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CONTRIBUTIONS OF REXLAB/UFSC TO THE PROMOTION OF MAKER CULTURE IN BASIC EDUCATION: A CASE STUDY ON THE TECHNOLOGY INTEGRATION IN EDUCATION PROGRAM (INTECEDU)

CONTRIBUIÇÕES DO REXLAB/UFSC PARA A PROMOÇÃO DA CULTURA MAKER NA EDUCAÇÃO BÁSICA: UM ESTUDO DE CASO SOBRE O PROGRAMA DE INTEGRAÇÃO DE TECNOLOGIA NA EDUCAÇÃO (INTECEDU)

CONTRIBUCIONES DEL REXLAB/UFSC PARA LA PROMOCIÓN DE LA CULTURA MAKER EN LA EDUCACIÓN BÁSICA: UN ESTUDIO DE CASO SOBRE EL PROGRAMA DE INTEGRACIÓN DE TECNOLOGÍA EN LA EDUCACIÓN (INTECEDU)

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ABSTRACT

The maker culture, with its focus on practical and collaborative learning, has gained prominence in education. However, there are still challenges to its implementation in basic education. The Remote Experimentation Laboratory (REXLAB) at the Federal University of Santa Catarina (UFSC) stands out for its efforts in promoting maker culture in basic education through the Technology Integration in Education Program (INTECEDU). Aiming to analyze how REXLAB/UFSC promotes maker culture in basic education through the INTECEDU program, this study employed a qualitative approach. Data collection procedures included interviews with eight informants, including members of REXLAB/UFSC, as well as a visit to the Laboratory's makerspace. The collected data were analyzed using Braun and Clarke's Thematic Analysis, seeking to identify patterns of meaning within the dataset. The results indicate that REXLAB/UFSC has been essential in creating innovative resources and methodologies, promoting the integration of technology in education. The research highlights the role of REXLAB/UFSC in teacher training, the development of materials, and the creation of collaborative spaces for implementing maker culture in schools. The findings point to the need for effective public policies for the implementation of maker culture in Brazilian basic education.

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Keywords: Information and Communication Technologies (ICTs). Maker Culture. Maker Education. REXLAB/UFSC. Educational Innovation.

RESUMO
A cultura maker, com foco na aprendizagem prática e colaborativa, tem se destacado na educação. No entanto, ainda há desafios para sua implementação na educação básica. O Laboratório de Experimentação Remota (REXLAB) da Universidade Federal de Santa Catarina (UFSC) se destaca por seus esforços na promoção da cultura maker na educação básica, por meio do Programa de Integração de Tecnologia na Educação (INTECEDU). Com o objetivo de analisar como o REXLAB/UFSC promove a cultura maker na educação básica por meio do programa INTECEDU, este estudo utilizou uma abordagem qualitativa. Os procedimentos de coleta de dados adotados foram entrevistas com oito informantes, incluindo membros do REXLAB/UFSC e uma visita ao makerspace do Laboratório de Experimentação. Os dados coletados foram analisados por meio da Análise Temática de Braun e Clarke, buscando identificar padrões de significado dentro do conjunto de dados. Os resultados indicam que o REXLAB/UFSC tem sido fundamental na criação de recursos e metodologias inovadoras, promovendo a integração da tecnologia na educação. A pesquisa destaca o papel do REXLAB/UFSC na formação de professores, desenvolvimento de materiais e criação de espaços de colaboração para a implementação da cultura maker em escolas. As descobertas apontam para a necessidade de políticas públicas eficazes para a implementação da cultura maker na educação básica brasileira.

Palavras-chave: Tecnologias da Informação e Comunicação (TICs). Cultura Maker. Educação Maker. REXLAB/UFSC. Inovação Educacional.

RESUMEN
La cultura maker, centrada en el aprendizaje práctico y colaborativo, ha ganado relevancia en la educación. Sin embargo, aún existen desafíos para su implementación en la educación básica. El Laboratorio de Experimentación Remota (REXLAB) de la Universidad Federal de Santa Catarina (UFSC) se destaca por sus esfuerzos en promover la cultura maker en la educación básica por medio del Programa de Integración de Tecnología en la Educación (INTECEDU). Con el objetivo de analizar cómo el REXLAB/UFSC promueve la cultura maker en la educación básica a través del programa INTECEDU, este estudio empleó un enfoque cualitativo. Los procedimientos de recolección de datos incluyeron entrevistas con ocho informantes, entre ellos miembros del REXLAB/UFSC, además de una visita al makerspace del Laboratorio de Experimentación. Los datos recopilados fueron analizados mediante el Análisis Temático de Braun y Clarke, buscando identificar patrones de significado dentro del conjunto de datos. Los resultados indican que el REXLAB/UFSC ha sido fundamental en la creación de recursos y metodologías innovadoras, promoviendo la integración de la tecnología en la educación. La investigación destaca el papel del REXLAB/UFSC en la formación docente, el desarrollo de materiales y la creación de espacios de colaboración para la implementación de la cultura maker en las escuelas. Los hallazgos señalan la necesidad de políticas públicas eficaces para la implementación de la cultura maker en la educación básica brasileña.

Palabras clave: Tecnologías de la Información y la Comunicación (TIC). Cultura Maker. Educación Maker. REXLAB/UFSC. Innovación Educativa.

