Active Learning in Virtual Environments in Higher Education: Pedagogical Strategies, Teaching Challenges and Perspectives

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Abstract

Active learning is becoming increasingly important given the rapid technological changes that the world is facing. Teachers must be aware of this reality and adopt active methodologies that allow students to interact more with their learning process. In other words, the role of the teacher becomes a mediator between the knowledge and learning of their students, offering them active learning tools and methods supported by information and communication technologies. The COVID-19 pandemic has generated many challenges and opportunities that, to date, are reflected in the way higher education institutions teach. This study examines the implementation of active learning in virtual environments within higher education, focusing on teachers' perceptions. For this purpose, the participation of teachers from the Systems Engineering program at the University of Córdoba, Colombia, was counted. A quantitative and cross-sectional approach was employed, whereby faculty members were administered a Likert-scale questionnaire to assess the use of e-learning tools in four dimensions (frequency, importance, difficulty, and satisfaction). Key findings revealed a strong theoretical appreciation of active learning strategies, particularly collaborative work, but revealed practical gaps in their adoption. While basic tools such as forums and quizzes are frequently used with high satisfaction, advanced strategies such as gamification and simulations have limited adoption owing to insufficient training and resources. This study underscores the need for institutional investment in faculty training, intuitive technological infrastructure, and policies that incentivize pedagogical innovation. These measures are critical for closing the gap between pedagogical intent and practical execution and ensuring equitable and effective active learning in higher education.

Keywords: Active learning, higher education, collaborative learning, E-learning.

The COVID-19 pandemic has marked a turning point in social, economic, and educational processes at a global level. Since its appearance in January 2020, this phenomenon has forced millions of people worldwide to reconfigure their daily routines, largely because of the confinement measures adopted to mitigate its spread. One of the sectors most affected by this situation was the education sector, which had to urgently adapt to a completely virtual teaching

model (Sofi-Karim et al. 2023). This transition not only revealed the opportunities offered by technology in the pedagogical field but also highlighted the existing limitations and inequalities in terms of access, infrastructure, and methodologies.

Although distance education had already been successfully implemented in various institutions and educational levels before the pandemic, there is an urgent need to ensure the continuity of teaching-learning processes. However, not all institutions, teachers, and students are prepared to face the challenges associated with this model (Liu, 2021). The lack of robust platforms to support high user traffic, lack of training in digital skills by teachers, and connectivity problems in rural areas and vulnerable sectors are among the most significant challenges (Kulikowski et al., 2022). In this context, there is a need to analyze the impact of virtuality from the perspective of active learning in higher education. This pedagogical approach, which seeks to actively involve students in their learning process, becomes especially relevant in scenarios where face-to-face interaction between students and teachers is limited (Soliman et al., 2021). Through activities such as problem solving, collaborative work, and the use of interactive technological tools, active learning allows not only to fosters the development of cognitive skills and promotes autonomy and critical thinking in students (Han et al., 2021).

The abrupt transition to remote education during the pandemic showed that beyond technical limitations, there was deep-rooted pedagogical and cultural resistance. Many teachers accustomed to traditional face-to-face methods faced difficulties in adapting their strategies to virtual environments, which generated fragmented and non-interactive educational experiences (Aretio, 2021). The saturation of platforms such as Zoom or Google Meet in their early stages reflected the lack of scalable infrastructure to serve millions of simultaneous users, a problem exacerbated in rural regions where only 10.7% of households had access to a stable Internet (Navarrete, 2021).

Faced with these challenges, active learning has emerged as a transformative axis. Institutions that integrated hybrid methodologies, combining synchronous sessions with asynchronous project-based activities, managed to increase student participation by 35% according to UNESCO data (Díaz, 2021). Tools such as collaborative forums and virtual simulators have proven to be effective in developing critical skills, although their success depends on teacher training in instructional design and formative assessment (Copado and Osorio, 2021; Aithal and Aithal, 2023; Barbetta, 2023). This adaptation not only maintained educational continuity but also revealed the potential of virtuality to personalize learning paths according to individual needs (Salinas, 2022).

However, the future of higher education demands a thorough review of its paradigms. The pandemic made it clear that the distance modality should not be a temporary patch but a structural component that requires investment in universal connectivity, continuous teacher training, and inclusive public policies (Salinas, 2022). Experiences such as those of UNAM in Mexico, where device loans and technical mentoring were implemented, show that it is possible to reduce the digital divide in the presence of institutional will (Salinas, 2022).

