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Maker Movement and STSE Education (Science, Technology, Society, and Environment): Outlines in Educational Projects of the Municipal Education Network of Curitiba[1]

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RESUMO

In reference to the assumptions of STSE Education (Science, Technology, Society, and Environment), we inquire about the potentialities of the Maker Movement within the scope of Science in the Early Years of Elementary Education, incorporating dimensions of the Sociology of Science. This paper highlights correlations related to the aforementioned theoretical frameworks concerning the creation and manipulation of representations involving stable, mobile, and combinable resources, and the reference to the cycle of production, distribution, utilization, and disposal of products, in reference to sociotechnical networks. Within this context, this article aims to: analyze outlines in educational projects of the Municipal Education Network (RME) of Curitiba, in reference to the assumptions of STSE Education and the Maker Movement, incorporating the perspective of the Sociology of Science. It refers to qualitative research and document and content analysis, with the investigation of documents related to educational projects linked to the RME of Curitiba. Broadly, it was evidenced that the educational projects are directed towards linking with the educating city (Curitiba) and the Sustainable Development Goals (SDGs), in alignment with STSE Education, as well as explicit references to the Maker Movement. Nonetheless, demands for the expansion of articulations related to the aforementioned theoretical frameworks are noted, concerning the products, in order to enhance the cognitive dimension and the analysis of social and environmental aspects concomitantly.

KEYWORDS: Science Teaching. STSE Education. Products. Sociology of Science.

1 INTRODUCTION

With the advancements in science and technology and the increasingly rapid and instantaneous access to information, changes in the educational domain have been demanded. In this context, educational actions with students are required to consider the specificities of learning within the scope of these changes involving science and technology, while paying attention to environmental preservation, as the productions in these domains pertain to natural resources and the relationships between humans and non-humans.

From the perspective of the Maker Movement, which comes from the English "to make" meaning "to create," it is understood that ordinary people can build, repair, modify, and fabricate a wide variety of products, as outlined by Blikstein, Valente, and Moura (2020). In the educational domain, it is important to highlight the appropriation of the Maker Movement and the associated productions. This refers to the approach where students and teachers are given the opportunity to participate in the process of exploration and experimentation.

In this context, the assumptions of STSE Education (Science, Technology, Society, and Environment) and aspects aligned with the Sociology of Science, inherent to the specificities of the construction and stabilization of science and technology and their social and environmental implications, are highlighted. In reference to this context, this paper aims to elucidate the propositions of understanding the correlations between the Maker Movement, STSE Education, and the Sociology of Science, concerning Science in the Early Years of Elementary Education.

Against the backdrop of these theoretical frameworks, the objective is proposed: to analyze outlines in educational projects of the Municipal Education Network of Curitiba (RME), in reference to the assumptions of STSE Education and the Maker Movement, incorporating the perspective of the Sociology of Science. The interpretative propositions refer to qualitative research and document and content analysis, involving documents related to educational projects linked to the RME of Curitiba, whose information is available on the website of the Municipal Department of Education of Curitiba (SME).

2 OUTLINES OF STSE EDUCATION, MAKER MOVEMENT, AND SOCIOLOGY OF SCIENCE

STSE Education, or STS (according to some authors), integrates the intentionalities of public participation and decision-making at the STSE interface; the development of the conception of science and technology as human and social constructions; and the relationships between beings and realms of interaction as collective compositions (SANTOS; MORTIMER, 2000; SANTOS, 2008; MACLEOD, 2012; MARTÍNEZ PÉREZ, 2012; SUTIL; ROEHRIG; LISBOA, 2021; CHRISPINO, 2021; SILVEIRA; OLIVEIRA JUNIOR, 2020).

> The STSE (Science, Technology, Society, and Environment) perspective in Science education is a way to problematize the scientistic and instrumental view of science and technology, highlighting their social, political, cultural, ethical, and environmental implications as relevant aspects to understand the scientific enterprise as a historical and human process mediated by

> various interests, ideologies, and competing viewpoints (MARTÍNEZ PÉREZ, 2012, p. 32).

Within this scope, it is proposed to incorporate the Sociology of Science, questioning the processes of construction and stabilization of science and technology and the relationships between humans and non-humans (LATOUR, 2000). Interactions among beings are understood in terms of the collective composition of a common world for the common good (LATOUR, 2004).

Latour (2000) inserts such processes within the scope of sociotechnical networks that permeate academic spaces and the living contexts of individuals. According to the author, the construction of facts and machines involves a collective process. In this scenario, he highlights "[...] a range of stronger and weaker associations," noting that "[...] **understanding** what facts and machines are is the same as understanding who the people are" (LATOUR, 2000, p. 232, author's emphasis).

