Integrating ICT-Mediated STEAM Pedagogy to Enhance Socio-Emotional Competencies in Primary Education: Evidence from Atlántico, Colombia

Autores: D. M. Vizcaino Lascano, Y. Rivera Julio

Fecha de recibido: abril 30 de 2025 – **Fecha de aprobado:** junio 06 de 2025–
Fecha de publicación: junio 27 de 2025

Como citar este artículo: D. M. Vizcaino Lascano, Y. Rivera Julio, "Integrating ICT-Mediated STEAM Pedagogy to Enhance Socio-Emotional Competencies in Primary Education: Evidence from Atlántico, Colombia", Inventum, vol. 20, no. 38, pp. 48-56, enero-junio año 2025. DOI: 10.26620/uniminuto.inventum.20.38.2025.06-27.

Editorial: Corporación Universitaria Minuto de Dios - UNIMINUTO.ISSN:1909-2520 eISSN: 2590-8219

Abstract

This research aims to generate a theoretical con- struct regarding innovative strategies for the development of STEAM competencies in primary school students from the Atlántico Department, Colombia. The study is grounded in the works of Ortiz and Suárez (2021), Pincay (2022), Campos (2020), Macaeli et al. (2020), and Castro and Guzmán (2022), and adopts an interpretive paradigm with a qualitative approach, employing hermeneutic phenomenology as the research method. Through observation and semi-structured interviews with four key teachers, the collected data were coded, categorized, and triangulated. The study identified emerging theoretical constructs encompassing conceptual references, descriptors of STEAM com- petencies, and types of innovative strategies. Findings suggest that implementing STEAM competencies promotes critical thinking and problem-solving in primary students. Ongoing teacher train- ing is recommended to keep educational practices aligned with technological and pedagogical advancements.

Keywords: innovative strategies, STEAM competencies, pri- mary education, qualitative research

I. INTRODUCTION

The rapid evolution of global challenges necessitates the transformation of traditional educational approaches. Integrat- ing STEAM competencies—Science, Technology, Engineer- ing, Arts, and Mathematics—in primary education offers a holistic pathway for fostering critical thinking, creativity, and collaborative problem-solving skills. In Colombia's Atlántico Department, educational institutions increasingly recognize the relevance of innovation in pedagogical strategies to prepare students for a dynamic and

PhD(R) Doctorado en Ciencias de la Educación, UMECIT, Panamá, Email: daysivizcaino.est@umecit.edu.pa

competitive future.

The current educational landscape demands that schools move beyond conventional disciplinary boundaries, embrac- ing interdisciplinary and experiential learning frameworks. STEAM education, by promoting inquiry-based learning and real-world application of knowledge, equips students with the cognitive and social tools necessary for navigating uncertainty and complexity. Moreover, it nurtures a mindset oriented to- ward innovation, adaptability, and continuous learning—traits essential for future personal and professional development.

The present study addresses the need to update teach- ing practices by exploring innovative strategies that enhance STEAM competencies at the primary level. Grounded in a qualitative interpretative methodology, the research contributes to the theoretical development of educational practices aligned with 21st-century competencies. Emphasis is placed on un- derstanding how pedagogical innovation can be contextually adapted to the sociocultural realities of the Atlántico Depart- ment, with a focus on equity, inclusion, and the democratiza- tion of access to technological and scientific knowledge.

By examining the implementation of STEAM-focused ini- tiatives in selected institutions, the study provides insights into the strengths and limitations of current approaches while proposing actionable recommendations. Ultimately, it aims to foster a more resilient, reflective, and inclusive educational ecosystem, capable of responding to the pressing needs of contemporary society through the empowerment of young learners.

II. THEORETICAL FRAMEWORK

The theoretical foundation of this study is based on four key dimensions that articulate the integration of STEAM education in primary schools: educational innovation, multidisciplinary learning through STEAM, development of socio-emotional competencies, and theoretical approaches such as connec- tivism and design thinking. These dimensions interconnect to shape a comprehensive pedagogical framework that responds to the challenges and opportunities of 21st-century education in the context of the Atlántico Department in Colombia.

resources (OER) and mobile learning initiatives that reach underserved rural or peri-urban populations.

