



TRANSFORMATIONS OF THE NATURAL SCIENCES CURRICULUM FROM A STSE APPROACH, BASED ON THE WORK OF A COMMUNITY.

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Abstract.

The research addresses the transformation of the curriculum of the natural sciences area at the Instituto Salesiano Pedro Justo Berrio, through the implementation of the Science, Technology, Society and Environment approach. This approach seeks to integrate scientific knowledge with technological, social and environmental factors, which allows students to understand science in a contextualized and critical way, connecting learning with their daily reality. The main purpose is to analyze how the reflections and practices of a community of Natural Science teachers contribute to this curricular transformation, promoting a curriculum that is more adaptable and coherent with contemporary demands. Through the dynamics of the community of practice, teachers have the opportunity to reflect on the relevance and effectiveness of the content they teach, adapting it to address local and global issues, such as climate change, biodiversity and the use of technology in everyday life. This process fosters more meaningful and relevant learning for students, who are motivated to participate actively and critically in their own learning process.

Keywords: CTSA approach, Curriculum, Natural Sciences, Community of Practice of Teachers.

Resumen.

La investigación aborda la transformación de la malla curricular del área de ciencias naturales del Instituto Salesiano Pedro Justo Berrio, mediante la implementación del enfoque Ciencia, Tecnología, Sociedad y Ambiente. Este enfoque busca integrar el conocimiento científico con factores tecnológicos, sociales y ambientales, lo cual permite a los estudiantes comprender la ciencia de manera contextualizada y crítica, conectando el aprendizaje con su realidad cotidiana. El propósito principal es analizar cómo las reflexiones y prácticas de una comunidad de profesores de ciencias naturales contribuyen a esta transformación curricular, promoviendo un currículo más adaptable y coherente con las demandas contemporáneas. A través de las dinámicas de la comunidad de práctica, los profesores tienen la oportunidad de reflexionar sobre la pertinencia y eficacia de los contenidos que enseñan, adaptándose para abordar problemáticas locales y globales, como el

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cambio climático, la biodiversidad y el uso de la tecnología en la vida cotidiana. Este proceso fomenta un aprendizaje más significativo y relevante para los estudiantes, quienes se ven motivados a participar de manera activa y crítica en su propio proceso de formación.

Palabras Clave: Enfoque CTSA, Currículo, Ciencias Naturales, Comunidad de Práctica de Profesores.

I. INTRODUCTION.

The current educational context demands a profound transformation in pedagogical approaches, especially in the natural sciences, where social and environmental challenges emerge as key factors in learning. Within this framework, the Science, Technology, Society, and Environment (STSE) approach is presented as a key approach for integrating scientific content with technological, social, and environmental aspects that are part of students' everyday lives. This approach not only promotes the development of disciplinary competencies but also fosters critical and reflective awareness of the interactions between science and reality.

A national study by Baquero (2014) analyzed the Basic Standards of Competencies (BSC) across educational cycles, concluding that many proposals do not adequately integrate Science, Technology, and Society (STS) connections, resulting in superficial treatment of topics. Since these standards are based on their 2006 edition, their revision is crucial for implementing the STSE approach in teaching, supporting the preparation of teachers capable of addressing socioscientific issues through innovative pedagogical strategies.

In this process, communities of practice among teachers stand out as a key mechanism for curricular transformation. According to Martínez and Pargas (2013), these communities allow teachers to reflect collaboratively, adapt the curriculum to local and global needs, and improve students' civic education by integrating scientific and social aspects. Through the STSE approach, teachers acquire tools to foster active and meaningful learning, encouraging critical argumentation and student engagement.

In this sense, the curriculum framework emerges as the space where these adaptations are materialized, adjusting to the specific realities of each educational institution. This work analyzes how, based on the reflections of a community of practice of natural science teachers at the Instituto Salesiano Pedro Justo Berrío (ISPJB), it is possible to transform the curriculum by integrating the STSE approach. These reflections not only reconfigure science teaching but also highlight the importance of educating critical citizens capable of understanding and acting upon the scientific, technological, social, and environmental challenges of the contemporary world.