Referring to these assertions, we consider productions related to the sociotechnical networks that foster their creation and dissemination, as well as the implications of these processes.

> The word network indicates that resources are concentrated in a few places – in the loops and nodes – interconnected – threads and meshes. These connections transform scattered resources into a web that seems to extend everywhere (LATOUR, 2000, p. 294).

Regarding this aspect, Latour (2000, p. 424) emphasizes that "the history of technoscience is, to a large extent, the history of resources spread along networks to accelerate the mobility, reliability, combination, and cohesion of the traces that enable action at a distance."

In alignment with Latour's (2000) propositions, this process highlights material and immaterial productions that refer to stable, mobile, and combinable resources, which allow compilations that can be correlated with other constructs. These productions relate to manipulable constructs in the empirical and concrete domain, such as models representing a building, as well as representations like equations that refer to phenomena, enabling articulation to a cognitive perspective.

> [...] how to act at a distance on events, places, and people little-known? Answer: by bringing these events, places, and people home. How to do this if they are distant? Inventing means that (a) make them mobile so they can be brought, (b) keep them stable so they can be brought and taken without distortions, decomposition, or deterioration, and (c) make them combinable so that, regardless of the matter they are made of, they can be accumulated, aggregated, or shuffled like a deck of cards. If these conditions are met, then a small provincial town, an obscure laboratory, or a backyard company, initially as weak as any other place, will turn into centers capable of dominating at a distance many other places (LATOUR, 2000, p. 362).

These outlines are associated in this study with the configurations of the Maker Movement in education.

The Maker Movement, concerning the educational domain, "[...] is characterized by the implementation of activities that combine science and technology (both in terms of spaces and curricular themes)" (BLIKSTEIN;

VALENTE; MOURA, 2020, p. 525). It aims to foster the participation of students and teachers in the process of exploration and experimentation, highlighting the pedagogical intentionality (RODRIGUES; ALMEIDA, 2019). This conception refers to the vision of protagonism, with subjects capable of creating, elaborating, and resizing what they learn, associating it with experiential aspects. This movement relates to Papert's (2008) ideas within the scope of constructionism and Resnick's (2020) views on creative learning.

In terms of outlining dimensions, perspectives, and correlations, two axes are denoted, interrelated with the theoretical panoramas of STSE Education, the Maker Movement, and the Sociology of Science, particularly concerning material and immaterial productions: the creation and manipulation of representations involving stable, mobile, and combinable resources; and the reference to the cycle related to the production, distribution, utilization, and disposal of products, in reference to sociotechnical networks. These axes permeate the analyses conducted and allude to curricular and methodological compositions in Science.

3 METHODOLOGY

This study employed qualitative research methods, based on Flick (2009), encompassing: the adequacy of methods and theories; recognition and analysis of varied perspectives; reflections on research as part of the process; and various approaches and methods.

The analysis of educational projects, being developed within the scope of the RME and with information available on the SME Curitiba website, constituted the focus of this work. It is important to note the significance of also addressing how the documents that support the projects are organized, particularly the *Elementary School Curriculum: Dialogues with the BNCC* of SME Curitiba (CURITIBA, 2020). In addition, the following were examined: *Curitiba: Paths that Educate* (CURITIBA, 2021a); *Pedagogical Guide: Playing with Curitiba, Curitiba in the Palm of Your Hand* (CURITIBA, 2021b).

The documents were examined according to the assumptions of document analysis (CELLARD, 2012) and content analysis (BARDIN, 2011). Regarding the specifications of the analytical procedures, the stages of preliminary analysis, according to Cellard (2012), were considered, encompassing five dimensions: context; author(s); authenticity and reliability; nature of the text; key concepts and internal logic of the text. These dimensions were associated with the analysis of: the context inherent to the educational institutions and projects linked to the SME; the organization related to the guiding documents and projects; authenticity and reliability, considering the information available on the SME website. Regarding the nature, key concepts, and internal logic of the text, content analysis was chosen.

In reference to the assumptions of content analysis, the explicitation of the analytical outline in line with the selection of units of analysis and their subsequent relation to axes of appreciation, similar to the notion of categories, which enable inferences in terms of interpretative propositions, is highlighted. For segments related to the units of context, the registration units "Maker" and "Science, Technology, Society, and Environment" were initially verified. Subsequently, references to products, concerning their creation, manipulation,

and analysis, provided other segments. In this direction, two axes of appreciation, established a priori, are highlighted, referring to the correlations between the Maker Movement, STSE Education, and Sociology of Science: creation and manipulation of representations involving stable, mobile, and combinable resources, forming a cognitive perspective; reference to the cycle related to the production, distribution, utilization, and disposal of products, in reference to sociotechnical networks, according to the socio-environmental perspective.

