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RESEARCH ARTICLE

Integration of the socio-emotional learning model in engineering education

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ABSTRACT

This paper addresses novel perspectives on developing socio-emotional education across various educational levels, drawing on activities framed within Science, Technology, and Society (STS) and the computational thinking framework. Emotional integration as an educational innovation in curricula is a recent phenomenon responding to diverse societal needs and national developmental imperatives. This research aims to delve into the socioemotional aspects of the student, recognizing them as fundamental elements ensuring learning and competency development to achieve effective performance during and after the educational stage. The proposed criteria permit identifying contexts and learning environments conducive to students' social and emotional development. While also enhancing their achievement capacities. These capacities include motivation, self-regulation, self-efficacy, teamwork, social skills, cooperation, trust, empathy, and emotional management. Additionally, a survey was conducted to gain deeper insights into the factors influencing students' socioemotional states and how they affect their academic and professional performance. Finally, a model grounded in STS and computational thinking is presented, designed to contribute to students' socioemotional development across various educational levels, adaptable to science, engineering, and humanities disciplines.

Keywords: Socio-emotional education; Science, Technology, and Society (STS); Computational thinking; Skills development; Learning contexts

1. Introduction

In the coming years, one of the principal challenges for various countries will be to prepare the different educational levels to face technological innovations and challenges in an increasingly robotized, artificial intelligence-driven, Industry 4.0, and automated world. In response to this imperative, international organizations dedicated to designing strategies on a global scale concur in recognizing that education and

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culture are essential tools to prepare students for this historic moment. This necessitates a significant reorientation of educational processes, with a notable impact on primary, secondary, and tertiary education levels. In this way, educational institutions play a fundamental role in preparing students for their academic and professional futures; therefore, it is of great importance to implement curricula that help them become more self-aware, make the best decisions, set goals, solve problems, and maintain appropriate interpersonal relationships [1,2]. In this regard, it has been demonstrated that high levels of emotional intelligence and socio-emotional control are related to higher academic performance.

Emotional intelligence utilizes traditional concepts of intelligence under the premise that in solving life's problems, intellect and emotion can and should go hand in hand [3]. Although it is based on fundamental life skills, the task's demands will determine the leading role of reason or emotion. Thus, emotional intelligence can be understood as processing emotional information as a legitimate capacity with their consequent influences on cognitive and personal functioning [4]. In this sense, several research claims that social-emotional development programs could reduce risk-taking, emotional stress, and conduct disorders. Furthermore, they suggest that students need the opportunity to learn and practice social-emotional skills to apply them in various situations, both in formal education and in their daily lives. Similarly, for educators, emotional skills are beneficial [5].

However, there are still outstanding challenges regarding developing these social-emotional skills among teaching teams, just like within educational institutions [6]. In practice, social-emotional education is more likely to be introduced in schools by teachers themselves than through educational policy. Hence, a school education based on technological, scientific, and social components, alongside computational thinking, leads to sufficient socioemotional development to perform effectively in professional life.

Socio-emotional education must be incorporated into the curriculum, based on the development and capacity of students to recognize and reflect on their own emotions, as well as to effectively engage with others, exercise empathy, and demonstrate leadership. In the learning process, students integrate into their life's values, attitudes, and skills that enable them to understand and manage their emotions, construct personal identities, establish relationships, and make decisions. Students must develop and implement tools to foster a sense of well-being with themselves and others, which can be achieved through routines associated with school activities. On the other hand, computational thinking has been gaining ground due to its promising impact at the educational level [7] [8]. Its essence lies in applying concepts associated with computing to problem-solving in other contexts. Several authors consider problem-solving to be the new foundation of 21st-century learning. To develop the ability to solve problems using computational concepts, it is necessary to include programming subjects as a necessary tool in all educational curricula, fostering computational thinking development.

It is essential to emphasize that the comprehensive education of a student positively influences their socio-emotional development if they are provided with tools to confront the technological advancements of today's society, including significant advances in science and technology and their impact and influence on society. Social studies of science, technology, and society (STS) provide the necessary theoretical framework to address this aspect [9] [10]. The complexity of keeping up with the dynamics of knowledge in STS makes its inclusion in curricula imperative to promote a more comprehensive education of engineers [11]. In this regard, it is crucial to highlight that social and emotional skills are essential for facing the challenges of the 21st century. Therefore, policymakers, educators, and parents can contribute to promoting these skills by improving the learning environments in which students operate. In Japan, many successful school programs involve parents and provide them with opportunities to learn how to create a cohesive learning environment between school and home [12].

