Acta Pedagogia Asiana

Review
Volume 4(1), 2025, 43–54
https://doi.org/10.53623/apga.v4i1.555

Active Learning Strategies: A Mini Review of Evidence-Based Approaches

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SUBMITTED: 10 December 2024; REVISED: 12 January 2025; ACCEPTED: 14 January 2025

ABSTRACT: Active learning strategies such as think-pair-share (TPS), problem-based learning (PBL), flipped classrooms, and collaborative projects are essential for promoting student engagement, critical thinking, and academic success. This review brings together evidence from multiple disciplines to examine the effectiveness of these strategies and their impact on educational outcomes. PBL is particularly popular in fields such as engineering and medicine, where it enhances problem-solving, self-directed learning, and teamwork by exposing students to real-world, interdisciplinary challenges. Flipped classrooms, where content delivery occurs outside of the classroom, can enable more interactive, discussion-based learning in class, which can improve student performance and satisfaction, despite challenges associated with preparation and varying learning rates. Collaborative projects are often used in economics and social sciences to foster important skills such as teamwork, leadership, and communication through group interaction. The effectiveness of these strategies is further enhanced by structured instructional models such as the analysis, design, development, implementation, and evaluation (ADDIE) framework, ensuring alignment with educational goals. In addition, the incorporation of artificial intelligence into active learning is transforming educational practice by providing personalized learning experiences and immediate feedback, although it also raises ethical concerns about the balance between technology and human interaction. In summary, active learning strategies, if carefully implemented, can provide students with important skills for academic and career success while meeting the changing demands of modern education.

KEYWORDS: Active learning; think-pair-share; problem-based learning; flipped classroom; collaborative projects

1. Introduction

Active learning is largely a new paradigm of education that transforms the focus of education from "teaching" students, where they are passive recipients of the information relayed by the tutors, to a setting where students are engaged in the learning process as participants. That is, active learning involves any instructional method that requires students to do something and think about what they are doing, not surprisingly including such activities as discussing, solving problems, case studies, and working in groups, in addition to writing that requires analysis,

synthesis, and evaluation rather than mere memorization. The participatory nature of this process enhances critical thought and the building of knowledge with understanding rather than rote learning [1].

Engagement, thus, relates to how active the student is, both cognitively and emotionally, with the learning process. It is comprised of interest in the material, motivation to learn, and participation in discussion and other activities. With more engaged learners, therefore, interactions with the content are more nuanced and thus often extended to applying the content to authentic contexts. Such high-level thinking, in fact, involves the use of certain cognitive skills that go beyond mere memorization and understanding. It actually involves using skills in analysis, evaluation, and creation that are directly related to critical problem-solving and decision-making. Such cognitive skills become the essence of the journey to the acquisition of deep knowledge and become very valuable when getting learners ready to face complicated real-life situations. Active learning has been shown to generate increased levels of engagement among students and to take into account higher-order thinking skills with better retention of knowledge, hence becoming a fundamental principle of contemporary pedagogy. All the same, in all dimensions, active learning puts pieces in place to ensure students are propelled past memorization learning and challenged to critically think and become competent and acting learners in meaningful ways [1, 2].

The roots of active learning go back to constructivist philosophies on which John Dewey, Jean Piaget, and Lev Vygotsky had earlier laid emphasis. Dewey particularly promoted experiential learning and laid great stress on "learning by doing," that students need to become active participants in their learning. Based on Piaget's cognitive developmental stages and Vygotsky's social-cultural theories, learning and teaching were once again redefined by active learning methodologies. It was in the era of greater shift toward learner-centered pedagogies in the 20th century that these traditional theoretical bases resulted in contemporary active learning strategies.

