

Connectivism And Collaborative Learning In Virtual Environments: An Integrative Review On Interactions, Autonomy, And Knowledge Construction

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Abstract:

Background: The expansion of virtual learning environments has intensified debates about how students interact, collaborate, exercise autonomy, and construct knowledge in digital networks. In this context, connectivism has been revisited as a theoretical perspective capable of explaining learning as a distributed, relational, and networked process, while collaborative learning has gained prominence as a pedagogical approach centered on interaction, shared responsibility, and collective knowledge production.

Materials and Methods: This study is an integrative literature review with a qualitative and exploratory-descriptive approach. Searches were conducted in ERIC, SciELO, BBE, Redalyc, Web of Science, Scopus, and the CAPES Journal Portal. The time frame covered publications from 2020 to 2026, in English, Portuguese, and Spanish. After duplicate removal and eligibility screening, ten studies composed the final analytical sample. Data were organized through a synoptic matrix and analyzed by thematic synthesis.

Results: The selected studies indicate that collaborative learning in virtual environments depends not only on digital tools, but also on instructional design, teacher mediation, group organization, student engagement, socioemotional interaction, and pedagogical intentionality. Three central analytical trends were identified: online interaction and collaboration, student autonomy in networked learning, and collaborative knowledge construction.

Conclusion: The review concludes that virtual learning environments can promote autonomy, dialogue, authorship, and collective knowledge construction when they are designed as human, interactive, and pedagogically mediated spaces. Technology should therefore be understood as a means for expanding connections and learning possibilities, not as an end in itself.

Key Word: *Connectivism; Collaborative learning; Virtual learning environments; Student autonomy; Knowledge construction.*

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I. Introduction

The expansion of virtual learning environments has profoundly changed the ways in which teaching, learning, and knowledge production are organized. With the growing presence of digital technologies, learning is no longer restricted to face-to-face spaces; it is increasingly mediated by networks, platforms, forums, multimodal resources, and synchronous and asynchronous interactions. In this scenario, understanding how students interact, collaborate, exercise autonomy, and construct knowledge in online environments has become a relevant issue for contemporary educational research.

Connectivism emerges as a theoretical perspective associated with networked learning, since it considers knowledge not only as something located within the individual, but also as something distributed across connections, information flows, digital communities, and technological systems. Although its seminal formulation is associated with Siemens [1], recent studies have resumed this theoretical framework to discuss the challenges of digital education, open learning, and the reorganization of technology-mediated formative processes [2,3].

From this perspective, learning involves establishing meaningful connections, selecting relevant information, participating in collaborative networks, and developing critical capacity in the face of excessive information. The student is no longer understood as a passive receiver of content, but as an active subject who seeks, organizes, shares, and resignifies knowledge. Thus, connectivism is directly related to contemporary discussions about student autonomy, lifelong learning, digital literacy, and participation in virtual communities [2,4].

Collaborative learning, in turn, is understood as a pedagogical approach that values interaction among subjects, negotiation of meanings, and collective knowledge construction. In virtual environments, collaboration may occur through forums, wikis, chats, videoconferences, shared documents, collaborative writing platforms, and other digital tools. Herrera-Pavo [5] argues that collaborative learning in virtual higher education requires pedagogical planning, active participation, shared responsibility, and interactional complexity.

Recent studies also indicate that online collaboration does not depend solely on the availability of technologies, but on the quality of interactions, instructional design, teacher mediation, and student engagement. Oyarzun and Martin [6] show that online learner collaboration involves technologies, design, facilitation, and learning outcomes. Similarly, Bach and Thiel [7] emphasize that the quality of digital interaction influences students perception of learning, participation, and satisfaction in online collaborative activities.

Another relevant aspect concerns student autonomy in virtual environments. Networked learning requires the learner to make decisions, manage learning pathways, select sources, interact with different actors, and critically evaluate information. Ransanz Reyes, Arana-Cuenca, and Manzanal Martinez [8] point out that well-structured online collaborative activities depend on contextual factors, pedagogical strategies, and technological resources that can support active participation and shared knowledge construction.

Despite the growing number of studies on connectivism, collaborative learning, and virtual environments, there is still a need to systematize how recent literature has articulated these three axes. Many studies analyze educational technologies, online collaboration, or student autonomy separately, but do not always discuss, in an integrated manner, how virtual interactions promote knowledge construction from a connectivist perspective.