This work aims to address an approach to foster social and emotional skills in students, proposing an educational model based on aspects of STS and computational thinking, which allows for developing experiences and promoting the culture of teamwork in such a way that improves performance during studies and impact on the professional future of students. In addition, the importance of involving parents in the educational process and improving learning environments to promote these skills is highlighted. In section 2 of this work, the research bases are shown. Section 3 highlights the methodological aspects. Then, the results and the discussion associated with them are shown. Finally, the conclusions and principal references used in the research are presented.

1.1. Psychosocial theories

Psychosocial theories are an essential approach to understanding the interaction between individual processes and the social contexts that shape human behavior. These theories focus on how social factors, such as family, culture, peer group, educational institutions, and the media, influence the construction of identity, decision-making, emotional regulation, and social skills of individuals [13].

One of the most influential theories in this area is Erik Erikson's theory of psychosocial development, which describes eight stages of human development, each associated with a particular psychosocial crisis that must be resolved for healthy growth. In the emerging adult stage, relevant for university students, the individual faces the dilemma between intimacy and isolation, which directly influences their relational and emotional capacities [14].

Albert Bandura's theory of social learning is also central to psychosocial analysis, highlighting the importance of modeling, observation, and self-efficacy in learning social behaviors. This theory underlines how individuals learn to regulate their emotions and actions based on social interactions and reinforcements received from the environment [15]. In this sense, human behavior is not only considered to be the result of internal impulses, but also the product of environmental influences mediated by cognitive processes.

From a more contemporary perspective, Urie Bronfenbrenner's bioecological theory of human development states that development is influenced by interrelated systems (microsystem, mesosystem, exosystem, and macrosystem), which allows us to analyze how diverse psychosocial factors interact dynamically in the formation of social and emotional competencies [16].

Likewise, Tajfel and Turner's theory of social identity postulates that the sense of belonging to a group strongly influences one's perception of oneself and behaviors towards others. This theory helps to explain phenomena such as collaboration, social exclusion, leadership, and the construction of collective norms in academic or professional contexts [17].

These psychosocial approaches provide a solid framework for understanding how socio-emotional skills are configured in educational contexts. Its integration into curricular analysis allows us to interpret the relationships between the individual, culture, emotions and society from a multidimensional and rigorous perspective.

1.2. Literature review

Previous studies have shown that social-emotional education is significant for students with and without special needs [18]. In addition, they could recognize how some students demonstrated their self-perception of their academic performance in certain subjects. This indicated the influence of factors such as support received, expectations, and self-efficacy on the perception of academic success. Another factor that contributed to recognizing the significance of socio-emotional skills was the students' appreciation for positive relationships with their peers. This underscores the pivotal role of school environments, particularly those designed for

interaction and communication. In this regard, socio-emotional education has emerged as a cornerstone in the comprehensive development of individuals. According to Greenberg and his colleagues [19], this educational approach equips students with the essential skills to comprehend and manage their emotions, foster healthy interpersonal relationships, and exercise sound decision-making. This emphasis on nurturing socio-emotional competencies resonates with mounting evidence suggesting their parity with traditional academic skills. Durlak and colleagues [20] found that incorporating socio-emotional skills into school curricula improves students' emotional well-being but also correlates with enhanced academic performance and increased job satisfaction in adulthood.

The relevance of socio-emotional education is manifested not only in the personal sphere but also in the professional sphere. Brackett et al. [21] argue that socioemotional education strengthens personal competencies such as self-awareness, self-management, empathy, and interpersonal skills, thus contributing to greater well-being and life success. These skills lead to better preparedness for addressing workplace challenges. Developing these personal skills results in improved readiness to tackle workforce challenges. Initiatives in social-emotional education demonstrate effectiveness in nurturing skills highly valued by employers, such as effective communication, teamwork, and problem-solving abilities [22]. The demand for social-emotional skills in the workplace continues to rise. According to the World Economic Forum [23], these skills are essential for success in today's work environment, where collaboration, adaptability, and emotional intelligence are increasingly important. Jones and collaborators [24] highlight those students who participate in socio-emotional education programs have a greater capacity to regulate their emotions, resolve conflicts constructively, and establish positive relationships with others, skills that are highly valued in the labour sphere.

