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Educational Robotics And Interdisciplinarity As Tools For Learning Recovery In Contexts Of Cell Phone Use And Misuse In The Classroom

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Abstract:
Background: *The advancement of digital technologies and the recent debates surrounding the use and non-use of mobile phones in classrooms have fostered reflections on the need for pedagogical strategies capable of promoting learning and student engagement within the contemporary educational context. In this scenario, educational robotics and interdisciplinarity have emerged as relevant alternatives aimed at reorganizing teaching practices and supporting learning recovery processes. This study aimed to analyze how educational robotics and interdisciplinarity can contribute to learning recovery in school contexts characterized by the use and non-use of mobile phones in classrooms, considering their impacts on student engagement, academic performance, and competency development.*
Materials and Methods*: The research was developed through a qualitative approach, considering the need to understand educational phenomena within their pedagogical, social, and interpretative dimensions. This approach enabled a broader analysis of the relationships and dynamics present in the school environment, favoring interpretations consistent with the complexity of contemporary educational practices. Regarding the methodological procedures, two complementary strategies were employed: bibliographic review and documentary research. The bibliographic review enabled the identification and analysis of scientific studies related to the investigated topic, whereas documentary research allowed the examination of normative and legislative documents associated with the use of technologies and the integration of robotics into basic education.*
Results: *The findings revealed that educational robotics and interdisciplinarity represent significant pedagogical alternatives for learning recovery in contexts marked by the use and non-use of mobile phones in classrooms. The results also demonstrated that these strategies contribute to strengthening educational practices, enhancing*

student engagement, and fostering the development of competencies aligned with contemporary educational demands.

Conclusion: *It was concluded that educational robotics, when associated with interdisciplinary approaches, can positively contribute to the reorganization of teaching and learning processes in contemporary schools. Furthermore, these pedagogical strategies have the potential to support learning recovery, encourage active student participation, and promote competencies essential for educational and technological contexts of the twenty-first century.*

Key Word: *Educational robotics; Interdisciplinarity; Learning; Digital technologies.*

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I. Introduction

The technological transformations of recent decades have significantly impacted the relationships between teaching, learning, and digital culture within the school environment. In this context, the use of mobile phones in schools has become one of the central themes in contemporary educational debates, particularly regarding students' attention, participation, and academic performance. Alongside the increased access to information and digital tools provided by mobile devices, discussions have emerged concerning attention dispersion, difficulties in maintaining focus, and the challenges faced by teachers in implementing effective educational practices. Recent initiatives aimed at restricting mobile phone use in schools have reignited debates about the urgent need to develop educational proposals capable of reconciling technological innovation, meaningful learning, and the comprehensive development of students.

Within this scenario, educational robotics and interdisciplinarity have increasingly been discussed as pedagogical alternatives directed toward the reconfiguration of teaching processes and learning recovery across different educational contexts. Educational robotics is characterized as a resource that stimulates active learning within collaborative and investigative environments, enhancing the development of logical reasoning, creativity, and problem-solving skills. Simultaneously, interdisciplinarity promotes the articulation between different fields of knowledge, fostering educational practices that are more contextualized and aligned with the demands of contemporary education. In this sense, educational robotics, when integrated into an interdisciplinary approach, emerges as a powerful resource for increasing student engagement and contributing to the recovery of learning weakened by recent transformations in the school environment.

The present study aims to analyze how educational robotics and interdisciplinarity can contribute to learning recovery in school contexts characterized by the use and non-use of mobile phones in classrooms, considering their impacts on student engagement, academic performance, and competency development. More specifically, the research seeks to investigate the impacts of the use and non-use of mobile phones in classrooms on students' learning processes, attention, and academic performance; evaluate the contributions of educational robotics as a pedagogical strategy for learning recovery and the enhancement of student engagement; and analyze the role of interdisciplinarity in integrating innovative pedagogical practices aimed at learning recovery and the development of cognitive and socioemotional competencies.

To achieve these objectives, the research was developed through a qualitative approach, considering the need to understand educational phenomena in their pedagogical, social, and interpretative dimensions. This type of approach enables a broader analysis of the relationships and dynamics present within the school context, favoring interpretations compatible with the complexity of contemporary educational practices. Regarding the methodological procedures, two complementary strategies were employed: bibliographic review and documentary research. The bibliographic review enabled the identification and analysis of scientific studies related to the investigated theme, whereas documentary research made it possible to examine normative and legislative documents associated with the use of technologies and the integration of robotics into basic education.

