore, directly relates the advance or backwardness of societies to the level of technological sophistication they have and can be classified as a conventional conception of technological innovation, linked to a liberal model for interpreting reality and the concept of development itself.

According to Baumgarten (2005), this model is based on the idea of man's supremacy over nature and considers economic and social inequality as necessary, interpreting innovation and technology as directly related to the market, the laws of supply and demand, and taking them as resources of competitiveness, pointing to the concepts of conventional technologies and technoscience. Still, on the subject, Godinho (2003) argues that even though the conventional conception of innovation is under debate, in practice, it is still present, often detected in programs and public policies aimed at science, technology, and innovation.

Alternative technologies to conventional technologies, on the other hand, are linked to another innovation model, social innovation, conceptualized by Mulgan et al. (2006, p. 145-146) as related to innovative activities and services that meet social needs, being developed by social organizations, teaching, and research institutions and, sometimes, public agents. In this context, TS are an example of a theoretical-practical alternative to conventional technologies to overcome the technocentric and diffusionist perspective and build a social perspective for science and technology under democratic rationality and integration between knowledge and practices.

Another way of investigating TS's roots is the historical survey of proposals for technological alternatives, such as those generically called Appropriate Technologies (TA). This type of technological alternative's historic origin goes back to the rehabilitation of traditional technologies, practiced in India's villages as a strategy to fight British rule at the beginning of the 20th century. Later, in the 1960s and 1970s, they were developed worldwide.

Considered as alternatives to the technologies in developed countries, TA were transplanted to several countries, mainly by multinational companies. However, this process did not represent a rupture with the current capitalist development model because, as Pinto (2005) states, the transfer of technology from central to peripheral regions provides profits for those who make the transfer and for those who will be its owners, and not for the population that will use it.

After a comprehensive analysis of the movement of TA, Dagnino, Brandão, and Novaes (2004) concluded that their various currents reveal a product, not a process, since innovation cannot be thought of as something done in one place and applied in another, and instead as developed in the place where the technology will be used, by the actors who will use it. For them, social innovation supposes a process in which social actors interact from the beginning to conceive, based on multiple criteria – often tacit and sometimes purposely uncoded (scientific, technical, financial, marketing, cultural, etc.) –, a knowledge that they will use locally (DAGNINO, BRANDÃO; NOVAES, 2004). This idea is at the origin of what we call TS.

Critical perspectives on Science, Technology, and Society: the role of TS

According to Kuhn (1989), the theses of neutrality and non-neutrality of science and technology have in common the impossibility of understanding technology as a social construction, an understanding that underlies the most recent critical conception of technology. Under this critical perspective to the traditional science and technology paradigm, the movement Science, Technology and Society (CTS) arises, especially during the 1970s, in Europe and the United States.

The researchers involved in this movement, according to Auler (2011, p. 74-76), turned to two trends, the European and the North American. The first focused on academic issues involving the investigation of the impacts of scientific and technological development in contemporary times, and the second on issues such as the social and environmental consequences of technological products and the effects that scientific and technological development would have on society and the environment, advocating for the democratic participation of citizens in scientific and technological decisions.

In the wake of the North American trend of CTS studies, the Critical Theory of Technology emerged, proposed by Feenberg (2004), who argued that technology would promote development to meet society's needs. However, it would require a social control that would guide such development, no longer under the technical rationality, but under democratic rationality that considers the technology at the service of humanity, and not the opposite.

In Brazil, authors like Sant'Anna (1978) already stated decades ago that Brazilian society could never overcome the "Science and Technology" issue or even point out alternative paths for its development from the relationships between the productive and scientific systems. This occurred because the country had renounced autonomous technological development in the name of a supposedly more profitable import of technology, linked to the so-called diffusionist model, which, for the author, would not be adequate to local realities.

According to Pinto (2005, p. 296-299), one of the consequences of this conception's hegemony is that the "non-technological" regions, less developed, run the risk of planning their technological development imitating the more developed regions; forgetting their objective conditions. For the author, this is evident in the transfer of technology from "central regions" to "peripheral regions," in which many take the technology from "central regions" as the most advanced and, in the process of technology transplantation, favor the profits of who make the transaction and who will own it, not the people who will host it.

The technique, then, gains more centrality than the human being who will receive it. This conception, for the author, should be replaced by a social conception of technology that considers the human being as the center of the processes and values the local populations, who need technological solutions to transform their reality and overcome their economic, social, environmental, educational difficulties, etc. (PINTO, 2005, p. 296-299). This view is close to Feenberg's theory, which takes technology as a social construction, central to the process of democratizing production, social relationships, and the construction and dissemination of knowledge.

The search to overcome the conventional perspective of technology under democratic rationality raised a challenge: the possibility of thinking about technology as a dimension of culture, rescuing a pedagogical vision and a historical understanding that situates technology as a human activity subordinated to other dimensions human, and not as superior to them, capable of contributing to the overcoming of inequalities and social inclusion (DAGNINO, 2014), as is the case of TS.

For Dagnino and Bagattolli (2009, p. 8), it requires disseminating in the research community that "social inclusion will only be encouraged by the Science and Technology Policy (PCT) when it is included in the decision-making agenda of public policy and, more than that, when the TS integrate the

public PCT policies." One of the ways pointed out by the authors would be to convince the research community of the convenience of changing their teaching, research, and extension agendas, moving away from the existing canons and reorienting the research and teaching potential in public institutions (DAGNINO; BAGATTOLLI, 2009, p. 3).

However, Costa (2013) points out that the TS, as an instrument of public policies, lack mediation between the State functions and the communities' social dynamics. Such mediation can be performed by actors linked to non-governmental organizations and teaching and research institutions, collaborating with the target communities' internal actors and their institutions. As highlighted by Klossowski, Freitas, and Freitas (2016, p. 62), research and extension actions can operationalize public educational institutions' social roles and bring them closer to society. In this sense, TS have significant importance as an instrument for the application of extension actions aimed at society's demands from a perspective in which scientific knowledge can be associated with popular knowledge, in a "reciprocal, mutually transforming relationship" (JEZINE, 2004, p. 3) and contribute to the construction of autonomy and organization of social actors in the communities and the transformation of social reality.

Social Technologies and Education: collective knowledge and social intervention

When dealing with TS from an educational perspective and considering what Gadotti (1988) calls pedagogy of praxis, Soffner (2014, p. 311) suggests that TS can be characterized as social pedagogy projects aimed at a socio-community praxis. This occurs because TS produce solutions that contribute to improving the quality of life of social groups and the integral educational development of people involved in the social transformation of the environment to which they apply.

For Maciel and Albagli (2004, p. 10), it is essential to consider that learning in the context of the production and application of social innovations is not limited to simple access to information. This occurs as such access does not necessarily generate knowledge or changes cognitive structures; they refer to a much broader and more complex process of acquiring and constructing different types of knowledge, skills, and abilities and their mobilization in action/innovation.

Concerning the production of social innovations, the authors (MACIEL; ALBAGLI, 2004) state that learning should be thought of as a social relationship and also cite other authors, such as Lundvall (2002) and Patrucco (2003), who highlight the importance of tacit knowledge as a source of innovation and the role of local interactions in the production and dissemination of such knowledge and analyze the processes of knowledge generation and sharing – especially tacit ones – and their influence on innovative local capacity. They propose that the production, socialization, and use of knowledge and information, as well as their conversion into innovations, are socio-cultural processes and point out that:

> [...] there are gaps in the sense of defining and developing methodologies and research instruments that empirically demonstrate the relevance of local knowledge flows for innovation and that highlight the socio-spatial factors that interfere in these flows (MACIEL; ALBAGLI, 2004, p. 9).