Initially, the classification and organization of the files were carried out according to the sets presented below in Table 1, following an investigation on the SME Curitiba website. Subsequently, the various documents associated with the educational projects were analyzed.

Table 1 – Sets associated with documents analyzed in the research

Set	Specification
Proceedings of the VIII National Meeting of Educating Cities/I SME Seminar - Territories, Innovation, Integral Education, and Sustainability: Contexts and Practices	Aggregates bibliographic productions about educating cities, according to the movement advocated by the International Association of Educating Cities (AICE), and their relations with formal, non-formal, and informal education.
Pedagogical Innovation Management	Displays educational projects implemented by the RME of Curitiba for the integration of digital technologies into the educational process.
Knowledge Lines Program	Presents a program aimed at strengthening urban consciousness, sustainability, and the sense of belonging of individuals, considering three fundamental pillars: knowing, loving, and caring for the city.
Educational Robotics	Concerns a project by the Pedagogical Innovation Management of the Professional Development Department of SME, providing schools with pedagogical and technical materials, remunerated scholarships for professionals who develop project activities in extracurricular time, as well as teacher training, courses, technical and pedagogical advice, studies, and participation in events.
Creative Learning	Refers to projects linked to the pedagogical approach developed at the MIT Media Lab by Mitchel Resnick, based on Seymour Papert's constructionism, and the ideas of Jean Piaget, Paulo Freire, Maria Montessori, and other thinkers.
Hands-on Project: Home Economics for Students of Curitiba's Municipal Education Network	Refers to a project aimed at offering students a quality education, incorporating practices into their daily lives that will contribute to

	their current and future lives.

Source: Curitiba (2022).

4 RESULTS AND DISCUSSION

In the *Elementary School Curriculum: Dialogues with the BNCC* of SME Curitiba (CURITIBA, 2020, p. 12), concerning Natural Sciences, it is noted the intention that "[...] students understand the Nature of Science and the influence of scientific and technological advances on society; understand the cultural, social, ethical, and environmental issues associated with the use of natural resources". This document emphasizes the integration of STSE in an interdisciplinary manner, focusing on skills and competencies through critical thinking, problem-solving, creativity, and innovation. Regarding the Maker Movement, the document proposes actions that include Active Learning, encouraging learning by doing, creating, and innovating; it promotes the use of technological productions, both manual and digital, through interaction, collaboration, and sharing, aiming to form critical and responsible citizens in the contemporary world. In this scope, the intention is to correlate the projects linked to the RME.

The RME Projects Department "proposes the development of actions aimed at the teaching-learning process, through the expansion of time, access to different experiences and/or educational environments" (CURITIBA, 2022, n.p.). It is subdivided into managements; this article highlights the one related to Educational Projects in Elementary Education.

Educational projects are developed to expand students' knowledge in the social context, considering their interests and repertoires, and providing them with conditions for holistic education. The analyses also refer to the information about the projects contained in the following materials: *Proceedings of the VIII National Meeting of Educating Cities/I SME Seminar - Territories, Innovation, Integral Education, and Sustainability: Contexts and Practices*, which present all the projects implemented in the educational network (Table 1); *Curitiba: Paths that Educate*, which presents the city's regions; and *Pedagogical Guide: Playing with Curitiba, Curitiba in the Palm of Your Hand*, which presents the principles of the city, how the official integration of educating cities occurred in 2019, and the actions promoted to serve the school community, aimed at Elementary Education.

Based on the analysis of the *Proceedings of the VIII National Meeting of Educating Cities/I SME Seminar - Territories, Innovation, Integral Education, and Sustainability: Contexts and Practices*, the strategies of the RME of Curitiba for promoting citizenship with a focus on learning and knowledge are noted, highlighting projects aimed at belonging and co-responsibility with the educating city, Curitiba. In the *Pedagogical Guide: Playing with Curitiba, Curitiba in the Palm of Your Hand*, the construction of maps, models, and others as resources in terms of representations is highlighted. These resources can be linked to both axes of appreciation, encompassing stable, mobile, and combinable resources and referring to the product cycle and its allocation in sociotechnical networks (LATOUR, 2000), to assist the student in constituting, understanding, and problematizing spaces.

> It is known that the various spaces of the city constitute pedagogical learning spaces, and as such, the teacher's planning can encompass objectives, content, and teaching-learning criteria from different curricular components. Starting from the teacher's planning and pedagogical intention, activities are suggested that can be carried out before, during, and after working with the models provided in the project Playing with Curitiba - Curitiba in the Palm of Your Hand (CURITIBA, 2022, n.p.).

These materials provides proposals based on data, cataloging students' knowledge regarding the instruments and strategies related to the content that underpin the curriculum, such as using the Google Earth tool, photographing spaces, links, and accesses that enhance learning and information acquisition. In this process, it is up to the teacher to define priorities, identify with the students the problems presented in the local community, considering specificities, and use the projects to solve these problems, based on dialogue and actions, hybrid teaching, and active methodologies, as referenced in the document.