1 INTRODUCTION

In Brazil, an emerging theme is digital technologies in education. A factor that contributes to this is the implementation of the National Education Plan for the decade from 2024 to 2034, which brings a School proposal that has technology, in a special way, as an element of education qualification. Such a public policy marks a process of consideration of the importance of digital technological resources for Brazilian education.

A milestone in Brazil for the pedagogical use of digital technologies in basic education was Law No. 14,180, of July 1, 2021, which institutes the Innovation Policy: Connected Education, which aims to ensure the necessary conditions for the insertion of technology as a pedagogical tool for daily use in public basic education schools. This law, among other principles, deals with broad access, promotion of the development and dissemination of quality digital educational resources, showing the relevance of the theme.

Another important law is No. 14,533, of January 11, 2023, which institutes the National Digital Education Policy (PNED), this law seeks to enhance the Brazilian population's access to digital resources, tools, and practices, among others. It brings an important change to basic education: digital education (with a focus on digital literacy and the teaching of computing, programming, robotics and other digital skills), as a curricular component of elementary and high school. The PNED has the following structuring axes and objectives: Digital Inclusion; School Digital Education; Digital Training and Specialization; Research and Development in Information and Communication Technologies (ICTs).

This policy complements the National Common Curricular Base for Computing, with axes and learning objectives by stages: early childhood education, elementary school and high school, regulated by Resolution CNE/CP No. 2, of December 22, 2017, which instituted the implementation of the National Common Curricular Base (BNCC) within the scope of Basic Education – Early Childhood Education and Elementary Education. In Chapter V – Final and Transitory Provisions, Article 22 determines that "The CNE shall prepare specific rules on computing".

In view of the new laws, some schools have already adopted this new possibility of using digital technologies and, currently, there are several aspects of information technology that are already implemented in teaching, whether face-to-face or at a distance. For Santos, for example:

However, it is worth remembering that this is a distant reality for many schools. Unfortunately, these periods of acquisition and technological adaptation in schools are not an easy process and present several obstacles, such as the financial resources necessary for the acquisition of good quality hardware and software, teacher training, adequacy of physical space, among other factors. (Santos, 2015, p.26)

However, there are still several barriers such as those mentioned by Santos for there to be effectively the integration of technology in Basic Education, so actions and procedures for the use of available resources (technologies) for school work need to be discussed, analyzed and researched. For Valente:

Computers are providing a true revolution in the teaching-learning process. A more obvious reason comes from the different types of teaching approaches that can be carried out through the computer, due to the numerous programs developed to assist the teaching-learning process. However, the greatest contribution of the computer as an educational medium comes from the fact that its use has provoked the questioning of the teaching methods and processes used. (VALENTE, 1991, apud Santos, 2015)

In view of the need to investigate and disseminate innovative practices that promote the integration of digital technologies in Basic Education, this study directs its focus to the actions of the Remote Experimentation Laboratory (REXLAB) of the Federal University of Santa Catarina (UFSC). REXLAB stands out as a center for research and development of innovative resources and methodologies for teaching and learning, with emphasis on Maker Culture .

Through the analysis of the interviews, the research intends to answer the guiding question: What are the contributions of REXLAB/UFSC to the integration of technology in education? The information collected allowed us to understand the role of REXLAB in teacher training, development of educational resources and creation of collaborative environments, contributing to the advancement of research and educational practice in the context of the integration of digital technologies.

2 LITERATURE REVIEW

Among the different types of literature review, we chose the narrative review to use in this research. According to Botelho, Cunha and Macedo (2011, p.125) the narrative revision is

used to describe the state of the art of a specific subject, from a theoretical or contextual point of view. We chose this review format also because of the possibility of acquiring and updating knowledge on a given topic in a short period of time, as we had a period of two months in the schedule foreseen for literature review.

After identifying the search question, we subsequently began the construction of the search strategy, defined the search string, and the database to find the 10 most cited articles. We defined the descriptors and divided them by subject to then form the search string, in subject 1 we searched for words related to the maker approach, in subject 2 we defined words related to the school scenario, as our research interest is the application of maker culture in a school environment.

a) Subject 1

"Maker Culture" OR "Maker Movement" OR "Education Maker" OR "Digital Fabrication" OR makerspace OR makerspaces OR "do it yourself" OR fablab OR "digital fabrication" OR "maker culture" OR "maker approach" OR "maker movement" OR "maker space" OR "do it yourself" OR "hands-on" OR "maker labs" OR "makers OR "digital fabrication" OR "creative culture" OR "Maker practices"

b) Subject 2

"Primary Education" OR "Primary Grades" OR "Primary Grade" OR "Elementary Education" OR "Elementary Grades" OR "Elementary Schools" OR "Elementary School" OR "Primary Schools" OR "Primary School"OR "Ensino Prima" OR "Educação Básica" OR "Educação Primaria")

We select the database. The database chosen was the Web of Science (Clarivate Analytics) because it has the option of classification by the most cited articles, access was via the CAPES Journal Portal (http://periodicos.capes.gov.br/), using the option "Collection" > "List of databases" and using the CAFE access.

Table 1

Database and Search String

Database	SEARCH STRING

Web of Science (Clarivate Analytics)	TS=("Maker Culture" OR "Maker Movement" OR "Education Maker" OR "Digital Fabrication" OR makerspace* OR "do it yourself" OR fablab OR "digital fabrication") AND TS=("Primary Education" OR "Primary Grade*" OR "Elementary Grade*" OR "Elementary School*" OR "Primary School*").