Socio-emotional education emerges as a fundamental pillar in the educational field of the 21st century, recognizing its crucial role in preparing students to face the challenges of an increasingly complex and diverse world. As Elias and his colleagues point out [25], this educational perspective addresses not only the student's academic development but also their emotional well-being and ability to relate effectively to their environment. Recent research supports the importance of social-emotional skills as significant predictors of academic and labour success. Domitrovich and his coworkers [26] emphasize that these skills influence students' academic performance and impact their adaptation to changing and complex work environments. Further, teaching these skills was associated with improved school climate and reduced disruptive behaviour, contributing to a more positive and safe learning environment.

Social-emotional education programs have emerged as a compelling strategy for addressing diverse facets of the school environment. Taylor and his colleagues [27] underscore that these initiatives not only enhance students' academic outcomes but also yield positive effects in mitigating instances of bullying and fostering a more inclusive and supportive educational milieu conducive to effective learning. Consequently, implementing social-emotional education programs emerges as a powerful tool to promote academic achievement and the emotional well-being of students within contemporary educational environments. On the contrary, within the current educational landscape, computational thinking emerges as a fundamental element in the educative preparation of students, recognized for its importance in equipping individuals with the skills necessary to meet the challenges of an increasingly digitized and technologically driven world. As posited by Wing [28], computational thinking transcends the boundaries of computing and embodies a cross-disciplinary cognitive skillset with wide-ranging applications across various domains of knowledge and in the resolution of intricate problems.

Recent research underscores that computational thinking transcends mere technical proficiency to encompass a foundational set of cognitive abilities, including problem-solving, creativity, abstraction, and

logic [29]. These skills are considered significant predictors of academic and work success, as they allow individuals to adapt to changing environments and solve problems efficiently and effectively [30]. Computational thinking integration into the school curriculum has been associated with multiple benefits for students and the educational system. As suggested by Kafai and Burke [31], teaching computational thinking promotes the development of skills such as critical thinking, collaboration, and creativity, preparing students to face the challenges of the 21st century. In addition, it has been observed that including computational thinking programs in schools improves students' academic performance, especially in subjects such as mathematics and science [32].

On the other hand, nations like Japan have long recognized the significance of social-emotional education within their educational framework, emphasizing values such as empathy, collaboration, and resilience. Japanese educational institutions, in addition to cultivating students' intellectual abilities, also pursue their emotional and social well-being [33]. This commitment is evident in their integration of extracurricular activities, such as participation in school clubs that emphasize teamwork, judo practice, and participation in the traditional tea ceremony, all designed to foster the development of social and emotional competencies [34]. In addition, Japan has proactively introduced programs to promote computational thinking from an early stage. Notably, the Japanese Ministry of Education has incorporated the "Information Technology" subject into the primary school curriculum, enabling students to grasp fundamental programming concepts and algorithmic problem-solving skills from an early age [35]. Moreover, at the secondary education level, the Ministry of Education, Culture, Sports, Science, and Technology of Japan (MEXT) has formulated comprehensive guidelines and learning standards for the integration of economics into the school curriculum. These guidelines outline a structured approach to teaching economics in secondary schools, offering elective courses covering basic economic principles, macroeconomics, microeconomics, and personal finance, among others [36].

On the other hand, Singapore has also integrated socio-emotional education into its educational system as part of a holistic approach to student development. Through programs such as Social-Emotional Learning (SEL), students learn to manage stress, establish positive relationships, and develop problem-solving skills. Furthermore, Singapore has instituted Physical Education, Art Education, and Social-Emotional Learning (PAL) programs in primary schools to foster the holistic development of students [37]. Singapore has also embarked on initiatives to promote computational thinking in schools. The government has launched the IT Masterplan in Education to integrate information technology and computational thinking skills across all educational levels [38]. Additionally, extracurricular programs and enrichment activities, such as the Mathematics and Computer Science Excellence Program, have been established to cultivate students' interest in computer science and programming.