The evolution of active learning strategies has been shaped by advancements in technology and shifts in educational paradigms. The introduction of flipped classrooms, where traditional lecture content is delivered online and classroom time is dedicated to active learning activities, represents a significant milestone. Similarly, PBL, an instructional method that originated in medical education, has been widely adopted across disciplines for its emphasis on real-world application and critical thinking. In recent years, digital tools such as interactive simulations, online discussion forums, and gamified learning platforms have expanded the possibilities for implementing active learning in both traditional and online settings [4, 5].

This review article aims to provide a comprehensive analysis of evidence-based active learning strategies, focusing primarily on higher education disciplines, to assess their impact on educational outcomes. The objectives are threefold: first, to define and categorize key active learning approaches such as TPS, PBL, flipped classrooms, and collaborative projects; second, to evaluate their effectiveness based on empirical evidence from various academic fields including engineering, medicine, business, and social sciences; and third, to identify the challenges and opportunities for broader adoption and improvement of these strategies. By examining the theoretical foundations, practical applications, and research findings associated with active learning, this review seeks to provide actionable insights for educators, policymakers, and researchers in higher education. Additionally, this article contributes to the ongoing discourse on enhancing teaching and learning practices in an era of technological

advancements and evolving student needs, emphasizing the importance of developing critical skills such as collaboration, communication, and adaptability, which are essential for students' success in the modern workforce [6, 7].

2. Key Evidence-Based Active Learning Strategies

Active learning emphasizes student engagement and participation, aiming to improve understanding and retention of knowledge. Several strategies have proven effective, including TPS, PBL, Flipped Classrooms, and Collaborative Projects (Table 1). Below is an in-depth analysis of these strategies, their implementation, and comparative effectiveness.

Table 1. Strategy of active learning.

Strategy	Description	Benefits	References
TPS	A three-phase strategy where students reflect individually, discuss with a peer, and then share insights with the class.	Enhances participation and critical thinking, particularly in STEM; fosters inclusivity and peer collaboration.	[8, 9]
PBL	A student-centered approach where learners solve complex, real-world problems, integrating knowledge from multiple disciplines.	Develops critical thinking, teamwork, and self-directed learning. Applied effectively in fields like engineering and medicine.	[10, 11]
Flipped Classroom	Shifts content delivery to pre-class activities (e.g., video lectures), using in-class time for active learning.	Increases engagement, self-efficacy, and academic performance. Promotes deeper understanding through active participation.	[12, 13]
Collaborative Projects	Involves students working in groups to achieve shared objectives, promoting teamwork and problem-solving.	Fosters leadership, adaptability, communication, and interpersonal skills. Effective in business and social sciences.	[14, 15]

2.1. Think-pair-share.

TPS is an effective active learning strategy that enhances student participation and critical thinking by fostering both individual and group engagement. In this approach, students first reflect on a question or problem independently (the "Think" phase). Then, they discuss their thoughts with a peer (the "Pair" phase), before finally sharing their insights with the class or group (the "Share" phase). This structured format encourages all students to participate actively, ensuring that even those who may hesitate to speak in a large group have a chance to articulate their ideas in smaller, less intimidating settings. Research has shown that TPS not only promotes participation but also strengthens critical thinking, particularly when applied in subjects like STEM, where conceptual understanding is key. One of the key advantages of TPS is its adaptability across educational levels and disciplines. Whether in high school or higher education, TPS can be used in various fields such as mathematics, biology, and the humanities. In STEM disciplines, for example, TPS has been found to facilitate deeper understanding by encouraging students to verbalize their reasoning, which can help clarify complex concepts. Additionally, the method encourages peer collaboration, allowing students to learn from one another’s perspectives, thereby fostering a sense of community in the classroom. Furthermore, TPS is relatively easy to implement and does not require significant resources, making it an

accessible tool for educators across diverse teaching environments. The method also provides immediate formative feedback to both students and instructors, offering insight into student understanding and areas that may need further clarification [8, 9].