II. REFLECTIVE ELEMENTS

The reflective elements of the that supports this research are are outlined below. These serve as the foundation for analyzing the transformations in the natural sciences curriculum at ISPJB. This study is based on the convergence of three fundamental theoretical pillars: the STSE approach, the community of practice of teachers, and the curriculum framework. These foundations not only guide the research from a conceptual perspective but also provide practical tools to address contemporary educational challenges, particularly in the context of teaching that seeks to be more critical, contextualized, and socially and environmentally engaged.

A. STSE Approach.

The STSE (Science, Technology, Society, and Environment) approach is presented as an integrative educational model that promotes a critical, reflective, and contextualized understanding of scientific knowledge. This approach recognizes that science and technology do not operate in isolation but are deeply intertwined with society and environment in which they operate. Consequently, it

proposes a science education that goes beyond the mere transmission of content, enabling students to understand science as a human construction influenced by cultural, political, economic, and ecological contexts (Romero et al., 2022).

The emergence of the STS approach emerged in the 1960s and 1970s, when the relationships between science and society began to be questioned. It later evolved into the STSE approach by explicitly incorporating the environmental dimension, driven by growing concerns about issues such as climate change, biodiversity loss, and pollution. This approach, adopted in Colombia since 2006 within the Basic Standards of Competencies (MEN), seeks to promote science education that enables individuals to face contemporary challenges critically and responsibly.

However, it is important to note that this approach presents different developments depending on academic contexts (Table 1). According to Quintero (2010), two major traditions can be distinguished:

Tabla 1
Comparativa de enfoque CTS europeo y americano.

Tradición Europea	Tradición Americana
- Institucionalización académica en Europa (En sus orígenes)	- Institucionalización administrativa y académica en Estados Unidos (en sus orígenes)
- Énfasis en los factores sociales antecedentes	- Énfasis en las consecuencias sociales
- Atención a la ciencia y secundariamente a la tecnología	- Atención a la tecnología y secundariamente a la ciencia
- Carácter técnico y descriptivo	- Carácter práctico y valorativo
- Marco explicativo: ciencias sociales (sociología, psicología, antropología, etc.)	- Marco evaluativo: ética, teoría de la educación, etc.

Nota. Fuente (Quintero, 2010)

The North American perspective has a more applied and practical focus, centered on the development of life skills and informed civic decision-making, whereas the European perspective has a more analytical, sociological, and reflective orientation regarding the factors that shape science and technology.

Although these two traditions differ, they are complementary. Together, they allow for a comprehensive approach to the relationships among science, technology, society, and the environment, which is essential for educating critical, aware, and engaged citizens capable of addressing the challenges of today's world.

In this way, the STSE approach in education invites teachers to rethink the role of science in students' everyday lives, recognizing its potential to address urgent social and environmental issues. It is not merely about incorporating these topics superficially, but about integrating them through the analysis of Socio-scientific Issues (SSI), which involves considering the ethical, social, and environmental implications of scientific and technological development.

Hodson and Arango (2021) argue that science teaching under this approach must move beyond the traditional view of science as a neutral body of knowledge and instead present it as a dynamic, contextual, and socially conditioned process. Therefore, they propose a four-stage model to develop the STSE approach in the classroom:

Appreciate the social and environmental impact of scientific and technological changes, recognizing that these are culturally conditioned.

Recognize the interests and inequalities behind scientific and technological development, understanding that their benefits are not distributed equitably and are linked to the distribution of power and wealth.

Address controversies and ethical dilemmas, helping students formulate and defend their own positions based on critical analysis and informed argumentation.

Prepare for and act on socioscientific and environmental issues, which include three sub-processes:

Learning from action: acquiring sociopolitical skills through case analysis, films, role-playing, and simulations.

Learning through action: becoming directly involved in community projects that generate tangible impacts.

Learning about action: critically reflecting on lived experiences and their outcomes.

This action-oriented approach seeks to enable young people to critically examine the society around them, question its values, and propose changes that contribute to building a more just, democratic, and environmentally sustainable model of development.

Therefore, integrating the STSE approach into education involves equipping students not only with knowledge but also with the skills to address socio-environmental

challenges critically and proactively. This translates into the need to transform traditional curricula into more flexible, contextualized proposals aligned with the problems and needs of their environment.

A key strategy for achieving this transformation is the creation of teacher communities of practice, which enable joint reflection, knowledge exchange, and the co-construction of curricular proposals that effectively incorporate the STSE approach.