Several Brazilian researchers in the TS area also consider collective learning dimensions fundamental for this type of project. The Institute of Social Technology (ITS, 2004) points out the relevance of learning and participation as simultaneous processes, under a systemic understanding of reality, respecting local identities. Similarly, Maciel and Fernandes (2011) propose, as one of the fundamental elements for the development of TS, the dialogue between different academic and popular knowledge; the accessibility and appropriation of TS by the community; and the dissemination and educational action related to it. In such proposals, the equitable valorization of the types of knowledge

indicates the organic collaboration between researchers and other external actors and the local actors with their traditional, tacit, non-codified knowledge.

In another aspect, Baumgarten (2005) states that a fundamental element for the country's economic and social sustainability would be articulating knowledge production – and its privileged locus, teaching and research institutions – and social innovation. Social networks researchers and other actors related to the production and dissemination of knowledge can help deepen the relationship between the scientific community and Brazilian society, enabling TS development to be integrated into local and regional public policies.

However, in the specific IFs context, according to Pichetti (2018, p. 7), in a thesis on the role of Technological Innovation Centers (NIT) in promoting the use of TS in IFs, which considered self-management cooperatives as included in the list of the TS, 69.2% of the surveyed IFs did not encourage cooperatives between 2013 and 2017. In contrast, technology transfer initiatives to the community in the same period appeared with a much greater emphasis (PICHETTI, 2018, p. 76-78).

The author states there is little interest from such centers, present in all 38 IFs, in TS development and reapplication, even considering that such functions are among the purposes for which they were created. There is a clear tendency to support the transfer of conventional technologies predominantly, compromising sustainable regional development, and concludes that:

> the role of the NITs in professional technological education could point to alternatives, such as the prioritization of extension activities, which help the community around their institutions more strongly (PICHETTI, 2018, p. 86).

Based on this scenario, the hypothesis considered throughout the research is: the engagement of the IF faculty itself, supported by appropriate training resources and adaptable to its teaching action and its educational and socio-cultural context, can generate extension projects that favor the development of TS as a way to promote sustainable local and regional development and, also, contribute to the integral training of students.

Professional and Technological Education from a critical perspective

The document "Um novo modelo em Educação Profissional e Tecnológica: concepção e diretrizes," - A new model in Professional and Technological Education: conception and guidelines - published in 2010 by the EPT Secretariat, linked to the Ministry of Education – MEC, presents a general conception of EPT from the Federal Network:

> [...] training processes based on the assumptions of integration and articulation between science, technology, culture, and specific knowledge and the development of scientific research capacity as essential dimensions for maintaining the autonomy and knowledge necessary for the permanent exercise of labor, which translate into teaching, research and extension actions. On the other hand, considering that it is essential for EPT to contribute to socio-economic progress, current policies effectively dialogue with social and economic policies, highlighting those with local and regional approaches. (MEC, 2010).

The document highlights the new institutionality brought by the IFs, not only in the context of the modality but also in the political, social, and educational scenario of their creation, during a new corporate project. The challenge posed is unifying education for work and citizenship by overcoming the competitive modernization paradigm, focusing on society's effective development. Thus, it is essential to reflect on the construction of new educational standards, which incorporate technical and technological progress to education in an emancipatory way and not reproducing economic and social inequalities (FERRETI et al., 2003).

This new paradigm involves the organic meeting of technical-professional education and propaedeutic education in a curricular totality, the so-called integrated teaching in the EPT context. There is the promotion of a unitary school that offers education in an equitable way for young people of all social classes so that everyone has access to the knowledge, culture, and mediations necessary to work and to produce their existence and social wealth (FRIGOTTO; CIAVATTA; RAMOS, 2005). Also, the assumptions that the human being is a producer of his reality, capable of appropriating it and transforming it, which makes work an educational principle; and the notion that training professionally is not only preparing for the exercise of work but also for the understanding of the socio-productive dynamics of modern societies, enabling people to exercise autonomously and critically professions (RAMOS, 2008).

According to this conception, teacher training in IFs needs to focus on dialogical production of knowledge, to promote direct contact by students, teachers, and technicians with the needs and problems of local communities, of which they are often part of, for a collective struggle against exclusion that incorporates scientific knowledge and popular knowledge and practices.

According to Moura (2014), the EPT is a formative space in which the counter-hegemonic struggle is arduous. The formation of subjects capable of critically analyzing the capitalist mode of production is contrary to the system's very structuring logic. The author argues that it is essential to consider the needs and expectations of both the education networks and the training subjects – the teachers. They, at times, have no initial training focused on teaching and need possibilities for didactic-political-pedagogical training in service.

Regarding the technological aspect of teacher training at RFEPT, Machado (2008) points out a mismatch between technical and technological training for the world of work and the conceptual and strategic understanding of technique and technology at EPT, which can be complemented by Freire and Batista (2017). They argue that teacher training, in this modality, would need to contemplate a deeper understanding of technology concepts and their reflexes in socio-cultural and political practices, which can be made possible through extension projects, thus supporting our research proposal and production of educational product for teacher training in TS in the context of EPT developed in the IFs.

METHODOLOGY

From the bibliographical surveys, the summary of which is contained in the theoretical references section of this study, the scarcity of objective information on the methodological and practical aspects of the development of TS projects in Brazil that could support the systematization of continuing education itineraries was identified. This scarcity, therefore, pointed to the need to conduct a systematic literature review on TS that could corroborate – or not – such a hypothesis.

In the context of such reviews, the article by Gapinski and Freitas (2016) stands out, quantitatively analyzing TS projects certified by Banco do Brasil Foundation (FBB) between 2007 and 2011. The study data come from the Bank of Social Technologies, base maintained by FBB, which currently has registered information on about a thousand projects. Analyzing a sample of 146 of them that involved municipal public agencies (from a universe of 401 TS certified at the time), the authors reported that each TS, to be part of the bank, is evaluated under five criteria to be met:

> 1. Be in business for at least two years; 2. Have proven results of social transformation; 3. Be systematized to the point of making it possible to reapply in other communities; 4. Count on the community's involvement in its conception or have been appropriated in its development or reapplication; 5. Respect the following principles and values: social protagonism, cultural respect; environmental care; and economic solidarity. (GAPINSKI; FREITAS, 2016, p. 8).

The study was a reference for the design of the MSL, as it contributed to reinforce the perception that methodological aspects, in general, are not privileged, in the case of TS, since, in the prior verification of the content of each of the criteria considered for certification of the TS submitted to BTS, no criteria were found related to the methodology used in the production or application.
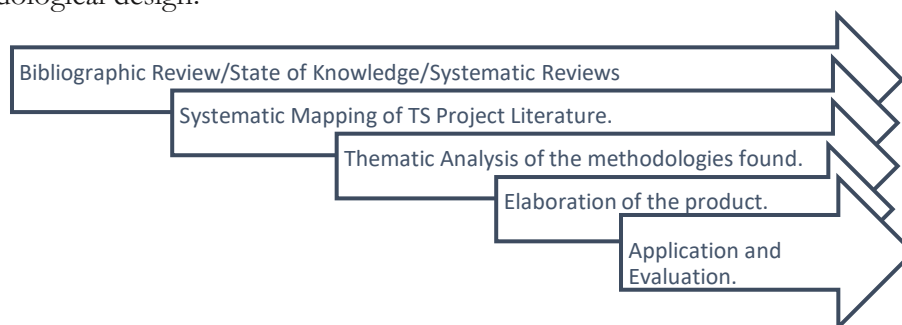
The study of Souza and Rufino (2017) described a data survey of all projects related to research, extension, and associated actions registered in the institutional virtual platform Integrated System for the Management of Academic Activities (SIGAA), used, in large part, by Universities and IFs that involved innovations and TS completed or ongoing. Also, it informed that a significant part of the extension projects aimed at TS did not meet the criteria expected to consider them as TS effectively. Of the 108 projects surveyed in the study, only 15 were identified as effectively TS; the three main exclusion factors were: 1) inadequate or non-participatory study plan; 2) mandatory action schedule; and 3) technical dependency.