The main objective of this research was to explore the effects of virtual education on the development of active learning during the pandemic period in higher education students. To do so, various factors will be considered, such as the adaptation of pedagogical strategies to digital platforms, the perceptions of teachers and students about the effectiveness of the virtual model, and the results obtained in terms of academic performance and acquisition of skills. In addition, the role of technology as a facilitator of the training process, as well as the barriers that have limited its success in specific contexts, will be analyzed. One of the most relevant aspects of this analysis is the methodology used, which is

based on distance education. This model, characterized by flexibility in learning times and spaces, offers a unique opportunity to examine how technological tools can be effectively integrated into pedagogical strategies. It also allows us to identify how students adapt to an environment in which self-management and personal motivation play fundamental roles in academic success.

The analysis of how the pandemic transformed educational paradigms is essential not only to understand the present but also to project the future of education in an increasingly interconnected and technology-dependent world. This study, focused on distance education and active learning, seeks to make a significant contribution to the field of Information and Communication Technologies (ICT) applied to the higher education sector, a case study of the University of Córdoba. This paper is organized as follows: related works, background, materials and methods, results, discussion, and conclusions.

Related Works

In (Rossi et al., 2021), incorporated published active learning strategies into an online construct, with problem-based research and inquiry research project design to serve as our primary active learning tool. Gains related to students' science learning experiences and their attitudes towards science were assessed using questionnaires before, during, and after the course. The course was attended by 83 students, most of whom (60.8%) were graduates. Our results show that the engagement provided by active learning methods can improve performance in both hard and soft skills. Student engagement seems more relevant when activities require the interaction of information, prediction, and reasoning, such as open-ended questions and research project design. Thus, our data show that during a pandemic, active learning tools benefit students and improve their critical thinking, motivation, and positive positioning in science.

In (Seitnazarov and Mambetkarimov, 2024), focused their research on the creation and utilization of digital educational resources specifically designed for teaching programming in higher education settings. This study explores the development process of digital resources, including their design, content creation, and implementation strategies. This study describes the effectiveness of digital resources in improving student learning outcomes and engagement in programming courses. Through a combination of qualitative and quantitative research methods, including surveys, interviews, and student performance assessments, this study assessed the impact of digital resources on students' learning experiences and academic achievements. The findings of this study contribute to the understanding of the potential benefits and challenges associated with integrating digital educational resources into programming education at the higher education level.

In (Ruiz-Rojas et al., 2024), explored the impact of generative AI tools on critical thinking and collaboration among university students, highlighting the importance of investigating these technologies because of their increasing integration into higher education and their potential to transform traditional pedagogical practices. A predominantly female sample was surveyed to assess their familiarity with, experience with, and perceptions of these tools. A total of 87% of the respondents had prior knowledge of generative AI tools, with 38% using them occasionally. Popular tools used included Canva 2024 (33%), Chat PDF (26%), and YOU.COM (24%). Furthermore, 64% of the respondents believed that these tools significantly improved their critical thinking abilities. Despite their high familiarity with and occasional use of these tools, the need for ongoing training and technical support was identified. While generative AI tools show promising potential for improving collaboration and critical thinking in higher education, previous research has limitations, including a

lack of longitudinal data, failure to address ethical considerations, and potential bias. More comprehensive research is needed to better understand their long-term impacts and maximize their potential benefits.

In (Jacob and Centofanti, 2024), presented a study aimed at assessing whether the use of interactive H5P resources improved learning outcomes in an online undergraduate psychology course. A randomized crossover design was used to test whether students exposed to interactive H5P videos had improved assessment outcomes compared with the control group. This study found no significant differences in the assessment scores between students exposed to H5P and those who were not. There was low overall engagement with interactive content. However, students who interacted with resources reported a positive experience and indicated a preference for more interactive elements in future courses. Future research should expand on the instructional design barriers identified in this study, for example, by examining whether improved accessibility and education regarding the benefits of interactive resources would increase engagement and grades.

In (Rossoni et al., 2024), presented a Virtual Reality application for active learning developed to help students in the initial stage of the course "Methods and tools for detailed design" to acquire a set of knowledge they are missing, including technical terminology related to mechanical parts and components, the ability to decompose mechanical systems into subparts, and to create a 3D model using a CAD tool from a 2D engineering drawing. To evaluate the effectiveness of the proposed approach, the application was tested on a cohort of students with different backgrounds and knowledge of mechanical design and CAD.

