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Article

Team-based learning—An approach to enhance collaboration and academic success in engineering education: A comprehensive study

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Abstract: Team-Based Learning (TBL) has emerged as an effective pedagogical approach for promoting active learning, collaboration, and academic success in higher education. This article explores the fundamental principles and implementation framework of TBL, emphasizing its relevance in engineering education, where the development of both technical and transversal skills, such as teamwork and problem-solving, is critical. Drawing on an extensive literature review and the authors' practical experience, the study examines the benefits and challenges associated with TBL, including increased student engagement, improved knowledge retention, and the development of critical skills. Additionally, it addresses obstacles such as resistance to change, time constraints, and the need for faculty training. The article further analyzes the potential integration of TBL with emerging technologies, such as artificial intelligence, virtual reality, and hybrid methodologies, creating more dynamic and interactive learning environments. This comprehensive analysis aims to support teachers and institutions in adopting TBL, thereby contributing to the enhancement of the quality and impact of the teaching-learning process.

Keywords: active methodology; hybrid methodologies; team-based-learning; engineering education; critical skills; learning environments; student participation; academic success

1. Introduction

In recent years, higher education has faced the challenge of preparing students for a constantly evolving job market, where, in addition to technical skills, transversal competencies such as communication and teamwork are essential. In this context, a profound reflection on the pedagogical methodologies employed by higher education institutions becomes imperative.

Traditional pedagogical methodologies—predominantly lecture-based, teacher-centered, and focused primarily on examination-based assessment—have proven inadequate for fostering these competencies in an integrated manner [1,2].

These pedagogical methods, typically characterized by a lecture-based, teacher-centered approach, have been criticized in higher education for their ineffectiveness in actively engaging students in the teaching-learning process. This model, primarily based on the unidirectional transmission of content and exam-based assessments, restricts the development of critical skills such as problem-solving, critical thinking, and teamwork, which are essential for professional practice in today's world.

This gap often results in a misalignment between market expectations and the skills of graduates, as these methods primarily emphasize technical content [3]. Additionally, students tend to adopt a passive role, showing limited engagement in the learning process. This lack of involvement, among other consequences, contributes to significant rates of failure and dropout. Traditional methodologies are also associated with lower long-term retention of content and the massification of the teaching process, as they fail to account for the diverse learning styles and paces of individual students [4].

Student-centered pedagogical practices, often grounded in active learning methodologies, have emerged as effective alternatives to traditional teacher-centered practices. By placing the student at the core of the teaching-learning process, these approaches emphasize active knowledge construction, the development of critical skills, and the practical application of what is learned. These methods contrast with traditional approaches by shifting the responsibility for learning from the teacher to the student, creating a more dynamic learning environment that is responsive to the individual needs of students [4,5]. Examples of strategies that can be integrated into active methodologies include gamification, problem-based learning, simulations, flipped classrooms, or team-based learning [6].

In this context, Team-Based Learning (TBL) has emerged as an innovative and effective pedagogical approach, designed to transform learning into collaborative and dynamic experiences that directly address these new demands [1,7,8].

This pedagogical approach was developed in the 1970s with the aim of fostering active student engagement in large classes. The central concept—group-based learning—was implemented by organizing classes into structured groups, encouraging students to actively participate in applying theoretical content to practical contexts [9]. The most widely accepted definition of this concept is: "TBL is an active learning and small group instructional strategy that provides students with opportunities to apply conceptual knowledge through a sequence of activities that includes individual work, teamwork and immediate feedback" [10].

In recent decades, TBL has been widely adopted across various fields of knowledge. In health sciences, it enables students to apply theoretical knowledge to practical healthcare scenarios [11]. In the field of management, TBL is used to develop managerial skills such as leadership and decision-making [8]. In teacher education and training, TBL is employed to develop pedagogical skills and to encourage the future adoption of active teaching methods [12]. In engineering education, TBL proves effective in developing complex problem-solving skills and teamwork abilities essential for future professional practice [13]. In addition to these more technical areas, it has also been used as a tool to promote critical thinking and student engagement in subjects such as literature, psychology, and theater [14], as well as in creative writing programs [15].