Source: The authors

The search in the databases returned data that allowed the construction of Table 2 containing the list of the ten most cited articles found below:

Table 2

Ten most cited articles

Authors	Title	Year
1.LESKINEN; KUMPULAINEN; KAJAMAA; RAJALA	The emergence of leadership in students' group interaction in a school-based makerspace	2021
2.LEINONEN; VIRNES; HIETALA; BRINCK,	3D Printing in the Wild: adopting digital fabrication in elementary school education.	2020
3.VUOPALA; MEDRANO; ALJABALY; HIETAVIRTA; MALACARA; PAN	Implementing the Maker culture in elementary school – students' perspectives.	2020
4.KUMPULAINEN; KAJAMAA	Sociomaterial movements of students' engagement in a school's makerspace	2020
5.HATZIGIANNI; STEVENSON; BOWER; FALLOON; FORBES	Children's views on making and designing	2020
6.NÄYKKI; LARU; VUOPALA; SIKLANDER; JÄRVELÄ	Affective Learning in Digital Education— Case Studies of Social Networking Systems, Games for Learning, and Digital Fabrication. Front. Educ	2019

7.STEVENSON; BOWER; FALLOON; FORBES; HATZIGIANNI,	By design: Professional learning ecologies to develop primary school teachers' makerspaces pedagogical capabilitie	2019
8.SCHLEGEL; CHU; CHEN; DEUERMEYER; CHRISTY; WHAT	Making in the classroom: longitudinal evidence of increases in self-efficacy and stem possible selves over time.	2019
9.VONGKULLUKSN; MATEWOS; SINATRA; MARSH	Motivational factors in makerspaces: a mixed methods study of elementary school students ⁚ situational interest, self-efficacy, and achievement emotions	2018

Source: The authors

2.1 MAKER CULTURE: THEORETICAL CONTRIBUTIONS AND ITS CONNECTIONS WITH THE INTERVIEWS

The maker culture has influenced the way many educators organize teaching and, consequently, influences how people learn and create, it did not emerge in isolation, its evolution can be understood through the contributions of authors who, over time, have brought different perspectives on how creativity, innovation and the economy relate to learning and the production of knowledge.

As a way to exemplify these contributions, we highlight the work of four authors: Seymour Papert, David Gauntlett, Chris Anderson and Dale Dougherty. Each of these authors, in different contexts, contributed to the understanding of maker culture, connecting pedagogical methodologies, social connections, economics and the idea of doing as a mode of transformation.

The beginning of the theoretical construction that influences the maker movement can be attributed to the mathematician and educator Seymour Papert who, in 1980, published the book: Mindstorms: Children, Computers, and Powerful Ideas, a work that brought to light the idea of how technology could be used in education. His theory, called "constructionism," proposed that children would learn more effectively by being actively involved in building something meaningful to them. This idea of "learning by doing" was central to the first steps of maker culture .

According to Papert (1980), the computer is a tool that allows the creation of new forms of cognitive experiences. He also argued that children should be seen as "designers", that is, responsible for designing their own learning. By advocating that children could use computers

to program, create, and experiment, Papert provided a methodological basis for what would later become maker culture, where technological tools, such as 3D printers and robotics kits, are used to stimulate creative learning.

The analysis of the interviews revealed a series of principles that guide the approach maker, corroborating the studies of different authors. One of the principles of maker culture it is intrinsically linked to creativity and "learning by doing", as highlighted by Papert and the interviewees.

The essence of the maker culture that learning takes place through action, construction and experimentation appears in the statement of interviewee 1 when he states:

> "Maker is doing. Do it yourself [...] our philosophy in terms of the laboratory, which is the fact of having the teacher and the student as creators, these people have to be creators. You have to create and build." (Manager)

Another author who came thirty years after Papert, in 2011, was David Gauntlett who published his book: "Making is Connecting: The Social Meaning of Creativity, from DIY and Knitting to YouTube and Web 2.0", expanding the understanding of how making connects individuals in social and digital networks. Thus, Gauntlett brought as a contribution, the social dimension to the maker culture, emphasizing how people, when creating, not only produce something tangible, but also build connections with other people. Gauntlett (2018) argues that "doing is connecting", creativity is a process of connection, not an isolated act, and that it brings people together.

Interviewee 2 emphasizes the importance of creativity, bringing that when the teacher uses creativity he grows as a teacher and this influences self-esteem, defined in the interviewee's speech as "starts to have a greater shine", exemplifying how the teacher brings his "brand". In the following excerpt from the speech, this importance of creativity is highlighted:

> It is very easy for you to explain the functioning and such, for example, of a pedagogical practice, but it is necessary to give strength to themselves, to the teachers. That they can give their own imagination, their own pedagogical creation and not take those ready-made things yet. So culturally for us, it has this meaning. Value the teacher and the potential that this teacher has much more, instead of delivering something ready for him to present in class. That he can create in his own mind, from his own experience, from his own experience, he creates something [...]. But it is important that the idea comes from them from the teacher, to take advantage of exactly what he has best. (Founder)

For Gauntlett, everyday creativity, enabled by Web 2.0, gives people the power to express themselves and share their creations on platforms like YouTube and Facebook. Web 2.0 tools make it possible for everyone to share their creations with a global audience, resulting in new types of social capital. (Gauntlett, 2018). This connection between the digital and physical creates a new form of social interaction and learning, where doing becomes a form of active participation in communities.