B. Communities of Practice among Teachers.

The establishment of a Communities of Practice among Teachers represents an essential pillar for the effective implementation of the STSE approach in educational settings. This type of professional collective is configured as a collaborative working strategy aimed at generating knowledge from practice through constant interaction, knowledge creation, shared reflection, and critical analysis of pedagogical work. These communities allow teachers to position themselves as active agents in the transformation of their practices and the curriculum, going beyond the mere reproduction of content and promoting contextualized, critical, and socially relevant teaching (Frateschi, 1999).

In this sense, the community of practice acts as a dynamic space for ongoing dialogue and exchange, where teachers can share meaningful experiences, confront ideas, analyze common challenges, and collaboratively construct solutions. Through systematic meetings, a culture of professional collaboration is fostered, strengthening not only disciplinary knowledge but also the pedagogical competencies needed to address contemporary challenges in natural science teaching. In addition, a support network is created in which teachers support one another, promote peer learning, and explore new teaching possibilities that respond to the real needs of their students and the local context.

From a curricular perspective, these communities also make it possible to collectively identify those aspects of the curriculum that need to be transformed in order to align with the principles of the STSE approach. This shared view of the curriculum enables the design of innovative proposals that integrate scientific, technological, social, and environmental dimensions, overcoming fragmented views of knowledge and embracing an interdisciplinary approach. In this way, the curriculum ceases to be a rigid document and becomes a flexible, participatory,

and context-based construction, in constant review and improvement.

Participation in a community of practice also strengthens the sense of institutional belonging, ethical commitment to education, and responsibility among members of the teaching team. Within this environment, a critical attitude toward educational reality is encouraged, collective problem-solving is promoted, and conditions for genuine pedagogical innovation are created. In this way, the teacher ceases to be an isolated executor of educational policies and becomes a transformative agent who, together with others, constructs meaningful, contextualized learning experiences with a strong humanistic and environmental component.

In addition to their role in curricular transformation, communities of practice represent a strategic component for strengthening the school as a formative space. As they consolidate as centers of pedagogical innovation, these communities go beyond the didactic dimension to influence the organizational culture of educational institutions, generating a collective identity based on dialogue, cooperation, and continuous improvement. This dynamic contributes to the construction of shared professional capital, enabling institutions to respond more effectively to challenges arising from social, technological, and environmental changes.

Within this framework, ongoing teacher education finds fertile ground, as the community of practice becomes a space for situated professional development, where theoretical knowledge is intertwined with experience and teachers' voices are revalued. Likewise, these communities can establish connections with universities, training centers, or inter-institutional networks that broaden their scope of action and provide access to new perspectives, resources, and pedagogical strategies. To ensure their continuity over time, they require institutional recognition, dedicated time for their development, and participatory management that values collectively constructed knowledge. In this way, they are consolidated not only as spaces for curricular transformation from the STSE approach but also as a sustainable commitment to teacher professionalization, educational equity, and the construction of more democratic schools engaged with their context.

C. Curriculum Framework.

The curriculum framework, understood as the concrete expression of the pedagogical decisions that guide the

teaching and learning process, plays a strategic role in this research. This pedagogical instrument is not limited to organizing content by subject areas or grade levels; rather, it represents the active interpretation that teachers make of the official curriculum. Through it, aims to construct meaningful learning experiences that respond to students' real needs, taking into account their social, cultural, and environmental contexts. This adaptation is crucial to ensure that the curriculum does not become a static document but evolves in response to contemporary social and environmental challenges (Rodríguez, 2017). Therefore, the curriculum framework becomes a bridge between institutional prescriptions and the dynamics of the classroom.

By conceiving the curriculum framework as a flexible and dynamic entity, its capacity for ongoing transformation in response to changes in the environment is recognized. It is no longer a fixed document but a dynamic tool, open to review, adaptation, and improvement based on processes of collective pedagogical reflection. This critical and situated perspective of the curriculum allows teachers to take on a leading role in curricular decision-making, moving beyond content implementation toward a more autonomous, creative, and contextualized practice.

From a meso-curricular perspective, the curriculum framework is positioned as an intermediate level between the macro-curriculum (national educational policies) and the micro-curriculum (classroom practices). Its design is based on official references such as the Basic Standards of Competencies (BSC), the Basic Learning Rights (BLR), and the Curriculum Guidelines (CG), which guide teaching processes according to shared quality criteria. However, its true strength lies in teachers' ability to articulate these guidelines with the particularities of the school context, adapting content, methodologies, and assessments to local realities and challenges.