Socio-emotional education is pivotal for fostering students' holistic development, encompassing their capacity to comprehend and regulate emotions, forge positive relationships, and exercise sound judgment. Central to emotional well-being is self-esteem, while teamwork skills play a significant role in its cultivation. As integral components of emotional and social intelligence, teamwork skills, such as effective communication, decision-making, and leadership, constitute essential elements of socio-emotional education. Strengthening these proficiencies enables students to cultivate heightened self-awareness, empathy, and confidence in their abilities [39]. Thereby positively influencing their self-esteem and emotional welfare. Moreover, the research underscores the imperative for ongoing training in socio-emotional skills to adeptly address emotions and anxieties within classroom settings, reinforcing the indispensable role of socio-emotional education in contemporary pedagogy. The benefits of training in social-emotional skills go far beyond students, as it also includes educators and the educational community. Enhancing teachers' social-emotional competencies fosters an atmosphere of empathy and support within learning environments, leading to improved learning outcomes

and emotional well-being for all stakeholders. Moreover, integrating social-emotional education into pedagogical approaches promotes an inclusive and safe school environment where students feel valued and supported. The study mentioned above [40] underscores the potential of social-emotional education programs not only to enhance students' emotional well-being but also to have a positive impact on their academic performance. This emphasizes the urgent need to invest in this area and to adopt innovative approaches that promote the comprehensive development of students.

2. Materials and methods

2.1. Type of study

The methodological design followed a quantitative, non-experimental, cross-sectional and descriptive approach. The aim was to characterize socio-emotional and cognitive traits in a population of university students, of the first and second semester of the Engineering Degree, to design educational interventions rooted in the principles of Science, Technology and Society (STS) and computational thinking. A survey instrument was designed ad hoc, incorporating a total of 62 items grouped into ten subscales aligned with constructs from the Collaborative for Academic, Social, and Emotional Learning (CASEL) framework and the European Digital Competence Framework (DigComp). The items were structured using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). It is important to note that the content validity of the instrument was assessed by a panel of five experts in education, psychology, and digital pedagogy from three institutions in Latin America. Based on their feedback, items were refined to ensure clarity, relevance, and alignment with the theoretical constructs. A pilot study was conducted with a group of 25 students, whose responses were analyzed to identify item comprehension issues and preliminary psychometric behaviour.

2.2. Participants

The final version of the questionnaire was administered to a non-probabilistic convenience sample of 148 students from first and second semester of a Polytechnic Universi-ty of Puerto Ordaz, Venezuela. The survey was applied anonymously online under the supervision of trained facilitators. On the other hand, the internal consistency of the subscales was confirmed using Cronbach's Alpha coefficients, which ranged from 0.712 to 0.854, indicating acceptable to high reliability across all dimensions. Data analysis was conducted using descriptive statistics to explore the frequency of socio-emotional and cognitive attributes, providing the foundation for the design of integrative activities presented in the results section.

2.3. Data processing and analysis

Following data collection, the responses from the 148 participating students were pro-cessed using IBM SPSS Statistics v.26. A descriptive statistical analysis was performed to explore the central tendencies and distribution of responses across the ten subscales. For each of the constructs (emotional self-awareness, self-regulation, empathy, social skills, problem-solving, creativity, digital competence, collaboration, critical thinking, and technological adaptability) mean scores, standard deviations, and frequency distributions were calculated.

To ensure internal consistency and reliability of each subscale, Cronbach's Alpha coefficients were computed, all of which exceeded the minimum acceptable threshold of 0.70. These results confirmed the internal coherence of the instrument, as shown in Table 1.

Table 1. Cronbach's Alpha Coefficient of the questionnaire.

Skill	Number of items	Cronbach's Alpha Coefficient
Emotional self-knowledge	8	0.854

Emotional self-regulation	6	0.783
Empathy	7	0.812
Social skills	9	0.827
Problem resolution	6	0.758
Critical thinking	8	0.815
Creativity	5	0.712
Digital competence	7	0.804
Collaboration	8	0.832
Technological adaptability	6	0.789

2.4. Ethical considerations

This research adhered to ethical standards aligned with the Declaration of Helsinki and the guidelines for educational research. As the study was conducted within a non-invasive, it did not require ethics board approval. Nevertheless, the researchers sought and obtained authorization from the participating, which reviewed the objectives, instruments, and procedures. All participants received a detailed informed con-sent form, which explained the voluntary nature of participation, the confidentiality of the data collected, and the exclusive use of results for academic research purposes. Only students provided explicit written consent were included in the study. To ensure anonymity, the survey responses were coded and analyzed in aggregate, without collecting personal identifiers such as names, grades, or addresses. The ethical integrity of the study was further reinforced by ensuring that no harm, psychological pressure, or academic consequences resulted from participation or non-participation in the re-search.

