

Constructivist Pedagogical Mediation and Student Retention in Higher Education: A Systematic Mapping Study with an Emphasis on STEAM Programs in Costa Rica

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Abstract. This study examines the relationship between constructivist pedagogical mediation and student retention in higher education, emphasizing STEAM programs in Costa Rica. A Systematic Mapping Study following PRISMA guidelines identified 176 records published between 2015 and 2026; 29 met the inclusion criteria. Evidence associates active learning, social interaction, and self-regulated learning with academic performance, engagement, motivation, and retention. Collaborative learning, problem- and project-based learning, design thinking, gamification, and educational technologies emerge as relevant mediation strategies, whose effectiveness depends on institutional support, teacher preparation, and student context. The scarcity of Costa Rican empirical studies, particularly in STEAM, highlights the need for local validation.

Keywords: constructivism, pedagogical mediation, student retention, higher education, STEAM.

Mediación pedagógica constructivista y permanencia estudiantil en la educación superior: un estudio de mapeo sistemático con énfasis en carreras STEAM en Costa Rica

Resumen. Este estudio analiza la relación entre la mediación pedagógica constructivista y la permanencia estudiantil en educación superior, con énfasis en carreras STEAM en Costa Rica. Mediante un Estudio de Mapeo Sistemático

basado en PRISMA se identificaron 176 registros publicados entre 2015 y 2026; 29 cumplieron los criterios de inclusión. La evidencia vincula el aprendizaje activo, la interacción social y la autorregulación con el rendimiento, la motivación, el compromiso y la permanencia. El aprendizaje colaborativo, el aprendizaje basado en problemas y proyectos, el design thinking, la gamificación y las tecnologías educativas destacan como estrategias de mediación. La escasez de estudios empíricos costarricenses, particularmente en STEAM, evidencia la necesidad de validación en el contexto nacional.

Palabras clave: constructivismo, mediación pedagógica, permanencia estudiantil, educación superior, STEAM.

1 Introduction

Higher education in Costa Rica faces economic, social, and pedagogical challenges affecting quality, retention, and graduation. In 2026, FEES negotiations have emphasized equity, employability, system efficiency, and shorter time-to-degree, reflecting growing reliance on outcome- and performance-based indicators (El Guardian CR, 2026).

These demands create tension between comprehensive education and efficiency; however, graduation timelines cannot be attributed solely to universities because students' trajectories span earlier educational stages and broader socio-educational conditions.

Retention and success are therefore multifactorial, arising from prior educational trajectories and students' economic, social, and academic conditions (Cabrera et al., 1993; Tinto, 1993; Yorke & Longden, 2008; UNESCO, 2021).

Dropout remains especially challenging in STEAM fields. Constructivism offers a relevant response by promoting active, meaningful, student-centered learning; accordingly, this study analyzes the role of constructivist pedagogical practices in student retention and graduation in STEAM programs.

2 Theoretical Framework

Constructivism conceives learning as an active process of knowledge construction involving cognitive and social dimensions (Carretero, 1997; Trenas, 2009) and teacher-student interaction oriented toward meaningful learning (Benítez-Vargas, 2023).

2.1 Cognitive Constructivism

Piaget (1970) describes knowledge as a construction produced as individuals reorganize cognitive structures through interaction with the environment.

According to Piaget, intellectual development requires exposure to change—an unfamiliar event that generates uncertainty and cognitive conflict—challenging existing paradigms and leading to the development of new ideas or functional schemas.

Through his theory, Piaget emphasizes individual principles for knowledge construction via the concept of equilibration, which conceptualizes intelligence as a sequence of states of disequilibrium and equilibrium. Disequilibrium is triggered by

external changes, whereas equilibrium represents the individual's activity in compensating for such disruptions, ultimately establishing a new cognitive balance (Piaget, 1969).

Ausubel complements this view by emphasizing prior knowledge as the basis for new learning: instruction should identify what learners already know and connect new content to that cognitive structure (Ausubel, 1968), thereby supporting meaningful and durable understanding.

2.2 Social Constructivism

Vygotsky (1978) places social interaction at the center of learning, emphasizing that knowledge construction is socially mediated rather than exclusively individual.

