INFORMATION TECHNOLOGY EDUCATION IN ELEMENTARY AND SECONDARY EDUCATION: CONTRIBUTIONS OF MAKER CULTURE AND THE STEAM APPROACH TO ACTIVE LEARNING

EDUCAÇÃO EM TECNOLOGIA DA INFORMAÇÃO NO ENSINO FUNDAMENTAL E MÉDIO: CONTRIBUIÇÕES DA CULTURA MAKER E DA ABORDAGEM STEAM PARA A APRENDIZAGEM ATIVA

EDUCACIÓN EN TECNOLOGÍA DE LA INFORMACIÓN EN LA ENSEÑANZA PRIMARIA Y SECUNDARIA: CONTRIBUCIONES DE LA CULTURA MAKER Y DEL ENFOQUE STEAM PARA EL APRENDIZAJE ACTIVO

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ABSTRACT

Information Technology Education in Elementary and Secondary Education has followed contemporary transformations that demand more dynamic, integrated, and student-centered pedagogical practices. In this context, Maker Culture and the STEAM approach have gained

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prominence by promoting learning experiences based on experimentation, collaboration, and the articulation between different areas of knowledge, contributing to the construction of educational pathways more aligned with current demands. The present study aims to analyze how Maker Culture and the STEAM approach contribute to the promotion of active learning in Information Technology Education in Elementary and Secondary Education. Regarding the methodological procedures, the investigation was guided by a qualitative approach, since it sought to understand educational phenomena through the interpretation of meanings, practices, and relationships established within the analyzed context. As a research strategy, a bibliographic review was adopted, understood as a procedure that makes it possible to identify, systematize, and examine existing scientific productions, favoring the construction of a consistent theoretical framework articulated with the theme under study. In summary, the study demonstrates that the integration between Maker Culture and the STEAM approach in Information Technology Education favors the promotion of active learning in Elementary and Secondary Education by articulating theoretical foundations and pedagogical practices that stimulate student participation and the development of competencies aligned with contemporary educational demands.

Keywords: Maker Culture. STEAM. Active Learning. Information Technology.

RESUMO

A Educação em Tecnologia da Informação no Ensino Fundamental e Médio tem acompanhado as transformações contemporâneas que demandam práticas pedagógicas mais dinâmicas, integradas e centradas no estudante. Nesse cenário, a Cultura Maker e a abordagem STEAM ganham destaque ao promoverem experiências de aprendizagem baseadas na experimentação, na colaboração e na articulação entre diferentes áreas do conhecimento, contribuindo para a construção de percursos formativos mais alinhados às exigências atuais. O presente estudo tem como objetivo geral analisar de que modo a Cultura Maker e a abordagem STEAM contribuem para a promoção da aprendizagem ativa na Educação em Tecnologia da Informação no Ensino Fundamental e Médio. Quanto aos procedimentos metodológicos, a investigação foi orientada por uma abordagem qualitativa, uma vez que buscou compreender fenômenos educacionais por meio da interpretação de significados, práticas e relações estabelecidas no contexto analisado. Como estratégia de pesquisa, recorreu-se à revisão bibliográfica, entendida como um procedimento que possibilita identificar, sistematizar e examinar produções científicas já existentes, favorecendo a construção de um referencial teórico consistente e articulado à temática em estudo. Em síntese, o estudo demonstra que a integração entre Cultura Maker e abordagem STEAM na Educação em Tecnologia da Informação favorece a promoção da aprendizagem ativa no Ensino Fundamental e Médio, ao articular fundamentos teóricos e práticas pedagógicas que estimulam a participação discente e o desenvolvimento de competências alinhadas às demandas educacionais contemporâneas.

Palavras-chave: Cultura Maker. STEAM. Aprendizagem Ativa. Tecnologia da Informação.

