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

**Abstract.** This study analyzes the relationship between constructivist pedagogical mediation and student retention in higher education, with a focus on STEAM programs in Costa Rica. To this end, a systematic mapping study was conducted to identify, classify, and analyze relevant research published in methodologically indexed databases. The results of the 29 selected articles show that constructivist principles, —particularly active learning, social interaction, and self-regulation— are associated with improvements in academic performance and student retention. Furthermore, pedagogical mediation strategies such as collaborative learning, problem-based learning, and the use of educational technologies are identified as key supporting factors for retention in higher education.

**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.** El presente estudio analiza la relación entre la mediación pedagógica constructivista y la permanencia estudiantil en la educación superior, con énfasis en carreras STEAM en Costa Rica, para lo cual, se realizó un estudio de mapeo sistemático para identificar, clasificar y analizar investigaciones relevantes publicadas en bases de datos indexadas a nivel metodológico. Los resultados de los 29 artículos seleccionados muestran que los principios constructivistas —particularmente el aprendizaje activo, la interacción social y la autorregulación— están asociados con mejoras en el rendimiento académico y la permanencia estudiantil. Por otra parte, se identifican estrategias de mediación pedagógica como el aprendizaje colaborativo, el aprendizaje basado en problemas y el uso de tecnologías educativas como factores de apoyo claves para la permanencia en la educación superior.

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

## 1 Introduction

Higher education at the national level faces multiple economic, social, and pedagogical challenges that directly affect the quality, retention, and graduation of students. In the current context—2026 in Costa Rica—these tensions are evident in the negotiations surrounding the Special Fund for Higher Education (FEES) led by the State, where metrics related to equity, employability, and, above all, the efficiency of the university system have been proposed.

The current negotiation has emphasized the need to reduce time-to-degree, which introduces a significant tension between comprehensive education and the system's efficiency demands. As highlighted in public debate, university funding is increasingly linked to outcome- and performance-based indicators (El Guardian CR, 2026), reflecting a transformation in expectations toward higher education.

However, attributing responsibility for graduation timelines exclusively to universities represents a reductionist perspective, as the educational process responds to a broader trajectory that includes primary and secondary education. In this regard, the issue should be addressed from a holistic perspective that considers pedagogical, academic, and socio-educational factors.

Student retention and success in higher education constitute multifactorial phenomena that cannot be attributed solely to institutional factors; rather, they emerge from the interaction between prior educational trajectories and students' economic, social, and academic conditions (Cabrera et al., 1993; Tinto, 1993; Yorke & Longden, 2008; UNESCO, 2021).

Student dropout in higher education remains a persistent challenge, particularly in STEAM fields, where academic demands tend to be higher. Within this context, constructivism stands out as a key pedagogical approach by promoting student-centered, active, and meaningful learning.

Based on this, the present study aims to analyze the role of pedagogical practices—particularly from a constructivist perspective—in student retention and graduation in STEAM programs.

## 2 Theoretical Framework

Teaching in STEAM programs is predominantly grounded in constructivist theory. From a critical standpoint, Carretero (1997) conceptualizes constructivism as an ongoing, individual process of knowledge construction rooted in both cognitive and social dimensions of behavior. Similarly, Trenas (2009) defines it as the process through which individuals construct their understanding of how the world operates and, pedagogically, how learning is developed. Furthermore, Benítez-Vargas (2023) characterizes constructivism as an interactive process between teacher and student, wherein content is revisited to promote meaningful learning.

### 2.1 Cognitive Constructivism

Piaget (1970) argues that knowledge is not merely a reflection of reality, but rather a construction of the human mind—referred to as cognitive constructivism—where each individual reorganizes their cognitive structures through interactions with the environment, thereby generating learning.

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).

Within his body of work, it is possible to identify key principles that must be implicit for the development of meaningful learning, as illustrated in Figure 1.


**Figure 1.** Key principles of constructivism according to Jean Piaget.

With reference to what is presented in Figure 1—Key principles of constructivism according to Jean Piaget—it is necessary to describe their specific characteristics, as follows:

- Uncertain scenario: The individual must be exposed to a situation different from what is familiar—one that challenges them and generates cognitive conflict beyond routine contexts.
- Schema: When encountering a new experience, the organizational structures of thought are reorganized.
- Assimilation: This is the process through which new information from the scenario is incorporated into existing schemas, allowing for the organization and integration of new knowledge

- Equilibrium: A state of balance between prior and new knowledge, in which previous understanding is harmonized with newly acquired knowledge, resolving disequilibrium and achieving cognitive congruence.