Background

3.1. Active Learning in Higher Education

Prince (2004) described Active Learning as an educational strategy that actively involves students in their learning process. Bowell and Eison (1991) highlighted the importance of students carrying out meaningful tasks and reflecting on their actions, emphasizing that activity and student engagement are fundamental pillars of this approach. Michael and Modell (2003) add that this method involves the development of mental models about what has been learned, its conscious evaluation to detect possible errors and the correction of these. According to research (Michael, 2001, 2004; Novak, 2002), these dynamic favors meaningful learning.

Key characteristics of active learning include collaboration, cooperative work, and participation in practical activities that require students to be physically and mentally involved. This approach contrasts with passive learning (Haidet et al., 2004), which is linked to traditional teacher-centered models (Kain, 2003), where students act as mere recipients (Rogers & Friedberg, 1994). In conventional lectures, the focus is on the teacher, assuming that his or her role is decisive in learning. However, in student-centered environments, it is crucial to understand how students interact and take ownership of knowledge, with their behavior being the decisive factor (Alexander & Murphy, 1998; Walczyk & Ramsey, 2003). Although lectures are useful for transmitting complex information, their effectiveness decreases when students adopt a passive role, limiting their capacity for comprehension and critical thinking (Bonwell and Eison, 1991; Komarraju and Karau, 2008; Machemer and Crawford, 2007).

Doyle (2008) stated that designing student-centered environments is essential for maximizing learning. This implies that students assume responsibilities beyond taking notes, such as making decisions regarding their educational processes. Mansson (2013) pointed out that higher education is moving from a teaching paradigm to a student-oriented one, where professors must facilitate autonomous learning opportunities. This model integrates collaborative activities and individualized

rhythms, and replaces lectures with interactive dynamics (Felder & Brent, 1996). Studies support the idea that cooperative work deepens understanding and encourages critical analysis (Cavanagh, 2011; Millis, 2010). In addition, research in the neuroscience and cognitive sciences (Doyle, 2011) confirms that learning arises from direct experience and active participation, consolidating when students become involved in their educational process (Davis, 1993).

3.2. Teachers' predisposition towards active learning and its influence on the educational relationship

A teacher's inclination to implement active learning or other innovative methodologies is intrinsically linked to his or her conceptions and beliefs regarding teaching and learning. Below, we analyze how the teacher-student relationship relates to this pedagogical approach.

- Pedagogical beliefs and their impact

Educators' perspectives and mental frameworks are essential elements in their practice (Nespor, 1987). Sharan (2010) points out that teachers not only transmit knowledge, but also project their identity, values, and ideological stances. This implies that teaching is inseparably linked to an educator's personal convictions, assumptions, and political views. As Freire (2000) states, no educational process is neutral; it always reflects power structures, even in higher education, where this power usually resides in teachers and institutions, not in students. Mann (2008) stresses that universities are not neutral entities, but rather reproduce historical and social practices. Montgomery (2008) adds that classroom interactions are permeated by power dynamics, which must be explicitly recognized to foster authentic learning (Freire, 2000). For active learning to thrive, it is crucial to question these structures since it requires students to assume greater autonomy in their training.

- Dynamics in the teacher-student relationship

Active learning involves active participation of students through collaborations, debates, or interactions with the teacher. This highlights the importance of analyzing links in university classrooms. Rogers (1993) proposed that the educator acts as a facilitator who cultivates trust, respect, and empathy towards students. However, Brookfield (1995) and Rogers (1993) agree that effective teaching is based on solid relationships and conscious management of power. According to Rogers (1983), a good teacher exercises authority without suppressing students' intellectual autonomy. Hooks (1994), with his committed pedagogy, advocates a holistic approach that values the life experiences of students and builds relationships based on mutual trust.

Freire (2000) emphasizes the need to start from the prior knowledge of students, something that is often ignored in massive undergraduate classes where students are homogenized. However, in small groups, teachers can adapt their teaching by recognizing their individual needs and offering personalized support. This flexibility not only enriches learning but also humanizes the educational process.

Material and methods

4.1. Methodology

The study adopts a non-experimental quantitative approach, descriptive-exploratory in scope, aimed at characterizing teachers' perceptions without manipulating variables. A cross-sectional design is used, collecting data at a specific time, which allows for the identification of immediate patterns and trends in the use of Moodle. This approach is ideal for exploring understudied realities, such as the integration of active learning in virtual environments in specific educational contexts.

4.2. Population and sample

Population: All professors of the Department of Systems Engineering at the University of

Córdoba linked to subjects taught in Moodle (N = 45).

Sample: 32 teachers participated (71% of the population), selected through non-probabilistic convenience sampling, as they were the ones who taught classes in the semester evaluated.