Concerning its structural organization, the article was divided into four main sections. The first corresponds to the introduction, in which the thematic contextualization, objectives, and general aspects of the research are presented. The second section addresses the methodology, describing the approach and methodological procedures adopted throughout the study. The third section presents the theoretical framework, structured around discussions concerning the use and non-use of mobile phones in classrooms, educational robotics, and interdisciplinarity. Finally, the fourth section brings together the final considerations, in which the main findings and reflections derived from the investigation are discussed.

II. Material And Methods

Educational robotics and interdisciplinarity as tools for learning recovery constitute a necessary discussion in light of recent technological transformations and the prohibition of mobile phone use in classrooms. In this context, the urgent need to develop pedagogical practices capable of integrating technology, student participation, and meaningful learning has increasingly occupied a central place in educational research and institutional discussions concerning pedagogical innovation. The integration of educational robotics into

interdisciplinary practices emerges as a methodological proposal aimed at reorganizing learning experiences, particularly within school contexts in which the excessive use or prohibition of mobile devices affects teaching and learning processes. Furthermore, this theme is directly associated with the promotion of logical reasoning, problem-solving abilities, and the active participation of students in knowledge construction processes.

Within this perspective, the development of pedagogical practices capable of integrating technology, student participation, and meaningful learning has become a central issue in educational research and institutional debates on innovation in teaching. The proposal of combining educational robotics with interdisciplinary approaches arises as a methodological alternative designed to restructure learning experiences, especially in schools where either the excessive use or the prohibition of mobile devices negatively impacts teaching and learning dynamics. In addition, the topic aligns directly with the need to foster logical reasoning, problem-solving skills, and students' active engagement in the construction of knowledge.

The research is qualitative in nature, as it seeks to develop an in-depth understanding of educational phenomena by considering their multiple social, pedagogical, and interpretative dimensions. Such an approach is indispensable for conducting a detailed and comprehensive investigation of the interactions and dynamics established within the school context. As argued by Antonio Carlos Gil, qualitative research enables a broader analysis of educational reality, taking into account not only the meanings attributed to situations but also the relationships established among the various elements and contexts involved in investigative processes. This perspective seeks to provide a deeper understanding of the specificities and complexities inherent in the educational environment. According to Antônio Joaquim Severino Triviños, qualitative research provides a more profound analysis of phenomena related to the social context, allowing for multiple interpretations aligned with the fluidity that characterizes the educational field. Consequently, the subtleties and complexities of social relationships become more evident within educational practices. Furthermore, Berwanger states that this type of approach enables a more critical and comprehensive understanding of educational practices and human experiences occurring within different teaching contexts. Such reflections allow all agents involved in the educational process to reconsider their experiences and relationships, thereby fostering a more accurate understanding of the interactions that occur within school environments. Qualitative research has become a widely adopted methodological approach in educational investigations, human sciences, and interdisciplinary studies worldwide, particularly because it enables in-depth analyses that consider specific contexts and interpretations grounded in historical, social, and cultural factors. For this reason, qualitative research is essential for deepening the understanding of the investigated phenomena.

During the development of the research, two complementary methodological procedures were employed: an extensive bibliographic review and a detailed documentary analysis. The combination of these methods enabled a broader and more comprehensive understanding of the investigated theme. The literature review aimed to compile different theoretical frameworks related to educational robotics and interdisciplinarity, including active methodologies and debates concerning digital technologies in education. According to Antonio Carlos Gil, this procedure allows researchers to critically engage with recognized scientific works, contributing to the construction of the analytical framework of the investigation. Likewise, Berwanger highlights that literature review is fundamental for organizing scientific knowledge and improving the theoretical understanding of the investigated subject. The review was based on the analysis of scientific articles published in academic journals and scholarly books related to the investigated topic, enabling the identification of relevant theoretical and methodological contributions to the advancement of the study.

The documentary research was conducted through the analysis of normative and legislative documents addressing the use of technologies and the teaching of robotics in Brazilian basic education. The following documents were examined: Law No. 15,100/2025, which prohibits the use of mobile phones and other portable electronic devices in elementary and secondary educational institutions; Bill No. 462/2021, which proposes amendments to Law No. 9,394/1996 in order to include programming, robotics, legal notions, and financial education within school curricula; and Bill No. 530/2022, which suggests the inclusion of robotics in elementary and secondary education curricula. According to Antônio Joaquim Severino Triviños, documentary research enables the analysis of institutional and normative documents capable of illuminating historical, political, and social aspects of the investigated phenomenon. Similarly, Antonio Carlos Gil argues that this method enriches the analytical possibilities of scientific research by providing documentary evidence relevant to the interpretation of the research object.