The study also contributed, with its project evaluation parameters, to the creation of study inclusion criteria and the categorization of MSL data undertaken in the research, with emphasis on the relevance of the community's participatory study plan and the types of dynamics of collaboration between the agents as decisive to characterize the project as effectively a TS.

The lack of specific methodological guidance resources for the development of TS aimed at the teachers of the IFs was defined as a research problem. Conducting an MSL on TS projects in Brazil was taken as a solution design, focusing on its methodologies, steps, and development procedures, followed by a qualitative analysis – Thematic Analysis – of the Mapping results referring to the methodological discoveries. Its final systematization subsidized the creation of an educational product for teacher training in TS to support and expand its production through extension projects in the context of the IFs.

The research methodology was applied in nature, with exploratory and descriptive objectives of the concepts, characteristics, and steps of developing the analyzed TS, and the approach was quali-quantitative. Figure 1 shows the methodological design.

Figure 1 – methodological design.

Bibliographic Review/State of Knowledge/Systematic Reviews

Systematic Mapping of TS Project Literature.

Thematic Analysis of the methodologies found.

Elaboration of the product.

Application and Evaluation.

Source: Prepared by the authors.

Based on the discussion from the MSL results, a Thematic Analysis was conducted to analyze essential data set patterns on TS production methodology to trace didactically transposable development trails for the educational product. The research's primary results were brought together to understand TS concepts and fundamental characteristics and the collaborative construction of an extension project in TS, to be applied by the participants in their working area in the IFS. The application steps and product evaluation were carried out at the IFS Lagarto Campus through a Case Study.

Conducting the MSL

Given the scarcity of information on the practical development of TS projects, the following scope was defined for the MSL: scientific articles reviewed by peers and published in journals indexed in databases recognized by the scientific community between 2013 and 2017 – a period in which, through preliminary search tests in databases relevant to the topic, a significant number of articles were identified that addressed TS in some way – describing concrete projects of TS developed in Brazilian communities and indicating information of a methodological nature (processes, steps, and/or procedures) for the production, application, and/or reapplication of the TS. The MSL protocol followed the model proposed by Petersen (2008) and adapted by Dias Jr. et al. (2013), as shown in Figure 2.

Figure 2 – Systematic Mapping Process according to Petersen.
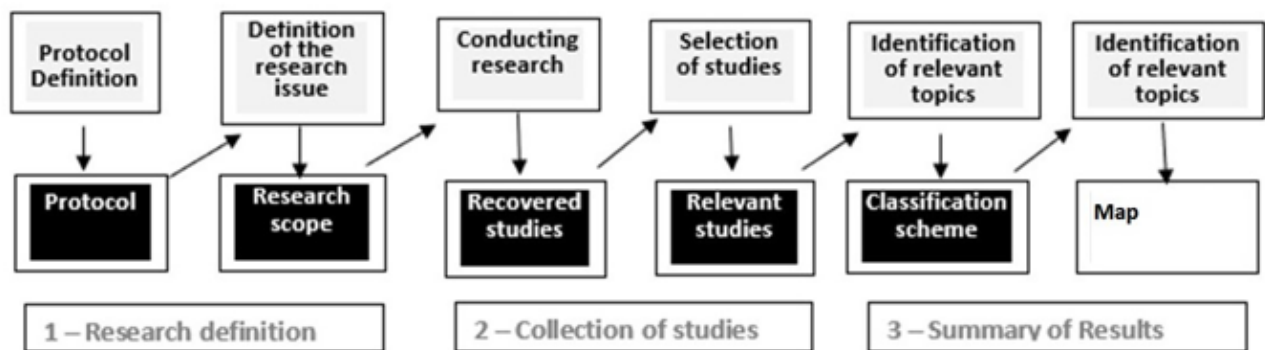
Source: (DIAS JR. et al., 2013).

The MSL's conduct went through the definition of the string and the search and selection strategies of the articles, and the establishment of detailed data extraction processes from the selected articles constituted a protocol represented by Figure 3.

Figure 3 – Document selection protocol

Source: Prepared by the authors.

The criteria indicated in Chart 1 were defined to reflect the appropriate picture concerning the object, scope, and research problem, avoiding the selection of irrelevant studies for the final objective of elaborating the educational product, notably articles that did not address the practical application of TS projects in the social reality. The theoretical production survey in books, theses, and dissertations on TS's topic was already undertaken.

Chart 1 – Inclusion and exclusion criteria

Inclusion Criteria (CI)	Exclusion Criteria (EC)
CI1 - Publications that address experiences of production, application, and/or reapplication of Social Technologies in Brazil and highlights the methodology used	**CE1** - Documents that are only available in the form of workshop/conference reports, abstracts, interviews, PowerPoint presentations, or secondary studies, book chapters, dissertations, theses, and articles published without revisions.
CI2 - Articles published in journals, conferences, or peer-reviewed journals.	**CE2** - Studies outside the scope of this research, such as those that address Social Technologies exclusively in administrative, business, economic-financial contexts, or under the perspective of public policies only; articles that deal with the theme exclusively from a theoretical and/or historical perspective, studies that touch on the concept of Social Technologies in a very generic or remote way without addressing any substantial experience of Social Technologies.
CI3 - Publications between 2013 and 2017.	**CE3** - Duplicate studies, which appear in searches in two or more databases.
CI4 - Articles in Portuguese or English.	**CE4** - Articles written in languages other than Portuguese or English.
CI5 - When more than one article describes the same Social Technology, only the most recent one will be included.	**CE5** - Older articles regarding the year of publication in the case of two or more articles dealing with the same Social Technology.
CI6 - When an article addresses more than one Social Technology, the one developed in the most recent period and/or provides more data regarding the established data extraction categories will be considered.	**CE6** - Social Technologies developed in less recent periods, in the case of articles that address more than one Social Technology, will be excluded, except when the less recent one reports more data regarding the established data extraction categories.

Source: Prepared by the authors.

Figure 3 shows that of the 186 studies obtained in the first step, only 11 remained, about 5.9% of the total. It may partly have occurred since most articles, despite including the term TS, treated the concept in an exclusively theoretical way, without dealing with projects applied in practice, or referred to the TS in a tangential, generic, or even erroneous way confusing it with Social entrepreneurship.

In the third step, such titles and abstracts were excluded; 55 were not dealing with substantial TS experience in a specific community. Chart 2 details the 11 selected articles.

A classification was previously established into categories and subcategories of data extracted from the selected articles to answer the research questions better. The first four categories referred to the mapped TS's general characterization, such as Type of demand/social problem; Type of Social Technology/solution; TS application location; and TS development/application period. Categories 5 and 6 referred to social actors and the dynamics of partnership and collaboration in distributing actions and tasks involved in the TS.