This gap becomes even more relevant when considering that much of the research on online learning still privileges instrumental aspects of technology, leaving in the background the analysis of interactional quality, distributed learning, student agency, and the social dimension of knowledge construction. Therefore, it is necessary to synthesize recent evidence capable of showing how these elements converge in the organization of virtual learning environments.

Based on this gap, the guiding question of this study is: how has recent scientific literature addressed the relationships among connectivism, collaborative learning, virtual interactions, student autonomy, and knowledge construction in virtual learning environments?

Accordingly, this article aims to analyze, through an integrative literature review, scientific publications from 2020 to 2026 on connectivism and collaborative learning in virtual environments, with emphasis on interactions, student autonomy, and knowledge construction processes.

II. Material And Methods

Study design: This study is characterized as an integrative literature review with a qualitative and exploratory-descriptive approach. An integrative review allows researchers to gather, analyze, and synthesize scientific

productions on a specific phenomenon, making it possible to identify trends, gaps, convergences, and theoretical contributions in the literature [9,10].

Justification for the design: This type of review was chosen because it enables the integration of empirical, theoretical, and review studies that discuss connectivism, collaborative learning, virtual interactions, student autonomy, and knowledge construction. The methodological process followed the stages of problem definition, formulation of the guiding question, database search, application of inclusion and exclusion criteria, study selection, data extraction, critical analysis, and synthesis of results.

Guiding question: The guiding question was formulated based on the central theme of the study and on the main conceptual axes of the investigation: connectivism, collaborative learning, virtual environments, interactions, autonomy, and knowledge construction. The following question guided the review: how has recent scientific literature addressed the relationships among connectivism, collaborative learning, virtual interactions, student autonomy, and knowledge construction in virtual learning environments?

Databases: The searches were carried out in July 2026 in national, Latin American, and international databases in the field of Education: ERIC - Education Resources Information Center, SciELO, BBE - Brazilian Bibliography of Education, Redalyc, Web of Science, Scopus, and the CAPES Journal Portal. These databases were selected because of their relevance for indexing studies on education, digital technologies, online learning, virtual environments, student development, collaboration, and knowledge construction.

Search descriptors and strategy: Descriptors were used in English, Portuguese, and Spanish and were combined with Boolean operators to increase search sensitivity and cover different indexing patterns. The main descriptors were: connectivism, conectivismo, collaborative learning, aprendizagem colaborativa, aprendizaje colaborativo, virtual learning environments, ambientes virtuais de aprendizagem, entornos virtuales de aprendizaje, online learning, virtual interactions, interações virtuais, student autonomy, autonomia discente, knowledge construction, construção do conhecimento, and construcción del conocimiento.

General search string: The general strategy was adapted to the specific characteristics of each database and followed this structure: (connectivism OR conectivismo) AND (collaborative learning OR aprendizagem colaborativa OR aprendizaje colaborativo) AND (virtual learning environment OR online learning OR ambientes virtuais de aprendizagem) AND (interaction OR interações OR interacciones) AND (autonomy OR autonomia OR autonomía) AND (knowledge construction OR construção do conhecimento OR construcción del conocimiento). Broader combinations were also performed in national and Latin American databases to avoid the loss of relevant studies that did not explicitly use the term connectivism.

Inclusion criteria: The review included peer-reviewed scientific articles published between 2020 and 2026, available in full text, written in English, Portuguese, or Spanish, and related to the thematic axes of the study. Studies were considered eligible when they addressed at least one of the following aspects: connectivism in digital education, online collaborative learning, interactions in virtual environments, student autonomy in digital contexts, collaborative knowledge construction, technology-mediated learning, or virtual learning communities.

Exclusion criteria: Duplicate texts, editorials, book reviews, simple abstracts, publications without full-text access, studies outside the defined time frame, studies unrelated to virtual learning environments, and publications that treated educational technology only in an instrumental way without discussing interaction, collaboration, autonomy, or knowledge construction were excluded.

Study selection: The study selection process was organized into identification, duplicate removal, screening, eligibility assessment, and inclusion. The organization of the selection flow was inspired by PRISMA 2020 recommendations, with adaptations to the integrative nature of the review [11].

Data extraction and organization: Data were extracted using a synoptic matrix developed for this review. The instrument included the following information: author(s), year of publication, title, database, journal, country or research context, objective, study type, methodological approach, participants, main results, and relationship with the review axes. The extracted data were organized in comparative tables.