The relationship established between the bibliographic review and documentary research proved to be appropriate for achieving the objectives of the investigation, as it enabled the intersection between theoretical discussions and normative evidence relevant to the analyzed theme. The literature analysis contributed to clarifying academic discussions concerning educational robotics, interdisciplinarity, and learning recovery, whereas documentary research proved essential for supporting the analysis of legal and institutional guidelines related to the use of digital technologies in basic education. The employed methodological combination enabled a more robust analysis of the investigated object, making it possible to articulate contemporary scientific debates

with the regulatory transformations currently affecting educational practices within teaching institutions. Consequently, the integration of these methodologies favored a more comprehensive and theoretically grounded understanding of the investigated phenomenon, strengthening the analytical depth of the study.

III. Theoretical Framework

This research was theoretically grounded in three interconnected thematic axes, considering the central elements that constitute the investigated problem. The first topic, entitled "Use and Non-Use of Mobile Phones in Classrooms: Pedagogical, Cognitive, and Behavioral Impacts on Learning," examines the effects associated with both the presence and restriction of mobile phones in educational settings, taking into account factors such as students' attention, academic performance, social interaction, and contemporary pedagogical practices.

The second topic, "Educational Robotics as a Strategy for Learning Recovery and Pedagogical Innovation," addresses the application of robotics as a didactic resource aimed at strengthening active learning, logical reasoning, and student participation within educational processes. This discussion emphasizes the potential of educational robotics to foster collaborative, investigative, and problem-solving practices aligned with contemporary educational demands.

Finally, the third topic, "Interdisciplinarity and Competency Development in the Context of Contemporary Education," analyzes the importance of interdisciplinary practices in the development of cognitive, social, and technological competencies aligned with the educational requirements of the twenty-first century. The organization of these thematic axes enabled the construction of a cohesive theoretical discussion, consistent with the objectives and the central proposal of the research.

Use and Non-Use of Mobile Phones in Classrooms: Pedagogical, Cognitive, and Behavioral Impacts on Learning

The presence of mobile phones in schools has increasingly shaped discussions and interventions within educational contexts, particularly because it is associated with concrete challenges affecting daily pedagogical practices, especially regarding the maintenance of students' attention and the quality of their engagement with proposed activities. In this sense, the use of mobile phones in classrooms can no longer be understood as a merely instrumental issue, but rather as a phenomenon requiring broader reflection concerning its effects on learning processes and academic performance. Consequently, school environments have begun to confront issues related to hyperconnectivity, attention dispersion, and pedagogical mediation in the face of the constant use of digital technologies. According to Yen et al. (2019), excessive smartphone use may affect young people's emotions, thinking patterns, and behavior, ultimately influencing their learning processes and social interactions within school environments.

The inappropriate use of mobile phones in classrooms directly interferes with teaching dynamics and teacher-student relationships, particularly when such devices are continuously employed to access social media, games, and entertainment applications. In this context, students' attention tends to become fragmented, thereby reducing their engagement with pedagogical activities developed during classes. In this regard, Cavalcanti et al. (2025) emphasize that the inappropriate use of mobile phones in schools significantly affects students' concentration and learning outcomes. Therefore, the issue surrounding the use and non-use of mobile phones extends beyond a merely disciplinary debate, encompassing pedagogical, cognitive, social, and behavioral dimensions that permeate contemporary school environments.

Within the current educational context, educational robotics associated with interdisciplinarity has consolidated itself as a relevant pedagogical strategy for strengthening learning processes and increasing student engagement. The articulation between different areas of knowledge, mediated through robotics-based practices, contributes significantly to the development of active methodologies, fostering problem-solving abilities and the construction of more meaningful learning experiences. In this context, such an approach also stimulates cooperation among students, enabling them to assume a more active and protagonist role within educational processes. Furthermore, activities centered on construction, coding, and experimentation play an essential role in promoting logical reasoning while simultaneously encouraging creativity and cooperation among different fields of knowledge. This type of approach may enrich learning opportunities, particularly in contexts characterized by the continuous presence of digital technologies.