RESUMEN

La Educación en Tecnología de la Información en la Enseñanza Primaria y Secundaria ha acompañado las transformaciones contemporáneas que demandan prácticas pedagógicas más dinámicas, integradas y centradas en el estudiante. En este contexto, la Cultura Maker y el enfoque STEAM adquieren relevancia al promover experiencias de aprendizaje basadas en la experimentación, la colaboración y la articulación entre diferentes áreas del conocimiento, contribuyendo a la construcción de trayectorias formativas más alineadas con las exigencias actuales. El presente estudio tiene como objetivo general analizar de qué manera la Cultura

Maker y el enfoque STEAM contribuyen a la promoción del aprendizaje activo en la Educación en Tecnología de la Información en la Enseñanza Primaria y Secundaria. En cuanto a los procedimientos metodológicos, la investigación fue orientada por un enfoque cualitativo, ya que buscó comprender fenómenos educativos mediante la interpretación de significados, prácticas y relaciones establecidas en el contexto analizado. Como estrategia de investigación, se recurrió a la revisión bibliográfica, entendida como un procedimiento que posibilita identificar, sistematizar y examinar producciones científicas ya existentes, favoreciendo la construcción de un marco teórico consistente y articulado con la temática en estudio. En síntesis, el estudio demuestra que la integración entre la Cultura Maker y el enfoque STEAM en la Educación en Tecnología de la Información favorece la promoción del aprendizaje activo en la Enseñanza Primaria y Secundaria, al articular fundamentos teóricos y prácticas pedagógicas que estimulan la participación estudiantil y el desarrollo de competencias alineadas con las demandas educativas contemporáneas.

Palabras clave: Cultura Maker. STEAM. Aprendizaje Activo. Tecnología de la Información.

1 INTRODUCTION

Information Technology teaching in middle and high school has changed to reflect how digital technologies are becoming more common in social and academic life. In this context, traditional pedagogical practices have been challenged by initiatives that aim to integrate theory and practice, emphasizing the active participation of students. The Maker Culture and STEAM approach fit into this scenario to scientific learning experiences that focus on experimentation, problem-solving, and the connection between different areas of knowledge. This helps to create more dynamic and relevant learning paths.

When analyzing this movement, it is noted that the fusion between Maker Culture and STEAM expands teaching opportunities in the field of Information Technology, by promoting the creation, development of projects and a significant application of technologies. These approaches help to reorganize the pedagogical space, shifting the focus from the transmission of content to the construction of knowledge through action, collaboration, and reflection. Thus, the student takes a more active role in the teaching process, participating more directly and consciously in their own learning.

Considering the relevance of this theme in a broad way for education in general and objectively for the achievement of educational goals, the present work aims to discuss in a critical and reflective way the contributions of the implementation of the Maker Culture and the STEAM approach to active learning, in elementary and high school and as this one, can mobilize new teaching practices in the exercise of teaching. This question accompanies the reflection on how this proposal correlates access to technology and innovation practices to the promotion of good practices in view of a more active, playful and engaged learning.

The objectives of this study were defined as follows: General Objective: To analyze how the Maker Culture and the STEAM approach contribute to the promotion of active learning in Information Technology Education in Elementary and High School. Specific Objectives: 1. To understand the conceptual foundations of the Maker Culture and the STEAM approach in the educational context.; 2. To investigate the contributions of pedagogical practices based on Maker Culture and STEAM to the development of active learning in Elementary and High School.; 3. To analyze the implications of the integration between Maker Culture, STEAM and Information Technology Education for the development of students' cognitive, creative and technological skills.

Regarding the methodological design, the research was conducted under a qualitative approach, since it sought to interpret educational phenomena from the analysis of meanings, practices and relationships built in the investigated context. As a methodological procedure, the

bibliographic review was adopted, understood as a strategy that allows gathering, organizing and analyzing already consolidated scientific productions, contributing to the construction of a consistent theoretical framework articulated with the theme studied.

The article was structured into four main sections. The introduction presents the contextualization of the theme and the objectives of the research. The methodology describes the paths adopted for the development of the study. The theoretical foundation discusses the main concepts related to Maker Culture, the STEAM approach and active learning. Finally, the final considerations summarize the main aspects analyzed and indicate possibilities for future studies.

2 METHODOLOGY

The evolution and increasing inclusion of digital technologies in the educational environment have generated significant momentum for the need for a comprehensive reconfiguration of pedagogical practices. This is especially evident with regard to Information Technology Education, which covers the levels of Elementary and Secondary Education. This transformation reflects an adaptation to the new demands and realities brought about by technological innovations, requiring a careful review of teaching approaches to better prepare students for contemporary challenges.