In addition to projects, the SME of Curitiba promotes events, seminars, and courses with the same principle, to favor learning in various environments of the social world and nature, including the Science curricular component, such as the “I Connect Education: Educating Cities” and actions developed in the Regional Education Centers. With education as the core for social changes, the projects designed permeate the following contexts: Elementary Education; Information and Technology; Connectivity; Transition Notebooks; Natural Sciences and Humanities Curricular Component; Official documents and methodological trends. This apparatus aims to assist in the formation for the exercise of citizenship (CURITIBA, 2022).

4.1 Curitiba, International Association of Educating Cities, and Sustainable Development Goals

The International Association of Educating Cities (IAEC) is an organization responsible for proclaiming education as a transformative force for territories in a collective logic, where all individuals are part of a connected network. This aspect correlates with the explanation of sociotechnical networks by Latour (2000), highlighting an appreciation axis concerning the product cycle from a socio-environmental perspective.

In 2019, the city of Curitiba joined the IAEC. As a documentary basis for the development of educational projects, the SME of Curitiba also relies on the Sustainable Development Goals (SDGs) "[...] to meet the legal provision on teacher training and to dialogue with the UN [United Nations] 2030 Agenda, instituting the teacher training program" (CURITIBA, 2022, n.p.).

The actions in this direction aim to address themes that seek to ensure relevant discussions in the social scenario, articulating pedagogical activities through the deepening of socio-scientific aspects. The proposals aim to expand the repertoire of knowledge that students already have and to articulate those proposed in the curriculum. These propositions may encompass socio-scientific aspects from a STSE Education perspective. Subsequently, some projects associated with this perspective are highlighted.

4.2 Projects in Line with the SDG Assumptions

The Knowledge Lines Program involves teachers and students for the "[...] promotion and strengthening of urban awareness, sustainability, and citizen identity through the subjects' sense of belonging to city spaces, through practices of exploration and knowledge of the city based on three pillars: knowing, loving, and caring for the city" (CURITIBA, 2022, n.p.). There is a reference to the appreciation axis from a socio-environmental perspective, where the production, distribution, use, and disposal of products conform to sociotechnical networks.

Regarding the data on the participation of the SME of Curitiba, the following results are presented: "In 2019, 29 educational units participated, totaling 40 projects, involving 8,748 students and 425 teachers" (CURITIBA, 2022, n.p.). Within this organization, other projects are found as presented below in Table 2, with an indication of the page for access.

Table 2 – Projects Involving SDGs

Project	Access
Education for Sustainable Entrepreneurship: In partnership with the Brazilian Support Service for Micro and Small Enterprises (SEBRAE), this project aims to encourage an entrepreneurial culture aligned with the development of cooperation, innovation, eco-sustainability, ethics, and citizenship.	https://educacao.curitiba.pr.gov.br/conteudo/projeto-educacaopara-o-empreendedorismosustentavel/11378
Fala Curitibinha: Aims to involve students and teachers in practices of exploring the city of Curitiba.	https://educacao.curitiba.pr.gov.br/conteudo/fala-curitibinhafala-curitibano/11871
AbeLinhas do Conhecimento: Aims to promote awareness among students and teachers about the importance and necessity of caring for and preserving bees, essential for maintaining life on the planet, through the construction of honey gardens.	https://educacao.curitiba.pr.gov.br/conteudo/abelinhas-doconhecimento/10496
Urban Agriculture and School Gardens: Aims to raise awareness about healthy and sustainable eating; the preparation and consumption of products from school and community gardens; the hygiene and proper handling of food; and strategies to avoid food waste. This project is developed in partnership with the Municipal Secretariat of Food and Nutritional Security (SMSAN) and the SME of Curitiba, through the Knowledge Lines Program and the Food Management.	https://educacao.curitiba.pr.gov.br/conteudo/projetoagricultura-urbana/11054
Aquatic Environment: Aims to provide students from the RME of Curitiba with moments of aquatic adaptation that include adjusting to the water environment, learning about water safety measures, and, consequently, survival	https://educacao.curitiba.pr.gov.br/conteudo/projetoambientacao-aquatica/11050

techniques in this environment.	
Where is the garbage that was here: [No objectives specified].	https://educacao.curitiba.pr.gov.br/conteudo/cade-o-lixo-queestava-aqui/12278
Ambassadors of the Future: Aims to develop in students civic competencies and active and investigative attitudes, seeking the sharing of experiences to solve local and global problems through diplomacy.	https://educacao.curitiba.pr.gov.br/conteudo/projetoembaixadores-do-futuro/11332

Source: Curitiba (2022)

It is important to highlight the connection to an appreciation axis associated with the product cycle, from a socio-environmental perspective, in actions to combat food waste, as seen in the project involving urban agriculture and gardens, which aims to:

> [...] promote awareness about healthy and sustainable eating; the preparation and consumption of products from school and community gardens; the hygiene and proper handling of food; and strategies to avoid food waste (CURITIBA, 2022, n.p.).