4.3. Data collection instrument

A structured questionnaire with 44 items was designed and divided into three sections:

- Sociodemographic data: age, gender, teaching experience, and ICT training.
- Perception of active learning in Moodle: 5-point Likert scale.

For data collection, a Likert-type questionnaire structured in four key dimensions was designed to evaluate teachers' perception of active learning in Moodle, based on frequency of use, degree of importance, degree of difficulty, and level of satisfaction, as shown in Tables 1 to 4.

Table (1). Based on Frequency of Use

Frequency	Value
Very frequent	5
Frequently	4
Occasionally	3
Almost never	2
Never	1

Table (2). Based on the degree of importance

Importance	Value
Very important	5
Important	4
Moderately important	3
Of little importance	2
Neutral	1

Table (3). Based on the degree of difficulty

Difficulty	Value
Very difficult	1
Difficult	2
Neutral	3
Easy	4
Very easy	5

Table (4). Based on the degree of satisfaction

Satisfaction	Value
Extremely satisfied	5
Very satisfied	4
Moderately satisfied	3
Slightly satisfied	2
Not satisfied	1

- Ethical Considerations
- Informed consent: The purpose of the study and the anonymous use of the data were explained to the participants.
- Confidentiality: The privacy of the responses was guaranteed through secure storage on institutional servers.
- Implications of the Study: The results of this study will serve as input to improve teacher training, designing active learning training strategies within Moodle.

Results

5.1. Instrument reliability

To evaluate the internal consistency of the Likert questionnaire, Cronbach's alpha coefficient was applied, a statistical method that analyzes the reliability of the scale based on four dimensions of the study: frequency, importance, difficulty, and satisfaction.

The results of the analysis showed a Cronbach's alpha of 0.9625, a value that greatly exceeds the reliability threshold of 0.80 established in the academic literature (Virla, 2010). This indicates very high internal consistency between the items of the instrument, validating its precision in measuring the proposed variables.

In addition, a detailed statistical breakdown is presented.

- Variance of the Items: 0.9613.
- The Guttman reliability coefficient (lambda G6-smc) is 1.0.
- The average correlation between items was 0.3609.

Each question in the questionnaire was identified with a code (for example, Q1 for question 1 and Q2 for question 2), following a sequential order up to question Q44, corresponding to the last item. These results reinforce the methodological solidity of the instrument in capturing teachers' perceptions rigorously. Figure 1 and Table 5 show the results.

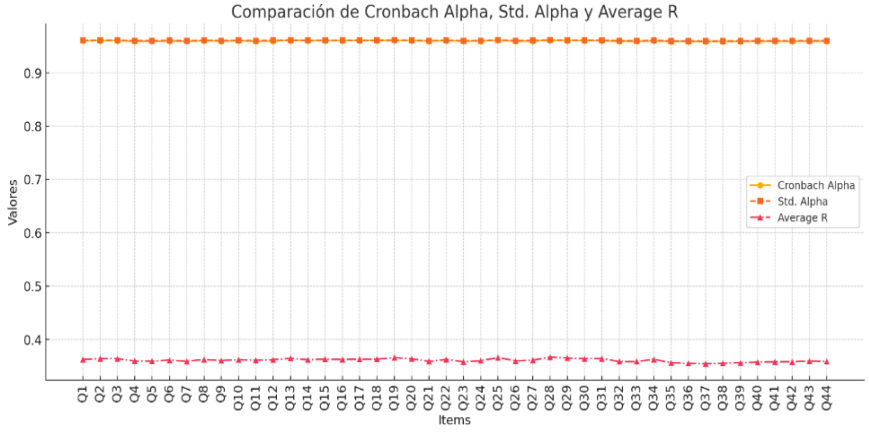

Figure 1. Instrument reliability results.

Table (5). Results of the questionnaire items.