Continuing within the framework of cognitive constructivism, David Ausubel highlights the fundamental role of prior knowledge in the construction of new understanding, arguing that the teaching–learning process must be grounded in the learner's cognitive structure. In this regard, Ausubel states that "the most important factor influencing learning is what the learner already knows. Ascertain this and teach accordingly" (Ausubel, 1968, p. 6). This underscores the need to design pedagogical strategies that activate and integrate prior knowledge, thereby promoting deep and lasting understanding through structured instructional organization and pedagogical mediation.

### 2.2 Social Constructivism

Beyond the cognitive dimension, it is essential to incorporate the social dimension of constructivism as a foundational basis for knowledge construction. Vygotsky (1978) posits that "human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them" (p. 88), thereby emphasizing the inherently social character of learning processes.

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 builds upon cognitive constructivism while evolving toward a sociocultural perspective. One of its most prominent proponents is Jerome Bruner, who shares Piaget's principle that learning is actively constructed, particularly through processes of 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

According to Mejía (2020), pedagogical mediation is conceived as an intentional process in which the teacher creates the conditions for students to construct knowledge in a critical, contextualized, and meaningful manner. This perspective is directly aligned with Coll (2001), who reinforces the guiding role of the teacher in shaping learning experiences.

Linking the concept of pedagogical mediation to constructivism, based on the theoretical perspectives previously discussed in this study, several key principles emerge. These include educational intentionality, whereby the teacher deliberately plans learning scenarios with specific objectives; scaffolding, in which the teacher supports the initial stages of knowledge construction and gradually withdraws assistance; the zone of proximal development, social interaction, and contextualization, through which learning is connected to the individual's environment, social interactions, and the level of support received.

Beyond the defining characteristics of pedagogical mediation within the constructivist framework, a set of functions can also be identified in relation to the roles of both teachers and students within the teaching–learning process (Bruner, 1960; Vygotsky, 1978; Bruning et al., 1999; Díaz Barriga, 2002; Sesento García, 2017), as illustrated in Figure 2.

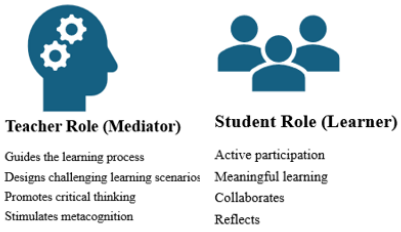


**Figure 2.** Role of the teacher and the student in constructivist pedagogical mediation.

As illustrated in Figure 2—Role of the teacher and the student in constructivist pedagogical mediation—effective pedagogical mediation requires a harmonization of the functions performed by each actor, resulting in learning environments that enable meaningful learning for individuals within their specific contexts.

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.

Finally, within the context of STEAM programs, pedagogical mediation becomes particularly relevant due to its practical orientation, student-centered focus, and emphasis on meaningful learning, all of which contribute positively to the development of skills and knowledge in learners.

# 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

The search strategy was designed to gather relevant scientific evidence on the critical examination of constructivism in higher education and student retention in STEAM programs. To identify pertinent studies, a search string based on keywords and Boolean operators was defined as follows: ("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"), with searches conducted between April 1 and April 12, 2026.

The bibliographic search was carried out across multiple information sources. Scopus and Web of Science were used to ensure coverage of high-impact global literature; IEEE Xplore was included for specialized technical content; ScienceDirect was used to expand access to high-impact full-text articles; and Dialnet was incorporated to provide a regional perspective on the topic. Additionally, Google Scholar was used as an initial exploratory support tool.

Search terms were applied in both Spanish and English to broaden the scope of the results. The selected time frame included publications from 2015 to 2026, with the aim of capturing both well-established theoretical developments and the most recent trends in the field.

### 3.4 Inclusion and exclusion criteria

To ensure the quality and relevance of the selected studies, the following criteria were applied:

Inclusion criteria: a) Peer-reviewed journal articles and conference proceedings; b) empirical studies, systematic literature reviews, or Latin American studies related to the defined search strings; c) studies focused on constructivism applied to higher education; d) research addressing pedagogical mediation, active learning, or student retention; e) availability of full-text access; f) publications in Spanish or English.

Exclusion criteria: a) Duplicate studies across databases; b) opinion-based publications lacking empirical or theoretical support; c) studies focused on primary or secondary education without explicit connection to higher education; d) research addressing constructivism only tangentially or without analytical depth; e) publications outside the 2015–2026 time frame.