The TBL approach incorporates several complementary methodologies, one of the most fundamental being the flipped classroom model. This model enables TBL to maximize classroom time for group problem-solving activities [16]. Another example is Problem-Based Learning (PBL) [5] which offers a more open and exploratory approach, allowing students to apply the knowledge gained through TBL to complex, real-world problems, case studies, or gamification [16]. These methodologies can also be combined to enhance the learning experience, such as the integrated use of TBL with the flipped classroom model and gamification [17].

Another combination, that of TBL with experiential learning, has proven to be highly effective by incorporating into TBL the principle that knowledge is most effectively acquired when students engage in practical activities and reflect on their experiences [18–21].

By requiring prior preparation and providing immediate feedback, TBL enables students to gain a deeper understanding of the content while developing essential skills for the job market [1,9,11,22,23].

TBL stands out as a particularly effective teaching-learning methodology. By actively engaging students in group work, it enables them to understand the impact of their actions on the group's success, thereby fostering a strong sense of responsibility and commitment to fulfilling their tasks. The well-structured stages and the inclusion of practical applications of content promote long-term knowledge retention, rather than short-term memorization. Additionally, it stimulates critical thinking and enhances communication skills, preparing students to face collaborative and complex situations.

An additional characteristic is that TBL can be efficiently implemented in large classes, maintaining high levels of student participation [24,25]. The professor primarily focuses on facilitation and guidance - intervening when necessary—but allowing students to take a central role in their own learning.

In summary, with traditional teaching methods increasingly questioned for their effectiveness, TBL emerges as an alternative to transform the teaching-learning process in higher education. This study aims to analyze and synthesize existing knowledge on the implementation, impacts, and benefits of TBL in the context of higher education, with a particular focus on its applications in engineering courses, where mastery of both technical and interpersonal skills is essential for students' entry into the job market and their professional success. It serves as a guide for teachers who wish to implement the methodology, as well as for students participating in the process. In addition to the existing literature, the authors draw on their extensive experience in the design, implementation, and assessment of TBL in engineering courses. The authors have been applying the methodology for several years across different subjects in engineering courses at a higher education institution, encompassing students in their 1st, 2nd, and 3rd years of undergraduate studies. Among the subjects, "Sustainable Construction" and "Business Management" stand out. The number of students in these subjects ranges from 30 to 300. This variety has allowed the methodology to be tested in both small and large classes, with students at different stages of their academic journey and in diverse scientific fields.

Based on the literature analysis, it is possible to identify the foundations that structure TBL as an active and effective teaching-learning methodology in engineering education. This article identifies the fundamental principles that define TBL, discusses the essential stages of implementation, and highlights the characteristics that distinguish it from other active methodologies. Additionally, drawing again on relevant studies and references, key elements of TBL will be explored, such as group formation, prior student preparation, and the phases of assessment and practical application, which together promote a collaborative, student-centered learning environment.

2. Fundamental principles

A deep understanding of TBL requires an understanding of its fundamental principles, which structure this methodology as an effective approach to the teaching-learning process. Several studies highlight the need to use the correct TBL framework to ensure effective results [7]. These principles include adhering to group formation rules, creating conditions for students to complete prior preparation, properly designing practical application activities, and ensuring continuous feedback [24–27]. Adhering to these principles in the design of curricula or courses is crucial to maximizing the pedagogical benefits.

2.1. Group formation

In group formation, it is essential to consider several factors. A common question is whether groups should be formed by the teacher or whether students should choose their own groups. When students form their own groups, they tend to select peers with whom they already have affinities or similar skills, which can limit the diversity of competencies, learning styles, and perspectives—elements that are crucial for the effectiveness of TBL. On the other hand, when groups are formed by the teacher, criteria can be introduced to promote diversity, enriching discussions and facilitating problem-solving. The ideal group size generally falls between 5 and 7 students, ensuring a good level of participation without compromising diversity [1,9,28].