A central concept within social constructivism is the zone of proximal development (ZPD), defined as the distance between what a learner can accomplish independently and what can be achieved with the guidance of a more knowledgeable other, such as a teacher or tutor. In this regard, Vygotsky (1978) asserts that “what a child can do today with help, they will be able to do independently tomorrow” (p. 87), highlighting the progressive nature of learning through guided interaction.

Furthermore, sociocultural constructivism conceptualizes learning as an inherently social and culturally mediated process, in which cognitive development does not occur in isolation but emerges through interaction with others within specific historical and social contexts. Consequently, the context in which individuals operate plays a determining role in shaping their cognitive processes, behaviors, and forms of socialization.

Moreover, Vygotsky (1986) argues that “the development of higher psychological processes occurs first on the social level and then on the individual level” (p. 57). This perspective extends the primarily cognitive focus proposed by Piaget by introducing a dual-level framework that integrates both social and individual dimensions in the construction of knowledge, thereby reinforcing the need for a comprehensive understanding of learning as a socially mediated process.

2.3 Sociocognitive Constructivism

Sociocognitive constructivism extends cognitive constructivism toward a sociocultural perspective. Bruner shares Piaget's view that learning is actively constructed, particularly through discovery.

Under this premise, Bruner (1960) posits that learning constitutes an active process in which learners construct new ideas or concepts based on their prior knowledge. This perspective aligns closely with Vygotsky's theoretical framework, wherein knowledge is shaped through social and cultural experiences.

Furthermore, Bruner (1966) argues that instruction should be organized in such a way that content is easily comprehensible for learners and structured to facilitate retention. In this regard, the teacher plays a critical role in providing an initial framework for knowledge construction and progressively organizing the complexity of learning tasks, thereby functioning as a guide within the pedagogical process.

The contributions of Piaget, Vygotsky, Ausubel, and Bruner collectively allow for the understanding of constructivism as a broad and complementary theoretical framework. While Piaget focuses on internal cognitive processes related to development, Vygotsky expands this view by incorporating social and cultural interaction. Similarly, Ausubel emphasizes the foundational role of prior knowledge in meaningful learning, moving beyond an exclusive reliance on discovery. Finally, Bruner integrates these perspectives by proposing guided instruction that articulates both individual and social dimensions through scaffolding.

Taken together, these perspectives complement and enrich one another in a holistic manner, providing a robust theoretical foundation for understanding learning as an active, contextualized, and mediated process—particularly relevant in contemporary educational environments.

2.4 Pedagogical Mediation

Pedagogical mediation is an intentional process in which teachers create conditions for critical, contextualized, and meaningful knowledge construction (Mejía, 2020), consistent with the teacher's guiding role described by Coll (2001).

Within a constructivist framework, mediation combines educational intentionality, scaffolding, the ZPD, social interaction, and contextualization. Teacher guidance is progressively adjusted as students assume greater responsibility for learning (Bruner, 1960; Vygotsky, 1978; Bruning et al., 1999; Díaz Barriga, 2002; Sesento García, 2017), as summarized in Figure 1.

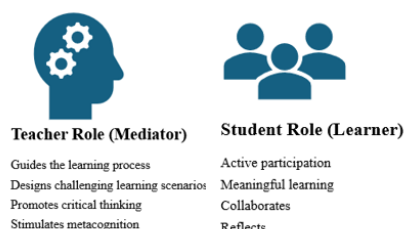


Figure 1. Role of the teacher and the student in constructivist pedagogical mediation.

Effective pedagogical mediation requires coordination of teacher and student roles to create meaningful learning environments adapted to specific contexts. Its principal contributions include:

This form of pedagogical mediation highlights significant contributions of constructivism in addressing contemporary social and educational challenges, particularly in the following aspects:

- **Emphasis on meaningful learning:** Rather than focusing on information retention or memorization, constructivist mediation prioritizes the understanding and application of knowledge through critical thinking and contextual problem analysis.
- **Inclusive education:** Learning is adapted to the individual's pace and context, recognizing that knowledge construction is mediated through interaction, thereby fostering more collaborative practices.
- **Learner adaptability:** Meaningful learning enables individuals to apply knowledge in dynamic and changing environments, as constructivism promotes key competencies such as autonomy and metacognition.
- **Humanistic orientation:** Constructivism places the learner at the center of the educational process, ultimately contributing to the development of reflective professionals.