Items	Cronbach Alpha	Std. Alpha	Average R
All itmes	0.9605	0.9613	0.3609
Q1	0.9599	0.9607	0.3626
Q2	0.9601	0.961	0.3641
Q3	0.9601	0.961	0.364
Q4	0.9593	0.9602	0.3594
Q5	0.9593	0.9602	0.3594
Q6	0.9596	0.9605	0.3612
Q7	0.9593	0.9601	0.3591
Q8	0.9601	0.9607	0.3624
Q9	0.9595	0.9604	0.3604
Q10	0.9599	0.9606	0.3621
Q11	0.9594	0.9604	0.3608
Q12	0.9597	0.9606	0.362
Q13	0.9604	0.9611	0.3646
Q14	0.96	0.9606	0.3618
Q15	0.9601	0.9608	0.363
Q16	0.96	0.9607	0.3623
Q17	0.9602	0.9608	0.363
Q18	0.9602	0.9608	0.3631
Q19	0.9605	0.9612	0.3658
Q20	0.9603	0.9609	0.3637
Q21	0.9596	0.9601	0.3589
Q22	0.9601	0.9607	0.3625
Q23	0.9595	0.96	0.3582
Q24	0.9597	0.9603	0.3601
Q25	0.9606	0.9613	0.366
Q26	0.9594	0.9603	0.3599
Q27	0.9597	0.9605	0.361
Q28	0.9605	0.9614	0.367
Q29	0.9604	0.9611	0.3651
Q30	0.9602	0.9609	0.364
Q31	0.9602	0.961	0.3642
Q32	0.959	0.9601	0.3585
Q33	0.959	0.96	0.3585
Q34	0.9599	0.9608	0.3628
Q35	0.9586	0.9596	0.3561
Q36	0.9586	0.9595	0.3554
Q37	0.9584	0.9594	0.3544
Q38	0.9586	0.9595	0.3554
Q39	0.9587	0.9597	0.3562
Q40	0.959	0.9599	0.3574
Q41	0.9592	0.96	0.3581
Q42	0.959	0.96	0.3584
Q43	0.9593	0.9602	0.3596
Q44	0.9591	0.9601	0.3587

The survey was designed using Google Doc and was applied using Google Forms. The statistical tool of Wesa(2017) was used to determine the reliability of the instrument.

5.2. Analysis of the results

A study on active learning in virtual environments in higher education analyzed teachers' perceptions regarding the use of the Moodle platform at the University of Córdoba. Four key dimensions were evaluated using a Likert-type questionnaire: frequency of use, degree of importance, degree of difficulty, and degree of satisfaction.

5.2.1. Frequency of Use

The results showed that Moodle tools were frequently used by teachers, especially in activities such as discussion forums, questionnaires, and multimedia resources. However, more interactive tools, such as simulations and collaborative projects, were used occasionally, possibly due to lack of training or familiarity with these functionalities.

The results reflect the perception of teachers in the Systems Engineering program regarding the use of virtual communities in Moodle to promote active learning. Below is a breakdown of the key findings and their implications:

- Promotion of learning communities

1. The 47% teachers promote communities frequently.
2. The 10% teachers do so very frequently.
3. The 34% teachers do so occasionally.
4. The 9% teachers rarely participate.

More than half of the faculty members (57%) actively fostered virtual communities, suggesting a significant commitment to collaborative learning. However, 43% did so sporadically or minimally, indicating a gap in the consistent adoption of this strategy.

- Development of activities for virtual communities

1. The 47% teachers design activities frequently.
2. The 6% teachers do so very frequently.
3. The 47% teachers carry out these activities occasionally, rarely or never.

Although 53% were actively involved, almost half 47% showed limited participation. This could reflect barriers, such as lack of training, time, or clarity on how to integrate these activities into the curriculum. The presence of one teacher who has never done so points to the need for specific interventions for critical cases.

- Use of tools to facilitate interaction

1. The 50% teachers use tools frequently.
2. The 10% teachers use them very frequently.
3. The 40% teachers use them occasionally, rarely or never.

60% regularly leveraged interaction tools, demonstrating the strong use of the LMS to energize communities. However, the remaining 40% underutilized these tools, which could limit the interactive experiences of students.

Strengths:

Most faculty (50%) promoted communities and used tools frequently, supporting an environment conducive to collaborative learning.

Weaknesses:

Almost half of the faculty (40%) showed limited engagement in key activities, potentially fragmenting community cohesion.

The decrease in the very frequent category from promotion (4%) to activity design (6%) suggests that some faculty members prioritize the idea over practical implementation.

Implications for active learning:

The results underline that although there is a strong foundation for fostering virtual communities, it is crucial to address implementation gaps. A comprehensive approach combining training, incentives, and continuous assessment could maximize the potential of the Moodle LMS as a space for interaction and collaboration. Figure 2 presents a summary of frequency of use.

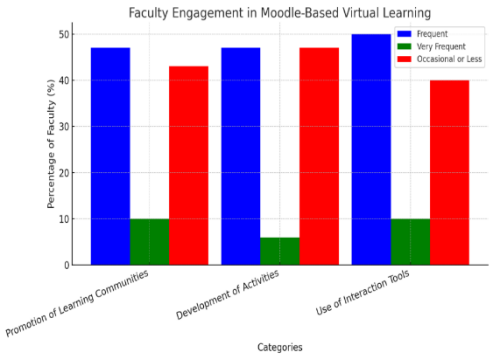

Figure 2. Summary of frequency of use.