2.2. PBL.

PBL is a student-centered pedagogical approach that emphasizes inquiry and active problem-solving by engaging learners in complex, real-world problems. In PBL, students work collaboratively to solve these problems, integrating knowledge from multiple disciplines. This method not only fosters critical thinking but also encourages self-directed learning, as students take ownership of their educational process. Additionally, PBL helps develop essential professional skills such as teamwork, communication, and the application of theoretical knowledge in practical contexts. In fields such as engineering and medical education, PBL has proven particularly effective. For example, in medical training, students often solve clinical cases, applying their theoretical knowledge in practical settings to enhance their diagnostic skills and decision-making abilities. In engineering, PBL helps students tackle real-world engineering problems, promoting the development of innovative solutions while improving teamwork and interdisciplinary integration. However, effective implementation of PBL requires careful instructional design. One widely used framework for structuring PBL is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). This model ensures that the learning experience is systematically designed to meet specific educational outcomes. The Analysis phase helps identify learning goals, while Design and Development ensure the problem scenarios are appropriately challenging and aligned with the desired learning objectives. Implementation and Evaluation phases ensure that the students' progress is monitored and that the learning experience is continuously improved based on feedback. Thus, a clear instructional framework is essential for maximizing the benefits of PBL [10, 11].

2.3. Flipped classrooms.

The flipped classroom model revolutionizes traditional education by reversing the typical order of content delivery. Instead of passive lecture-based instruction during class time, the flipped classroom shifts content delivery to pre-class activities, such as video lectures or readings. This allows in-class time to be used for more active, student-centered learning activities, such as discussions, problem-solving exercises, and collaborative group work. Studies have consistently shown that this approach enhances student engagement, self-efficacy, academic performance, and satisfaction, particularly in higher education. One of the key advantages of the flipped classroom is that it fosters a more interactive and participatory learning environment. Students come to class prepared, having already encountered the material, which allows them to engage more deeply with the content through hands-on activities. This model also supports diverse learning styles, as students can review content at their own pace before the classroom session. Furthermore, the active learning in-class activities help reinforce and clarify concepts, promoting a deeper understanding of the subject matter. However, there are challenges associated with this model. Ensuring that students complete pre-class assignments and come to class prepared can be difficult. Some students may not take the initiative to engage with the material outside of class, which can hinder their performance during active learning sessions. Additionally, managing diverse learning paces in class can be challenging, especially when some students grasp content more quickly than others. These challenges can be addressed

through structured guidance, clear expectations, and providing additional support such as online discussions or office hours to ensure all students are adequately prepared and engaged [12, 13].

2.4. Collaborative projects.

Collaborative projects are a key active learning strategy that involves students working together in groups to achieve shared objectives, which encourages the integration of diverse perspectives and skillsets. This approach not only promotes academic learning but also nurtures critical interpersonal skills such as communication, negotiation, and conflict resolution. In effective collaborative projects, key processes such as trust-building, clear role assignment, and structured communication are essential for fostering a productive and supportive team dynamic. By engaging in collaborative work, students develop the skills needed to manage group dynamics, solve complex problems, and achieve collective goals. The benefits of collaborative projects are particularly evident in fields like business and social sciences, where teamwork, leadership, and adaptability are crucial. In business education, for instance, collaborative projects often mimic real-world work environments, allowing students to practice decision-making, delegation, and responsibility within teams. Similarly, in social sciences, collaborative learning encourages students to draw on different cultural and disciplinary perspectives, enhancing their understanding of complex social issues. These projects foster leadership qualities and adaptability, as students must learn to navigate diverse viewpoints and reach consensus on solutions. Additionally, collaborative projects contribute to the development of emotional intelligence, as students must manage their own behaviors and emotions in a group setting, an important skill in both academic and professional environments. Thus, collaborative projects not only enhance learning outcomes but also prepare students for success in diverse professional contexts, where effective teamwork and interpersonal skills are increasingly valued [14, 15].