Chart 2 – Articles selected for data extraction

TITLE	AUTHOR	JOURNAL	YEAR
Sociotechnical associations and management practices in development: analyzing traces through the route of P1MC.	Andrade, J. A.; Cordeiro Neto, J. R.; Valadão, J. A. D.	Cadernos EBAPE.BR	2013
Sociotechnical bases of social technology: translation of pedagogy of alternation in Rondônia.	Andrade, J. A.; Cordeiro Neto, J. R.; Valadão, J. A. D.	Revista Organizações e Sociedade.	2017
Bioremediation of domestic sewage: the case of green septic tank in arid rural communities of Alagoas.	Oliveira Netto, A. P.; Guerra, L. R. M.; Silva, M.R.P.; Silva, R. S.	Revista Produção e Desenvolvimento	2015
Sustainable development and social innovation: recycling from the perspective of social technology.	Horst, L. V. M.; Freitas, C. C. G.	Revista Tecnologia e Sociedade	2016
Participatory environmental diagnosis and of health risks from the surrounding communities the Petrochemical Complex of Rio de Janeiro, Brazil.	Moniz, M. A.; Saboia, V. M.; Carmo, C. N.; Hacon, S. S.	Ciência e Saúde Coletiva.	2017
Collaborative production and midia convergence on TV: a proposal of innovation and social technologies for University TVs.	Magalhães, C. M.; Paschoal Neto, J. D.	Revista da Avaliação da Educação Superior.	2013
Methodological proposal for redesigning informal communities – constructing resilience in hydrological stress conditions.	Cerqueira, L. F.; Silva, F. L.	Ambiente & Sociedade.	2016
Social Representations of Water and Social Technologies.	Polli, G. M.; Kuhnen, A.	Psico (PUC – RS)	2013
Social Technology, University and Society: The Extension Space as Strategic Policy.	Oliveira, E. M.	Revista Tecnologia e Sociedade	2013
Social Technology apply to national policy on solid waste: solid waste management integrated in the countryside.	Oliveira, G. K. L. P.; Santos, N.	Revista de Direito e Sustentabilidade	2016
Feasibility of continuous biogester use: a case study in Community Arara, Tavares municipality (PB).	*Silva, M. L. C.; Araújo, A. O.*	Revista de Geografia e Interdisciplinaridade.	2016

Source: Prepared by the authors.

In the course of data extraction, all selected articles were identified as indicating networks of actors with hybrid compositions, i.e., with different types of social actors; in none, a type of isolated social actor acting in the addressed TS was identified, and the local community – internal social actor – integrated all the compositions found.

From the discoveries about the types of collaboration dynamics among the TS actors described in the articles, a subcategory was constructed for such patterns of relational mediations between the actors – Community centrality, Participatory production, Combined interests, Theory of social relationships – to investigate, further on, the possible link between such types of relationship and the types of the methodology of development of the TS.

Category 7 translated the main focus of the Mapping: Type of TS Production Methodology – Methods, processes, procedures, steps, and/or sociotechnical criteria for the production/application of TS. According to the information identified, this category was classified in the subcategories: Proprietary methodologies; Research-action; Research-action + LIUDD; Alternation pedagogy.

The subcategory "Proprietary methodologies" was created during the research to name the different methodologies, specially created for the development of each TS approached, in their specific contexts. This category proved to be predominant in the mapped studies.

Throughout the research, a significant adherence was identified between concepts and characteristics of the TS enunciated by several authors present in the researched theoretical references; as being a solution built from the problems and the vision of the community itself, and the design of methods specific to each group of social actors involved in the project, which, in this way, collectively build processes and steps of production and application of TS, according to each local social reality, profile, and demands of the community. No other term or definition for this type of methodology was found in the researched literature, which led us to propose the term "Proprietary methodologies."

Finally, category 8 referred to the Type of TS reapplication method in other contexts, classified into the subcategories: Systematized with each community, Sociotechnical Adequacy (AST) + Social Constructivism of Technology (CST); Indian Continuous Flow Model.

It is noteworthy that any application of TS involves, in some way, a process of sociotechnical adequacy (DAGNINO, 2010), so, in TS, the concept of replication is not used, but of reapplication, considering that in each different context, the TS it will have to be redesigned (JESUS; COSTA, 2013, p. 22). The prevalence of "Proprietary methodologies" in the addressed TS points towards an alignment with the notion that to reapply them in other communities would be to redesign them completely.

The data of the selected articles were extracted during the full reading according to the established categories and, to the quantitative analysis of the results of the MSL, a qualitative analysis was carried out using a Thematic Analysis (AT) of the information related exclusively to the category "Types of development methodology of TS."

This method of analysis, according to Braun and Clarke (2006), is qualitative and applied to a set of data to identify, analyze, and report significant patterns, characteristics that contributed significantly to subsidize the selection, organization, systematization, and didactic transposition of contents for the educational product of teacher training in TS.

Conducting Thematic Analysis

AT was conducted through the six steps shown in Figure 4 below.

Figure 4 – Steps of conducting the Thematic Analysis

| Familiarization with the data | Generation of initial codes | Search by themes | Review of the themes | Delimitation/ naming of themes | Thematic Analysis Report |

Source: Prepared by the authors based on the steps of conducting thematic analyses proposed by (BRAUN; CLARKE, 2006, p. 77-101).

Based on the flow represented in Figure 4, step 1 of familiarization with the data started in the AT conducted in the research; with the rereading, in the mapped articles, of the information regarding the types of TS development methodology, to know them in-depth.

In step 2, of the generation of initial codes, a systematic coding of all the text of the previously mapped articles was carried out using highlights from excerpts, annotations, and comments

to recognize patterns and gather, under the same code or label, similar information or close relative to each specific subcategory of a type of methodology.

In this step, the codes adopted were the same as those of the subcategories created in the MSL since they translated the subtypes of TS development methodology found in the data set of the mapped articles, with emphasis on the "Proprietary methodologies."

In step 3 of the search by themes, starting from the coding carried out in the previous step, several codes were gathered around potential themes or subthemes, using the mental map's resource to visually expose the relationships between themes and subthemes that represented patterns found in textual data of the articles. We searched for themes that had a standardized meaning within the data set extracted in the Mapping, capturing something relevant to answer the main research question, such as information about processes and/or applied steps/phases of each type of development methodology indicated in the previously established codes. Then, the first relevant result was obtained, the preliminary thematic summary represented in figure 5.