### 3.5 Data Extraction

For each selected study, structured information was extracted. To facilitate comparative analysis, specific extraction criteria were established. The main data extracted included:

- Author(s) and year of publication
- Title of the article or conference paper
- Database source
- Type of study
- Country of the study
- Main contribution related to student retention or reported pedagogical mediation strategy
- Access link

These criteria enabled the systematic organization of the evidence and supported the process of addressing the defined research questions.

### 3.6 Study Classification Framework

The study selection process followed the PRISMA guidelines. In accordance with the methodological guidelines proposed by Kitchenham (2004) and Petersen et al. (2015) for conducting systematic mapping studies, the process was structured into three phases: planning, execution, and reporting of results. During the planning phase, the research gap was identified, the research questions were defined, and the search strategy was designed, including the specification of inclusion and exclusion criteria.

During the execution phase, the search for studies was conducted. First, duplicate records across the selected databases were removed. Subsequently, titles and abstracts were reviewed to exclude studies that were not relevant to the research. Finally, full-text screening was carried out to further refine the selection of studies.In the results phase, the selected studies were classified according to the established criteria.

Following the methodological recommendations of Kitchenham (2004), Kitchenham et al. (2010), and Petersen et al. (2015), the process yielded the following results:

1. The initial search identified 176 potential studies, of which 38 were removed as duplicates across databases, leaving 138 studies for further analysis.
2. From these 138 studies, titles, abstracts, and keywords were reviewed, and additional exclusion criteria were applied (e.g., lack of full-text access, publication year outside the defined range, non-verifiable links, opinion-based articles, or non-representative samples), resulting in the exclusion of 95 studies, leaving 43 studies.
3. A full-text review of the remaining 43 studies was conducted, leading to the exclusion of those not focused on higher education or lacking alignment with the inclusion criteria. As a result, 14 studies were excluded, yielding a final sample of 29 studies included in the systematic mapping study.

# 4 Results

Overall, a total of 29 studies selected through the PRISMA protocol were analyzed. These studies were classified according to their methodological approach and their main findings related to constructivism, higher education, student retention, and STEAM education.
Table 1 (Appendix 1) summarizes the classification of the studies based on the defined criteria and search strings, serving as the foundation for addressing the research questions. Additionally, detailed information on the selected studies is provided to facilitate verification.

## 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 emerges as the most prominent principle in the literature. Students who engage in active learning environments achieve measurably higher learning outcomes compared to those in traditional lecture-based settings, even when their initial subjective perceptions favor traditional instruction. This finding reveals a gap between perceived learning and actual learning outcomes (Deslauriers et al., 2019). At a broader scale, however, active instruction remains a minority practice in STEAM classrooms in North America, highlighting a persistent tension between available evidence and its effective implementation (Stains et al., 2018).

Self-regulated learning (SRL) appears as the second most frequently documented principle. In digital environments, SRL is positioned as a transversal component of contemporary constructivism (Faza & Lestari, 2025). Training programs focused on self-regulation have been shown to improve academic performance, learning strategies, and motivation in higher education, with an effect size of $g = 0.37$ (Theobald, 2021). Additionally, structured scaffolding that is progressively withdrawn significantly enhances metacognition and student performance, in alignment with Bruner's (1966) concept of scaffolding and Vygotsky's (1978) zone of proximal development (Shao et al., 2023).

Social interaction, as a core constructivist principle, is supported by empirical evidence in face-to-face learning contexts, where inquiry-based communities grounded in peer interaction enhance student engagement (Ariati et al., 2023). Likewise, students' perceptions of constructivist approaches are positively associated with the development of critical thinking and autonomy, both of which derive from socially mediated interaction (Doan et al., 2025).

Taken together, the literature supports these three principles as the operational foundations of constructivism in higher education—particularly within STEAM programs—and establishes a robust empirical basis for analyzing their implementation through specific pedagogical mediation strategies.

## 4.2 Constructivist-Based Pedagogical Mediation Strategies (RQ2)

The review identified a set of constructivist-based pedagogical mediation strategies present in the higher education literature. The categorized strategies include active methodologies, interactive technological

environments, and collaborative dynamics. Within these categories, approaches such as project-based learning (PjBL/PBL), design thinking, gamification, and academic tutoring are reported. These strategies are systematically presented in Table 1, noting that the categories are not mutually exclusive.

**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% |

Within the domain of active methodologies, the implementation of social constructivism in engineering programs has been shown to improve both academic performance and student retention rates by fostering environments in which learners collaboratively construct knowledge within the zone of proximal development (Khalid et al., 2023). Similarly, student engagement—closely associated with collaborative learning—has been identified as the most robust predictor of university retention in Southeast Asian contexts (Immanuella et al., 2023).