2.5. Survey conducted

The questionnaire comprises ten subscale representing skills related to socio-emotional education and computational thinking. Emotional self-awareness, demonstrated by items 1 to 8, refers to the ability of individuals to identify, understand, and effectively manage their emotions, contributing to greater emotional well-being and better decision-making. Emotional self-regulation, represented by items 9 to 14, involves individuals' ability to control and manage their emotions in various situations, allowing them to remain calm and respond appropriately to challenges and adversities. Empa-thy, indicated by items 15 to 21, pertains to individuals' ability to understand and share the feelings and perspectives of others, facilitating the building of positive inter-personal relationships and effective collaboration. Social skills, represented by items 22 to 30, encompass a variety of skills necessary for interacting effectively and cooperatively with others, including communication, conflict resolution, and teamwork. Problem solving, evidenced by items 31 to 36, entails individuals' ability to identify, analyse, and solve problems efficiently and creatively, employing critical and analytical thinking. Creativity, indicated by items 37 to 41, refers to individuals' ability to generate original ideas and innovative solutions to problems, contributing to adaptability and flexibility in different contexts. Digital competence, as represented by items 42 to 48, encompasses individuals' capacity to efficiently utilize information and communication technologies (ICT) for acquiring, processing, and disseminating information, as well as for collaborating and communicating in digital environments. Collaboration, indicated by items 49 to 56, relates to an individual's capacity to work effectively and cooperatively with others to achieve common goals, fostering active participation, open communication, and mutual respect. Finally, technological adaptability, demonstrated by items 57 to 62, involves individuals' ability to adapt and effectively use emerging technologies in different contexts and situations, contributing to innovation and technological progress.

3. Results

Considering the students' responses, the activities in Table 2 were developed, which can then be implemented in the classroom to evaluate their effectiveness and efficiency in the educational process.

Table 2. Activities designed from the students' responses.

Skills Category	Practical activities
Personal and interpersonal emotional skills	- Emotions Diary: Students record and reflect on their daily feelings, identifying emotional triggers and coping strategies. - Conflict resolution workshop: students practice effective communication, empathy, and conflict resolution skills in simulated situations. - Family workshop on emotional management: Organize a workshop in which students and parents learn together about emotional management. During these workshops, strategies and tools can be shared to identify and manage emotions in the family and at school.
Socio-moral skills	- Community Service Project: Students identify a need in their community and design and implement a project to address it, promoting solidarity and social responsibility. - Family Ethical Debate Nights: Organize evenings dedicated to ethical debates, where parents and children discuss moral and ethical dilemmas prevalent in society. These activities promote critical reflection, respect for different points of view, and effective communication within the family.
Cognitive skills	- Problem Solving Challenge: Students engage in challenges that demand critical thinking, creativity, and collaboration to devise solutions to environmental or social issues. - Scientific Research Project: Students engage in scientific - investigations focused on subjects concerning technology and society, applying the scientific method to gather data and draw conclusions.
Other sports and artistic skills	- Family Sports or Art Club: Establish clubs where parents and children participate in sports or artistic activities together. These initiatives will promote self-expression and teamwork and strengthen family ties through shared quality time. - Technology Art Project: Students utilize technological tools to craft works of art addressing social, familial, or environmental concerns, blending creativity and technology seamlessly.

Students need to develop a strong work ethic, discipline, and respect. This aligns with Japanese society, where success is not determined by individual skills or intelligence but rather by effort. This approach aims to provide students with better educational and professional opportunities. The proposed curriculum in this research is based on the fundamental principle of fostering students' ability to solve problems and navigate situations independently. The goal is not for students to exclusively follow procedures or memorize facts but to understand the "how" and "why" behind things, enabling them to apply their knowledge in any context.

From the perspective of this study, it is emphasized that the emotional spark is ignited through the constant exploration of new ideas, the fostering of innovation, and active participation in projects that arouse students' curiosity and interest, particularly in the field of science. The importance of providing hands-on experiences in laboratories and learning environments that allow students to experiment, discover, and tangibly apply concepts is highlighted, which can lead to greater engagement and enthusiasm for learning.