In summary, these elements support the understanding of constructivism not merely as a theory of learning, but as a relevant response to current social and educational challenges. Its approach provides a robust framework for addressing contemporary demands in a comprehensive manner, recognizing that learning involves far more than the acquisition of content—it entails the integration of knowledge with context, experience, and social interaction.

These features are particularly relevant in STEAM programs because their practical, student-centered orientation links knowledge to authentic problems and changing contexts.

3 Methodology

3.1 Research Design

As a methodological approach, this study adopts the Systematic Mapping Study (SMS), a strategy aimed at comprehensively organizing a research field through the identification, classification, and analysis of existing scientific evidence (Petersen et al., 2015). Unlike traditional systematic reviews, which address specific research questions, SMS provides a broader overview of the available body of knowledge.

Within the context of this study, the SMS approach is employed to analyze constructivism and its relationship with student retention in higher education, with a particular emphasis on STEAM programs. This approach allows for a comprehensive examination of its pedagogical implications as well as the identification of existing gaps within the field.

3.2 Research Questions

To guide the mapping process, the following research questions were defined:

RQ1. What are the most commonly applied constructivist principles in higher education, and which authors support their pedagogical use?

RQ2. What constructivist-based pedagogical mediation strategies are reported in higher education studies?

RQ3. What empirical evidence exists regarding the relationship between constructivist practices and student retention or dropout?

RQ4. What contextual, institutional, or teaching-related factors influence the effectiveness of constructivism in higher education environments?

RQ5. How does constructivist pedagogical mediation influence student retention in STEAM programs within Costa Rican higher education?

3.3 Search Strategy

Searches were conducted from April 1 to April 12, 2026 using: ("constructivismo" OR "constructivism") AND ("educación superior" OR "higher education") AND ("permanencia estudiantil" OR "student retention" OR "deserción" OR "dropout") AND ("mediación pedagógica" OR "pedagogical mediation" OR "aprendizaje activo" OR "active learning").

Scopus, Web of Science, IEEE Xplore, ScienceDirect, and Dialnet were searched, with Google Scholar used for exploratory support. Spanish and English publications from 2015-2026 were considered to combine international, technical, and regional evidence.

3.4 Inclusion and exclusion criteria

Studies were selected using predefined criteria. Inclusion required peer-reviewed journal articles or conference papers; empirical studies, systematic reviews, or Latin American research aligned with the search; a higher-education focus on constructivism, mediation, active learning, or retention; full-text access; and Spanish or English publication.

Exclusion criteria were duplicates, unsupported opinion pieces, primary/secondary studies without an explicit higher-education link, tangential treatment of constructivism, and publications outside 2015-2026.

3.5 Data Extraction

For each study, the extracted fields were author(s), year, title, database source, study type, country, main contribution related to retention or pedagogical mediation, and access link. These fields supported comparative analysis and the research questions.

3.6 Study Classification Framework

Following PRISMA and SMS guidance (Kitchenham, 2004; Kitchenham et al., 2010; Petersen et al., 2015), the process comprised planning (gap, research questions, search strategy, and criteria), execution (duplicate removal, title/abstract screening, and full-text screening), and reporting/classification of the selected evidence.

The search yielded 176 records. After removing 38 duplicates, 138 remained; title/abstract/keyword screening and eligibility checks excluded 95, leaving 43 for full-text review. Fourteen additional studies failed the higher-education or inclusion criteria, producing a final sample of 29 studies.

4 Results

The 29 studies selected through PRISMA were classified by methodological approach and findings on constructivism, higher education, retention, and STEAM education. The resulting evidence addresses the five research questions below.

4.1 Main Constructivist Principles in Higher Education (RQ1)

The collected evidence highlights the constructivist principles that account for the majority of documented pedagogical applications in higher education: active learning (10 studies, 34.5%), social interaction (8 studies, 27.6%), and self-regulated learning (4 studies, 13.8%). These principles do not operate in isolation; rather, they are integrated into pedagogical practices that position the student as the central agent in the learning process.

Active learning (10 studies; 34.5%), social interaction (8; 27.6%), and self-regulated learning (4; 13.8%) were the most frequent constructivist principles. Active learning produces higher measured learning than traditional lectures despite students sometimes perceiving the opposite (Deslauriers et al., 2019), yet remains a minority practice in North American STEAM classrooms (Stains et al., 2018).