Collaborative dynamics as a pedagogical mediation strategy are supported by empirical evidence across multiple contexts. Constructivist problem-based learning (PBL) has been shown to enhance both entrepreneurial competencies and academic performance in higher education students (Wiyono et al., 2025). Likewise, the integration of design thinking with constructivist approaches has been associated with improvements in student motivation and the ability to solve complex problems (Tsai et al., 2023). Furthermore, design thinking as a constructivist pedagogical mediation strategy promotes creativity and knowledge transfer from a multinational perspective (Guaman-Quintanilla et al., 2022).

Regarding the use of interactive technological environments, technology-mediated constructivist settings have been found to generate higher levels of motivation and more effective learning strategies (Do et al., 2023). Gamification, when aligned with constructivist active learning approaches, enhances content retention and student engagement in higher education (James et al., 2024). Additionally, active learning in technology-enhanced environments significantly reduces academic anxiety and fosters positive attitudes toward learning, thereby functioning as an additional mediating factor between pedagogical strategies and student retention (Rezai et al., 2025).

A cross-cutting finding is that none of these strategies operates effectively in the absence of intentional pedagogical mediation. This reinforces the role of the teacher as a facilitator and scaffolder within constructivist pedagogical mediation (Mejía, 2020).

### 4.3 Constructivist Practices and Student Retention (RQ3)

The reviewed evidence is largely convergent, albeit heterogeneous: approximately half of the studies (44.8%) report direct effects on student retention, while a similar proportion (41.4%) report indirect effects through variables associated with dropout. The remaining studies focus on dropout or do not provide explicit evidence regarding retention.

The analyzed studies indicate that active learning reduces achievement gaps among underrepresented groups and decreases failure rates in STEAM programs—both factors directly associated with student dropout—as demonstrated in a meta-analysis involving 44,000 students (Theobald et al., 2020). Additionally, constructivist pedagogical practices implemented by instructors in engineering courses have been shown to significantly increase student retention within programs (Hempel et al., 2020).

Inclusive pedagogy derived from constructivism emerges as a direct strategy for addressing retention challenges in university STEAM programs, as it accommodates the diversity of student trajectories, learning paces, and contextual conditions (Lagrimas & Buenaventura, 2023; Jackson-Summers et al., 2024).

Conversely, non-active pedagogical methods have been identified as one of the institutional factors most strongly associated with university dropout between 2020 and 2024, aligning with the literature that critiques the predominance of traditional teaching approaches (Quincho Apumayta et al., 2024). In the Latin

American context, a strong correlation has been observed between perceived educational quality—including the quality of pedagogical mediation—and student retention in technological institutes (Núñez-Silva et al., 2025). Furthermore, the gap between traditional teaching practices and contemporary educational demands has been identified as a primary driver of student attrition in Latin American universities (Salgado Medina et al., 2024).

Overall, the majority of the studies reveal a consistent trend: constructivist practices are associated with lower levels of student dropout, particularly when combined with teacher support, social interaction, and student self-regulation.

### 4.4 Effectiveness of Constructivism in Higher Education (RQ4)

The effectiveness of constructivism in higher education is neither uniform nor automatic; rather, its impact is conditioned by a set of factors that the literature organizes across three levels: institutional, teaching, and student-related.

At the institutional level, educational infrastructure, teaching quality, and accreditation processes are identified as key pillars that determine whether the minimum conditions for a constructivist pedagogy are present, particularly within the Latin American context (Alcaraz, 2025). Additionally, the social dimension of institutions—understood as the set of equity policies and student support mechanisms—is crucial in enabling students to access, persist in, and complete their studies (Iriarte et al., 2019).

At the teaching level, there is a positive and statistically significant association between teacher self-efficacy and student academic performance, positioning teachers' confidence and pedagogical competence as primary mediating factors (Ma et al., 2025). Teacher training grounded in constructivism and reflective practice is a necessary condition for the effective implementation of active learning environments (Lalor et al., 2015). Furthermore, tutoring, mentoring, and personalized academic support have been empirically shown to reduce student dropout rates (Ziadet Bermúdez et al., 2025).

At the student level, academic interaction with teachers and peers emerges as the individual factor most strongly associated with academic success and student retention, particularly among underrepresented populations (Crisp et al., 2015). Additionally, self-regulated learning, enhanced by structured constructivist environments, is identified as the most robust predictor of academic performance in contemporary higher education students (Faza & Lestari, 2025).