In interpersonal relationships and teamwork dynamics, collaborative group work is widely favored. However, it is imperative to recognize that a minority of students prefer individual and autonomous work. This underscores the significance of achieving equilibrium between group and individual activities, allowing students to develop collaborative and autonomous skills tailored to their learning preferences and requirements. In addition, it is crucial to advocate for strategies to cultivate effective communication, mutual respect, and appreciation of diverse opinions within team environments. These efforts will substantially enhance the establishment of an inclusive and enriching learning atmosphere conducive to the progress of all students. Based on these results, Table 3 outlines the proposed allocation of hours for each core subject within the school's curriculum to determine the minimum number of instructional hours needed to effectively integrate

activities that promote social-emotional education (SEL) and computational thinking (CT). Based on these results, Table 3 outlines the proposed allocation of hours for each core subject within the school's curriculum.

Table 3. Minimum number of hours necessary to include in the school curriculum.

Subject	Hours for Education Socio-emotional	Hours for Computational Thinking
Mathematics	5	10
Language and Literature	8	6
Natural Sciences	6	8
Economics	5	8
Social Sciences	7	5
Languages	4	4
Physical Education	3	3
Ethics and Philosophy	5	7
Physics	6	5
Biology	7	6

This educational proposal aims to enhance students' social-emotional skills and computational thinking, acknowledging the significance of both aspects in their holistic development and readiness to tackle the challenges of the 21st century. Integrating socioemotional education promotes emotional intelligence, empathy, self-regulation, and interpersonal skills, which are fundamental aspects of personal well-being and healthy social relationships. On the other hand, the inclusion of computational thinking seeks to develop students' ability to solve problems logically, think algorithmically, and understand the functioning of technology today. This combination of educational approaches aims to prepare students to be competent citizens, capable of adapting to a constantly changing world and making meaningful contributions to their environment. Additionally, this educational proposal seeks to promote reflection among students on their professional interests and aspirations, providing them with tools to identify their passions and define their academic and professional goals more clearly. Students' education should go beyond acquiring technical skills like carpentry, electrical work, or programming. It should also foster a deep understanding of their interests and talents. By having a clear vision of their goals and a solid understanding of their strengths, students will be better prepared to choose an educational and professional path that aligns with their values, interests, and skills, enabling them to achieve a greater sense of fulfillment and success in their future careers. In light of this, Table 4 outlines aspects of the proposal for state or institutional policies.

Table 4. Proposal for state or institutional policies.

Proposals for educational policies
To incorporate social-emotional education and computational thinking as integral components of the school curriculum at all levels.
Develop teacher training programs that include training in socio-emotional education and teaching of computational thinking.
Allocate financial and technical resources to effectively implement activities and projects related to socio-emotional education and computational thinking in educational institutions.
Promote research and development of good practices in socio-emotional education and computational thinking through collaboration between educational institutions, government organizations, and civil society.
Establish evaluation and monitoring mechanisms to measure the impact of policies and programs related to socio-emotional education and computational thinking to make adjustments and continuous improvements.
Promote the active participation of parents and the community in social-emotional education promotion and computational thinking through awareness and collaboration activities.

Proposals for educational policies
Establish strategic alliances with the private sector and other institutions to develop and implement innovative programs in socioemotional education and computational thinking.

Table 4. (*Continued*)

The teacher is in the best position to determine student success as the leader in a classroom. It is essential that the teacher can understand and know the students and teach them to develop skills to adapt to situations. Teaching involves daily work based on social interactions where the teacher must make a great effort to regulate not only his own emotions but also those of the students/she must bet (Greenberg et al., 2003).

3.1. Development strategies for the implementation of the proposal

As part of the educational curricula, elements of artificial intelligence, laboratories, and video games should be incorporated to foster socio-emotional aspects in students, enabling them to recognize that attending school is not merely an obligation but a pathway to experiential learning. Consequently, each class should design itself with a clear objective and a series of activities to achieve it. To effectively address the students' socio-emotional development, Figure 1 outlines the main steps to facilitate this transformation.