- **STEAM Education:**

STEAM education (Science, Technology, Engineering, Arts, and Mathematics) proposes a holistic model that integrates different domains of knowledge in a cohesive learning paradigm. Aguilera et al. (2021) stress that STEAM is not limited to content acquisition, but involves the cultivation of habits of mind such as curiosity, perseverance, and intellectual flexibility. Through inquiry-based and project-based learning, students ex- plore real-world problems that require the application of knowledge across disciplines. The integration of the arts within STEM plays a crucial role in promoting divergent thinking, narrative construction, and design sensibility. These qualities are vital not only for future careers in science or engineering, but also for civic participation and lifelong learning. In the context of early childhood and primary education, STEAM lays the foundation for scientific literacy and digital competence from an early age. Students learn by doing, observing phenomena, collecting data, building models, and collaborating with peers in interdisciplinary teams. This approach fosters agency and a deeper understanding of how knowledge is produced and validated in society.

- **Socio-emotional Competencies:**

Socio-emotional competencies (SECs) are essential for holistic development and for ensuring that students thrive both academically and personally. According to Camacho et al. (2019), empathy—the ability to understand and share the feelings of others—is fundamental for building trust and cooperation in group learning environments. Díez (2022) highlights assertiveness as the capacity to express opinions and needs clearly and respectfully, en- abling students to participate in discussions and decision- making processes effectively. Tirapu (2020) emphasizes self-regulation as a key metacognitive skill that allows learners to control impulses, manage frustration, and sustain attention on complex tasks. These competen- cies are not only valuable in interpersonal relationships but also enhance resilience and adaptability—traits cru- cial in an ever-changing world. Within STEAM-oriented classrooms, socio-emotional skills are practiced in au- then-

tic situations: working collaboratively on prototypes, responding to failure as part of the iterative process, giving and receiving constructive feedback, and cele- brating collective achievements. The synergy between cognitive and emotional dimensions enriches the learning experience and supports the development of responsible and empathetic citizens.

- **Connectivism and Design Thinking:**

Connectivism and design thinking are two theoretical approaches that underpin the pedagogical models em- ployed in STEAM education. Siemens and Downes (2008) introduce connectivism as a learning theory for the digital age, where knowledge is distributed across

a network of connections, and learning consists of the ability to construct and traverse those networks. In the digital classroom, students interact with diverse informa- tion sources—videos, simulations, datasets, forums—and must learn to evaluate, synthesize, and apply knowledge in various contexts. Connectivism supports the idea that learning is no longer individualistic but deeply social and technological. This framework is particularly relevant in STEAM environments that use platforms such as virtual labs, collaborative design tools, and coding environments that connect students with global knowledge communi- ties.

In parallel, Rowe (1987) and more recent authors such as Brown (2009) define design thinking as a human-centered, iterative approach to problem solving that in- tegrates empathy, ideation, prototyping, and testing. Ap- plied in education, this methodology invites students to understand users' needs, brainstorm creative solutions, build tangible artifacts, and refine their ideas through feedback. In STEAM projects, design thinking provides a scaffold for interdisciplinary integration and allows stu- dents to experience the process of innovation firsthand. It promotes the development of systems thinking, creativity under constraints, and perseverance. Together, connec- tivism and design thinking form a dynamic pedagogical foundation that prepares students for future challenges in a world increasingly mediated by technology, complexity, and interdependence.

III. METHODOLOGY

This study adopts an interpretive paradigm with a qualitative approach, aiming to explore and understand the subjective meanings and lived experiences of primary school teachers implementing STEAM strategies in their classrooms. The interpretive paradigm is grounded in the belief that reality is socially constructed and context-dependent; therefore, knowl- edge is co-created through interaction between the researcher and participants (Denzin & Lincoln, 2018). This approach is particularly appropriate for studies focused on educational innovation and human behavior in dynamic teaching environ- ments.