In recent years, the responsible application of technology within educational institutions has emerged as a central topic of discussion, reflecting tensions among innovation, regulation, and the quality of educational processes. This situation is largely associated with the strengthening and implementation of public policies aimed at regulating the use of mobile devices in educational environments. Such a shift in perspective reflects concerns regarding how technological innovations are being integrated into school contexts, ensuring that they are employed appropriately and beneficially for all participants involved in educational processes. In the Brazilian context, Law No. 15,100 (2025) established several restrictions concerning the use of mobile phones and other portable electronic devices within basic education institutions. This legislation highlights the importance of

implementing educational practices capable of fostering a productive balance between technology use, student learning development, and social interaction within school environments. Likewise, Martins and Ferreira (2024) argue that educational policies aimed at promoting the responsible and conscious use of technology in schools should be accompanied by pedagogical strategies capable of encouraging students' active participation, stimulating critical thinking, and ensuring the appropriate mediation of digital resources during classroom activities. Consequently, it becomes essential to establish a synergy between technological applications and pedagogical practices in order to provide richer and more meaningful learning experiences.

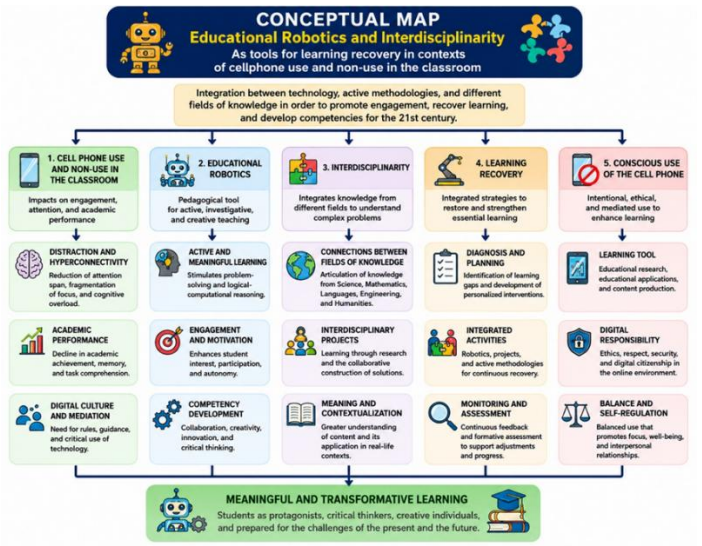
This debate becomes even more relevant when considering the effects of excessive mobile phone use on young people's memory, attention, and academic performance. According to Lopes and Silva (2022), the habitual presence of mobile phones in school environments tends to generate attention dispersion and reduced cognitive performance in tasks requiring prolonged concentration. These aspects demonstrate the importance of creating pedagogical strategies capable of transforming technology into a resource that promotes active learning, rather than merely functioning as a source of digital distraction. Educational robotics, therefore, may operate as a pedagogical resource that fosters inclusion while simultaneously increasing students' participation in school activities.

In other countries, different educational systems have also faced challenges related to managing mobile phone use in classrooms. Williams and Thomas (2020) point out that schools in several countries experience difficulties related to students' attention, discipline, and participation due to the constant use of mobile devices during classes. Simultaneously, Alimi et al. (2021) observed that excessive smartphone use among young individuals may be associated with emotional and behavioral changes, directly affecting the balance between school life, mental health, and academic performance.

Given this scenario, it becomes evident that the educational challenge does not lie solely in restricting the use of technology, but rather in constructing pedagogical alternatives capable of resignifying its presence within school environments and transforming it into a resource that supports learning processes. This involves promoting forms of technological use capable of dynamizing educational content, expanding possibilities for pedagogical interaction, and fostering students' engagement and interest. In this context, educational robotics emerges as a promising strategy, as it enables an active, guided, and meaningful use of technology. By encouraging practices centered on experimentation, problem-solving, and collaboration, educational robotics contributes to transforming digital devices into instruments of learning rather than mere sources of distraction (Moreira et al., 2025).

To summarize the main points addressed in this section, Figure 1 presents a conceptual map developed from the theme "Use and Non-Use of Mobile Phones in Classrooms: Pedagogical, Cognitive, and Behavioral Impacts on Learning." The conceptual map graphically organizes the interconnections among digital distraction, attention, academic performance, digital culture, pedagogical mediation, educational robotics, and interdisciplinarity, facilitating the understanding of how these elements are interconnected within the current context of basic education.

Figure 1 – Conceptual Map: Educational Robotics and Interdisciplinarity as Tools for Learning Recovery in Contexts of Mobile Phone use and non-use in Classrooms



Source: Elaborated based on Alexandre and De Alexandria (2023), Almeida and Mill (2021), Motta, Gurczakoski, and Teófilo (2024), Rocha et al. (2023), Santos, Fernandes, and Silva (2026), Silva et al. (2024), and Silva et al. (2025).