A contradictory trend emerges regarding implementation: despite the strong body of evidence supporting constructivist approaches, most university instructors in STEAM disciplines continue to rely on traditional lecture-based teaching. This indicates that the gap between pedagogical evidence and teaching practice constitutes a significant and systemic institutional barrier (Stains et al., 2018).

To synthesize the main factors influencing the effectiveness of constructivism in higher education, Table 2 categorizes the reviewed studies according to key dimensions identified in the literature, this classification enables a clearer understanding of how different variables contribute to the successful implementation of constructivist approaches across institutional, teaching, and student-related levels.

**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% |

As shown in Table 2, a proportion of the studies indicate that the factors associated with the effectiveness of the constructivist approach are concentrated in four main dimensions: motivation, equity/inclusion, engagement, and student contextual conditions.

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

This research question represents the most specific focus of the study and, simultaneously, the most significant gap in the literature identified through the review. No direct evidence was found to address this

question within the Costa Rican context; therefore, the response is partial and formulated as a theoretically grounded inference based on international evidence, rather than as a local empirical finding.

No studies were identified that simultaneously and directly address constructivist pedagogical mediation, STEAM programs, and student retention within the Costa Rican context. The only national study included in the systematic mapping study analyzes factors associated with university dropout in Costa Rica using a multinomial predictive model; however, it does not focus on constructivist pedagogical strategies nor is it restricted to the STEAM domain (Fernández-Martín et al., 2019).

This absence does not invalidate the relevance of the research question; rather, it justifies a cautious extrapolation from international evidence. The impact of active learning on reducing achievement gaps in STEAM (Theobald et al., 2020), the improvement of retention through constructivist practices in engineering programs (Khalid et al., 2023; Hempel et al., 2020), the role of teacher support as a key mediating factor (Ma et al., 2025), and the determinants of student retention in Latin American contexts (Núñez-Silva et al., 2025; Salgado Medina et al., 2024) collectively constitute a convergent body of evidence. This allows for a theoretically grounded inference that constructivist pedagogical mediation has the potential to positively influence student retention in STEAM programs. Consequently, future research should aim to empirically validate this hypothesis within the Costa Rican context.

**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% |
| | Technological environments | 4 | 13.8% |
| | Others | 11 | 37.9% |
| Effectiveness factors (RQ3) | Motivation | 4 | 13.8% |
| | Inclusion | 4 | 13.8% |
| | Engagement | 3 | 10.3% |
| | Student context | 3 | 10.3% |
| Geographic context (RQ5) | Costa Rica | 1 | 3.4% |
| | International | 28 | 96.6% |

Table 3 systematizes the evidence map of the study, illustrating the distribution of the analyzed articles across the main dimensions. A concentration is observed in constructivist principles—particularly active learning and social interaction—as well as a predominance of international studies compared to the limited evidence available in the Costa Rican context.

## 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

This study provides a comprehensive overview of how constructivism has been applied in higher education and its relationship with student retention, with a particular focus on STEAM programs.

Based on the analysis of the 29 selected studies, a consistent trend emerges: when learning is student-centered, promotes active participation, and strengthens interaction, both academic outcomes and student retention tend to improve.

In relation to the research questions, the following conclusions can be drawn:

(i) The most recurrent constructivist principles in higher education are active learning, social interaction, and self-regulated learning, which are integrated into student-centered pedagogical practices;

(ii) The most frequently reported pedagogical mediation strategies include active methodologies, interactive technological environments, and collaborative dynamics, among which problem/project-based learning, design thinking, and gamification stand out;

(iii) There is convergent—albeit heterogeneous—empirical evidence linking constructivist practices to student retention, both directly and indirectly through variables such as academic performance, motivation, and engagement;

(iv) The effectiveness of constructivism depends on institutional, teaching, and student-related factors, with motivation, inclusion, engagement, and the quality of pedagogical mediation being particularly relevant;

(v) The absence of studies directly addressing the relationship between constructivist pedagogical mediation, student retention, and STEAM programs in Costa Rica represents a clear opportunity for the development of applied research within the national context.

Overall, this study contributes to a deeper understanding of the role of constructivism in higher education within STEAM programs, suggesting that strengthening this approach may represent a robust alternative for addressing student retention challenges.

Finally, future research should focus on conducting empirical studies that directly examine these phenomena within the Costa Rican context—particularly in STEAM programs—by integrating pedagogical, institutional, and social factors that influence student retention.

### 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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