Figure 5 – Thematic Summary
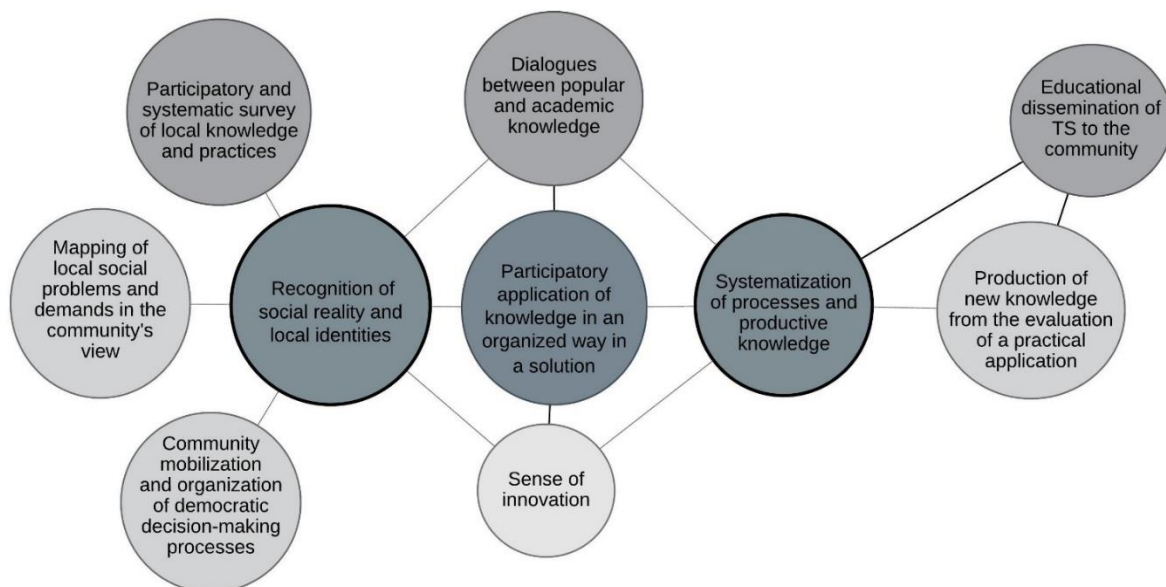
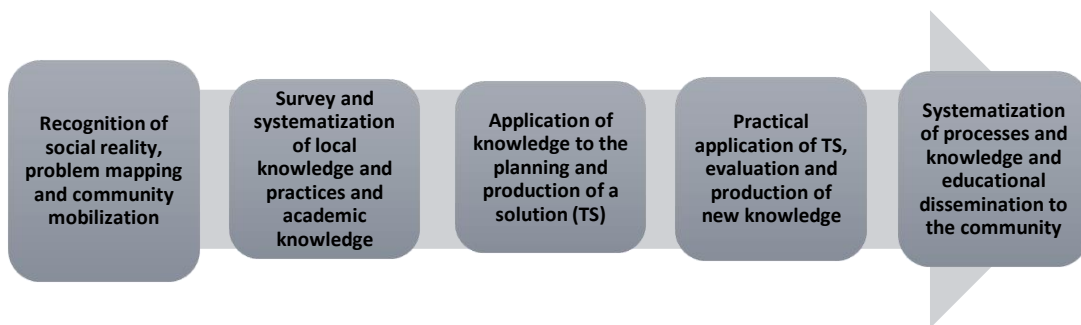

Source: Prepared by the authors.

In the mental map shown in Figure 5, the three central circles, the darkest ones, represent themes corresponding to phases or steps discovered in most of the TS development descriptions present in the mapped articles and confronted with categories theoretically established in studies on characteristics analysis of TS, especially that of Garcia (2007), who highlights characteristics linked to the dimensions of Knowledge, science and technology and innovation; Education; Participation, citizenship and democracy; and Social relevance.

There is an initial phase of "Recognition of the social reality and the local identities of each target community." This phase yields related sub-themes, developed differently depending on the specific TS approached, which are identified under systematic labels throughout the analysis, such as "Survey and systematization of local knowledge and practices with the community"; "Mapping local social demands from the point of view of the community"; and "Mobilization and organization of the community." There is an intermediate phase, of "Participatory application of knowledge in an organized

way in a solution" to the demands of the community – the solution is the systematized and developed TS; this phase is also linked to related subthemes, which characterize the way the phase takes place in each TS, transposed in the research as "Dialogue between popular and academic knowledge" and "Sense of innovation" of the project. Moreover, finally, there is the "Systematization of the processes and knowledge produced" throughout TS development, an essential phase for the appropriation of knowledge by the community; related to the systematic sub-theme throughout the analysis as "Evaluation and knowledge production," carried out from the practical application of the TS, its evaluation and dissemination to the community.

Then, the 4ᵗʰ step, the Review of the themes – represented in Figure 6 below –, was carried out, with a reorganization of the themes and subthemes created to arrive at coherent standard themes, which synthetically represented the phases of a process or TS production flow according to the data corpus analyzed and that could guide the development of the educational product.

Figure 6 – Reviewed thematic summary

Source: Prepared by the authors.

However, it is essential to note that this general flow of processes, suggested by the reviewed thematic summary, does not indicate the specific practical sequences to be adopted to develop each process and obtain the desired results. There is no way of knowing through the flow, for example, which specific steps, procedures, and instruments can be applied to map, recognize, or mobilize the community, determine local knowledge and practices, etc.

To identify such procedures, we use the flow as a key for analyzing the research results related to methodological aspects. This enabled us to recognize how the social actors involved in the analyzed experiences proceeded, throughout each project, to guide the steps of development of the TS.

In step 5 of the Thematic Analysis methodology, the "Delimitation and naming of themes" is carried out, in which the essence of each one was sought – without losing the order, their organization, suggested by the flow – and thus, obtaining the final map of themes, named synthetically, but coherent and expressive of meaning in the analyzed data set, to contribute more clearly to the purpose of the research. Figure 7 below shows this final thematic summary.

Figure 7 – Final thematic summary

Source: Prepared by the authors.

In Figure 7, each theme corresponds to a step of TS development, arranged in a general flow of production and application of this type of project, according to the qualitative analysis of the studies done so far. It is important to note that the subthemes were not indicated in the final thematic summary because they are not many and diverse, since, for each theme (step), there are several possibilities of "sub-steps," processes or procedures for TS development, depending on the type of methodology followed and the specifics of each TS and each network of actors involved.

In step 6, the AT report production, the interpretation of the meanings of the themes and the relationships they establish with each other was obtained to answer with which specific procedures each phase of TS development proceeded from the final thematic summary, thus pointing towards the possibilities of building TS production flows appropriate to the context of the FIs and the objectives of teacher training.

PRESENTATION AND DISCUSSION OF RESULTS

The results concerning the types of methodologies, steps, procedures, processes, or methods of development and/or application found supported the initial hypothesis: that it is feasible to find such types of information through an MSL focused on the selection of articles whose concrete TS experiences in Brazil are addressed.

Only the results related to the TS development methodologies, the main focus of the research, and some of the results related to the actors involved in the TS and the collaboration dynamics they establish will be highlighted. This is because these results were revealed, in some aspects, related to the methodology types employed in the TS. The results related to other categories linked to the TS characterization will not be part of this section. The AT's main results on the picture of relevant MSL results will also be discussed here to support the systematization of the educational product of teacher training in TS.

Results of Systematic Mapping

As Figure 8 below shows, proprietary methodologies are prevalent, with steps and procedures developed specially for each project, which points to a possible interpretation for the absence – identified in the previous survey – of methodological guidance materials, such as manuals or guides for the development of this type of project. As they are essentially participatory, TS have their development often guided by processes created collaboratively by the network of social agents involved in them, according to each target community's specific demands, as indicated by the prevalence of "Proprietary methodologies" type in the research.

This scenario intensified the importance of qualitative research on the articles mapped as to the steps and procedures of the so-called "Own methodologies," in the sense of systematizing TS production processes that are equally appropriate to the contexts and social actors of the IFs.

Figure 8 shows that 18% of the TS were based on Research-Action, – 9% alone and 9% added to LIUDD – urban planning methodology with low environmental impact.