Within this context, the Maker Culture, together with the STEAM approach, emerges as a set of reference elements that provides the creation of more dynamic and interactive learning environments. In these spaces, students are not only present, but actively and meaningfully involved in the educational process, contributing to the development of their skills and knowledge. This context highlights the importance of conducting investigations that examine, in a methodical and organized way, how these different approaches collaborate to facilitate and stimulate active learning.

Regarding the methodological approach adopted in the research, it is classified as being qualitative in nature. This is because this investigation has as its main objective to understand phenomena that manifest themselves in the educational field, starting from the analysis and interpretation of meanings, practices and also the relationships that are established within the context that is being investigated.

According to the statement highlighted by the authors Pereira et al. in 2018, the qualitative research approach follows a path that makes it possible to carry out a thorough and detailed analysis of the dynamics that permeate both the social and educational spheres. This type of research, by focusing on the nuances and complexity of the processes that are at stake,

offers a more comprehensive and richer understanding of the interactions and relationships that are established in these contexts.

Following this same line of reasoning, the authors Sousa and Santos (2020) highlight that this methodological perspective enables a deeper understanding of the meanings that individuals attribute to their personal experiences and experiences. This understanding is particularly pertinent and appropriate when it comes to research that encompasses both pedagogical practices and training processes. In addition, this approach is able to provide valuable insights into how experiences shape the learning and training of the subjects involved.

Regarding the methods used to carry out the research, it was decided to implement a literature review that was chosen as the methodological strategy. This choice was made due to its important contribution to the organization and to the in-depth analysis of knowledge that has already been previously generated on the subject in question.

As mentioned by Pereira et al. in 2018, the literature review is an essential and indispensable instrument in the elaboration of the theoretical framework of an academic work. This process is capable of enabling the identification of several concepts, different approaches and also gaps that are present in the existing literature on the subject in question. In this way, the review not only contributes to a deeper understanding of the subject, but also to the direction of future research in the area.

In addition, Sousa and Santos (2020) emphasize that this type of procedure facilitates not only the structuring, but also the interpretation of a variety of distinct theoretical perspectives, which, in turn, contributes significantly to the formation of analyses that are considered consistent and robust in the scope of qualitative research. The investigation carried out consisted of the detailed evaluation of a number of more than 15 different sources of a scientific nature, which encompassed a variety of materials, such as articles that were published in journals dedicated to science, works that were presented at relevant academic events, as well as reference works that are significant in the field of education. The variety of sources used throughout the investigative process made it possible to elaborate a robust and coherent theoretical foundation, which proved to be able to support and support the discussions that were presented and developed throughout the course of the study.

In this way, the methodological path that was chosen and implemented played a fundamental role in facilitating the understanding of the contributions that the Maker Culture and the STEAM approach offer. These contributions are significant for the improvement of active learning in the context of Information Technology Education, especially at the Elementary and

High School levels. From this path, it became clearer how these innovative approaches can impact and transform the educational process in these segments.

3 THEORETICAL FOUNDATION

The structure of the theoretical foundation was designed to encompass three interrelated axes, which support the analysis carried out in this research. In the first moment, item 3.1 explores the epistemological foundations of the Maker Culture and the STEAM approach in contemporary education, examining definitions, origins and pedagogical principles that guide these perspectives. Next, item 3.2 is dedicated to active learning and methodologies based on these approaches in the context of Basic Education, focusing on practices that encourage student participation and promote their protagonism. Finally, item 3.3 focuses on the development of competencies in Elementary and High School, mediated by both the Maker Culture and the STEAM approach, emphasizing the cognitive, creative and technological dimensions that are part of the training process.