The projects developed in this program are based on the *2030 Agenda* and the Sustainable Development Goals (SDGs), according to the guide *Education for Sustainable Development*, in partnership with the United Nations Educational, Scientific, and Cultural Organization (UNESCO). Resources and materials used include: ONU.#SDGGAME; Coletivo Leitor website; editions of Turma da Mônica and the global goals addressing clean and affordable energy, sustainable cities and communities; documentaries produced by Maria Farinha Filmes titled: *Muito além do peso*, *Criança a alma do negócio*, *Criança e a Natureza*, and *Repense o elogio*. Additionally, the World's Largest Lesson website presents creative tools and shared learning experiences globally based on the SDGs, with a thematic focus promoted annually for educational organizations; and the *Ecological Footprint booklet* (CURITIBA, 2022).

All proposals are articulated with the curricular outlines of the Curitiba Municipal Education Network (RME), the principles of the *Educating Cities Charter*, the SDGs, and the National Common Curricular Base (BNCC) (CURITIBA, 2022). The YouTube platform "Linhas do Conhecimento" provides explicit actions, including continuous training available to RME teachers, as well as the dissemination of programs, projects, and events conducted.

4.3 STSE Education and Maker Movement in Curitiba's RME Educational Projects

The analyzed projects of Curitiba's RME, outlined in Table 2, are offered to elementary school students in the initial years, integrated into curricular areas. Each project's theme corresponds to the specificities of each educational stage, addressing the corresponding age groups.

Educational materials and plans are also organized according to the class/year they will be developed in. The articulation of the projects focuses on the actions of the teacher, students, and school community, including practices

developed considering the uniqueness of contexts, to structure the formation of citizenship among the participants.

Each project has a development period with the classes, according to SME guidelines, which does not mean that deadlines cannot change, as it depends on the engagement and conditions of the students and context. According to information available on the SME website, teachers implementing the projects have a continuous training program called "Veredas Formativas," corresponding to a process in which:

> The deepening themes in professional development originate from actions the professional develops in their area of activity. From specific areas, in confrontation with the operationalization in different institutional realities, problems of practice arise, requiring the mentor's sensitivity to channel them into good training projects. In parallel to the themes, the training requires the establishment of methodologies, or new methodologies, for resolving what comes to light in training and its practical application with the effective aim of overcoming the difficulties that motivated the training (CURITIBA, 2022, n.p.).

Teachers are offered meetings, lectures, courses, forums, agreements, pedagogical trails, workshops, seminars, specialization, and pedagogical exchange corresponding to initial training, broad continuous training, and specific continuous training. Activities are conducted via the SME platform, and training actions occur both in-person and remotely, to meet and prepare teachers in their formative and professional journey. The platform also serves the community with informative lectures and course offerings. The specifics of this continuous training program, such as the teacher's available time or the higher or lower correlation with each project, are not within the scope of this work.

The identified actions for the composition of projects are based on the principles of active methodologies, which can include: problem-based learning; flipped classroom; gamification; station rotation; hybrid teaching; maker culture; seminars and discussions; dialogicity. These occur through methodological strategies/resources such as themes; pedagogical guides; e-books; magazines; virtual environments; videos and video lessons. These actions align with Bacich and Moran's (2018, p. 9) assertion that "active methodology is characterized by the interrelationship between education, culture, society, politics, and school, developed through active and creative methods, centered on the student's activity with the intention of fostering learning". Table 3 below summarizes the characteristics of the projects analyzed in this work.

Table 3 – Characteristics of Analyzed Projects

Project	Methodology	Strategy/Resource
Education for Sustainable Entrepreneurship	✓ Maker Movement ✓ Meetings ✓ Advisory ✓ Fairs	Entrepreneurial culture; cooperation; innovation; eco-sustainability; ethics; citizenship; partnership with SEBRAE; thematic notebooks.
Fala Curitibinha	✓ Dialogicity ✓ Active Learning	Exploration of Curitiba's demands from the citizens' perspective; online research.