One of the most effective ways to revitalize the curriculum framework is through the inclusion of interdisciplinary projects that address contextual issues. This approach promotes more meaningful learning, in which students engage with real-life situations that require critical thinking, collaboration, and civic commitment. Topics such as climate change, sustainability, public health, and community issues become cross-cutting axes of school knowledge,

fostering the integration of knowledge and the development of conscious and active individuals in transforming their reality.

In this way, the curriculum framework ceases to be merely a planning instrument and becomes a tool for educational and social transformation. Its participatory redesign, based on approaches such as STSE, allows school content to be re-signified in light of contemporary challenges. Thus, it fosters a school that is more open to dialogue with its territory, capable of educating critical, reflective citizens committed to building a more just and sustainable society.

In this sense, transforming the curriculum framework from the STSE approach not only involves a thematic reorganization but also a profound reconfiguration of educational purposes. By incorporating the reflections of a community of practice of teachers, the participatory and collaborative nature of curriculum design is strengthened, where decisions arise not only from institutional guidelines but also from the shared analysis of the issues affecting students and their environment. This collective construction promotes the recognition of science as a situated practice, shaped by ethical, political, and cultural dimensions, which gains meaning insofar as it connects with everyday life. Thus, the curriculum framework not only articulates scientific knowledge but also local knowledge, school experiences, and future perspectives, generating a more humanizing and contextualized pedagogical proposal. Ultimately, this process fosters a school culture in which the curriculum ceases to be an end in itself and becomes a powerful means to drive meaningful transformations in natural science teaching, oriented toward social justice, environmental sustainability, and democratic participation.

Likewise, in the process of curricular transformation from the STSE approach, it is essential to rethink assessment strategies, orienting them toward a formative perspective that values the development of critical thinking, argumentation, and responsible decision-making in relation to real-world issues. Similarly, it is recognized that this curricular redesign implies a reconfiguration of the student's role, who assumes an active position as a subject of knowledge and an agent of change within their environment. However, this process is not without tensions: structural limitations, resistance to change, and gaps in teacher training are challenges that emerge, but

they also open the possibility of consolidating stronger processes of educational innovation.

In this regard, ensuring the sustainability of curricular transformations requires strengthening ongoing spaces such as the community of practice, as well as institutional commitment to recognizing the value of a living, critical, and situated curriculum framework. Finally, by incorporating the STSE approach, the curriculum assumes an unavoidable ethical dimension, inviting the formation of citizens capable of understanding that scientific and technological decisions are not neutral, and that their impact on society and the environment demands a comprehensive, committed, and deeply humanistic education.

D. Relationship of Theoretical Foundations.

The articulation between the STSE approach, communities of practice, and the curriculum framework forms an integrated model of educational transformation. Each of these pillars fulfills a specific function, but only their interconnection enables a deep and sustainable redefinition of pedagogical practices of pedagogical practices, as illustrated in Figure 1.

First, institutional documents ensure that modifications are aligned with national educational policies, guaranteeing coherence and compliance with academic standards.