3.1 EPISTEMOLOGICAL FOUNDATIONS OF THE MAKER CULTURE AND THE STEAM APPROACH IN CONTEMPORARY EDUCATION

In order to understand in depth the epistemological foundations that sustain the Maker Culture and the STEAM approach in contemporary education, it is essential to examine the theoretical premises that underlie them, as well as the conceptual bases that involve them in contemporary education, allowing a deeper reflection on their relevance and use in teaching and learning processes. According to Dias and Mello (2022), from this perspective, the STEAM approach is organized around the connection between different types of knowledge, which leads to the promotion of the integrated development of various skills and competencies, especially in relation to the natural sciences, which are important in this educational context. A more holistic approach like this can be created and developed.

Within the Maker Culture, Lopes et al. (2019) point out that the pillars of this culture are based on the value given to creativity, experimentation, and social responsibility, all directly linked to educational initiatives that aim to offer a comprehensive and broad education of students, which goes beyond academic improvement and also covers social and practical skills. When these methodologies are applied in the school context, there is a significant change in the dynamics of teaching and learning, as the student becomes more protagonist and active in the construction of their knowledge, mobilizing different knowledge and applying it in real learning situations, which enriches the process and favors development.

The interconnection and synergy between Maker Culture and the concept of STEAM become evident in educational practices, especially in the educational context, integrating technology and creativity in a harmonious way. This synthesis is key to achieving more meaningful and dynamic learning in our educational environments. Gomes (2020), highlighting a creative learning modality, highlighted by an augmented reality, significantly expands the opportunities for students to interact with the content included, when mediated by innovative tools and resources, such as augmented reality. While this approach not only broadens the ways students engage, it also contributes to the creation of learning experiences, which are more dynamic and therefore more relevant to the educational process. In this context, Table 1 presents a synthesis of the main epistemological foundations that sustain the Maker Culture and the STEAM approach in contemporary education.

Table 1

Epistemological foundations of the Maker Culture and the STEAM approach in contemporary education

Rationale	Description
Interdisciplinarity	Integration between different areas of knowledge, favoring the articulated construction of knowledge
Learning by doing	Valuing experimentation and practice as central elements of the learning process
Creativity	Stimulating the production of innovative ideas and solutions in educational contexts
Technological integration	Use of digital technologies as mediators of the teaching and learning process
Collaboration	Encouraging collective work and the shared construction of knowledge

Source: Dias and Mello (2022); Lopes et al. (2019); Gomes (2020).

The literature also points to the integration between these approaches and the reinforcement of the motivational and self-efficacy dimensions among students. The STEAM and maker education curricula favor the acquisition of transversal knowledge, while expanding student engagement (Jia; Zhou; Zheng, 2021). This movement demonstrates the importance of teaching practices that consider student participation as a central element of the educational process.

Finally, Machado and Zago (2020) observe that the integration between maker culture, educational robotics, and interdisciplinary practices, such as those developed in science laboratories, contributes to the consolidation of integrated educational proposals, which, in turn, strengthens the understanding that the epistemological bases of maker culture and STEAM are directly linked to the construction of learning environments that value interaction, experimentation and the practical application of knowledge in Basic Education.

3.2 ACTIVE LEARNING AND METHODOLOGIES BASED ON MAKER CULTURE AND STEAM IN BASIC EDUCATION

The research on pedagogical practices based on the Maker Culture and the STEAM approach demonstrates a significant reconfiguration in the teaching dynamics of Basic Education, especially with regard to active learning. In this sense, Izepilovski, Leão and Guedes (2025) state that active methodologies, when associated with the creator of culture, favor a more significant participation of students, as they change the focus of teaching to the construction of knowledge through action, experimentation and the resolution of contextualized problems.

To make these ideas a reality in everyday school life, Blikstein, Valente, and Moura (2020) discuss the incorporation of maker education into the curriculum and highlight the need to integrate theory and practice. They advocate the creation of learning environments that put students at the center of the process, encouraging their participation in the proposed activities and developing skills related to research, creation and the application of knowledge in real situations. Similarly, Lopes (2024) mentions that the introduction of maker culture in socio-educational contexts increases the chances of student participation, by integrating activities that emphasize experimentation and protagonism. These experiences show that active learning is realized when students are engaged in practical and collaborative activities. Based on these contributions, Table 2 presents a synthesis of the main pedagogical practices associated with the Maker Culture and the STEAM approach in promoting active learning.