The articulation among educational robotics, interdisciplinarity, and pedagogical innovation emerges as an important pathway for strengthening learning recovery in contexts characterized by the use and non-use of mobile phones in classrooms. The proposal of interdisciplinary interactions involving science, technology, mathematics, arts, and problem-solving contributes to reducing excessively expository learning environments, while simultaneously increasing students' participation and active engagement in contrast to passive interaction.

Furthermore, the implementation of practical robotics-based activities transforms students' relationship with technology by guiding them toward a more intentional use directed at educational purposes. In this perspective, educational robotics promotes learning experiences centered on experimentation, creativity, and collaborative problem-solving, favoring the development of cognitive, technological, and socioemotional competencies aligned with the demands of contemporary education.

Educational Robotics as a Strategy for Learning Recovery and Pedagogical Innovation

Educational robotics has increasingly become a highly significant component in discussions surrounding pedagogical innovation and the need to strengthen and revitalize learning processes within basic education. Its growing relevance is associated with its differentiated approach, which contributes to the modernization of teaching practices and supports the development of essential twenty-first-century skills among students. In educational environments facing challenges related to students' lack of attention, low motivation, and the negative effects resulting from excessive mobile phone use during classroom activities, pedagogical approaches grounded in experimentation, collaboration, and problem-solving have gained considerable prominence. Such practices are recognized as viable alternatives for enhancing students' engagement with learning processes. According to Alexandre and De Alexandria (2023), educational robotics plays a significant role in advancing learning, as it promotes the development of cognitive skills, encourages social interaction among students, and stimulates more active participation in learning-centered activities. This approach not only enriches educational processes but also creates favorable conditions for the exchange of ideas and collaboration among students as they explore new concepts and construct knowledge.

Within the scope of active methodologies, educational robotics contributes significantly to the creation of pedagogical environments that are more dynamic, participatory, and interactive. In these innovative contexts, students are no longer restricted to passive and receptive positions during learning processes. Instead, they are encouraged to engage actively, assuming a more proactive role that promotes collaborative and engaged knowledge construction. This approach substantially transforms educational experiences, allowing students to participate effectively in the development of their own skills and competencies. According to Almeida and Mill (2021), pedagogical robotics offers multiple possibilities for connecting theoretical concepts with the practical application of knowledge. This characteristic of educational robotics significantly contributes to increasing student engagement by encouraging learners to participate more actively and effectively in the construction of their own learning processes. Within this educational context, the implementation of projects involving multiple disciplines and associated with programming practices, prototype development, and challenging problem-solving activities plays a fundamental role in expanding students' interest in school activities. Furthermore, this methodological approach strengthens processes aimed at recovering learning experiences affected by periods of reduced student participation in academic activities.

In addition to contributing significantly to the strengthening of active methodologies, robotics education establishes a direct and relevant connection with the development of computational thinking and the consolidation of project-based learning. This approach promotes a more engaging and interactive educational process in which students not only absorb theoretical knowledge but also apply it in practical situations, thereby developing competencies considered essential for the future. These approaches encourage the development of fundamental skills related to planning, logical analysis, decision-making, and problem-solving, demonstrating their applicability and relevance in different educational contexts. According to Motta, Gurczakoski, and Teófilo (2024), the interdisciplinary use of educational robotics generates positive impacts by providing pedagogical experiences more closely aligned with students' social and educational realities. Such an approach enables a more meaningful integration between different disciplines included in school curricula and the investigative practices developed by students throughout learning processes. Consequently, the importance of this methodology for improving teaching practices and promoting a more comprehensive educational formation becomes evident. Likewise, methodological approaches involving the development of robotics projects expand opportunities for meaningful learning while simultaneously strengthening students' active participation and engagement in school activities.

Another important aspect concerns the capacity of educational robotics to promote and strengthen students' autonomy and protagonism throughout their learning trajectories. By engaging in activities centered on construction, experimentation, and the formulation of practical solutions, students begin to assume more proactive and committed roles in the construction of their own knowledge. Thus, learners do not merely absorb information passively, but rather become more significantly involved in learning processes, contributing to the development

of deeper and more relevant understandings. According to Rocha et al. (2023), the incorporation of robotics into elementary education institutions significantly improves the quality of educational processes. This phenomenon occurs because robotics functions as an effective means of encouraging student autonomy, stimulating creativity, and promoting teamwork skills. Moreover, this educational methodology is fundamental for the development of competencies aligned with the current demands of digitally oriented societies. Within this context, knowledge acquisition transcends the mere expository transmission of information and evolves into the integration of collaborative and interactive experiences that encourage the active participation of all individuals involved in educational processes.