Gauntlett's contemporary, Chris Anderson published in 2012: Makers: The New Industrial Revolution. Anderson explored the economic dimension of maker culture, arguing that the maker movement represents a new industrial revolution. With the advancement of accessible technologies like 3D printers and open-source tools, anyone could design, manufacture, and distribute products, democratizing production.

We realized in the interviews the importance of technological tools for maker culture in education, such as the 3D printer and the laser cutting machine. These tools democratize production, beyond the economic dimension brought by Chris Anderson, making the creation process more accessible and allowing teachers and students to explore new possibilities as we observe in this excerpt from the interview:

> "I see maker culture, when I hear the term maker culture, the first thing that came to my mind is to use technology, some concept more of getting your hands dirty, an example, the laser cutting machine, the electronic 3D printer in a way that can help teachers in pedagogical practices in schools, something in this sense". (DEVELOPMENT AND TECHNICAL TEAM)

Anderson (2012) argues that manufacturing has become more accessible than ever, with unprecedented creative potential. He saw maker culture as an opportunity for small businesses and individuals to compete with large corporations, driven by digital fabrication tools that were previously inaccessible. Anderson's central idea is that maker culture is not only a creative practice, but also an economic engine, changing the way products are manufactured and distributed globally.

Finally, in 2016, Dale Dougherty, considered the "father" of the "maker movement", published: "Free to Make: How the Maker Movement is Changing Our Schools, Our Jobs, and Our Minds". Dougherty, who founded Maker magazine and Maker Faire, formalized the concept of Maker culture, highlighting its impact on education and the job market. For Dougherty, the Maker movement is more than a trend; it's a profound shift in the way people learn and create.

Dougherty (2016) sees the Maker movement as a force that empowers individuals, allowing them to take control of their own learning and creation. The Maker movement is not limited to the production of objects. He cultivates a mindset that believes in the possibility of accomplishing anything through the application of creativity and curiosity. He also believes that the maker movement has the power to transform education, as it provides students with an environment where learning is hands-on and collaborative, helping to develop crucial skills such as problem-solving and critical thinking. The issues of democratization and empowerment appeared in the speech of a teacher interviewed from the indigenous school:

> I think that the maker culture comes so that we can solve a problem based on what we have. Using creativity, getting my hands dirty and producing, making my main objective which was to make them the indigenous protagonists, because as the materials we produced were in Guarani I also have no knowledge of the language, I needed it to be really produced by them, for me the maker culture is this, it is hands-on, it is working with creativity, teamwork, partnership, making the student the protagonist. (Teacher)

Considering the theoretical contributions that support the maker culture and the Brazilian legislation that recommends teaching and learning practices with such approaches, we can observe in the interviews that maker culture connects with REXLAB projects, in particular, the Program for the Integration of Technology in Education (INTECEDU), which includes an articulated set of research and extension projects that are being developed in a procedural and continuous way since 2008.

3 INTECEDU PROGRAM FRAMEWORK

The Remote Experimentation Laboratory - REXLAB, of the Federal University of Santa Catarina - UFSC, was created in 1997, founded by Prof. Dr João Bosco da Mota Alves, being part of the laboratories of INE/CTC (Department of Informatics and Statistics of the Technological Center). The name came about in 1997, when the first remote laboratory was developed, called Remote Experiment Lab, which originated the name RExLab.

Figure 1

Rexlab Logo

Source: RexLab (2024).

One of the principles of REXLAB is open access technology, so we bring an interpretation of the laboratory logo according to Silva, Silva Nardi, Bilessimo and Alves (2024) because these ideas can be observed in this analysis. The color used (green) refers to social and technological issues; the lowercase initial "r" represents the branch, more specifically the branches of the tree; the treetops suggest virtual transmission of information; and the ellipse is formed by the speed of the internet.

Figure 2

Remote Lab

Source: field visit at the RExLab makerspace, 2024.

Rexlab in its creation began with remote experiments with programming languages for microcontrollers. We made a field visit to the REXLAB Makerspace where we observed the structure set up for teaching microcontrollers, the user can load his own program on the microcontrolled remote platform, using the Internet as a communication channel, and run the program, later receiving all the results on his PC, again via the Internet.

REXLAB develops several projects such as RELLE – Learning Environment with Remote Experiments, which is an environment that allows the manipulation and management of remote experiments. Labs4STEAM, an open platform for sharing pedagogical practices. The Indigenous Apoi@Educação, a bilingual platform for sharing pedagogical practices in Guarani and Portuguese and MORE, an Online Reference mechanism hosted at SETIC. In this research, the focus is on the InTecEdu program, which has a virtual teaching and learning environment https://intecedu.rexlab.ufsc.br/

In 2008, REXLAB began the implementation of the Technology Integration Program in Education (INTECEDU) for the integration of digital technologies in basic education. The program's structure includes open educational resources, free software and open hardware, and virtual and remote laboratories for practice in STEM (Science, Technology, Engineering and Mathematics) areas. For Silva, Silva Nardi, Bilessimo and Alves (2024) the program has its actions structured around two axes:

a) training that aims to train teachers in relation to technologies
b) integrate digital technologies into teaching activities.