5.2.2. Degree of Importance

Teachers considered active learning in Moodle to be very important in fostering student autonomy and participation. The flexibility and accessibility of the platform are highlighted as key factors for improving teaching in virtual environments. However, some have pointed out that effectiveness depends on the ability of students to manage their own learning.

Analysis of the results on the promotion of virtual communities in the Moodle LMS. The results reflect the perceptions of teachers in the Systems Engineering program on key strategies to promote active learning in virtual environments. The findings and their implications are summarized below:

- Collaborative work

1. 50% of teachers consider collaborative work as important and 50% very important.
2. Collaborative tools: 53% consider them very important and 47% important.
3. Activity design: 53% see them as important and 47% as very important.

Collaborative work is universally recognized as essential, although there is a slight preference for tools over activity design. This suggests that teachers prioritize technical resources but may need further training to design effective collaborative dynamics.

- Debate and discusión

1. 88% consider debate important and 12% moderately important.
2. Tools for debate: 50% see them as important and 50% as very important.

Although debate is valued, the presence of 12% in the moderately important category indicates that some teachers do not fully integrate it into their practice. However, tools are valued equally, reflecting their facilitating roles.

- Interactive content

1. The 66% consider the use of interactive content important, compared to 34% who see it as very important.
2. Tools to generate them: 56% rate them as very important and 44% as important.

There is a gap between appreciation of interactive content and the tools used to create it. This could indicate that, although teachers recognized the usefulness of the content, they perceived technical barriers or a lack of training to develop it.

- Communication mechanisms

1. The 100% rate communication mechanisms as important.
2. Synchronous/asynchronous tools: 62% consider them very important and 38% consider them important.

Communication is critical in virtual environments, especially in synchronous (e.g., videoconferencing) and asynchronous (e.g., forum) tools. The high rating of the latter underlines its role in the flexibility and accessibility of learning.

- Dynamization of communities

1. 59% consider community building important, 38% very important and 3% moderately important.
2. Designing activities for communities: 56% see them as important and 41% as very important.

Although the majority value virtual communities, 3% underestimate them, revealing a disconnection with their pedagogical potential. This sector may require raising awareness of how communities can enhance student interaction and engagement.

All strategies (collaboration, debate, interactive content, and communication) are

perceived as important or very important by the majority, reflecting an environment conducive to active learning.

The results show that the teaching staff committed to active learning strategies, but with areas for improvement in practical implementation. An approach that combines technical training, pedagogical innovation, and institutional recognition could maximize the impact of the Moodle LMS on educational experience. The dynamization of communities and the creation of interactive content have emerged as priority challenges in closing the gaps between perception and action. Figure 3, illustrates their perceptions of importance.

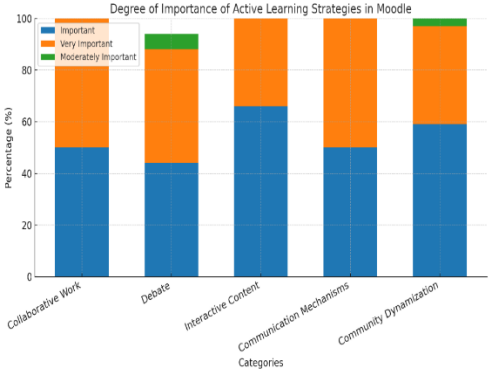

Figure 3. Summary of the degree of importance

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5.2.3. Degree of Difficulty

The results were mixed in terms of difficulty. While basic tools such as assignment submission and the use of forums were rated as easy to implement, advanced active learning strategies (such as gamification and simulators) were perceived as difficult to integrate due to lack of training and limited technological infrastructure in some cases.

The results reflect the perception of professors in the Systems Engineering program on the ease of use of tools in Moodle to energize active learning strategies. Key trends and their implications are highlighted below.

- Tools for debate and discussion

1. The 59% teachers consider them easy or very easy.
2. The 38% teachers are neutral.
3. The 3% teachers see them as difficult.

Although most perceived these tools as accessible, the high percentage of neutral responses suggests that some teachers are unsure of their effectiveness or require more practice to take full advantage of them.

- Promotion of analysis and reflection

1. The 47% teachers are neutral when using them.
2. The 47% teachers consider them easy or very easy.
3. The 6% teachers rate them as difficult.