Hermeneutic phenomenology, rooted in the works of Hei- degger and Gadamer, was selected as the guiding methodol- ogy. This approach seeks to reveal the essence of participants' experiences by interpreting their narratives in relation to their sociocultural and institutional contexts. Unlike purely descrip- tive phenomenology, the hermeneutic tradition allows the re- searcher's pre-understanding and interpretive lens to contribute to the construction of meaning. This methodology is well- suited for capturing the complex, emotional, and reflective dimensions of teachers' engagement with STEAM education, providing insight into how they make sense of their roles, challenges, and pedagogical transformations.

The methodological design emphasizes depth over breadth, privileging rich, contextualized data that reveal the nuances of educational change processes. In line with this philosophy,

data analysis was conducted through iterative cycles of coding and interpretation, following Van Manen's phenomenological approach. Particular attention was paid to identifying themes related to pedagogical innovation, affective responses, class- room interactions, and institutional support mechanisms.

IV. EXPERIMENTAL DESIGN

A. Research Design

This study employed a qualitative, multiple-case study de- sign framed within the hermeneutic phenomenological tradi- tion. The design aimed to explore, interpret, and describe the lived experiences of primary school

INVENTUM Volumen 20 No 38 enero-junio año 2025 | ISSN 1909-2520 | eISSN 2590-8219
DOI: 10.26620/UNIMINUTO.INVENTUM.20.38.48-56 |

teachers implementing STEAM strategies supported by Information and Communi- cation Technologies (ICT), with a focus on their influence on school coexistence. This interpretive methodology emphasizes understanding meaning from the participants' perspectives and within their contextual realities.

The design is aligned with Van Manen's (1990) approach to hermeneutic phenomenology, which integrates reflection on lived experience with interpretative analysis. The selection of cases—teachers from varied primary school contexts—allowed for a comparative, in-depth analysis of practices across in- stitutional and geographic settings (urban and semi-rural). The triangulation of methods (interviews, observations, and pedagogical artifacts) reinforced the internal validity of the study and ensured a rich, multi-layered understanding of the phenomena.

B. Objectives and Research Questions

General Objective:

To analyze how STEAM strategies mediated by ICT influence school coexistence practices in primary education settings in the Atlántico Department, Colombia.

Research Questions:

•How do primary school teachers integrate ICT-mediated STEAM strategies into their classroom practices?

•What meanings do teachers assign to these strategies in terms of their impact on school coexistence?
•How do students respond—socially and emotionally—to these pedagogical interventions?

C.Participants and Sampling

The participants were four in-service primary school teach- ers, purposefully selected based on the following inclusion criteria:

•Minimum of three years of teaching experience in primary education.

•Documented participation in professional development related to STEAM and/or educational technology.

•Evidence of classroom implementation of interdisciplinary, ICT-supported strategies.

The sampling strategy was non-probabilistic and criterion- based, aiming to capture rich, experiential narratives from informants identified as pedagogical innovators in their institu- tions. The teachers worked in varied settings (two urban, two semi-rural), allowing for contextual diversity in the analysis.

D. Intervention Context and Duration

Although not a traditional experimental manipulation, the study involved the observation and interpretation of a naturally occurring pedagogical intervention: the implementation of STEAM projects involving ICT tools over a three-month pe- riod. Each teacher integrated 3–5 STEAM-based projects, ad- dressing both disciplinary content and social-emotional com- petencies related to school coexistence. The projects included the use of digital storytelling, collaborative platforms, creative design apps, and coding environments, all adapted to real classroom needs.

E.Data Collection Techniques

The data collection process followed a triangulated strategy involving:

• **Semi-structured Interviews:**
Conducted in two phases with each teacher. Interviews explored pedagogical decision-making, reflections on stu- dent behavior, perceived changes in classroom dynamics, and professional development processes.