When educational robotics is integrated into school contexts, it is frequently associated with discussions concerning maker-based education and the search for innovations in pedagogical practices. This relationship highlights the necessity of integrating technological and creative tools into learning processes in order to foster more practical and collaborative educational experiences. Teaching practices grounded in the maker approach emphasize pedagogical experiences centered on creation, experimentation, and the development of projects designed by students themselves. In addition to stimulating creativity, this active methodology also increases students' motivation and engagement with curricular content (Costa et al., 2026; Gomes et al., 2026). When students become actively involved in these processes, they tend to establish stronger connections with what they are learning, making educational experiences more meaningful and relevant to their lives. According to Santos, Fernandes, and Silva (2026), educational robotics, when associated with active teaching methodologies, promotes learning processes that are more investigative, creative, and collaborative. Collectively, these elements substantially enhance students' educational experiences. Practices aligned with the maker perspective, particularly those related to robotics, considerably reduce the predominance of teaching methods grounded primarily in memorization. Such educational experiences not only enrich learning processes but also expand learning possibilities through practical and collaborative approaches, creating environments in which interaction and knowledge application are highly valued (Costa et al., 2026; Gomes et al., 2026).

Within the scope of teacher education, the implementation of educational robotics also requires continuous professional development processes specifically directed toward the pedagogical application of digital technologies. In this sense, it is insufficient merely to introduce robotics into schools; rather, ongoing teacher education is necessary to enable educators to employ these technologies critically and reflectively within teaching and learning processes. According to Silva et al. (2024), many teachers continue to face different difficulties when attempting to integrate technologies into their pedagogical practices. This situation is primarily associated with structural limitations present within educational institutions and the lack of adequate continuing education programs capable of preparing educators to use such technologies effectively in classroom contexts. Therefore, for educational robotics to truly enrich and expand existing learning approaches, access to technological resources alone is insufficient. It is equally essential to establish pedagogical practices that integrate innovation, promote interdisciplinarity, and are mediated by highly qualified educators.

It is also important to emphasize the political and curricular debates concerning the inclusion of robotics within Brazilian basic education. Bills No. 462/2021 and No. 530/2022 clearly demonstrate the growing concern and interest of educational institutions in integrating programming and robotics as essential components of school curricula. The primary objective of this integration is to modernize education and prepare students for the demands of an increasingly technological future. These initiatives represent advances aligned with contemporary educational demands, particularly regarding the urgency of preparing students for environments characterized by increasing digitalization and technological advancement across different fields of knowledge. Consequently, it becomes essential for educational systems to adapt in order to equip individuals with the competencies necessary to address the challenges of the contemporary world. In this perspective, educational robotics is no longer understood merely as a specific technological tool, but rather as a pedagogical strategy primarily intended to enrich learning processes and develop competencies fundamental for the twenty-first century. This new perspective allows robotics to become meaningfully integrated into school contexts, making learning experiences more dynamic and interactive (Brasil, 2021, 2022).

Recent studies in the fields of education and innovation have increasingly focused on understanding the relationship between educational robotics, contemporary competencies, and learning recovery processes. These investigations seek to examine how the integration of robotics may catalyze the development of competencies considered essential for the twenty-first century while simultaneously functioning as a valuable resource for the recovery of meaningful learning experiences. According to Silva et al. (2025), competencies such as creativity, critical thinking, communication, teamwork, and problem-solving are strengthened through teaching approaches that employ robotics as an educational tool. The adoption of these educational practices not only improves learning outcomes but also plays a crucial role in the development of competencies considered fundamental within contemporary educational contexts. In situations characterized by both the use and non-use of mobile phones during classroom activities, the proposed strategies become essential for redirecting the use of digital technologies toward more organized and pedagogically planned educational purposes. Consequently, such approaches increase

students' participation and expand the possibilities for their active engagement in the multiple activities developed within school environments.

To summarize the main aspects discussed in this section, Table 1 presents the principal contributions of educational robotics to learning recovery and pedagogical innovation. The table was developed based on the diverse possibilities offered by educational robotics, particularly those associated with learning recovery, innovation in pedagogical practices, and increased student engagement within contemporary educational contexts.