AbeLinhas do Conhecimento	✓ Dialogicity ✓ Experiential and Practical Approach	Construction of honey gardens; awareness about the importance of bees; lectures and technical visits.
Urban Agriculture and School Gardens	✓ Active Learning ✓ Experiential and Practical Approach	Awareness of healthy eating; preparation and consumption of garden products; hygiene; strategies to avoid waste; city spaces for these approaches.
Aquatic Environment	✓ Active Learning	Adaptation to the aquatic environment; knowledge about water safety; survival techniques; aquatic activities.
Where's the Trash that was Here?	✓ Study and Reflection on Themes ✓ Practical Activities ✓ Environmental Education	Pedagogical workshops; development and dissemination of actions through media resources; waste collection, classification, and proper disposal.
Ambassadors of the Future	✓ Active Learning	Development of civic competencies and investigative attitudes; diplomacy.
Robotics and Programming Language	✓ Maker Movement ✓ Practical, Creative, and Hands-on Learning	Construction and programming of automated models; LudoBot kits; classes and competitions between schools.
Creative Learning	✓ Maker Movement ✓ Constructionism	Creative educational practices; participation in the "Hands-on" campaign; sharing of activities and literary contributions.
Hands-on: Home Economics for Students of Curitiba's Municipal Education Network	✓ Active Methodologies ✓ Maker Culture	Constructions; sewing; crafts; customization; food preparation; educational notebooks.

Source: Own Authorship (2024).

Subsequently, the specifications of the projects are presented: Pedagogical Innovation Laboratory (LAPI); Robotics and Programming Language; Creative Learning; Hands-on: Home Economics for Students of Curitiba's Municipal Education Network. Regarding these, analytical procedures and interpretation proposals are detailed.

In these projects, the following theoretical foundations stand out: the New School thought, supported by the ideas of Dewey (1979), which introduces innovations in practical teaching based on experiences; Freire (1979), who views education through dialogicity, using real-life situations as the backdrop for approaches and themes; Almeida and Valente (2012), regarding the use of digital technologies; Resnick (2020), based on constructionism; Piaget (2001), rooted in constructivism; Montessori (2019), responsible for the Montessori method, among other thinkers. Additionally, Papert (2008) is mentioned for digital

approaches, as exemplified in the Pedagogical Innovation Laboratory (LAPI) project, which is described as: "[...] an integrated, innovative, and progressive educational environment that should become a reference in public education, conceiving new active teaching and learning methodologies" (CURITIBA, 2022, n.p.).

In this space, research, experimentation, modeling, and prototyping are proposed based on maker initiatives. In these actions, various digital materials and a collection of instruments and artifacts that support experimentation and planning are utilized. The technological equipment includes: chromebooks; headphones; 3D printer; Makey Makey programming kits; Scopabits educational electronics kits; Arduino robotics kits; Educational tablets; Multifunction laser printer; Microbits robotics sets, Lego Education WeDo, and EV3 Lego Mindstorms Education; Educational netbooks with augmented and virtual reality programs. Such materials serve children and students from Kindergarten to Elementary School, teachers and the community. These resources and processes integrate the cognitive perspective in terms of stable, mobile, and combinable resources.

Thus, the analysis of the projects reveals that the articulation between world knowledge and social and scientific perspectives in learning construction involves relationships between subjects and scientific and technological productions, aiming to contribute to the critical and reflective formation of those involved, considering converging or diverging viewpoints in problem-solving actions. The analyzed projects demonstrated correlations with the principles of STSE Education, considering that: "[...] the contents of STS curricula present a broad dimension of science, discussing many aspects beyond the nature of scientific investigation and the meaning of scientific concepts" (SANTOS; MORTIMER, 2000, p. 116-117). Regarding the appreciation axis aligned with the socio-environmental perspective, the feasibility of problematizing the product cycle is noted. This direction proposes not only emphasizing cognitive aspects related to the elaboration and manipulation of products but also questioning their production, distribution, use, and disposal, as well as their socio-environmental impacts.

The implemented projects, correlated with STSE Education, can contribute to the understanding of belonging and citizenship, add knowledge, and reverberate in learning, affecting society, technology, and the environment. Despite these identified potentials, it is crucial to highlight the demand for pedagogical intentionality in articulation with STSE Education principles, where product development is embedded in a process of problematization and action at the STSE interface.

It is argued that integrating the Maker Movement with the panorama of STSE Education and the Sociology of Science in the educational sphere, through projects, can help transcend the banking education model that Freire (1979) warned about, where students were mere content receivers without considering other aspects that permeate learning, such as socio-environmental issues. The analyzed projects present maker context proposals that aim to promote student autonomy and bring content closer to reality, using instruments and methodologies that encompass experiential aspects and strategies in terms of: approaches, times, spaces, material and resource manipulation, in a collective or individual perspective.

In this scope, the "Robotics and Programming Language" project of Curitiba's SME is mentioned, which: "[...] contributes to learning through the construction and programming of automated models, enabling robots to perform tasks and solve proposed problems" (CURITIBA, 2022, n.p.), where maker practice is evident in actions.