• **Classroom Observations:**
Non-participant observations were carried out during STEAM sessions. Field notes and a structured observation guide were used to document instances of collaboration, emotional expression, conflict resolution, and technology integration.

• **Pedagogical Artifacts:**
Student-created products (digital stories, visual designs, programming outputs) and teacher lesson plans were collected to contextualize observed practices and support the interpretive analysis.

F. Data Analysis Strategy

Data were analyzed through an iterative, thematic co-

ding process using NVivo. The stages included:

1) Transcription and organization of interview and obser- vation data.

2) Initial coding to identify recurring concepts (e.g., empa- thy, collaboration, digital ethics).

3) Axial coding to group concepts into broader categories (e.g., socio-emotional mediation, digital citizenship).

4) Interpretive synthesis, combining codes with narrative excerpts and visual evidence to reconstruct the peda- gogical meaning of ICT-STEAM strategies.

Coding reliability was enhanced through researcher triangu- lation and member checking with participants. Data saturation was reached after the second interview round, as no new conceptual categories emerged.

G. Ethical Considerations

The research adhered to ethical protocols in accordance with national educational research guidelines:

• Informed consent was obtained from all participants.

• Anonymity was preserved through coded identifiers.

• Teachers were allowed to withdraw from the study at any time without penalty.

• Audio recordings and documents were securely stored and used only for academic purposes.

V. RESULTS

Drawing on semi-structured interviews and classroom ob- servations, our hermeneutic phenomenological analysis under- scored the key role of multimedia tools in fostering teachers' digital competences, while also highlighting how STEAM- oriented pedagogical practices significantly enhanced students' socio-emotional skills and improved classroom coexistence. The interpretive analysis yielded several interrelated cate- gories—spanning teachers' adoption of multimedia applica- tions, conceptual references supporting digital competence formation, contributions to pedagogical practices, and teacher agency—alongside emergent themes related to digital citizen- ship and the need for infrastructure improvements. Simulta- neously, the integration of Information and Communication Technologies (ICT) within STEAM strategies further catalyzed positive transformations in school coexistence and classroom climate. Below, we present these interconnected findings in detail.

A. 1. Multimedia Tools Employed by Teachers

Teachers reported using a variety of multimedia applications to strengthen their digital competences and enrich student learning. Common platforms included Google Suite tools (Drive, Classroom, Meet), specialized software for design or presentations (Canva, PowerPoint), and interactive apps (Ka- hoot, ClassDojo). These resources facilitated lesson planning, grade tracking, content creation, and classroom management. Despite these benefits, frequent connectivity disruptions and limited device availability often constrained the full potential of multimedia integration, especially in semi-rural schools.

B. 2. ICT Usage in STEAM Contexts

Within STEAM-based projects, teachers intentionally har- nessed ICT to promote disciplinary learning alongside values- based reflection. Activities such as coding cooperative games, designing digital prototypes to solve community issues, or creating interactive stories about conflict situations boosted student engagement and collaboration. Observational data showed reduced verbal aggression and stronger cohesion among students working in digitally mediated group tasks. Participants attributed these shifts to structured interactions in multimedia or coding environments, which reinforced not just disciplinary content but also communication skills and empathy.

C. 3. Conceptual References Supporting Multimedia in Digital Competence Formation

Participants frequently cited guidelines from UNESCO re- garding ICT integration in teacher training, along with the Colombian Ministry of Education (MEN, 2013) standards on digital competences. These frameworks highlighted the need for continuous professional de-

INVENTUM Volumen 20 No 38 enero-junio año 2025 | ISSN 1909-2520 | eISSN 2590-8219
DOI: 10.26620/UNIMINUTO.INVENTUM.20.38.48-56 |

velopment encompassing both technical know-how and pedagogical design. However, teachers noted constraints such as limited formal training programs and scarce resources, leading many to rely on peer collaboration or self-directed tutorials. This reliance on personal initiative underscores a gap in institutional support and hints at how school policies and training structures must evolve to bolster teachers' digital competence.