Figure 8 – Types of TS development methodologies.
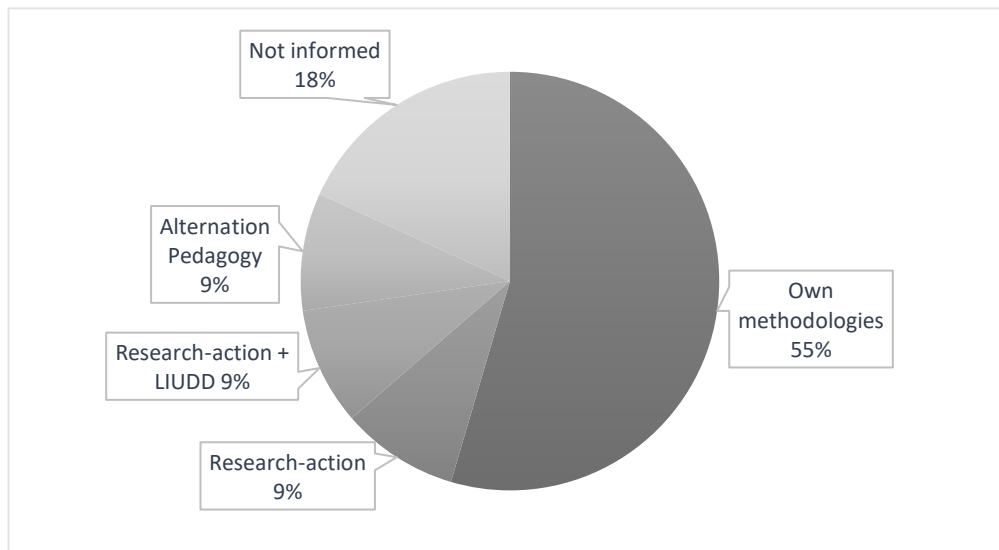
Source: Prepared by the authors.

As for the composition of social actors' networks involved in the mapped TS, all types of actors' composition included the Community as a member. This fact supports the characterization of the projects described in the selected studies as being effectively TS. According to Souza and Rufino (2017), a low or non-participatory study plan is the primary criterion for excluding a social intervention project from the list of TS. It stands out as the predominant composition, about 37% of the total, the one that brings together "Community" and "University Researchers," with no network including researchers from IFs.

It is also necessary to consider that the support of the public authorities was identified as very significant for the development of the TS – about 45% of the network compositions included representatives of the public power, mainly municipal and state, with 9% of them including researchers from Universities, as Figure 9 shows below.

Figure 9 – Composition of social actor networks.
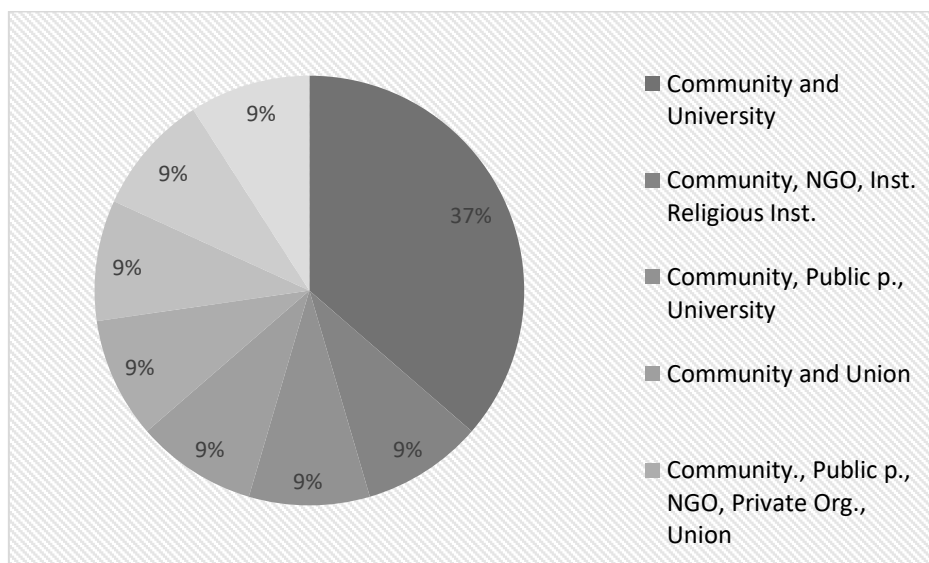
Source: Prepared by the authors.

Professionals linked to the research are noted to be the predominant external social actors in the TS addressed by the research, and they are the ones who, in most cases, show in the studies the methodological aspects of the development of the TS and those linked to the dynamics of collaboration between the actors that make up the hybrid production and application networks of TS.

The results related to the dynamics of collaboration between the social actors show that, despite being built through different criteria and methods, all the dynamics went through appreciating the community's role, as Figure 10 shows.

Figure 10 – Types of dynamics among social actors.
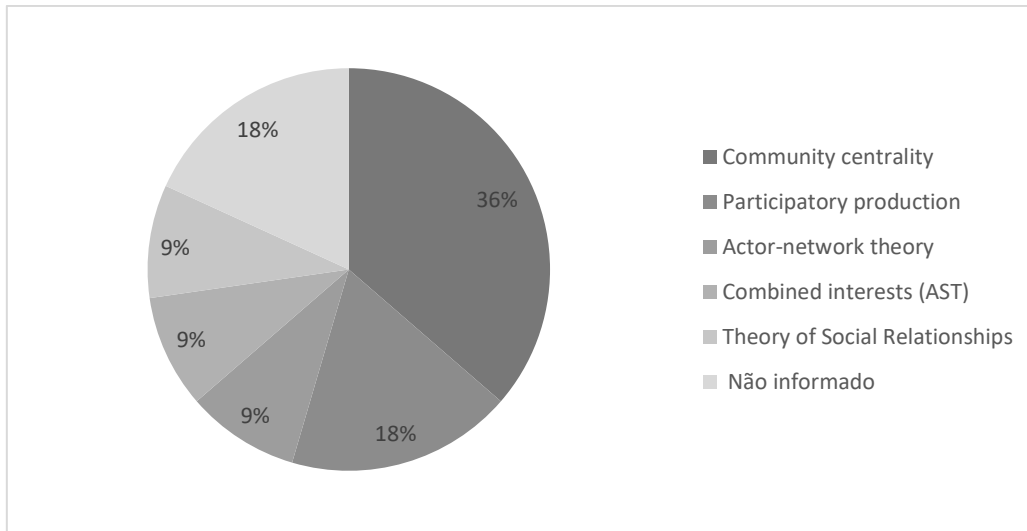
Source: Prepared by the authors.

The discoveries resulting from the crossing of results from methodology development types of TS and types of dynamics among the actors involved were also relevant. According to Figure 11, the "Proprietary methodology" type was related to the "Community centrality" dynamic type in about 27% of the mapped TS, possibly indicating that when the community is the TS protagonist, the network of actors tends to adopt a methodology built by the group and according to their expectations.

Figure 11 – Crossing between Types of dynamics and Types of methodology
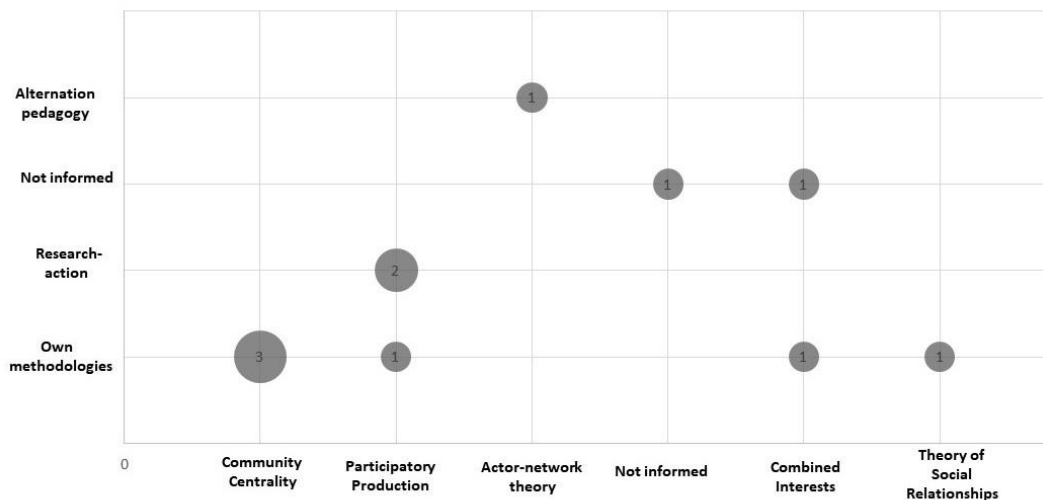
Source: Prepared by the authors.