> In a multidisciplinary manner, the use of logic as a structuring element of the work involving curriculum components is highlighted, addressing concepts of Mathematics, Physics, Engineering, Computing, Design, Science, and Technologies (CURITIBA, 2022, n.p.).

However, it is essential to warn about the need for articulation not only between science and technology; socio-environmental aspects form the STSE interface, where scientific and technological productions are located in socio-technical networks. There is an urgent need for advances not only from a cognitive perspective, and the involvement in problematizing the product cycle and its socio-environmental impacts is required.

The project activities are developed during the extracurricular period. SME supports schools with pedagogical materials, advisory services, LudoBot kit distribution, and teacher training. The project documents align with the Maker Movement principles, as exemplified in the activity schedule of the events held, including the studying robot structures with scrap materials, building robots with recyclable materials and programming with S4A.

The project webpage presents a timeline of the introduction of educational robotics in Curitiba's Municipal Education Network, starting in 2004 with the acquisition of kits; in 2005 with the formative process for involved teachers; in 2007 with the classification of the first team of gifted students; from 2012 to 2017 with the implementation of projects in more teaching modalities; and from 2017 to 2020 with project expansion and participation in events like the First Lego League (FLL) tournament, with three teams qualifying for the national stage. 191 schools from Curitiba's Municipal Education Network, from 1st to 9th grade, are served and have: "[...] been highlighted and received several awards over the years in all the events in which it participates, winning regional, national, and world stages in different events" (CURITIBA, 2022, n.p.). The results achieved reflect the engagement and participation of students and teachers in coordinated actions. Noteworthy digital materials and instruments provided include: mDesigner Setup; Scratch; EV3; Programming language and Arduino.

Another project utilizing Maker Movement strategies is "Creative Learning," this Project reffers to.

> [...] a pedagogical approach developed at MIT Media Lab by Professor Mitchel Resnick. It involves the "Hands-on" campaign in partnership with the Brazilian Network for Creative Learning (RBAC), promoting creative and relevant educational practices throughout Brazil (CURITIBA, 2020, n.p.).

This project involves sharing educational activities developed nationwide, offering literary resources on the subject, and participating in events that promote active methodologies. There is a noted interconnection between projects related to STSE Education and the Maker Movement, in alignment with the contents proposed in the *Elementary School Curriculum: dialogues with the BNCC*. The Maker Movement's reference in the analyzed projects is evident, yet

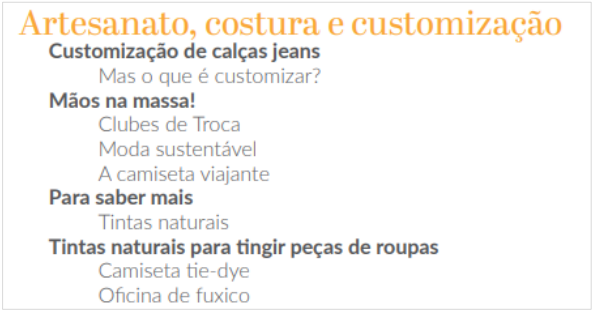
there is a call for greater articulation with STSE Education principles, addressing products not only in terms of creation and handling but also by problematizing their lifecycle and allocation within sociotechnical networks.

In line with this proposal, the SME launched the "Hands-on: Domestic Economy for Curitiba's RME Students" project, organized into 10 pedagogical booklets for 6th to 9th-grade students. The project covers various knowledge areas: Art, Mathematics, Physical Education, Foreign Language, Portuguese Language, Religious Education, Science, Geography, and History.

In this project, cognitive perspectives highlight the interaction feasibility involving materials and ideas, alluding to instruments and resources for problem-solving. In Science, for example, the topic "Origin of Bread" includes the history of gastronomy, informative videos and texts, recipes, and curiosities about wheat (CURITIBA, 2022).

Figure 1 below presents an example of proposals related to this project in the area of Science, specifically associated with clothing.

Figure 1 – Proposals from the "Hands-on: Domestic Economy for Curitiba's RME Students" Project



Source: Curitiba (2022).

In terms of the socio-environmental perspective, it encompasses correlations with the product cycle, emphasizing, for example, "Swap Clubs", "Sustainable Fashion", and the composition of natural paints. In Table 4, examples of analysis related to the socio-environmental perspective in the mentioned project are presented.