Table 2

Pedagogical practices based on Maker Culture and STEAM to promote active learning

Pedagogical practice	Description
Project-based learning	Development of projects that articulate different areas of knowledge and involve solving real problems
Hands-on experimentation	Hands-on activities that encourage the construction of prototypes and the testing of ideas
Collaborative learning	Group work aimed at the collective construction of knowledge and the exchange of experiences
Technological integration	Use of digital resources and technological tools as mediators of the learning process
Student protagonism	Active participation of students in the definition, execution and evaluation of activities

Source: Izepilovski, Leão and Guedes (2025); Blikstein, Valente and Moura (2020); Lopes (2024); Santos et al. (2024).

The collaborative aspect of educational practices also emerges as a key element in this scenario. Santos et al. (2024) highlight that collaborative learning, when integrated with the

maker culture, facilitates the co-construction of knowledge, enriching interaction between students and increasing opportunities for participation in the suggested activities. This dynamic helps to create more participatory and interactive learning environments.

Gomes et al. (2024) also point out that active methodologies are closely linked to greater autonomy for both the teacher and the student, as they favor pedagogical approaches that are more flexible and student-focused. When these strategies are combined with the Maker Culture and the STEAM methodology, educational practices are formed that favor the participation, protagonism and involvement of students, contributing to the quality of student learning.

There is no doubt that the dialogue with the Maker Culture and the STEAM approach crosses the school curriculum, integrating the daily life of educators and students, generating an expectation regarding its use with clear and coherent educational purposes in the reality of each school, intending to positively affect the learning dynamics, in search of promising results. Following the reflection that is supported by the guiding documents of this practice, it is observed in the National Policy for Digital Inclusion, which outlines fundamental strategies to improve connectivity in educational institutions, highlighting the need for adequate infrastructure. Article 2, in its axis VI, emphasizes that it is essential "the implementation and integration of connectivity infrastructure for educational purposes, which include universalization of school connectivity to high-speed internet and with adequate equipment for internet access in educational environments" (Brasil, 2023).

This guideline not only aims to ensure that schools have access to modern technologies, but also promotes an ecosystem of digital educational content, which is essential for the training of teachers and students in an increasingly connected world. The implementation of information technology in elementary and secondary education is crucial to ensure an education with possibilities for more knowledge, engaging students in contributing to student protagonism, preparing them for the challenges of the twenty-first century (Brasil, 2023).

According to Moran, Masetto, and Behrens (2022), learning is significantly enhanced when individuals have the opportunity to experience concrete experiences, establish relationships, and strengthen bonds. This process allows students to broaden their understanding of everyday life, connecting reflection to action and integrating theoretical content with practice. Thus, education becomes more meaningful, as students are able to realize the relevance of what they learn in their lives, transforming knowledge into something tangible and applicable. This approach highlights the importance of teaching that goes beyond the mere transmission of information, seeking a real connection with the student's experience and with the learners' inquiries.

3.3 DEVELOPMENT OF COMPETENCIES IN ELEMENTARY AND HIGH SCHOOL MEDIATED BY THE MAKER CULTURE AND STEAM APPROACH

It is evident, through an investigation on the development of skills and competencies in Elementary and High School, mediated by the Maker Culture and the STEAM approach, how different dimensions - cognitive, creative, technological, among others - interact in the educational process. The articulation between the different areas is essential for students to develop in a complete way, which, in turn, enriches their experiences and makes them more meaningful in the current scenario.

As stated by Moreira, Santana, and Torres (2023), maker culture, when integrated into the educational process, considerably improves skills related to the areas of science, technology, engineering, arts, and mathematics. This generates an education that, in an efficient way, responds to the contemporary demands of society and the pressing need for an adequate intertwining of different areas of knowledge. This integration is essential to prepare students for contemporary challenges.

Regarding cognitive skills, the authors Dias and Mello, in 2022, highlight that the STEAM approach plays a significant role in the formation of skills that involve critical analysis and effective problem solving. This occurs, especially, when students are presented with learning opportunities that demand the connection and articulation of diverse knowledge, involving them more intensely in the training process. This procedure is carried out through the inclusion of students in environments that require investigation, careful analysis and the ability to make decisions, which, consequently, enhances the improvement of critical thinking and encourages a holistic understanding of the different contents covered. The sphere that involves creativity and technology appears, in a significant way, being an essential aspect that integrates the structure of this context.