D. 4. Technological Tools for Socio-Emotional Learning

Teachers also emphasized the significance of multimedia in developing socio-emotional competencies. Platforms like Book Creator, Canva, and coding interfaces (e.g., Scratch) offered students meaningful opportunities to practice empathy, perspective-taking, and collaborative decision-making. One project asked learners to produce short animated films about real-life classroom conflicts—prompting them to propose nonviolent solutions and reflect on the emotional implications of each scenario. This creative, simulation-based usage of technology motivated emotional literacy, allowing students to approach coexistence challenges in a safe, mediated environ- ment.

E. 5. Contributions of Multimedia Tools to Pedagogical Prac- tice

All participants recognized substantial benefits arising from their use of multimedia tools:

•Enhanced Engagement: Visually appealing content, in- teractive simulations, and dynamic media maintained students' curiosity and active involvement in class.

•Personalized Instruction: Multimedia-based activities, such as videos, animated tutorials, and gamified quizzes, enabled students to learn at their own pace and according to their individual learning styles.

•Collaborative Learning: Shared documents and group- based projects, facilitated by digital applications, pro- moted teamwork, creativity, and collective problem- solving.

Despite these strengths, teachers noted the need for infras- tructure upgrades—including reliable internet and sufficient devices—and consistent institutional support to ensure equi- table multimedia access for all students.

F. 6. Teacher Agency and Pedagogical Transformation

A pivotal finding concerned the professional agency of trained teachers. Those who had participated in workshops on STEAM and ICT integration showed higher confidence and autonomy in designing technology-mediated instruction. Their lesson plans deliberately aligned STEAM competencies with socio-emotional objectives, modifying activities in response to classroom dynamics. As one teacher explained, "technology allowed me to redirect conflicts into learning moments," shifting from a reactive disciplinary stance to a proactive, coexistence-building approach. This underscores how teacher agency can translate digital resources into meaningful ped- agogical action when backed by institutional support and ongoing training.

G. 7. Emerging Theme: Digital Citizenship and Coexistence

Interview and classroom data revealed digital citizenship as a core element in fostering positive coexistence. Students or- ganically used phrases like "respecting opinions," "listening to others," and "collaborating online," signifying the internaliza- tion of coexistence principles in STEAM-based digital tasks. Teachers contributed to this process by emphasizing digital ethics, equitable participation, and the appropriate expression of emotions. Consequently, digital coexistence evolved from a peripheral add-on to a central axis in instructional design, demonstrating the transformative potential of well-aligned technology use.

H. 8. Evidence from Observational Measures

1) Changes in Classroom Coexistence Indicators:

To com- plement qualitative insights, a coding of student behaviors (Collaboration, Peaceful Conflict Resolution, and Classroom Climate) revealed a clear upward trend in median scores and a reduction in variability after the introduction of ICT in STEAM projects. Figure 1 displays these boxplots, reflecting im-

proved peer interactions and heightened cooperative skills among learners.

Qualitative Coding of STEAM-Based Coexistence Indicators

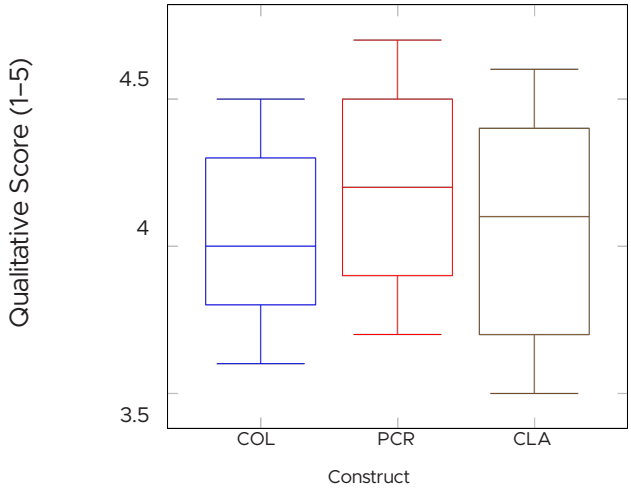

Figure 1. Boxplots of Teacher-Coded Coexistence Indicators (COL, PCR, CLA)