Self-regulated learning is a transversal component of contemporary digital constructivism (Faza & Lestari, 2025). Training improves performance, strategies, and motivation ($g = 0.37$; Theobald, 2021), while progressively withdrawn scaffolding strengthens metacognition and performance (Shao et al., 2023), consistent with Bruner (1966) and Vygotsky (1978).

Social interaction also supports engagement in face-to-face inquiry communities (Ariati et al., 2023) and is associated with critical thinking and autonomy (Doan et al., 2025). Together, these principles form the main operational basis of constructivist practice in higher education.

4.2 Constructivist-Based Pedagogical Mediation Strategies (RQ2)

The literature groups mediation strategies into active methodologies, interactive technological environments, and collaborative dynamics (Table 1), including project/problem-based learning, design thinking, gamification, and tutoring; categories may overlap.

Table 1. Constructivist-based pedagogical mediation strategies.

Strategy	Number of Studies	Percentage Representation
Active methodologies	5	17.24%
Interactive technological environments	4	13.79%
Collaborative dynamics	9	31.03%
Other uncategorized strategies	11	37.92%

In engineering, social constructivism can improve performance and retention through collaborative knowledge construction (Khalid et al., 2023), while engagement linked to collaborative learning predicts retention (Immanuella et al., 2023). Problem/project-based learning strengthens competencies and performance (Wiyono et al., 2025), and design thinking supports motivation, complex problem solving, creativity, and knowledge transfer (Tsai et al., 2023; Guaman-Quintanilla et al., 2022).

Technology-mediated constructivist environments improve motivation and learning strategies (Do et al., 2023); gamification enhances content retention and engagement (James et al., 2024); and technology-supported active learning can reduce anxiety and improve attitudes (Rezai et al., 2025). Across strategies, intentional teacher mediation remains essential (Mejía, 2020).

4.3 Constructivist Practices and Student Retention (RQ3)

Evidence is convergent but heterogeneous: 44.8% of studies report direct effects on retention and 41.4% indirect effects through dropout-related variables; the remainder focus on dropout or provide no explicit retention evidence.

Active learning reduces STEAM achievement gaps and failure rates, as shown in a meta-analysis of 44,000 students (Theobald et al., 2020), while constructivist practices in engineering increase program retention (Hempel et al., 2020). Inclusive constructivist pedagogy also responds to diverse trajectories, learning paces, and contexts (Lagrimas & Buenaventura, 2023; Jackson-Summers et al., 2024).

Conversely, non-active methods are associated with dropout (Quincho Apumayta et al., 2024). Latin American evidence links perceived educational quality and pedagogical mediation to retention (Núñez-Silva et al., 2025) and identifies the mismatch between traditional teaching and contemporary demands as a contributor to attrition (Salgado Medina et al., 2024). Overall, constructivist practices are associated with lower dropout when combined with teacher support, interaction, and self-regulation.

4.4 Effectiveness of Constructivism in Higher Education (RQ4)

Constructivist effectiveness depends on institutional, teaching, and student factors. Institutionally, infrastructure, teaching quality, accreditation (Alcaraz, 2025), equity policies, and support mechanisms (Iriarte et al., 2019) shape implementation conditions.

At the teaching level, self-efficacy and pedagogical competence are positively associated with student performance (Ma et al., 2025); constructivist/reflective teacher

preparation supports active learning (Lalor et al., 2015); and tutoring or mentoring can reduce dropout (Ziadet Bermúdez et al., 2025). At the student level, interaction with teachers and peers supports retention, especially among underrepresented groups (Crisp et al., 2015), while self-regulation predicts performance (Faza & Lestari, 2025).

Despite this evidence, traditional lecture-based teaching remains common in STEAM, revealing a systemic implementation gap (Stains et al., 2018). Table 2 summarizes the main dimensions identified: motivation, equity/inclusion, engagement, and student contextual conditions.

Table 2. Effectiveness of constructivism in higher education.

Core Dimension	Number of Studies	Percentage Representation
Student motivation	4	13.8%
Equity and inclusion	4	13.8%
Engagement	3	10.3%
Student contextual factors	3	10.3%

4.5 Constructivism and Student Retention in STEAM Programs in Costa Rica (RQ5)

No study directly addressed constructivist pedagogical mediation, STEAM programs, and student retention simultaneously in Costa Rica. The only national study in the mapping analyzes university dropout through a multinomial predictive model but does not focus on constructivist strategies or STEAM (Fernández-Martín et al., 2019). Thus, RQ5 can only be answered through cautious inference from international evidence.