2.5. Comparative analysis.

Each active learning strategy has distinct advantages that align with different educational contexts, and choosing the most appropriate approach depends on various factors such as class size, subject matter, and student needs. TPS is particularly beneficial in large classrooms where individual student engagement can be challenging. This strategy fosters inclusivity by giving all students a chance to reflect on a question independently, discuss it with a partner, and then share their insights with the larger group. It allows for immediate feedback, which helps address misunderstandings on the spot [16]. Think-Pair-Share can enhance student participation, especially in large and diverse classes, ensuring that even less vocal students are given a voice. The approach can be applied effectively in a wide range of subjects, particularly in introductory or lecture-heavy courses, where it helps break the monotony of traditional teaching. On the other hand, PBL is ideal for disciplines that emphasize practical application, such as medicine, law, or engineering. This method challenges students to engage with complex, real-world problems that require interdisciplinary solutions, making it an essential tool for professional education. PBL encourages students to apply their knowledge in practical scenarios, thereby enhancing critical thinking, decision-making, and problem-solving abilities [17]. This approach is particularly useful for helping students integrate theoretical knowledge with practical experience, which is essential in fields that require professional competence.

However, it can be more resource-intensive as it requires careful design of scenarios and often works best in smaller group settings. Flipped Classrooms, where traditional lectures are moved outside the classroom in favor of more interactive, hands-on activities during class time, offer another distinct advantage. This strategy enhances student engagement by allowing students to engage with theoretical content at their own pace before class, freeing up in-class time for practical applications, discussions, and problem-solving activities. This model is effective in courses where both theoretical understanding and practical application are crucial, such as in the sciences and social sciences. By flipping the classroom, students are better able to manage their learning at their own pace and come to class prepared for more engaging and dynamic activities. The approach has shown significant improvements in student engagement, academic performance, and satisfaction [18]. Collaborative Projects are highly effective for developing teamwork, leadership, and communication skills, which are vital in many professional fields. This strategy encourages students to work together to complete a task or project, helping them build interpersonal skills and engage in practical, hands-on learning. Collaborative projects also allow students to leverage diverse perspectives, which can enhance creativity and problem-solving. This strategy works well in disciplines that require group work and can be particularly beneficial in fields like business, design, and the humanities. However, it requires careful management to ensure that all group members contribute equally and that conflicts are resolved productively. While these strategies often overlap in their benefits, their effectiveness depends on careful implementation and alignment with the course's learning objectives. Educators are encouraged to tailor their approach by combining methods to suit specific disciplines and student needs. For instance, an instructor might use Think-Pair-Share in a flipped classroom to ensure all students engage with the material before applying it in collaborative group activities. These strategies, when integrated thoughtfully, collectively support the transition from passive to active learning, equipping students with the skills necessary for success in academic and professional environments [19, 20].

3. Impact of Active Learning on Educational Outcomes

Active learning has been widely shown to have a significant impact on various educational outcomes, including student engagement, retention, and the development of critical thinking skills (Table 2). Strengthening the connection to the modern context, studies suggest that active learning significantly enhances students' understanding of content through active participation, as opposed to the passive reception of information. In the current educational landscape, active learning techniques, such as flipped classrooms, collaborative projects, and problem-based learning, have proven to outperform traditional teaching methods in terms of both academic performance and student satisfaction. These strategies have gained even more relevance in the modern context of education, where there is an increasing emphasis on equipping students with practical skills for the rapidly evolving workforce. One of the key advantages of active learning is its ability to foster deeper engagement with the material. Research consistently shows that students in active learning environments exhibit higher levels of participation, enthusiasm, and involvement, leading to improved academic performance [21, 22]. These techniques not only promote critical thinking and problem-solving skills by placing students in situations where they must apply their knowledge in practical scenarios, but they also encourage collaboration and peer interaction, which have become integral components of modern education. As a result,

students are more likely to retain information over the long term, moving beyond surface-level memorization to achieve a deeper understanding of key concepts.