Figure 1. Curricular changes considering new elements that influence the socio-emotional development of students

Curricular changes consider new elements that influence the socio-emotional development of students. Figure 2 shows the generality of the proposed model based on CTS activities, incorporating computational strategies and activities. The essential elements are, on the one hand, introducing aspects of science, technology, and society (STS) and computational thinking tools [41], [42].

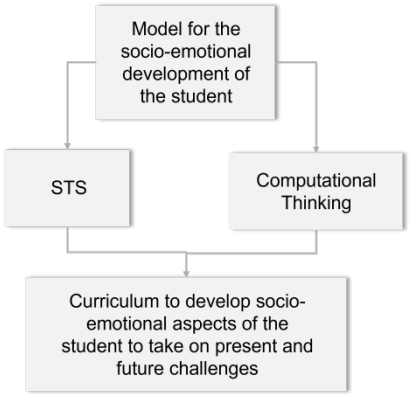

Figure 2. The general outline of the elements is to be considered in the curricular proposal to develop socio-emotions in students

4. Discussion

The Science, Technology, and Society (CTS) component explores the multifaceted relationship between these domains. It delves into areas like the environmental impact of technology, including its effect on ecosystems and climate change. Ethical considerations in technology development are discussed, focusing on dilemmas like online privacy and artificial intelligence. The component also examines advancements in healthcare technology, like telemedicine and surgical robotics, with their social and ethical implications. It

analyzes the influence of technology on the economy, including job automation and wealth distribution. Additionally, it explores how technology transforms education through online learning, gamification, and information access. Finally, citizen science projects like bird watching and environmental data collection are encouraged for student participation.

The proposal addresses a broad spectrum of interrelated topics, highlighting the pervasive influence of technology on modern life. It emphasizes digital security, equipping students to protect personal data and navigate the complexities of online safety. It also fosters connections between technology and artistic expression, from music and film to virtual reality, allowing students to combine creativity with innovation. Exploring advances in transportation - from autonomous vehicles to intelligent infrastructure - sheds light on how technology is changing urban mobility. Finally, the proposal examines the potential of technology to bridge social gaps, addressing its benefits for marginalized groups and promoting inclusive design for all.

The proposed curriculum prioritizes computational thinking, encompassing core elements for well-rounded student development. Students will develop logical reasoning and problem-solving through algorithms and breaking down complex issues [43]. Abstraction skills are nurtured, allowing them to identify patterns and simplify problems. The program equips students with coding and technological solution creation through automation and programming. Critical thinking is fostered for solution evaluation and continuous improvement. Finally, collaboration and communication are emphasized through programming projects, teaching teamwork, idea sharing, and collaborative problem-solving.

Integrating Science, Technology, and Society (STS) elements with computational thinking and social-emotional competencies is crucial for today's education. This synergy fosters a holistic approach to developing the critical skills needed in our increasingly interconnected and technological world. By marrying STS principles (which explore the relationship between science, technology, and society) with computational thinking (which includes logical reasoning, problem-solving, and algorithmic creativity), students acquire the tools necessary to understand and effectively address contemporary challenges. Additionally, incorporating socio-emotional competencies like empathy, collaboration, and emotional self-regulation promotes a comprehensive learning approach, recognizing the importance of interpersonal skills and emotional well-being for personal and professional success [44]. This balanced combination equips students to ethically, creatively, and collaboratively tackle 21st-century challenges, empowering them to become meaningful contributors to a constantly evolving society.

The proposed model, based on activities that integrate Science, Technology, and Society (STS) with computational thinking, offers a versatile framework applicable to primary, secondary, and even tertiary levels of education, with the necessary adaptations for each stage. This flexibility extends to subject areas, as the model can be adapted to scientific and humanistic disciplines. By incorporating these relevant aspects, the model significantly impacts the student's socioemotional development, equipping them with valuable skills that will be highly useful for a successful professional future [45].

Computational thinking offers students a deepened lens for understanding the human aspects of learning, including perspectives, emotions, behaviours, and decision-making. This is especially relevant as technology automates classroom activities, from laboratory practices to using information and communication technologies (ICT). By adopting computational thinking, educational activities become more engaging and compelling. This approach equips students with practical and effective tools to apply these skills in real-world learning scenarios [46].

Computational thinking requires students to be conscious and intentional throughout the problem-solving process and develop essential attitudes such as [47]:

- Face doubts by looking for answers.
- Persist through iteration and experimentation.
- Teamwork.
- Lead learning with inquiry.
- Position yourself as a leader and learner at the same time.