Table 1. Contributions of Educational Robotics to Learning Recovery and Pedagogical Innovation

Pedagogical Elements	Contributions of Educational Robotics	Impacts on Learning Recovery
Active Methodologies	Encourages students' active participation in investigative and collaborative activities	Greater engagement and participation in school activities
Computational Thinking	Development of logical reasoning and problem-solving skills	Strengthening of cognitive and analytical competencies
Project-Based Learning	Construction of prototypes and interdisciplinary solutions	Meaningful and contextualized learning
Maker Education	Experimentation, creativity, and collaborative production	Expansion of student autonomy and protagonism
Gamification	Use of interactive and dynamic challenges	Increased motivation and sustained participation in pedagogical activities
Interdisciplinarity	Integration among different areas of knowledge	Greater articulation between theory, practice, and educational reality
Pedagogical Innovation	Use of digital technologies and participatory strategies	Reduction of passive learning and strengthening of pedagogical mediation
Twenty-First-Century Competencies	Development of creativity, communication, collaboration, and critical thinking	Formation more aligned with contemporary educational demands

Source: Elaborated based on Alexandre and De Alexandria (2023), Almeida and Mill (2021), Motta, Gurczakoski, and Teófilo (2024), Rocha et al. (2023), Santos, Fernandes, and Silva (2026), Silva et al. (2024), and Silva et al. (2025).

As demonstrated in Table 1, educational robotics constitutes a pedagogical tool that promotes the construction of more participatory, collaborative, and interdisciplinary educational practices, thereby strengthening learning recovery processes across different school contexts. According to Almeida and Mill (2021), the integration of pedagogical robotics with active methodologies enhances opportunities for meaningful learning while further increasing students' engagement in educational activities.

Interdisciplinarity and Competency Development in the Context of Contemporary Education

Interdisciplinarity, understood as the interaction among different fields of knowledge, has assumed a highly relevant role in contemporary discussions concerning modern education. This relevance becomes particularly evident in educational contexts that demand more effective curriculum integration, the implementation of innovative pedagogical practices, and the promotion of students' holistic development. In this sense, interdisciplinary approaches seek not only to connect different forms of knowledge but also to enrich educational experiences, preparing students to address the challenges of the contemporary world. In educational environments affected by both the use and non-use of mobile phones during classroom activities, interdisciplinary practices play an important role in restructuring teaching and learning processes through the implementation of more contextualized approaches that stimulate student participation and align with contemporary social and technological demands. Consequently, these practices contribute to the construction of more dynamic educational environments adapted to the realities students experience beyond school contexts. According to Soares and Silva (2024), interdisciplinarity is beneficial because it promotes stronger articulation among different areas of knowledge, enabling a more meaningful integration between curricular content and educational experiences developed within school environments. Such integration not only enriches learning processes but also facilitates deeper dialogue among disciplines in the construction of knowledge.

Within the current educational scenario, characterized by constant transformations and the search for greater effectiveness in teaching processes, interdisciplinarity is closely related to the necessity of overcoming fragmented and excessively compartmentalized pedagogical approaches. This transformation is essential for promoting more integrated and holistic educational experiences, enabling students to connect knowledge from different fields in cohesive and meaningful ways. According to Azevedo, Queiroz, and Dantas (2024), the articulation among different forms of knowledge contributes significantly to the implementation of more integrative educational practices. This connection not only encourages collaborative knowledge construction but also expands opportunities for a more critical and in-depth understanding of reality, allowing students to develop

more reflective and conscious perspectives regarding the world around them. In this context, curriculum integration becomes an important ally in the construction of more relevant and meaningful learning experiences. This process is particularly evident in pedagogical proposals that establish connections among educational robotics, practical problem-solving, and the use of active methodologies within basic education. Furthermore, such integrated approaches provide students with more comprehensive and engaging educational experiences.

Interdisciplinarity is also directly associated with the strengthening of competencies established by the Brazilian National Common Curricular Base. Within contemporary educational contexts, the development of cognitive, socioemotional, and collaborative skills is considered a fundamental component of students' integral formation. According to Polizello et al. (2025), competencies related to creativity, communication, critical thinking, collaboration, and problem-solving have become increasingly important amid the social, technological, and cultural transformations of the twenty-first century. In this context, educational robotics, through interdisciplinary practices, emerges as a resource capable of enriching pedagogical experiences, making them more active, collaborative, and meaningful.

Beyond curriculum integration, interdisciplinarity also enables meaningful learning by relating school knowledge to students' everyday experiences. According to Souza et al. (2022), pedagogical practices that integrate different disciplines increase students' interest in classroom activities, particularly when associated with investigative projects, problem-solving, and collaborative knowledge construction. In educational contexts where digital technologies are constantly present, these strategies enhance student engagement and create broader opportunities for active participation in learning processes.