The construction of the framework by REXLAB proposes strategies that seek to address the four guiding assumptions of the InTecEdu Program:

1. The need for more attractive environments for teaching and learning in basic education;
2. The growing use of mobile devices and the internet by children and adolescents;
3. The need for teacher training for the use of ICT in pedagogical practice;
4. The lack of infrastructure, especially in Brazilian public schools.

The work plan of the framework (INTECEDU) is composed of five "Work Packages" (WP) components:

WP.1 - Project Management;

WP.2- Provision of resources and infrastructure for the development of the program; WP.3 - Strategies related to teachers;

WP.4 - Strategies related to students; and WP.5 - Dissemination and exploitation of results.

According to Silva, Nardi Silva, and Bilessimo (2020, p.173), the framework uses the TPACK (Technological Pedagogical Content Knowledge) model. The authors describe that for the construction of the framework, an initial diagnosis was carried out with the teachers, seeking their perception in relation to their knowledge: technological, pedagogical and disciplinary/content and how they integrated technology in their classrooms. The model, inspired by the Maker Culture, sought to allow basic education teachers to be the protagonists of the integration of technology into their lesson plans.

Regarding strategies related to teachers, the program INTECEDU carried out actions with the objective of qualifying teachers to integrate technology into their lesson plans, from 2016 to 2019 REXLAB held a 120-hour course entitled "Integration of Digital Technologies in Basic Education Disciplines", offered as an extension course at UFSC, 398 teachers participated in the course and one of the strategies used was the provision of digital didactic content, produced by them, in the InTecEdu VLE Program. Therefore, it is part of the The Program INTECEDU a virtual teaching and learning environment (VLE InTecEdu) to house digital didactic content produced by Basic Education teachers and lesson plans produced by them. According to Silva, Nardi

Silva, and Bilessimo (2020, p.189) among the resources made available, teachers had access to Virtual and Remote Laboratories, with lesson plans in the subjects of Science (Elementary School) and Physics and Biology (High School), 20 remote laboratories were made available to support practical activities. The integration of technology in the lesson plans occurred through the availability of VLE content and tablets in the classroom, where 3,252 students were served (1,898 elementary school - early years; 1,266 elementary school - final years and 88 school years - high school).

As part of the documentary research, the data found from the INTECEDU program are 2020 to 2024, it served 45 Basic Education schools, from the public school network (including 04 rural and 01 rural indigenous school), in the states of Santa Catarina, Rio Grande do Sul, Minas Gerais and Sergipe. In these 338 teachers, 660 classes and 16,512 students, accessed (totaling 16.3 million accesses) didactic content produced by the teachers at AVEA.

In the period 04/2020 to 06/24, 62 distance learning courses were offered (with a workload of 20 to 140 hours). In all, 11,757 teachers from the 27 federative units of Brazil participated in the training and met the requirements to obtain the certificates. Certificates issued by UFSC in the form of extension courses.

Currently, the following courses are active: "Maker Edu: innovative practices of educational materials and robotics in Basic Education"; and, "Maker Culture in the classroom - Creating Educational Materials" for 179 teachers from the municipality of Santa Rosa do Sul in partnership with the municipal government; 89 teachers from the state network, in partnership with CRE Araranguá; course Innovating in Education with Digital Skills and Remote Laboratories, for 381 professors at the national level, in partnership with PPGIE/UFRGS; Programming Course with Arduino for 86 undergraduate students from UFSC and the external community; Introduction to Robotics course for 190 students from the

following schools: Governador Pedro Ivo Campos, from Santa Rosa do Sul/SC; Maria Garcia Pessi, in Araranguá/SC; Sebastião Toledo dos Santos, in Criciúma/SC; Antônio Silva State School, Timóteo/MG.

4 METHODOLOGY

The research used documentary research to analyze the initiatives and resources made available by REXLAB/UFSC. The data sources for documentary research were:

a) Scientific productions: Survey and analysis of scientific articles, books and theses produced by researchers linked to REXLAB/UFSC.
b) Online platforms: Investigation of online platforms maintained by REXLAB/UFSC, such as repositories of teaching materials, online courses, seeking information about the actions and resources made available.

The data collection procedure of the research was interviews with eight informants and the data analysis method was the Thematic Analysis of Braun and Clarke. According to these authors, TA becomes widely recognized as a unique and valuable method in its own right, along with other more established qualitative approaches, TA is an accessible, flexible, and increasingly popular method of analyzing qualitative data.

The choice of TA was due to its configuration as a method that allows: to identify, organize and systematically offer insights into patterns of meaning (themes) in a set of data. By focusing on the meaning of a data set, it allows the researcher to see and make sense of meanings and experiences. Among the various patterns that can be identified in any given dataset – the goal of thematic analysis is to identify those relevant to answer the research question (Braun and Clarke, 2012).

The Thematic Analysis was carried out in six phases: below we briefly describe the phases of TA that were used in the research, with reference to Braun and Clarke, 2012.

Phase 1: Familiarization with the data.

Phase 2: Systematic analysis of the data through coding.

Phase 3: Research of Themes, analysis moving from codes to themes.

Phase 4: Review of potential themes, the themes under development will be reviewed against the coded data and the entire dataset.

Phase 5: Defining and Naming themes, definition of TA themes. Phase 6: Produce the report.