A final consideration regarding group management is that groups should remain the same throughout the duration of each course, curricular unit, or module, and across all TBL activities. The group development model (formation-conflict-norming-performance-dissolution) is particularly relevant for understanding the process of group formation and growth within the TBL context [29].

2.2. Pre-class preparation

Creating favorable conditions for students' prior preparation is another central principle of TBL, as it ensures that students come to class with a basic understanding of the content. This is a crucial point in the implementation of TBL, as it challenges the traditional practice of studying after class, requiring students to prepare in advance. It involves reading materials and studying key concepts to ensure that classroom time is dedicated to practical application and problem-solving. The study materials should be clear, concise, and directly related to the learning objectives. In other words, they should contain essential information, avoiding content overload [27].

The materials should also, whenever possible, be diversified. In addition to texts, they can include videos, audios, or presentations to cater to different learning styles and make the content more accessible and engaging for students [30].

2.3. Problem solving activities

The third principle involves the proper design of practical application activities. These activities should have characteristics that allow for maximizing engagement and the effectiveness of learning.

They should preferably be problem-based, reflecting real-life situations [31], allowing students to apply theories and concepts practically, while increasing their motivation by observing the direct application of knowledge in their future professional practice. The activities should also be challenging enough to stimulate critical thinking and problem-solving. Each task should be structured to require in-depth analysis—it can be divided into phases that guide students more clearly—and promote collaboration among group members in seeking a solution to the posed problem.

A valuable tool in designing these activities is the integration of the experiential approach, a fundamental strategy for promoting learning in real-world contexts. This approach facilitates the development of both technical and interpersonal skills in an integrated and meaningful way, providing students with a more engaging and applied learning experience [32–34].

In the context of engineering, it is beneficial for activities to include technological tools or accessible resources that simulate the professional environment, such as simulation software or programming tools. This enables a more authentic and practical application of the concepts learned [35].

2.4. Continuous feedback

Finally, the principle of ensuring continuous feedback, both from the teacher and peers, is essential to enable students to adjust their understanding and progression strategies. Prompt and structured feedback helps students correct errors and reinforce what they have learned during the activity [36]. In addition to fostering deeper learning, it also enhances team performance and cohesion, maximizing the benefits of active methodologies in higher education [37,38].

3. Implementation structure

TBL is structured around three fundamental phases (**Figure 1**), designed to promote collaborative learning and facilitate the practical application of acquired knowledge [8,12,24,25,27]. Each of these phases plays a specific role in the teaching-learning process, from the initial preparation of students to the feedback and reflection stage, creating a dynamic and participatory learning environment.

The first session of each course/module in TBL should be entirely dedicated to explaining its operation and forming student groups (see rules outlined in the previous section). Familiarity with the working structure allows students to maximize the benefits of the methodology, fostering an effective collaborative learning environment, which is at the core of the approach. Furthermore, a clear understanding of the method and group dynamics by students is essential to ensure a smooth transition from traditional teaching to TBL [9,26,39].

After forming the groups, the teacher should support students in clearly defining their expectations and the roles of each group member. This initial process is essential to ensure that students understand their responsibilities and the impact of their role within the group [40]. A proven tool that supports this process is the group contract [41]. Once formed and activated, the groups should remain unchanged throughout all TBL activities.

The following sections provide a detailed description of the main phases guiding the effective implementation of TBL, highlighting how each phase contributes to the development of essential skills and the deepening of the content studied.