Another important aspect concerns the extent to which interdisciplinary practices contribute to the development of critical thinking within classrooms. According to Costa (2020), the development of critical thinking requires the creation of educational experiences capable of stimulating reflection, argumentation, analysis, and students' active participation. In this sense, interdisciplinary initiatives associated with educational robotics make it possible to establish more investigative and collaborative learning environments in which students become protagonists in problem-solving processes and in the creation of solutions connected to school contexts and broader societal realities.

The themes of creativity and innovation in education are also directly associated with interdisciplinary proposals that characterize contemporary education. Lima (2021) emphasizes that new educational approaches should encourage creativity, experimentation, and collaborative knowledge construction, thereby promoting more flexible and participatory learning environments. In pedagogical approaches that integrate educational robotics, interdisciplinarity, and active methodologies, students begin to develop competencies related to autonomy, teamwork, and critical thinking, which contributes significantly to strengthening learning recovery processes in different educational contexts.

From methodological and research perspectives, interdisciplinarity also creates possibilities for multiple interpretations and the construction of scientific knowledge. According to Anjos, Rôças, and Pereira (2019), interpretative approaches enrich the understanding of contemporary educational phenomena, especially in investigations related to pedagogical practices and interactions occurring within school environments. Likewise, Oliveira, Fenner, and Menezes (2024) emphasize that interdisciplinarity in science education remains a constant challenge amid curricular demands and the transformations affecting contemporary education. In this perspective, the integration of educational robotics with interdisciplinarity and pedagogical innovation contributes significantly to strengthening educational actions aimed at learning recovery, competency development, and the integral formation of students within contemporary basic education.

IV. Final Considerations

Discussions concerning the use and non-use of mobile phones in classrooms have increasingly occupied a central position within contemporary educational contexts, particularly due to technological transformations that directly affect teaching and learning processes. In this perspective, educational robotics and interdisciplinarity have begun to be understood as pedagogical strategies capable of making educational practices more participatory, contextualized, and aligned with the demands of contemporary education. The present investigation demonstrated the relevance of this theme by revealing how pedagogical practices grounded in the integration of knowledge from different areas and the use of technological tools may serve as important allies in learning recovery processes within school contexts marked by challenges related to students' attention, engagement, and academic performance.

According to the results obtained throughout the research, all proposed objectives were successfully achieved. The study fulfilled its general objective, which sought to analyze how educational robotics and interdisciplinarity contribute to learning recovery processes in contexts characterized by the use and non-use of mobile phones in classrooms through theoretical and documentary discussions. Likewise, the specific objectives were also accomplished, since the investigation examined how the use and restriction of mobile phones affect students' attention and learning processes, evaluated how educational robotics may enhance student engagement,

and analyzed the importance of interdisciplinarity in integrating pedagogical practices aimed at developing cognitive and socioemotional competencies.

Throughout the development of the topic entitled "Use and Non-Use of Mobile Phones in Classrooms: Pedagogical, Cognitive, and Behavioral Impacts on Learning," it became evident that mobile phones may assume different roles within school contexts, ranging from tools for accessing information to factors associated with distraction and reduced student attention when used inappropriately. Regarding the topic "Educational Robotics as a Strategy for Learning Recovery and Pedagogical Innovation," the findings demonstrated that robotics favors active learning practices, problem-solving, collaborative work, and the development of logical reasoning. Concerning the topic "Interdisciplinarity and Competency Development in the Context of Contemporary Education," it became clear that interdisciplinary practices contribute both to the integration of curricular content and to the development of competencies aligned with current educational and social demands.

The study also made it possible to understand that the integration between educational robotics and interdisciplinarity may strengthen the creation of school environments that are more dynamic, collaborative, and technologically aligned. In this sense, teaching strategies involving experimentation, problem-solving, and the articulation among different areas of knowledge may foster more meaningful learning experiences and higher levels of student engagement. Furthermore, the investigation demonstrated that debates surrounding the use or prohibition of mobile phones in classrooms should not be restricted solely to a perspective of prohibition, but should also address the urgent need to create pedagogical practices capable of guiding the critical, conscious, and educational use of digital technologies within school environments.

Finally, it is recommended that future investigations focus on the practical analysis of educational robotics implementation across different levels of basic education and that additional studies explore the effects of these strategies on academic performance, student engagement, and the development of digital and socioemotional competencies. It is also recommended that further research be conducted concerning teacher education for the use of educational technologies and interdisciplinary practices in schools characterized by different structural and social realities.

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