4.1 UNIVERSE OF PARTICIPATING SUBJECTS AND RESEARCH LOCATION

Members of REXLAB/UFSC participated in this research: a founder, two Coordinators, four members of the Development and Pedagogical Team and two teachers from the public school system. An online project presentation meeting was held with the three members of REXLAB on 08/06/2024 and a field visit on 08/19/2024 at the REXLAB makerspace, inaugurated in 2019, located at the Federal University of Santa Catarina Campus Araranguá. The makerspace was a renovation carried out in the same place where REXLAB already operated with the installation of new equipment.

The structure has: remote laboratories, spaces for prototyping, 3D printing, coffee space, meeting space for videoconferences, recording studio, coworking and environment for the application of methodologies for teacher training.

4.2 INTERVIEW SCRIPT

The qualitative interviews were structured based on the general strategy described by Taylor, Bogdan and Devault (2016), based on the use of open and descriptive questions on general topics. To ensure that key topics and the same areas were explored with all respondents, we used an interview script. As highlighted by Taylor, Bogdan, and Devault (2016, p.123) whether or not you use a formal interview script, it's always a good idea to try to create a set of descriptive, open-ended questions before an interview.

To conduct the interviews, we developed a set of open questions, we sought to explore different perspectives and ensure the comfort of the participants. The research was carried out in pairs, the script served for both interviewers to explore the same areas with the interviewees. The interviews were conducted by video call through Google meet during the months of August and September 2024. To facilitate data collection, we use the Google Chrome extension Tactiq for transcription of meetings.

To ensure the ethics and integrity of the research, ensuring the rights and autonomy of the participants, all interviewees signed the Informed Consent Form (ICF). This document deals with the objectives of the research, the interview procedures and ensures confidentiality about participation.

a) Formal interview script:

1. Who are you on Rexlab?
2. What is your participation in the Framework Program for the integration of Technology in Education, developed by Rexlab?

3. How did the idea of building the Framework come about?
4. Tell us a little about your experience with the Education Kit?
5. What are the difficulties and challenges during the implementation of the program with the Framework?
6. Tell us a little about the meaning of Maker Culture?
7. What are the essential elements in a maker planning?
8. What are the differences between the simple use of games in learning and the maker pedagogical practice? 9- What level of reach or contribution do you understand RExlab represents for the concept of Maker Culture?

5 INTERVIEW RESULTS

The analysis of the interviews had the purpose of focusing on the universe of the concept of "maker culture". From the results of the interviews, we first tried to outline the profile of the 8 interviewees. The analysis of the first question of the script: Who are you in REXLAB?, showed that the combination of different profiles of respondents contributed to the richness of the survey, ensuring a more comprehensive view, as the diversity of experiences and perspectives allows for a more complete analysis of the topic in question.

Among the profiles of the interviewees, we had the founder and manager of REXLAB who guaranteed a vision of the history, goals and actions of the program. The inclusion of collaborators and scholarship holders, with different areas of expertise, allowed an understanding of the inner workings of REXLAB and the various activities it develops. The participation of teachers from the state public school system and indigenous school, who had direct contact with REXLAB's resources and materials, provided a perspective on the practical application of maker culture in the classroom, the challenges and opportunities encountered in the process.

Table 3

Profile of the interviewees

PROFILE	MANAGEMENT		DEVELOPMENT AND TECHNICAL TEAM				APPLICATION OF TRAINING	
	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8
Who are you at RexLab?	Founder	Manager	Collaborator	Scholar	Scholar	Scholar	Professor at network state public	Public school teacher

Activities Developed	Acts how mentor and encouraging	Coordinator and teacher	Data analysis support	Technical support to teachers and in the creation of educational hits.	Support in the workshops	Workshop coordination	Physics teacher. Received the Kits from robotics of the REXLAB and applied it with the students.	Indigenous School. Participated in REXLAB training such as the ODS Maker Course.

Source: The authors

There are many actors participating in Rexlab, in different roles and with diversified contributions to the construction of the Project as a whole. From Table 1 it is possible to have a glimpse of the participatory levels and the hierarchy of attributions existing in the Rexlab Project which this work deals with, can be grouped into three basic categories: Management, Technique and Application.

Participants classified in the Management category (Participants 1 and 2) stand out for their strategic and leadership role, with roles that involve creating an institutional vision for RexLab, conceptually designing the project, and tracking progress. These roles are essential to ensure that the project's goals are achieved in an efficient and sustainable manner, as well as to establish an environment conducive to innovation and encouragement to overcome challenges. The project management has an approximate role in the articulation between the different actors.

In the Development Team or Technical Team, scholarship holders and other volunteer collaborators who offer technical and pedagogical support (Participants 3, 4, 5 and 6) work. Its performance is directly linked to the implementation of innovative technologies and methodologies in the educational context. The functions range from data analysis and technical support to teachers to conducting workshops and effective production of materials conceived from the ideas of teachers and their classes.

The third category - Application of Training - covers Participants 7 and 8 and emphasizes the practical application of technologies in the school environment. Basically, they are teachers from the participating education networks and make up the final link in the RexLab work chain, where the knowledge and technologies developed are applied in real contexts.