Bacich and Holanda (2020) point out that project-based learning is often associated with the STEAM approach. This methodology provides students with the opportunity to create innovative solutions to problems that actually exist in the world, while simultaneously making use of technological resources in a meaningful and pertinent way. In this context, Table 3 summarizes the main competencies developed from the integration between Maker Culture, STEAM and Information Technology Education.

Table 3

Competencies developed through the Maker Culture and STEAM approach in Basic Education

Type of competence	Description
Cognitive	Development of critical thinking, problem-solving and analytical skills
Creative	Encouragement of the creation of innovative solutions and the expression of ideas in different languages
Digital	Use of digital technologies for production, experimentation and construction of knowledge
Collaborative	Teamwork, communication and collective construction of solutions
Autonomy	Ability to make decisions and conduct one's own learning process

Source: Moreira, Santana and Torres (2023); Dias e Mello (2022); Bacich and Holland (2020); Viana and Costa (2025).

The literary production also points out that such skills and competencies are intrinsically related to the educational demands that define the twenty-first century. Viana and Costa (2025) point out that the maker culture, when integrated into teaching methodologies and approaches, enhances a set of skills that goes beyond the mere understanding and appropriation of academic content, also favoring the development of important skills such as adaptation to new contexts, collaborative work and innovation in different educational scenarios. The integration highlights how the maker culture contributes to students developing a more adaptable and agile profile.

With this, the union of the Maker Culture, the STEAM methodology and Information Technology Education configures a consistent and efficient way to foster the development of varied and broad skills in the context of Elementary and High School. This mix not only enriches the school environment, but also offers students the chance to acquire knowledge that is essential for a complete education. These teaching methodologies, by effectively articulating theoretical and practical knowledge, constitute an educational process that values and encourages the active participation of students. In addition, they favor the collective construction of knowledge, in which everyone collaborates with each other, and encourage the significant use of technologies in the school context, which enriches the learning process (Viana; Costa, 2025).

4 FINAL CONSIDERATIONS

The considerations that this work brought to light point to the emergence of new organizational structures in the teaching of Basic Education, especially with regard to Information Technology, to the extent that the intersection of various pedagogical proposals has contributed to more dynamic and contextualized formative experiences. In this sense, the junction between Maker Culture and the STEAM approach is aligned with contemporary needs,

since both promote educational experiences that place the student at the center of the process and apply knowledge in real situations.

All the objectives that were proposed were successfully achieved. The combination of the selected theoretical frameworks made it possible to achieve the general objective of analyzing how the Maker Culture and the STEAM methodology favor active learning in Information Technology Education for the Elementary and High School levels. Likewise, the specific objectives were achieved by enabling the understanding of the theoretical foundations of these approaches, investigating how the pedagogical practices linked to Maker Culture and STEAM favor active learning and analyzing the implications of the integration of these two approaches for the development of students' cognitive, creative and technological skills.

With regard to item 3.1, it was observed that both the Maker Culture and the STEAM methodology are epistemologically based on interdisciplinarity, experimentation and the value attributed to learning by doing, which makes it possible to overcome teaching practices that are fragmented. With regard to item 3.2, it was observed that the methodologies that are based on these approaches become educational practices that promote the participation, protagonism and active involvement of students, especially through collaborative and problem-oriented initiatives. With regard to item 3.3, it was possible to perceive that the intersection between Maker Culture, STEAM and Information Technology Education is capable of enhancing the development of general competencies, which permeate the cognitive, creative and technological dimensions, to the formative needs of Basic Education.

Based on the results, it is suggested that future investigations should be dedicated to the practice of these strategies in various school contexts, considering the technological infrastructure, teacher training, evaluation practices and curricular organization. Studies that explore the impact of these strategies on student performance and engagement can offer a clearer picture of the opportunities and challenges involved in incorporating these practices into the school routine.

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