Data analysis: The data were analyzed through thematic synthesis. Initially, all included articles were read in full, with identification of central ideas, main findings, and contributions to the field of digital education. Subsequently, the extracted data were grouped into thematic categories: virtual interactions and collaboration

among students; student autonomy and networked learning; digital technologies and pedagogical mediation; collaborative knowledge construction; and limits and challenges of virtual learning environments.

Table no 1: Study selection flow according to the integrative review process.

Stage	Procedure	Records
Identification	Records retrieved from the selected databases	n = 86
Duplicate removal	Duplicate records removed	n = 18
Screening	Records screened by title, abstract, and keywords	n = 68
Exclusion in screening	Records excluded for lack of thematic adherence	n = 42
Eligibility	Full texts assessed for eligibility	n = 26
Full-text exclusion	Studies excluded after full-text reading	n = 16
Inclusion	Studies included in the integrative review	n = 10

Source: Prepared by the author (2026), based on the search and selection process.

III. Result

General characterization of the included studies: The results correspond to the final analytical sample of ten studies selected after the application of the eligibility criteria. The set of publications includes empirical studies, quasi-experimental investigations, systematic reviews, and studies focused on digital tools that support collaboration and knowledge construction. Most studies were conducted in international contexts and were concentrated in higher education, online learning, teacher education, and technology-mediated collaborative activities.

Analytical trend 1 - online interaction and collaboration: The first trend concerns the consolidation of online collaborative learning as a pedagogical practice that requires intentional instructional design. The included studies indicate that collaboration is not produced by the mere presence of digital platforms. It depends on the quality of interactions, clarity of tasks, organization of groups, teacher facilitation, and students active engagement. Studies such as Oyarzun and Martin [6] and Leow and Neo [12] show that collaboration becomes more meaningful when learners are involved in authentic, project-based, problem-oriented, and socially shared activities.

Analytical trend 2 - student autonomy in networked learning: The second trend is related to student autonomy. In virtual environments, students need to manage information, participate in networks, make decisions, communicate with peers, and assume responsibility for their own learning trajectories. This trend connects the selected studies to connectivist principles, especially when learning is understood as a process distributed across connections, interactions, and digital flows. Aldalalah [14] contributes to this debate by relating e-collaborative learning to digital self-efficacy and the organization of information in higher education.

Analytical trend 3 - collaborative knowledge construction: The third trend involves collaborative knowledge construction. The studies indicate that digital tools, collaborative argument maps, group awareness tools, online writing platforms, videoconferences, and educational platforms can support the collective production of meanings. However, these resources become pedagogically relevant only when combined with mediation, monitoring, feedback, and assessment of the collaborative process. Ouyang et al. [16] and Peng et al. [17] are particularly relevant because they show how digital resources can make group contributions visible and strengthen engagement in online collaborative activities.

Challenges identified in the studies: The reviewed studies also reveal recurring challenges, such as low participation, communication difficulties, unequal access to technology, weak teacher mediation, poorly structured tasks, and the risk of reducing online education to a technical procedure. These challenges reinforce the need to understand virtual learning environments as complex pedagogical spaces that require planning, inclusion, interaction, and sustained support.

Table no 2: Key studies included in the integrative review.

No.	Author(s)/Year	Design/Context	Main analytical contribution	Review axis
1	Leow; Neo (2023)	Project-based connectivist learning environment focused on students collaborative experiences.	Shows that connectivism can support student-centered collaborative practices through technology, projects, interaction, and active knowledge construction.	Connectivism and collaboration

No.	Author(s)/Year	Design/Context	Main analytical contribution	Review axis
2	Aldalalah; Alhalaq; Eyadat (2023)	Quasi-experimental study with teachers on e-collaborative learning and digital thinking skills.	Highlights the relationship between connectivist theory, online collaboration, and digital competencies required in virtual environments.	Digital competencies
3	Aldalalah (2025)	Higher education study on e-collaborative learning, big data organization, and digital self-efficacy.	Expands the discussion of autonomy and self-efficacy by showing that networked learning requires information management and active participation.	Autonomy and self-efficacy
4	Oyarzun; Martin (2023)	Systematic review on online learner collaboration, technologies, design, facilitation, and outcomes.	Provides a theoretical and methodological basis for understanding online collaboration as dependent on design, mediation, and learning results.	Online collaboration
5	Adomaitis; Dauksiene; Trepule (2023)	Study on interaction and collaboration in schools during emergency remote learning.	Shows that digital collaboration involves institutional, communication, and pedagogical challenges, especially in distance learning contexts.	Interaction and challenges
6	Ouyang et al. (2024)	Study on collaborative knowledge construction using a collaborative argument map tool.	Demonstrates how digital tools can support argumentation, visualization of ideas, and group collaboration.	Knowledge construction
7	Peng et al. (2022)	Study on group awareness tools, engagement, performance, and online collaborative writing.	Indicates that group awareness resources can support engagement, participation, and positive perceptions in virtual collaborative tasks.	Engagement and participation
8	Wang; Wang (2022)	Study on student grouping methods for massive online collaborative learning.	Shows that group composition influences the effectiveness of online collaborative learning.	Group organization
9	Tan et al. (2022)	Study on Microsoft Teams for online collaborative learning in higher education during COVID-19.	Highlights the role of platforms in mediating collaboration, communication, and task organization in virtual environments.	Digital platforms
10	Lehtinen; Kostiainen; Näykki (2023)	Study on knowledge co-construction and socioemotional interaction in video-based online collaborative learning.	Demonstrates that collective knowledge construction depends on socioemotional interaction as well as cognitive and technological dimensions.	Socioemotional interaction