Dominant neutrality indicates that, although the tools exist, their application to foster critical analysis is not intuitive for almost half of the teaching staff. This could reflect a gap between technical availability and pedagogical integration.

- Management of interactive content

1. The 60% teachers find it easy to create or use content.
2. The 34% teachers are neutral.
3. The 6% teacher see it as difficult.

- Contrast in content design

1. The 47% teachers consider the use of specialized tools easy.
2. The 37% are neutral and 16% see them as difficult.

Teachers are good at handling existing content; however, designing interactive materials poses challenges. This could be related to the complexity of specialized software or the lack of training in instructional design.

- Building virtual communities

1. The 50% teachers find it easy to promote communities.
2. The 31% teachers are neutral and 19% teachers find it difficult.

- Designing activities for communities

1. The 44% teachers rate it as easy.
2. The 37% teachers are neutral and 19% teachers see it as difficult.

Community-building is perceived to be more complex than other tasks. This could be due to the need for additional social and pedagogical skills (e.g., forum moderation and group facilitation).

The results reveal that teaching staff master the basic technical aspects of Moodle LMS but face challenges in complex pedagogical strategies. Recurrent neutrality and difficulties in interactive communities and content highlight the need for a holistic approach that combines technical support, pedagogical training, and institutional encouragement. Prioritizing these areas will not only improve the teaching experience but also enrich students' active learning. Figure 4 illustrates the need for a holistic approach that combines technical support, pedagogical training, and institutional encouragement.

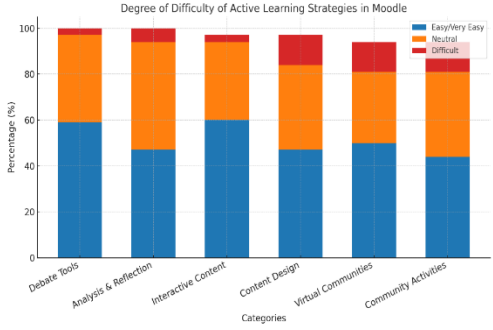

Figure 4. Summary of the degree of difficulty.

5.2.4. Degree of Satisfaction

The results of the study on the satisfaction of professors of the Systems Engineering program at the University of Córdoba revealed significant trends in the perception of virtual tools to encourage interaction, debate, reflection, and the construction of learning communities. The following is a structured analysis of the key findings.

• General Satisfaction in the Use of Tools

1. The 75% High Satisfaction (Very/Extremely Satisfied):

2. The 25% are "very satisfied" and 13% "extremely satisfied." However, 12% express dissatisfaction, suggesting potential gaps in the usability or effectiveness of specific discussion tools.

Satisfaction was higher than in the debate (56% were very satisfied, 19% were extremely satisfied). This could indicate that the tools for analysis (forums and case studies) are more effective or better integrated into Moodle.

• Contents and Tools for Interaction

1. The 85% high satisfaction

2. The positive evaluation of the content as a means of promoting interaction is highlighted. Only 15% show dissatisfaction, which reflects a successful adaptation of materials in Moodle.

• Communication Mechanisms

1. The 91% high satisfaction

2. The 9% not satisfied

This was the highest indicator for the entire study period. Platforms such as videoconferencing, chats, and asynchronous forums are highly valued for their effectiveness in communication. This finding reinforces the importance of fluid communication in active learning.

• Building Learning Communities

1. 75% high satisfaction

2. 25% dissatisfied

Although positive, this area had the lowest relative satisfaction. The 25% dissatisfaction could be due to challenges in community revitalization or lack of collaborative strategies.

• Tools for community activities

1. 81% high satisfaction

2. 19% dissatisfied

The 81% are satisfied. This is higher than in the general construction, suggesting that the tools exist, but their strategic implementation could be improved. Figure 5 shows the degree of teachers' satisfaction.

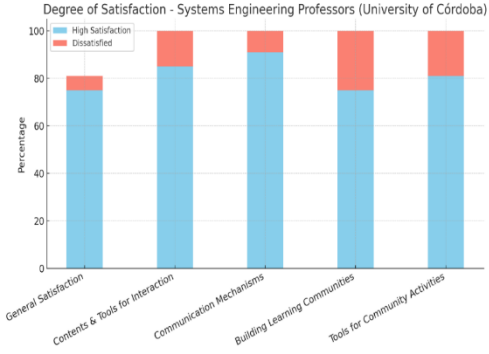

Figure 5. Teacher satisfaction level.