However, the integration of active learning in contemporary classrooms also comes with challenges. One of the most notable barriers is resistance from both students and instructors. Some students may initially resist active learning because it demands greater responsibility for their own learning, which can feel uncomfortable when compared to the more traditional, lecture-based approach [23, 24]. Similarly, educators may face resistance due to concerns over the additional time and effort required to prepare and manage active learning activities. Given the growing importance of student-centered learning and technology integration in the post-pandemic era, overcoming these barriers is crucial for the success of active learning.

Moreover, the implementation of active learning places significant demands on resources such as smaller class sizes, access to collaborative technology, and classroom spaces conducive to group work. In a post-pandemic world, where hybrid learning environments are becoming increasingly common, these resource constraints may limit the feasibility of widespread adoption, particularly in large-scale institutions or in courses that have traditionally been lecture-heavy [25, 26].

Despite these challenges, numerous case studies from across disciplines highlight the success of active learning. For instance, in STEM education, active learning has been shown to improve both student retention and the quality of learning. In mathematics and engineering courses, strategies like flipped classrooms and problem-based learning have led to higher pass rates and increased student engagement. Furthermore, evidence from social sciences and humanities courses suggests that active learning strategies can significantly enhance student collaboration and critical thinking, especially when the activities are aligned with the course objectives. This demonstrates that active learning not only addresses the need for academic rigor but also aligns with the growing demand for real-world, applicable skills, which are crucial for students' success in an increasingly digital, interconnected, and technology-driven world [27, 28].

Table 2. Key aspect and impact of active learning on educational outcomes.

Key Aspect	Active Learning Impact	Challenges	References
Engagement	Active learning increases student participation, enthusiasm, and involvement in the learning process. It leads to deeper engagement with course material.	Resistance from students due to discomfort with responsibility and active participation; instructors may resist due to additional preparation time.	[21, 22]
Retention	Active learning strategies promote long-term retention by encouraging deep understanding and moving beyond memorization to application of knowledge.	High resource demands (e.g., smaller class sizes, access to technology and collaborative spaces) may limit widespread implementation.	[23, 24]
Critical Thinking and Problem-Solving	Active learning fosters critical thinking, problem-solving, and the ability to apply knowledge in practical, often collaborative situations.	Increased demands on resources and time for instructors to design and manage activities.	[25, 26]
Academic Performance	Active learning techniques, such as flipped classrooms and collaborative projects, improve academic performance and student satisfaction compared to traditional methods.	Initial resistance from students and instructors to adopt new approaches; challenges in adapting for large courses.	[27, 28]

4. Future Directions and Best Practices

The future of active learning is significantly shaped by emerging trends in technology, particularly the integration of artificial intelligence (AI). As active learning strategies evolve, educators are increasingly leveraging AI-enhanced tools to personalize learning, increase student engagement, and improve outcomes across different educational contexts. One of the most promising directions in active learning is the incorporation of AI to create customized learning experiences. AI tools can facilitate personalized content delivery, tailoring lessons to individual students' progress, learning styles, and needs. For instance, generative AI applications are being used to design interactive learning activities, such as simulations and role-playing scenarios, which engage students more deeply in the subject matter. Additionally, AI-powered systems can analyze student data in real-time, offering immediate feedback and adjusting learning paths to enhance comprehension and retention. This shift toward personalized learning models is making active learning more adaptive, ensuring that each student can progress at their own pace while maintaining engagement and motivation.

The role of AI extends beyond personalization to support collaborative and experiential learning. Tools such as intelligent tutoring systems and virtual assistants can guide students through PBL scenarios and provide collaborative platforms for group work. These tools help students develop critical thinking and problem-solving skills by offering scaffolded support throughout complex tasks. AI can also assist educators by automating administrative tasks, allowing them to focus more on active teaching and less on grading or content delivery. Despite these advancements, there are notable challenges and considerations for the widespread adoption of AI in education. One concern is the potential for over-reliance on technology, which could undermine the crucial human aspects of teaching, such as empathy, creativity, and adaptive responses to diverse learning needs. Educators must strike a balance between leveraging AI's capabilities and maintaining the personal touch that fosters meaningful student-teacher interactions. Moreover, there are ethical issues regarding data privacy and the potential for bias in AI algorithms, which need to be addressed to ensure that these technologies are used responsibly.