Source: Prepared by the author (2026), based on the studies included in the review.

IV. Discussion

The analyzed studies show that connectivism and collaborative learning in virtual environments cannot be understood merely as consequences of digital technology use. The presence of platforms, forums, applications, or interactive resources does not, by itself, guarantee meaningful learning. What emerges from the review is that interaction, collaboration, autonomy, and knowledge construction depend on pedagogical intentionality, activity design, teacher mediation, and the ways in which students engage in learning networks.

This interpretation is aligned with the central principle of connectivism, according to which learning means establishing relevant connections among subjects, information, resources, communities, and digital systems [1,2]. In this sense, virtual environments should not be treated as spaces for content transmission, but as formative ecosystems in which knowledge circulates, is shared, questioned, negotiated, and reconstructed collectively.

The findings of Leow and Neo [12] reinforce this perspective by indicating that project-based learning environments grounded in connectivism can foster more meaningful collaborative experiences. In this pedagogical organization, learning occurs through active participation, problem solving, exchange of ideas, and collective production. Therefore, online collaboration becomes more powerful when it is connected to authentic tasks, contextualized problems, and shared objectives.

However, collaboration in virtual environments does not occur spontaneously. Oyarzun and Martin [6] demonstrate that online learner collaboration involves different dimensions, including technologies, instructional design, facilitation, and learning outcomes. This understanding shifts the focus from the tool to the pedagogical project. In other words, it is not enough to place students in a digital environment; it is necessary to create conditions for them to interact, negotiate meanings, assume responsibilities, and construct knowledge together.

Interaction therefore appears as a central analytical category. It is manifested in student-student, student-teacher, student-content, and student-technology relationships. In virtual environments, these interactions may occur synchronously or asynchronously through forums, chats, videoconferences, shared documents, argument maps, and collaborative platforms. Nevertheless, their effectiveness depends on task clarity, student participation, teacher mediation, and continuous monitoring of the learning process.

The socioemotional dimension of online collaborative learning is also relevant. Lehtinen, Kostiainen, and Näykki [20] indicate that knowledge co-construction in video-based online collaborative learning involves not only cognitive aspects, but also active listening, mutual support, humor, and regulation of interactions. This finding is significant because it shows that virtual learning is not a purely technical or informational process. Even when mediated by screens, educational relationships continue to depend on trust, presence, communication, and social bonds.

Student autonomy also emerges as a fundamental axis of discussion. In a connectivist context, autonomy does not mean learning alone, but being able to navigate networks, identify reliable information, participate in communities, make decisions, and critically evaluate knowledge. Thus, autonomy is not isolated from collaboration. It is an interdependent autonomy constructed through the relationship among individual initiative, peer interaction, digital resources, and teacher mediation.

The studies by Peng et al. [17] and Ouyang et al. [16] contribute to this discussion by showing that digital tools designed to support collaboration can increase engagement, participation, and collaborative knowledge construction. Resources such as group awareness tools, argument maps, and collaborative writing platforms help make individual and collective contributions visible. This enables students to follow their own performance, understand the role of peers, and participate more responsibly in the learning process.

On the other hand, the reviewed studies also reveal important limitations. Online collaborative learning may be weakened by low participation, communication barriers, unequal access, lack of teacher mediation, poorly structured tasks, and a merely instrumental use of technology. Adomaitis, Dauksiene, and Trepule [15], when analyzing interaction and collaboration during pandemic distance learning, show that collaboration was essential to deal with educational challenges, but also that pedagogical organization needs to go beyond the simple adoption of digital solutions.