International findings converge on reduced STEAM achievement gaps through active learning (Theobald et al., 2020), improved engineering retention through constructivist practices (Khalid et al., 2023; Hempel et al., 2020), teacher support as a mediating factor (Ma et al., 2025), and Latin American retention determinants (Núñez-Silva et al., 2025; Salgado Medina et al., 2024). This supports a theoretically grounded hypothesis of positive effects that requires empirical validation in Costa Rica; Table 3 shows the evidence distribution and the predominance of international studies.

Table 3. Evidence map of the systematic mapping study.

Dimension	Category	Number of Studies	Percentage
Constructivist principles (RQ1)	Active learning	10	34.5%
	Social interaction	8	27.6%
	Self-regulation	4	13.8%
	Others	7	24.1%
Pedagogical mediation strategies (RQ2)	Collaborative dynamics	9	31%
	Active methodologies	5	17.2%

Effectiveness factors (RQ4)	Technological environments	4	13.8%
	Others	11	37.9%
	Motivation	4	13.8%
	Inclusion	4	13.8%
	Engagement	3	10.3%
Geographic context (RQ5)	Student context	3	10.3%
	Costa Rica	1	3.4%
	International	28	96.6%

5 Discussion

The findings of this study indicate that pedagogical practices grounded in constructivism—particularly active learning, social interaction, and self-regulated learning—are associated with improved academic outcomes and more favorable conditions for student retention in higher education.

Active learning emerges as the most prominent approach identified in this study, aligning with existing literature that challenges the predominance of traditional teaching methods in STEAM disciplines. However, a significant gap in its implementation is observed, suggesting that the primary challenge for educators lies not in the theoretical understanding of constructivist principles, but rather in their practical application within the classroom. This finding is consistent with previous studies that position active learning as a central driver in the transformation of higher education teaching practices.

Furthermore, the relationship between constructivism and student retention is not always direct. In many studies, its impact is mediated through intermediate variables such as motivation, academic performance, and student engagement, indicating that retention should be understood as a multifactorial phenomenon.

Similarly, the effectiveness of the constructivist approach depends on a range of factors, including teacher training, institutional context, and student conditions. In this regard, the role of the teacher as a mediator is fundamental for ensuring the effective implementation of these pedagogical strategies.

Finally, the absence of studies directly addressing this relationship within the Costa Rican context highlights a significant gap in the literature. This not only reinforces the relevance of the present study but also underscores the need for the development of empirical research at the local level, particularly within STEAM programs.

6 Conclusions

Across the 29 studies, student-centered learning that promotes active participation and interaction is consistently associated with stronger academic outcomes and retention. In relation to the research questions:

- (i) active learning, social interaction, and self-regulation are the most recurrent constructivist principles in higher education;
- (ii) active methodologies, technological environments, and collaborative dynamics—especially problem/project-based learning, design thinking, and gamification—are the most reported mediation strategies;
- (iii) empirical evidence links constructivist practices to retention directly and indirectly through performance, motivation, and engagement;
- (iv) effectiveness is conditioned by institutional, teaching, and student factors, particularly motivation, inclusion, engagement, and mediation quality; and
- (v) the lack of studies directly connecting constructivist mediation, retention, and STEAM in Costa Rica creates a clear opportunity for applied research. Future empirical studies should validate these relationships nationally while integrating pedagogical, institutional, and social factors.

Author Contributions

The authors contributed to the development of this study as follows: theoretical framework development, methodological design, systematic investigation, source verification, and manuscript writing.

Conflict of Interest

The authors declare that there are no conflicts of interest related to this research.

Statement on the Use of Artificial Intelligence and AI-Assisted Technologies

During the preparation of this work, the authors used ChatGPT to enhance the language quality and readability of the manuscript, as well as Gemini and Perplexity for exploratory analysis. Following the use of these tools, the authors reviewed, analyzed, and edited the content, thereby assuming full responsibility for the accuracy and integrity of the information presented in this publication. AI tools were used exclusively for language refinement and exploratory support, without generating original scientific content or influencing the study's results.

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