To effectively adopt AI and other technology-driven active learning strategies, educators should follow several best practices. First, training and professional development are essential to ensure that instructors can integrate these tools effectively into their teaching. This includes familiarizing themselves with both the potential and limitations of AI and understanding how to use it ethically and responsibly. Additionally, educators should focus on the alignment between technology, learning objectives, and student needs, ensuring that any tool or method used enhances, rather than detracts, the learning experience. Looking ahead, further research is needed to fully understand the long-term impacts of AI-enhanced active learning on educational outcomes. While preliminary studies show promising results in terms of engagement and academic performance, more empirical data is required to validate these findings across diverse educational contexts. Future studies could focus on the effectiveness of AI tools in fostering deeper learning and developing soft skills such as communication and collaboration, which are essential for success in both academic and professional settings. Future direction and challenge in active learning is summarized in Table 3.

Table 3. Future direction and challenge in active learning.

Key Aspect	Future Directions in Active Learning	Challenges	References
Personalized Learning	AI tools allow for customized content delivery, tailoring lessons to individual student progress, learning styles, and needs. Generative AI is used for interactive learning activities.	Risk of over-reliance on technology, which might undermine human aspects of teaching such as empathy and creativity.	Greene-Harper, 2023
AI and Collaborative Learning	AI-powered systems like intelligent tutoring and virtual assistants support collaborative problem-based learning (PBL) and group work, enhancing critical thinking and problem-solving.	Potential ethical issues with data privacy and bias in AI algorithms.	Greene-Harper, 2023
Teacher Support	AI can automate administrative tasks, giving educators more time to focus on active teaching.	The balance between technology and maintaining personal, meaningful student-teacher interactions must be carefully managed.	Greene-Harper, 2023
Training and Professional Development	Educators need training to integrate AI and other technology-driven tools effectively into teaching. Understanding both the potential and limitations of AI is crucial.	Ensuring that AI tools align with learning objectives and student needs, and using them ethically and responsibly, requires ongoing professional development.	Greene-Harper, 2023

4. Conclusions

Active learning strategies, when implemented effectively, can greatly improve student engagement, critical thinking, and academic performance. Techniques like TPS, PBL, Flipped Classrooms, and Collaborative Projects each offer specific benefits suited to different educational settings. For example, Think-Pair-Share works well for large classes, promoting inclusivity and feedback, while PBL is effective in fields that require problem-solving and interdisciplinary learning. Flipped classrooms allow more interactive in-class activities by having students review theoretical content independently beforehand. Collaborative projects foster teamwork and practical skills in professional environments. The integration of AI and technology is becoming a significant trend in active learning, offering opportunities for personalized experiences and real-time feedback. AI-driven tools can adapt to students' needs, enhancing both learning and administrative efficiency. However, challenges such as ethical concerns and data privacy must be addressed to avoid over-reliance on technology. Moving forward, educators are encouraged to combine active learning strategies to meet specific objectives and student profiles. Research on the long-term effects of AI in education is needed to validate its effectiveness across various contexts. Overall, active learning, enhanced by technology, prepares students for success in an evolving academic and professional landscape.

Acknowledgments

We would like to express our sincere gratitude to everyone who supported and contributed to this work.

Author Contribution

Maria Eugenia Martinez contributed to the conceptualization, methodology, and writing of the manuscript. Valeria Gomez provided critical review and feedback on the manuscript and contributed to the analysis and interpretation of the data.

Competing Interests

The authors declare no competing interests.

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