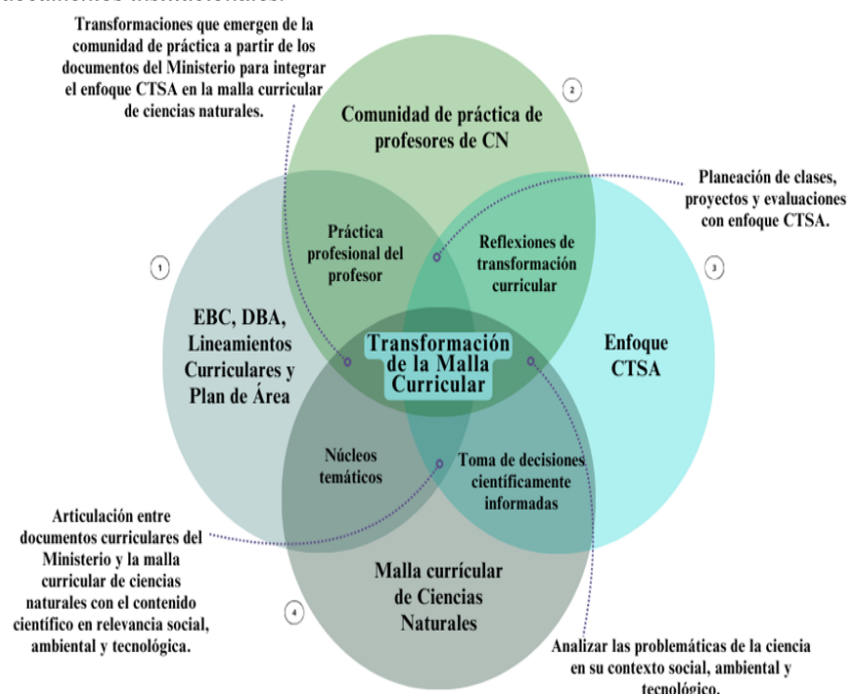
Second, communities of practice serve as the organizational driving force, acting as a catalyst for teacher reflection and collaboration in curricular change. Within this space, teachers not only analyze their own practices but also identify opportunities for improvement and curricular adaptations to integrate the new approach, resulting in more relevant and contextualized teaching. Third, the STSE approach, as one of the central theoretical foundations, provides the framework that connects scientific knowledge with contemporary social and environmental challenges, promoting an education that goes beyond the mere transmission of information toward a complex and interdisciplinary vision of scientific knowledge.

Finally, the curriculum framework, integrated with this approach, becomes the pedagogical mechanism that channels and materializes these transformations into coherent and meaningful classroom experiences, enabling students to address relevant issues through

active and meaningful methodologies for scientifically informed decision-making.

Figura 1

Transformación de la malla curricular; su relación entre fundamentos teóricos y documentos institucionales.



These reflective elements represent a conceptual foundation to guide curriculum transformation. By integrating these practices, a dynamic and adaptable educational environment is fostered, where the curriculum not only responds to current demands but also anticipates and adapts to future changes. Teachers, by collaborating and sharing their knowledge and experiences, enrich the educational process, promoting a culture of continuous improvement.

Students will not only be equipped with the knowledge necessary to understand and analyze their reality but will also be able to actively participate in building a more sustainable and equitable future. Ultimately, this curriculum transformation should be seen as an opportunity to empower both educators and students, promoting an education that goes beyond the classroom and has a positive impact on society.

In the context of ISPJB, this articulation has opened spaces for dialogue among natural science teachers across all educational levels, strengthening their critical capacities and designing curricular proposals centered on real-world problems. The interaction among these three components has demonstrated the possibility of constructing a curriculum that is more human-centered, inclusive, and relevant, aligned with the challenges of the 21st century and the educational needs of students.

This integrated model is not only valid within the specific context of this research but can also serve as a reference for other curriculum transformation processes at different levels and areas of knowledge. Promoting critical, participatory, and contextualized science education, it aligns with a transformative pedagogy that seeks to develop individuals capable of acting ethically and politically in response to global and local challenges.

III. FINAL CONSIDERATIONS.

The experience of curriculum transformation through the STSE approach, driven by the ISPJB teachers' community of practice, highlighted that educational reforms require more than the incorporation of new content or approaches; they demand a transformation of teaching practices, collaborative practices, and the role that scientific knowledge plays in students' daily lives.

A key finding has been the value of collective work. Curriculum decisions built through peer dialogue not only gain greater validity but also respond more effectively to the true needs of the school environment. However, this process also revealed several challenges, such as managing resistance to change, balancing institutional requirements with teacher autonomy, and maintaining motivation and commitment over time.

The transformation of the curriculum framework presented an opportunity to critically reconsider science teaching from a more contextualized perspective. This exercise led us to question the rigidity of official curricula and envision more flexible and integrative approaches attentive to local issues. The inclusion of socioscientific issues, rather than being an added burden, became a means to foster critical thinking, informed decision-making, and commitment to students' social and environmental reality.

Moving forward, the challenge is not only to sustain these changes but also to expand them to other levels and areas of knowledge. How can networks be built among communities of practice across different institutions? How can students actively participate in co-creating the curriculum? What role do families, community leaders, and other social actors play in this process?

These reflections open the door to new research and experiences that deepen curriculum transformation from

a critical and situated perspective. Rather than providing definitive answers, this work aims to continue provoking questions, conversations, and new ways of thinking about the school as a living space, where knowledge is collectively constructed and meaningful.

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