2)Teacher Confidence in Coexistence Management: Be- yond student outcomes, teachers reported significant growth in their capacity to manage coexistence through STEAM- based ICT. Figure
2 shows a comparative bar chart of four surveyed teachers' self-assessed confidence levels (on a 1– 5 scale) before and after the intervention.

The clear gains in all four cases highlight the positive impact of targeted ICT training and reflective teaching practices on teacher self- efficacy and classroom harmony.
Taken together, these qualitative and quantitative indicators reinforce the idea that integrating multimedia tools and STEAM-based strategies not only augments academic

Teacher Confidence Before and After STEAM Intervention

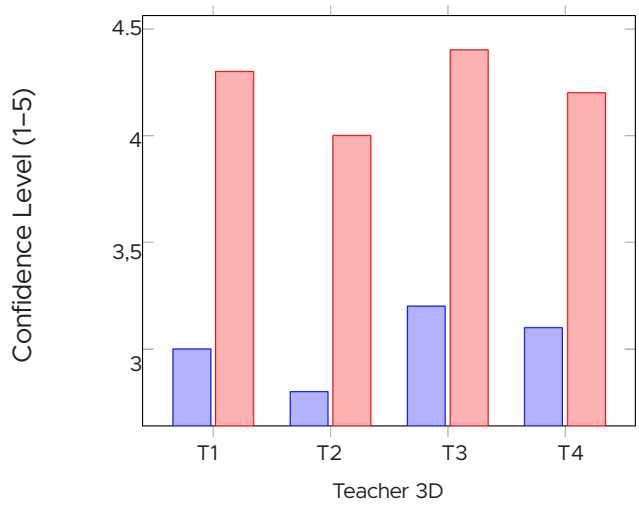

Figure 2. Teacher-Reported Confidence in Promoting Coexistence with STEAM

engagement but also contributes to the construction of emo- tionally safe, ethically grounded learning environments. As demonstrated by both teacher narratives and coding data, the cohesive implementation of ICT fosters positive behavioral changes in students and empowers educators with heightened confidence, opening a pathway for sustained innovation and inclusive educational practices.

VI. DISCUSSION

The findings of this study reinforce the idea that STEAM- based educational strategies—particularly those mediated by Information and Communication Technologies (ICT)—have the potential to significantly enhance school coexistence in primary education. Teachers reported that the interdisciplinary and student-centered nature of STEAM promoted active en- gagement, emotional regulation, and collaborative behavior among learners. These strategies not only facilitated the devel- opment of academic and technological competencies but also strengthened students' socio-emotional skills, such as empathy, conflict resolution, and digital citizenship.
The integration of ICT tools, when framed within mean- ingful learning experiences, enabled teachers to design ped- agogical situations that addressed real-life social dilemmas, encouraged prosocial decision-making, and provided safe envi- ronments for reflective dialogue. Students responded positively to activities that allowed emotional expression and collective pro-

INVENTUM Volumen 20 No 38 enero-junio año 2025 | ISSN 1909-2520 | eISSN 2590-8219
DOI: 10.26620/UNIMINUTO.INVENTUM.20.38.48-56 |

blem-solving, especially when using creative platforms such as digital storytelling and collaborative design.
However, several challenges persist. Limited access to tech- nological resources—particularly in rural schools—remains a barrier to the widespread implementation of these approaches. Teachers expressed concerns about insufficient equipment, unstable internet connections, and restricted availability of classroom time for interdisciplinary projects. In addition, al- though the participating teachers had prior experience with educational innovation, many highlighted the need for continu- ous professional development specifically focused on STEAM methodologies and socio-emotional pedagogy.