Students learn to ask bold questions and persist through complexities toward solutions yet to be imagined. In this way, educational systems, in general, have focused on enhancing students' cognitive dimension while overlooking the socio-emotional dimension. Currently, a significant group of researchers emphasizes the importance of emotional education in the educational system, underscoring that the purpose of education is the student's development in their affective, cognitive, and social characteristics for the holistic development of personality.

The proposed teaching-learning system cultivates a spirit of inquiry and innovation in students. By encouraging them to ask questions, seek answers, explore new paths, and think critically, the curriculum empowers them to transform future challenges into opportunities. This approach prioritizes STS activities and computational thinking as core elements. Additionally, insights gleaned from student surveys inform socio-emotional education practices, fostering a deeper understanding of adolescents' emotional needs and promoting their active participation in the learning process, which is crucial for their personal development.

In this way, it is expected that the curricular proposal contributes in terms of:

- Development of skills to learn another language.
- Motivation for software management.
- Interest in good spelling and writing.
- Sensitivity to perceiving, valuing, and expressing emotions.
- Concern about maintaining satisfactory interpersonal relationships.
- Knowledge of security in their performance and good self-esteem.
- Development of empathy, happiness, joy, and permanent optimism.
- Responsibility to resolve conflicts and make decisions.

4.1. Rationale for curricular integration

Although students' socio-emotional development has traditionally been addressed through artistic activities, limiting their formation exclusively to these areas proves insufficient in the face of the complex challenges of today's educational context. In disciplines such as engineering, where technical training predominates, there is an increasing need to strengthen transversal competencies related to emotional management, empathy, collaboration, and ethical decision-making. Thus, the inclusion of a specific course on socio-emotional education is not intended to replace disciplines such as the arts, but rather to complement them through a systematic and intentional pedagogical approach. This curricular space enables the integration of strategies such as computational thinking, STS (Science, Technology, and Society) analysis, and the use of interactive technologies to foster soft skills in technical contexts, promoting a more humanistic, critical, and socially engaged education.

Furthermore, this proposal responds to concrete needs observed among secondary school students in urban areas, where academic stress, emotional disconnection, and lack of motivation are notably high. Through

activities specifically designed for these contexts, the course seeks to strengthen students' overall well-being and prepare them for university and professional environments in which socio-emotional skills are increasingly valued. In this regard, the significance of the subject lies not only in its content but also in its transformative approach—capable of linking the emotional with the technological, the familial with the institutional, and the individual with the collective. This curricular perspective advocates for an emotionally intelligent, socially situated, and technologically mediated education aligned with the challenges of the twenty-first century and the demands of an active, reflective, and ethical citizenship.

4.2. Limitations

The limitations identified in the research process were, mainly, those related to the scope of the participation of engineering students, since they are usually occupied with a large amount of academic load and the topic of socio-emotions has not yet been formally integrated into the curriculum. This context may have limited the understanding or interpretation of some constructs included in the instrument. In addition, the dissemination of the questionnaire through digital platforms could have excluded students with limited access to the internet or with a low level of digital literacy, which possibly affected the representativeness of the sample.

4.3. Conclusions

This study presents an intervention intended to improve students social-emotional competencies, recognizing the crucial participation of teachers, families, and educational institutions. Integrating computational thinking with its components, the intervention broadens the avenues for teaching social-emotional competencies. Attractive technology serves as a tool not just for entertainment, but also for fostering creativity, problem-solving, and peer interaction.

Supplementing education with programming, simulations, and artificial intelligence (AI) tools empowers students in two ways. First, they learn to conceive, plan, design, and create computer programs to influence their world. Second, this approach fosters a range of cognitive skills encompassed by computational thinking, such as creativity, abstraction, problem analysis, logical and critical thinking, communication, and collaboration.

Implementing the proposed program throughout secondary education underscores the importance of fostering socio-emotional learning. These programs not only act as protective resources for students' well-being but also provide a solid framework for their comprehensive development in a complex and ever-changing educational landscape. Today investment in digital infrastructure in the scholar system is vital, since most countries have opted for the continuity of the educational process through online modalities. The use of the Internet offers a unique opportunity for bringing the school and educational processes closer to students in confined conditions.

Conflict of interest

The authors declare no conflict of interest

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