Discussion

The results of this study demonstrate a recurring paradox in the implementation of active learning in virtual environments. Although there is general recognition of its pedagogical importance, significant gaps persist between theory and practice. This discrepancy is manifested in key aspects, such as the frequency of use of interactive tools, the perception of difficulty in advanced strategies, and the moderate satisfaction of teachers, aspects that require critical analysis in light of the literature and the current context.

Frequency of use and gaps in the adoption of interactive tools

The predominant use of basic tools (forums and questionnaires) contrasts with the low adoption of strategies such as simulations or collaborative projects. This phenomenon coincides with previous studies that indicate that although LMS platforms offer versatile functionalities, their potential is underutilized because of barriers, such as lack of teacher training (Kulikowski et al., 2022) and resistance to abandoning traditional methods (Aretio, 2021). The neutrality expressed by almost half of the teachers in the design of collaborative activities (47%) suggests a disconnect between the theoretical assessment of active learning and its practical application, possibly aggravated by administrative burdens or institutional limitations in integrating pedagogical innovations.

Perceived importance vs. operational difficulties

Although 100% of teachers recognized collaborative work as important or very important, only 53% of the design activities were frequent. This gap reflects a structural challenge: the lack of training in instructional design and formative assessment (Copado & Osorio, 2021), as well as the absence of institutional incentives to prioritize active methodologies. In addition, the perceived difficulty in strategies such as gamification or the creation of interactive content (40% neutrality or difficulty) highlights the need for specialized technical training, a critical aspect in reducing the learning curve and fostering teacher confidence.

Moderate satisfaction and challenges in student motivation

High satisfaction with communication tools (91%) contrasted with concerns about student motivation and limited interaction. This could be explained by the persistence of passive models in virtual environments, in which LMS flexibility does not always translate into student autonomy (Han et al. 2021). Dissatisfaction with community building (22%) underlines the complexity of energizing meaningful interactions in the absence of clear pedagogical strategies, a challenge widely documented in distance education contexts (Salinas, 2022).

Institutional and pedagogical implications

- These findings support the urgency of institutional policies that integrate the three axes.
- Continuing teacher training: Programs focused on instructional design, advanced use of interactive tools, and management of virtual communities.
- Investment in infrastructure: Improvement of LMS platforms with intuitive and accessible tools along with permanent technical support.
- Recognition and evaluation: Incentives for teachers who implement active

methodologies and evaluation systems that measure their impact on student learning.

Limitations and future projections

The study focused on a small sample (32 professors from the systems engineering program at the University of Córdoba), which limits its generalizability. Future studies could broaden this perspective by incorporating student perceptions and comparing multiple institutions. In addition, we explored the impact of artificial intelligence and emerging tools on active learning.

Conclusions

The study concludes that Moodle is an effective tool for active learning in higher education, but its impact depends largely on teacher training and access to an adequate technological infrastructure. To maximize its potential, strengthening the development of digital skills in teachers and improving the integration of active methodologies in the platform are recommended.

Although teachers value active learning as a pedagogical strategy (especially collaborative work, debate, and interactive content), barriers to its implementation persist. The frequency of use of advanced tools (simulations and gamification) is low, attributed to lack of training, resistance to innovative methodologies, and technical limitations. This shows the disconnect between conceptual assessment and practical action. Teacher satisfaction with basic tools (forums and questionnaires) contrasts with the difficulties in energizing virtual communities or designing interactive activities. This underlines the need to invest in more intuitive LMS platforms, accompanied by ongoing training in instructional design and management of emerging technologies. The digital divide, especially in rural areas, demands institutional policies that guarantee equitable access to devices and connectivity.

Regarding student interaction and motivation, it can be noted that despite the high rating of synchronous/asynchronous tools (91% satisfaction), concerns persist about student autonomy and motivation in virtual environments. This reflects the need for pedagogical strategies that encourage active participation, combining flexibility with clear support structures and formative assessment. Finally, this study highlights the urgent need for policies that integrate the :

- Teacher training: Practical approaches in active methodologies and advanced use of digital tools.
- Institutional incentives: Recognition of teachers who innovate in their pedagogical practices.
- Holistic evaluation: Mechanisms that measure the impact of active learning on student performance.

In summary, the study confirms that although platforms such as Moodle have the potential to transform higher education, their success depends on an ecosystem that combines technological investment, comprehensive teacher training, and inclusive policies. The pandemic has accelerated the adoption of virtuality, but its consolidation as an educational model requires overcoming pedagogical, technical, and social gaps to guarantee equity and quality in active learning.

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