The actors of the Rexlab team cater to a large audience that can also be characterized by its diversity. As an example, it is possible to mention the use of the robotics kit by a physics

teacher and the production of a game with a theme about the treatment of waste in the environment by a teacher who works in an indigenous community; both conceived ideas with their students, received support and the materiality of their ideas in Rexlab and applied the productions in their classes, which demonstrates the successful integration of technological tools in the curriculum and the project's reach in areas of attention to cultural and social issues. These participants form the backbone of the project, being responsible for the practical execution of the ideas developed in the strategic planning phase. Workshop coordination, in particular, ensures that the technological tools and kits are adapted to the needs of the needs of the teachers and students involved.

After familiarizing the data with the mapping of the interviewees, a systematic analysis of the data was carried out through the identification of common topics in the interviewees' statements. The common topics reveal nine main items that allow a better and more detailed global perception of Rexlab's work:

a) Topic 1: History and origin of REXLAB - Description: initial development and expansion activity of the laboratories;
b) Topic 2: Teacher training - Description: Courses and training to enable teachers in the use of educational technologies;
c) Topic 3: Financial challenges - Description: Difficulty in obtaining financing and maintaining infrastructure;
d) Topic 4: Integration of technologies - Description: Implementation of educational kits and learning platforms for basic education and higher education;
e) Topic 5: Student Involvement - Description: Active participation of basic education students in maker and robotics projects.
f) Topic 6: Digital and social inclusion - Description: Promotion of accessibility and digital inclusion through projects that reach disadvantaged communities.
g) Topic 7: Technical Challenges - Description: Infrastructure limitations, access to devices and teachers' difficulties with digital platforms.
h) Topic 8: Maker Culture in Education - Description: Impact of the Maker philosophy on the development of practical and creative skills of students and teachers.
i) Topic 9: Sustainability and Scaling Up - Description: Need to develop sustainable practices and expand projects to more schools.

Table 4 seeks to allow the comparative analysis of the answers of the participants in the interviews of this work, presenting the points of view of each one in objective phrases that represent the essence of each answer:

Table 4 represents a synthesis of the interviewees' perceptions regarding the main common topics addressed. The analysis of the answers indicates that the perception that REXLAB has a potential for relevance in the theoretical and technical support for teacher training. Their role is described as encouraging and facilitating the implementation of educational technologies, strengthening autonomy and digital inclusion.

With respect to the Framework that was the object of this work, the idea that the Framework arose from the need to structure the integration of technologies in education, promoting teacher autonomy and enabling innovative practices in the classroom, stands out. One of the most positive aspects of the project are the kits produced with the participants, which are described as generators of engagement and teachers and students, a motivating and transforming factor in the teaching-learning process.

In the matter of the challenges mentioned, a diversity of opinions is perceived, largely due to the role in which each interviewee worked, with emphasis on the lack of funding and resources, technical difficulties and infrastructure limitations in schools, in addition to gaps in the technological domain on the part of some teachers.

The most theoretical element of the Framewortk project – the concept of Maker Culture – was described by the interviewees as a movement that encourages creativity, collaborative work and the resolution of real problems. The hands-on philosophy is central to hands-on learning and building innovative solutions. When they expressed ideas about what differentiates maker culture from traditional activities, Maker Culture is described as active and creative, while games are considered more static tools. The maker approach allows for more dynamic participation, promoting autonomy and problem-solving.

Finally, the interviewees' overview of Rexlab in the context of this work reveals REXLAB as a catalyst for educational trends by integrating maker culture technologies and practices into teaching. It contributes to the democratization of access to innovative educational resources and to the transformation of the role of teachers and students as protagonists of learning.

Table 4

Individual Perception of the Interviewees

Interview Script	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8
What is your participation in the Framework Project to integrate technology in education?	Technical and encouraging support;	Development Leader; Teacher training.	Collaborator	Technical Support.	Technical Support; Teacher support	Technical Support; Teacher support	Teaching participant	Teaching participant
How did the idea of building the Framework come about?	Initiative to promote digital inclusion and teacher autonomy	Need for structure to train teachers in educational technology.	Build a solid theoretical foundation for integration.	Need for platforms to support hands-on teaching for students.	Develop an integrated structure for the teaching of technology.	Develop the need to integrate technology with active methodology.	Make science teaching more accessible and practical.	Promote inclusion and access to technological resources in schools.
Tell us a little about your experience with the Education Kit?	It emphasizes the autonomy of teachers and practical use.	Good experience in making learning practical, and challenging.	Positive experience in the expansion of practical teaching.	Attention to the production and sending of kits to teachers.	The kits generate engagement and hands-on experience.	The kits encourage hands-on skills.	Students more motivated by the use of robotics and kits in class.	Use of the kits to solve local issues of the indigenous people.
What are the difficulties and challenges during the project of the Framework?	Lack of financial support from the State and lack of structure.	Difficulties in financing and prolonging the project.	Financial issues and turnover of scholarship holders.	Technical challenges with equipment maintenance	Difficulty with teachers without technological mastery.	Challenges with logistics for resources and sending kits.	Difficulty in schools with a needy structure.	Difficulties with basic structure and access to resources.
Tell us a little about the meaning of Maker Culture?	Collaborative practice that encourages creativity.	Movement that transforms education through creativity.	Philosophy that promotes practice and creativity.	A movement that democratizes access to technological creation.	Culture that fosters adaptive collaborative learning and practice.	Practical teaching that sparks interest in technology and application.	Encouragement of creative education and autonomy.	Solve real problems with available resources.
What are the essential elements in a maker planning?	Autonomy and engagement of teachers and students.	Focus on sustainable practices and teacher engagement.	Accessibility and simplified planning.	Be accessible and practical for teachers.	Be application- and utility-centric.	Aimed at educational purpose.	Creativity allows for active creation, games are a passive use.	Creativity allows for active creation, games are a passive use.