In this regard, teacher mediation remains indispensable. Although connectivism values networks, autonomy, and distributed learning, the teacher continues to play a strategic role in curating information, organizing activities, monitoring interactions, and problematizing the knowledge produced. The teacher acts as a mediator, facilitator, and designer of learning experiences, creating conditions so that collaboration does not become a mere division of tasks, but results in effective collective construction of knowledge.

Knowledge construction, in this context, should be understood as a social, interactive, and progressive process. The studies indicate that virtual environments favor more meaningful learning when students are challenged to argue, compare ideas, revise productions, negotiate meanings, and solve problems in groups. Therefore, knowledge is not only accumulated individually, but produced in the relationships among participants, digital resources, and learning situations.

The discussion also reveals that connectivism still appears in part of the literature more as a theoretical lens than as an empirical operational framework. Many studies address online collaborative learning, interaction, and autonomy, but do not always explicitly articulate these phenomena with connectivist theory. This confirms the gap identified in the introduction: there is a need for studies that more systematically integrate connectivism, online collaboration, student autonomy, and knowledge construction.

Another aspect observed is the predominance of international studies, especially in higher education and online education contexts. Although these studies offer relevant contributions, further investigations are needed in Brazilian and Latin American contexts, considering digital inequalities, institutional conditions, teacher education, and cultural specificities of virtual learning environments.

Overall, the findings indicate that collaborative learning in virtual environments can strengthen autonomy, participation, and collective knowledge construction when supported by consistent pedagogical planning. Connectivism helps explain this phenomenon by emphasizing that contemporary learning occurs in networks, through connections, interactions, and information flows. However, for these networks to become learning environments, educational intentionality, critical mediation, and active student participation are required.

V. Conclusion

This integrative review made it possible to understand that connectivism and collaborative learning, when analyzed in the context of virtual environments, reveal a deeply human dimension of digital education. Although technologies occupy a central place in contemporary transformations of teaching and learning, the studies analyzed show that the pedagogical value of virtual environments is not located only in platforms, tools, or resources, but in the relationships constructed through them.

Learning in networks does not mean replacing human encounter with technological mediation. On the contrary, it means recognizing that knowledge can be expanded when subjects connect, dialogue, share experiences, confront ideas, and construct meanings collectively. Connectivism contributes to this understanding by highlighting that contemporary learning occurs through flows, connections, and communities. However, it is people - with their histories, questions, emotions, and ways of participating - who give meaning to these networks.

The results also show that collaborative learning in virtual environments requires more than internet access or technical mastery of digital tools. It depends on pedagogical intentionality, planning, teacher mediation, listening, shared responsibility, and active student participation. When these elements are present, virtual environments cease to be cold spaces for content transmission and become territories of encounter, authorship, dialogue, and shared knowledge construction.

Student autonomy, in this context, should not be understood as leaving learners to themselves. Being autonomous in virtual environments does not mean learning in isolation, but developing the conditions to seek information, make decisions, collaborate with peers, critically evaluate content, and participate responsibly in learning networks. It is therefore a mediated, accompanied, and humanized autonomy.

The review also showed that knowledge construction in virtual environments becomes more meaningful when students are invited to participate actively in the educational process. Arguing, interacting, revising ideas, producing collectively, solving problems, and sharing experiences are practices that strengthen collaborative learning and bring learners closer to a more critical, participatory, and socially situated education.

As limitations, this review was restricted to studies published from 2020 to 2026, written in English, Portuguese, or Spanish, and available in the selected databases. This delimitation may have excluded relevant studies published in other languages, indexed in other databases, or produced outside the selected time frame. Another limitation is the predominance of studies conducted in higher education contexts, which limits direct generalization to basic education.

Future research should deepen empirical investigations in Brazilian and Latin American educational contexts, especially in basic education, in order to understand how connectivism and collaborative learning materialize in realities marked by digital inequalities, different levels of teacher training, and diverse institutional conditions. Studies that examine students experiences, teacher mediation, and the socioemotional dimension of online collaboration may also contribute to strengthening the field.

In conclusion, virtual learning environments can promote autonomy, collaboration, and collective knowledge construction when they are planned from a humanized pedagogical perspective. More than connecting machines, education must continue connecting people. More than organizing information, it must produce meaning. More than adapting to technologies, it must reaffirm its commitment to learning that recognizes the student as an active, sensitive, critical, and participatory subject in the construction of knowledge.

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