Table 4 – Analysis Examples – Project "Hands-on: Domestic Economy for Curitiba's RME Students"

Unit of Analysis	Specification
For this activity, ask students to bring old jeans that they no longer use for a customization workshop. This workshop aims to reduce waste generation, as consumption and waste generation are closely related. When reflecting on the impact caused by the waste we generate, we must consider the meaning that consumption takes on in our society (CURITIBA, 2022).	**Socio-environmental perspective** Product cycle: consumption and waste disposal
Sustainable fashion is a proposal that focuses on methods to reduce environmental impacts. This fashion arises from the need for a change in behavior not only in the fashion industry but also among consumers, as much of the raw material used	**Socio-environmental perspective** Product cycle: production and

to make clothes, shoes, and other items comes from natural resources, causing significant pollution and environmental degradation (CURITIBA, 2022).	natural resources

Source: Own authorship (2022).

Each curricular component brings proposals that stimulate learning possibilities through doing, resulting in decision-making where the student sees themselves as part of the knowledge construction process. In light of this, actions such as building content through practical learning, in economic, political, social, and spatial aspects, among others, bring the approach closer to STSE Education, encompassing other cultures through the practice of citizenship. In the analyzed projects, with reference to the axes of appreciation, aspects were highlighted that span the following perspectives: cognitive, in which material and immaterial representations are associated with stable, mobile, and combinable resources; socio-environmental, in which the production, distribution, use, and disposal of products and their allocation in socio-technical networks are problematized.

FINAL CONSIDERATIONS

Based on the analysis of the documents, there is a clear concern regarding the need for innovation in educational practices to ensure learning through various significant strategies and methodologies. The themes aim to correspond to the students' context and correlate with what is proposed in the *Elementary School Curriculum: Dialogues with the BNCC* of SME Curitiba.

Upon analyzing the projects, the presence of STSE Education assumptions was noted, which articulates with the Sociology of Science, correlating with the SDGs in promoting critical thinking, belonging, integrating technologies, and resonating actions within society. In this perspective, there is a noteworthy allusion to understanding the city as an educator, which integrates possibilities for approaching socio-technical networks involving science and technology productions.

Materials developed to support the projects highlighted activities aimed at skills and competencies from an interdisciplinary perspective, encompassing STSE Education issues with proposals from the maker culture domain. Nevertheless, the connections between cognitive aspects and the insertion of products into socio-technical networks could be significantly expanded in the analyzed projects. In this regard, pedagogical intentionality aligned with the problematization and action involving products interrelated with STSE in the panorama of socio-technical networks stands out in addressing the challenges associated with STSE Education.

It is evident that incorporating assumptions from the Maker Movement into the educational domain demands the problematization of aspects from both cognitive and sociological perspectives. Therefore, there is a call for the expansion of research and studies, including actions with students, to demonstrate possibilities and limitations of products in terms of their development and manipulation in educational activities. Such products should be conceived in terms of problematizing their lifecycle and not solely focused on cognitive aspects related to their creation and manipulation.

MOVIMENTO MAKER E EDUCAÇÃO CTSA (CIÊNCIA, TECNOLOGIA, SOCIEDADE E AMBIENTE): DELINEAMENTOS EM PROJETOS EDUCACIONAIS DA REDE MUNICIPAL DE ENSINO DE CURITIBA

RESUMO

Em alusão a pressupostos da Educação CTSA (Ciência, Tecnologia, Sociedade e Ambiente), indaga-se sobre as potencialidades do Movimento Maker no âmbito de Ciências nos Anos Iniciais do Ensino Fundamental, agregando dimensões da Sociologia da Ciência. Neste trabalho, evidenciam-se correlações atinentes aos quadros teóricos supracitados em relação à elaboração e manipulação de representações envolvendo recursos estáveis, móveis e combináveis; e à alusão a ciclo de produção, distribuição, utilização e descarte de produtos, em referência a redes sociotécnicas. Nesse panorama, no presente artigo, objetiva-se: analisar delineamentos em projetos educacionais da Rede Municipal de Ensino (RME) de Curitiba, em referência a pressupostos de Educação CTSA e Movimento Maker, agregando perspectiva da Sociologia da Ciência. Reporta-se à pesquisa qualitativa e à análise documental e de conteúdo, com a averiguação de documentos concernentes a projetos educacionais vinculados à RME de Curitiba. De forma ampla, evidenciou-se o direcionamento dos projetos educacionais à vinculação com cidade educadora (Curitiba) e aos Objetivos de Desenvolvimento Sustentável (ODS), em aproximação à Educação CTSA, bem como referências explícitas ao Movimento Maker. Não obstante, denotam-se demandas por ampliação de articulações, atinentes aos referidos quadros teóricos, no que concerne aos produtos, de maneira a potencializar a dimensão cognitiva e de análise de aspectos sociais e ambientais de forma concomitante.

PALAVRAS-CHAVE: Ensino de Ciências. Educação CTSA. Produtos. Sociologia da Ciência.

NOTES

1 Extended and revised version of the article presented at the National Symposium on Science and Technology Teaching (SINECT) 2022.

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