Institutional support emerged as a critical enabler of success. Schools that promoted teacher autonomy, interdisciplinary planning, and curricular flexibility were better positioned to implement these strategies effectively. Conversely, rigid sched- ules and lack of administrative alignment hindered sustained implementation. Therefore, educational policy and leadership must prioritize structural and cultural shifts that support peda- gogical innovation aligned with 21st-century skills and values of peaceful coexistence.

VII. CONCLUSIONS

The interpretive and visual findings of this study support the conclusion that integrating STEAM and ICT within primary school education can serve as a powerful driver of school coexistence and socio-emotional development. Specifically:

• STEAM-based methodologies promote empathy, collab- oration, and responsible participation, reinforcing peace- ful conflict resolution and improving classroom climate.

• ICT tools, when used intentionally and ethically, support inclusive, emotionally responsive learning environments and serve as mediators for democratic dialogue and digital citizenship.

• Teacher training and agency are essential for the successful design and facilitation of these strategies. Empowered educators can effectively align technological innovation with coexistence goals.

• Institutional commitment and infrastructure investment are necessary to ensure equity in access to educational technologies and continuity of innovation in both urban and rural contexts.

VIII. FUTURE WORK

Building on the results of this study, future research should consider:

•Conducting longitudinal studies to examine the sustained impact of STEAM strategies on student behavior, emotional development, and social dynamics over time.

•Developing mixed-methods approaches that integrate qualitative interpretations with robust quantitative data on academic performance, coexistence indicators, and socio- emotional competencies.

•Designing context-sensitive technological resources adapted to the realities of rural and low-income schools in the Atlántico Department, ensuring culturally relevant content and offline functionality.

•Exploring teacher professional learning communities (PLCs) focused on STEAM and digital coexistence, enabling collective reflection, co-design of strategies, and dissemination of good practices across institutions.

REFERENCES

[1] D. Aguilera et al., “STEAM Education for the 21st Century,” Revista Educativa, vol. 45, no. 2, pp. 203–221, 2021.

[2] G. Campos et al., “Innovación educativa en la práctica docente,” Revista Iberoamericana de Educación, vol. 82, no. 1, pp. 87–102, 2020.

[3] J. Castro and M. Guzmán, “Estrategias innovadoras en la enseñanza primaria,” Innovación Educativa, vol. 14, no. 3, pp. 54–69, 2022.

[4] T. Macaeli et al., “Integración de las artes y la tecnología en la educación,” STEAM Now Journal, vol. 7, no. 1, pp. 88–104, 2020.

[5] L. Ortiz and P. Suárez, "Competencias STEAM en niños y niñas del Atlántico," Educación y Futuro, vol. 11, no. 4, pp. 145–160, 2021.

[6] A. Pincay, "Estrategias innovadoras para mejorar el desempeño docente," Tesis Doctoral, Universidad César Vallejo, 2022.

[7] G. Siemens and S. Downes, "Connectivism and the future of learning," International Journal of Instructional Technology, vol. 5, no. 1, pp. 12– 25, 2008.

[8] J. Tirapu, "Neuroeducación y autocontrol," Psicología Educativa, vol. 10, no. 2, pp. 34–49, 2020.

Mg. Daysi Margarita Vizcaino Lascano

Estudió la maestría en pedagogía en la Universidad Autónoma del Caribe, en la actualidad es doctorante en el Doctorado en Ciencias de la Educación con Énfasis en Investigación, Evaluación y Formulación de Proyectos Educativos, UMECIT, Panamá. Centra sus estudios en STEAM e innovación educativa.

INVENTUM Volumen 20 No 38 enero-junio año 2025 | ISSN 1909-2520 | eISSN 2590-8219
DOI: 10.26620/UNIMINUTO.INVENTUM.20.38.48-56 |