Such discoveries pointed to the need to elaborate an educational product that would provide training for the construction of the TS under the target community's perspective and favor TS production processes developed by the network of actors – teachers, students, and community. They also pointed to the notion that building training in TS would require to follow the participatory nature of the TS itself: sharing knowledge and creating solutions among teachers, throughout their learning, under a logic similar to that of Proprietary methodologies identified through the research.

Then, the general product conception was built as the proposition of collaborative trails for the construction of TS suitable to each teaching reality and, mainly, to the reality, the problems, and the world view of each local community depending on each campus.

At the end of the Mapping, only 5.9% of the articles in the sample analyzed showed some methodology, method, process, sequence, flow, or set of steps applied to the development of the addressed TS. Of these, around 55% indicated the use of "Proprietary methodologies" developed especially for TS, which were then analyzed qualitatively through a Thematic Analysis.

Based on the Final Thematic Summary (Figure 7) already presented, which represents a general sequence of steps of development of TS, the specific procedures (sub-themes) applied to each step were analyzed in each TS addressed in the studies that indicated "Proprietary Methodology."

Thematic Analysis Results

The variety of TS types, community demands, and collaboration in the networks of actors involved in each project resulted in sequences of different steps between them. Such sequences were named TS development trails.

As an example, two trails were selected, each corresponding to the development of a different TS. Throughout the research, the 6 TS trails based on "Proprietary methodologies" were systematized.

The article "Tecnologia Social, Universidade e Sociedade: a Extensão como Espaço Estratégico de Intervenção" (OLIVEIRA, 2013) addresses an income generation TS, which was developed in an extension project for researchers from a TS incubator at a University, in partnership with a group of women from a peripheral neighborhood.

Figure 12 – Income generation TS development trail.
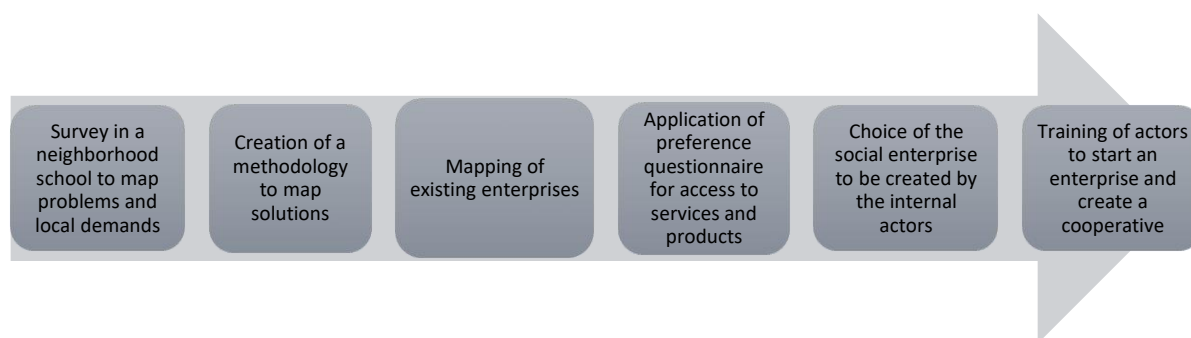
Source: Prepared by the authors.

The trail in Figure 12 shows that the initial step, which would correspond to Recognition, was conducted through a survey performed at a school in the neighborhood, which mapped local demands from the students' mothers' and grandparents' perspectives. This is because an initial survey of

the researchers showed that 60% of families were single parents. The Survey of Knowledge was also initiated at this step, with interviews with women who diagnosed demand for income generation.

The second step of the trail corresponded to the Elaboration of a solution and was carried out based on the demand diagnosis. In this step, the incubator researchers created a procedure called "Territorialization and opportunity mapping," which consists of their methodology for diagnosing social business opportunities (within the broader TS development methodology) to point out possible demand solutions. Performed in two phases, in this step, elements of the Survey of Knowledge are also perceived. In phase 1, the researchers visited the neighborhood to map the existing enterprises (quantity and types of activity); in phase 2, they applied a questionnaire to a sample of residents about which services and products they would like to access in the neighborhood. The women chose the social enterprise to be created from the mapping results: a sewing workshop with recyclable.

In the last step, actions for Solution application (TS) took place when the researchers trained women to start the enterprise by creating a Cooperative of Social Entrepreneurs Women in Action.

In the development of this TS, the women's group was central in all steps, with researchers' support to map local opportunities, choose the enterprise of most significant interest, and have more skill, and become sustainable. Also, the local reality's recognition was done preliminarily, and the problems and demands were raised under the view of the community's internal actors, not of the external researchers.

This example of a trail for the development of TS was later transposed to the educational product, accompanied by proposals for reflection and debate by the teachers on: the strategies used, in each phase of the TS, regarding the valorization of the community's view of its reality, its problems and demands; on the participation and centrality of the group of women in decision making in the process of building the solution (TS); and on the technical-scientific support that the researchers were able to provide concerning the Solution Elaboration and Solution Application phases.

The article "Diagnóstico participativo socioambiental e de riscos à saúde das comunidades do entorno do Complexo Petroquímico do Rio de Janeiro, Brasil" (MONIZ et al, 2017), addresses a TS for planning actions and policies for participatory environmental management.

Figure 13 – Environmental management TS development trail.
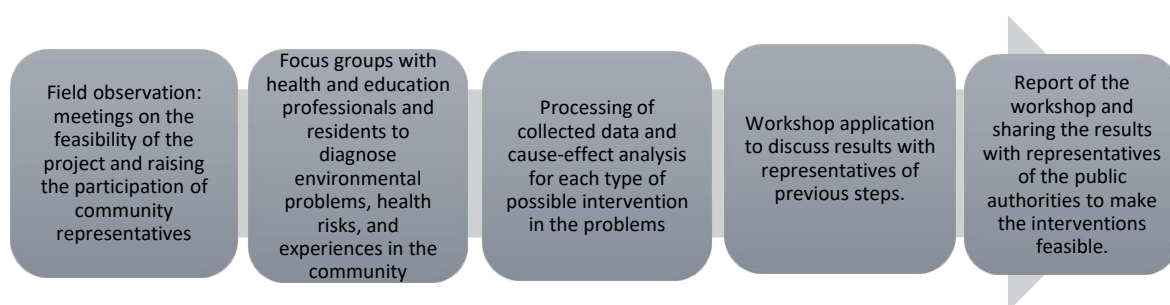
Source: Prepared by the authors.

What would correspond to the Recognition step was accomplished through the first two steps of the trail; in the first, the researchers (external actors) undertook an observation in the field to approach the community representatives and to discover, through meetings, if the project would have concrete viability and if the residents would agree to participate in the TS.

In the second step, the community's problems and their demands were identified by mapping the perceptions of internal actors – residents and health and education professionals who work

in the place –, made through discussions in Focus Groups concerning the local environment. The theme of environmental degradation and its consequent priority risks to the health of residents were noted to be pre-defined by the researchers, according to the previous conception of the need to protect ecosystems and the social environment in communities that have experienced recent and profound socio-environmental transformations, as is the case of the target community of TS, which lives around a petrochemical complex.