What are the differences between the simple use of games in learning and maker practice?	Games are tools, while maker involves creating and solving problems.	The games are static; Maker allows for dynamic adaptations of learning.	Maker creates autonomy, games keep the student passive.	Maker offers creation; Games are limited in education.	Maker is active, active participation ; games are limited.	Maker offers creative and dynamic experience.	Maker involves creation and active participation .	It expands opportunities and promotes inclusion in technical education.

Source: The authors

Then, we moved on to the organization of the data referring to the statements of the interviewees on thematic issues within the context of the object of the work. The information was structured in the form of quotes from the interviewees who highlighted each theme, as shown in Table 5 below:

Table 5

Thematic Structure Present in the Interviews

Themes	Evidence in Transcripts
1- Digital Inclusion and Teacher Autonomy	- "It is important to train teachers", "encourage us to learn how to use technologies" (Teacher) - "Train teachers to use technologies" (Manager) - "REXLAB has this objective, it is to contribute to society" (Development and Technical Team).
2- Maker Culture in Education	"The Maker culture, it can enable the teacher to use the imagination he wants", "make the teacher's life easier in the classroom" (Manager) - "We will build, create and build, then take some games" (Manager) - "We have to have a good structure, and this is the main challenge" (Manager).
3-Challenges Of Integration of Technologies	- "Lack of financial support from the State and lack of structure" (Manager) - "The big challenge is to have human resources and get financing", "we are having difficulty in financing and everything else to be able to develop these projects" (Development and Technical Team) - "The biggest difficulty is the resources to be able to do it" (Manager).
4-Impact Of Integration of Technologies in Learning	- "Kits generate engagement and practical experience" (Manager) - "Students more motivated by the use of robotics and kits in class" (Manager).
5-Development of Innovative Educational Resources Challenges of Implementing the Maker Culture at School	- "REXLAB has this function, it is to provide support" (Development and Technical Team) - - "The biggest challenge is to have the human resources", "we are having difficulty in financing", "we have to have the human resources" (Development and Technical Team) - "There is a difficulty, is that we cannot have the resources to buy materials" (Development and Technical Team) - "The challenge is to find material, it has to be a collaborative work" (Teacher).

6-O Paper of the REXLAB at Maker Culture	- "For me, the Maker culture is very important", "we have to give this freedom", "people need to have this experience" (Development and Technical Team) - "I think we are working very well with this", "for sure, we have to give this freedom, to the students, to the teachers", "we always try to help" (Development and Technical Team) - "REXLAB helped me to give life to my desires" (Teacher) - "I think that the maker culture, that's it, it's hands-on" (Professor).

Source: The authors

Theme 1: Digital Inclusion and Teacher Autonomy

It demonstrates the importance of teacher training for the use of technologies and the need for resources and infrastructure for digital inclusion, internet access and the need for technical support for teachers.

Topic 2: Maker Culture in Education

Maker projects and activities developed by Rexlab, such as robotics workshops, kit construction and production of teaching materials and experiences that highlight the impact of the Maker methodology on learning.

Topic 3: Challenges of Integrating Technologies and Challenges of Implementing the Maker Culture at School

Difficulties in obtaining financing for projects, problems related to infrastructure and internet access, lack of resources for the acquisition of materials and equipment. Lack of institutional support for the implementation of the Maker culture. Challenges of working with teachers who have no experience with Maker culture and the need to training in the use of tools and technologies

Theme 4: Impact of Technology Integration on Learning

The motivation of students in activities with technology and the impact of digital tools on teaching practice was evident. Importance of training teachers to use technologies effectively and creatively.

Theme 5: Development of Innovative Educational Resources

Examples of projects for the development of innovative teaching materials by Rexlab, such as robotics kits, educational games and online platforms, initiatives for the production of digital educational resources, the importance of creating materials that respond to the specific needs of students and teachers.

Theme 6: The Role of REXLAB in Maker Culture

REXLAB's objectives in relation to the Maker culture, such as promoting creativity, collaborative work and problem solving. - Reflections on the scope of REXLAB in terms of

impact on education and dissemination of Maker culture, sharing of successful experiences and examples of projects that demonstrate the application of Maker culture in practice.

6 FINAL CONSIDERATIONS

The results of the narrative review will provide insight into research trends in maker culture in the context of fundamental education. The thematic analysis of the data collection of the interviews and the identification of the central themes generated from the codes allowed a better understanding of what are the contributions of REXLAB/UFSC to the integration of technology in education.

Among the contributions of REXLAB, we observed a significant impact on basic education in the pedagogical use of technology, facilitating its introduction in schools with the training and training of teachers. Contribution to innovative practices and in the development of technological skills in teaching. Promotion of digital inclusion and opportunity for access and autonomy for minority communities such as indigenous communities.

We hope that this research can guide future educational work and interventions, promoting a more practical, inclusive education adapted to contemporary needs, aligned with the principles of the Maker culture of "learning by doing".

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