The third step of this trail corresponds to the Planning and Elaboration of the solution. In this step, the knowledge acquired in the initial steps was systematized, processing the collected data, the cause-effect analysis for each possible intervention type in the mapped problems, and a workshop discussing results, with community representatives involved in the previous steps; which helped in the elaboration of the solution and ensured the Dissemination and learning of what had been built by the representatives of the community.

The last step was to systematize a report of the workshop results and the discussion and its sharing with representatives of the municipal public power involved in the 1st step, to make the Application of the TS feasible. This also contributes to the Elaboration of a solution and TS Dissemination, besides preparing the TS Application step with operational support from the local public power. However, TS elaboration and its practical application were not described, and no evaluation procedures for the application of the TS were indicated.

From the general steps' perspective presented in the Thematic Summary, the result of its fifth step, some of the 6 TS development trails identified in the analyzed studies, and systematized throughout the AT, were noted to present an initial step in which there was no real Recognition of the social reality of the community, nor a participatory mapping of its problems. In these cases, it seems that the "problem" was proposed beforehand by the external social actors, which goes against one of the fundamental criteria to characterize a project as TS.

In some trails, there was a greater detail of the TS's development processes and the sharing of knowledge produced through educational actions in the community. In other trails, there was a flow more related to the reapplication of a TS already developed in another community, not the development of a new TS.

The questions related to the variety of steps and procedures of development of TS found and the Proprietary methodologies trails systematized from the AT were fundamental for developing the educational product of teacher training.

Application of results: Educational product of teacher training in TS

The results of the research were applied to the educational product to contribute to the integral educational development of the people involved in the production of TS as an instrument for making the hierarchy between knowledge more flexible, under a dialectical and inclusive prism, for building collective learning and knowledge (LATOUR, 1994). This enabled the socio-cultural processes of generation, sharing, and dissemination of knowledge, including tacit ones, and favored – under the participatory logic of knowledge generation similar to that of the TS itself – the development of projects fully suited to each local context, not only in what it concerns each community surrounding each campus, but also adjustable to the particularities of teaching actions and the organization of pedagogical work.

To this end, the following was transposed to the educational product didactically – an interactive digital mini-course in the distance learning mode, made available on the Moodle platform –, in addition to general information about TS and their relationships with science, technology, and social

development, methodological and practical guidelines of TS development through the use of "TS development trails," created throughout the research and based on the actual projects researched.

Such trails represent viably and validated sequences of production and application of this type of project but adaptable to each context's needs and constitute the praxis axis, suggested by Kuenzer (1999), to guide the structuring of technological extension projects in the IFs.

On the other hand, the trail's concept elaborated in the research also represents a path for collaborative learning by teachers through the mini-course and a way to stimulate the constitution of learning communities, which can bring together teachers, technicians, students, and actors from the local community, during the processes that permeate the production and application of TS.

According to Tennant and Pogson (1995), teacher training resources should direct the learning of new knowledge to build a meaning for teaching experiences and reflect pedagogical practices based on the newly acquired knowledge. In the same direction, Zeichner (2008) states that pedagogical reflection must pass through recognizing practical experiences and teachers' and students' social contexts (ZEICHNER, 2008, p. 543-544). This process can result in a collective attitude of constructing a learning community whose mutual growth can be supported and incite transformations in the teaching and learning processes and teaching institutions and society.

Thus, in the product "Teacher Training Mini-course in TS," educational proposals for collaborative construction of flexible and adaptable knowledge to the participants' teaching practices and their local educational and social realities were sought to make sense of the different teaching experiences. Examples of this are the didactic proposals for the collective production of previously unpublished by the teachers, based on the trails systematized in the research and presented as changeable models in the mini-course.

The other mini-course learning situations' design was based on active and collaborative learning principles and the opportunity for reflection, under an emancipatory perspective, on the new knowledge acquired. Notions related to dialogical learning and the formation of learning communities were used, as well as strategies inspired by the hands-on-tec active methodology model (ROSA et al., 2013), whose translation would be something like "Hands-on technology." This proposal was adapted from the Hands-on technique (CHEVALÉRIAS, 2002), which focuses on the practical application of theoretical knowledge, articulates these two spheres of knowledge, and produces solutions to real problems like the process of TS development.

This model combines the principles of active methodology to stimulate discoveries and the collective production of knowledge to solve problems in using technological resources applied to Education. It enables the development of observation, investigation, registration, discussion, and systematization, and collective application of the knowledge produced; focused on the Mini-course through opportunities for collective interaction via the Forum and in learning situations via collaborative production tools, such as Wiki, contributing to the final construction of a technological extension project in TS applicable to the participants' teaching area.

Throughout the research, the results and initial versions of the content of the product were presented to professors and technicians from the Instituto Federal de Sergipe – Campus Aracaju and discussed during a pedagogical day centered on proposals to make the integrated EPT curriculum viable at IFS, generating exciting contributions to the final structuring of the mini-course.

In its final version, the mini-course was applied – after a pilot test – to a group of interested professors and educational technicians from the Instituto Federal de Sergipe – Campus Lagarto (unit-case), who evaluated the product through qualitative and quantitative research. As relevant results of the quantitative phase, 87.5% of the participants positively evaluated both the feasibility of sharing with

students what was built during the mini-course, the practical applicability of the learning, and the feasibility of implementing a TS extension project for the product on their campuses. In the qualitative phase, suggestions were made to improve navigability in the mini-course and the Moodle platform tools' usability.

FINAL CONSIDERATIONS

The initial assumptions, which helped to outline the research's scope generating this study, about the nature of social intervention projects in federal institutions and the lack of methodological guidance publications for the development of TS, were supported by the research's preliminary surveys. The assumptions point out as relevant the search for information about which methodologies or systematic sets of actions, steps, and procedures are being used to develop, apply, and reapply in TS projects in Brazil, which could subsidize an educational product's production for teacher training in TS.

During the research's methodological design, the hypothesis was raised that it would be possible to find methodological information for TS's development in Brazil. This could be done using an MSL of the articles that addressed TS projects implemented in Brazil recently and indicate their development steps and procedures to generate thematic categories that can be analyzed qualitatively by an AT study, generating subsidies for the development of an educational product of teacher education in TS, which, throughout the research, proved to be an effectively feasible option.

Despite the relatively small number of articles selected in the MSL concerning the universe initially obtained, the results were able to clarify, in addition to other aspects, the methodological bases applied to the mapped TS projects, providing essential data such as the predominance of the use of "Proprietary methodologies" development projects, built by the social actors involved and according to the specificities of each project.

The MSL results enable the upcoming AT, with information on processes and/or phases applied to each predominant type of methodology qualitatively analyzed, emphasizing what was conceptualized and named during the research and in this study as "Proprietary methodologies."

The AT results subsidized in a very satisfactory way the systematization of several "Trails of development of TS" (strategy created and named during the research) based on the qualitative findings on the various paths of production and application of the analyzed TS. Such trails indicate the steps, processes, and instruments used in the so-called "Proprietary methodologies" addressed in the analyzed articles. The trails, added to the results obtained in the previous research steps, formed the core of the educational product, meeting the research objectives outlined at the beginning of this study, satisfactorily subsidizing an educational product to support teaching work carrying out extension projects for TS development. This meets the IFS communities' needs and contributes to its students' integral and integrated training.

The Social Technologies Training Mini-course based on the results of the research is considered as having obtained positive evidence to become useful as a first step in promoting the engagement of teachers and technicians in social technology development practices in a systematic way on their campuses, generating sustainable solutions for problems relevant to local communities and contributing to the integrated training of students; supporting them in building, together with their students, an effective exchange of knowledge and practices with local communities, to favor social inclusion appropriately in each community.

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