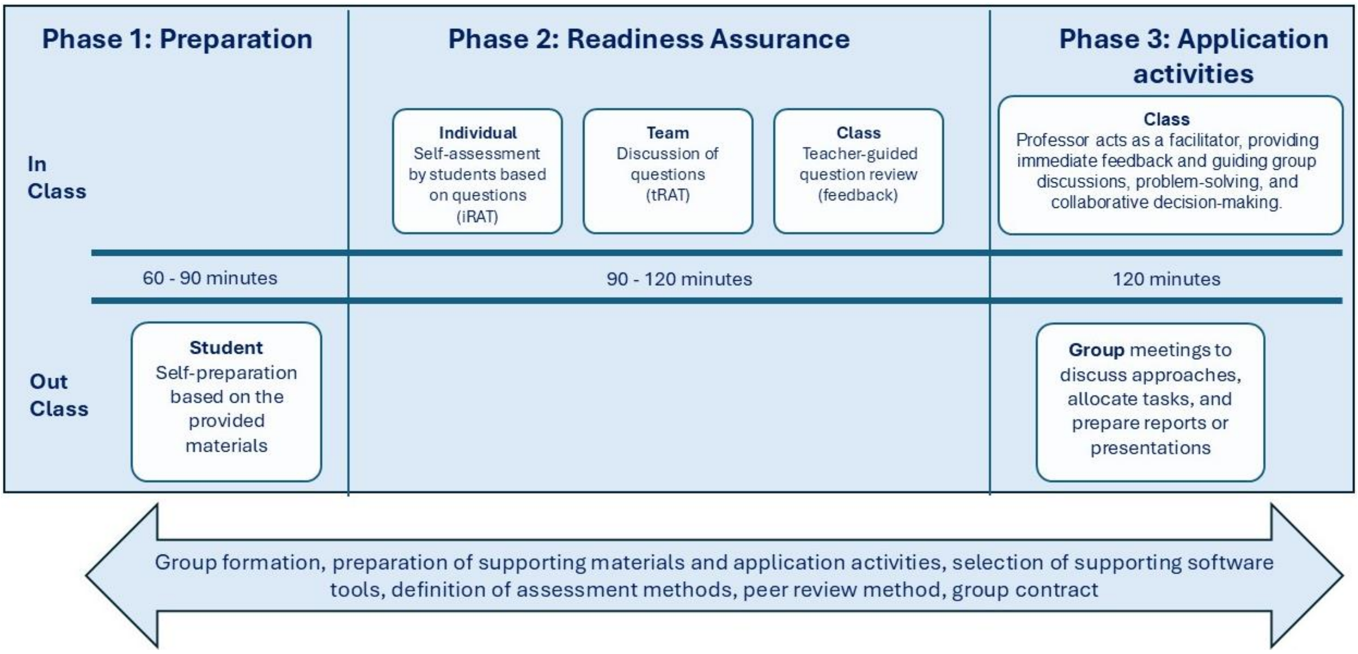

Figure 1. Team-based learning structure: the sequence of activities.

3.1. Phase 1: Pre-class preparation

The pre-class preparation phase is essential to ensure that students arrive in the classroom with an initial understanding of the content to be addressed. The teacher's role is critical in this phase; the study materials provided to students should cover the fundamental concepts in a clear and objective manner, avoiding overly detailed descriptions that might discourage students from engaging in prior study.

There are several platforms that provide comprehensive support for this phase, enabling teachers to select, organize, and deliver study materials to students in an interactive and diverse range of formats. Examples include Moodle, Microsoft Teams, and Google Classroom. Emerging AI tools, such as NotebookLM, also play a significant role in motivating students and making the learning process more efficient and engaging. These tools can adapt content to individual student needs, facilitating better understanding and retention of knowledge.

Pre-class preparation is one of the critical success factors of TBL and requires a significant shift in students' study habits. Students are responsible for acquiring a basic understanding of the content before the class, which contrasts with the traditional model where knowledge is introduced during face-to-face sessions and studied afterward [17,42]. The main objective is to create the necessary conditions for all students to acquire a common knowledge base, enabling them to actively participate in discussions and group activities [39].

3.2. Phase 2: Readiness assurance (in-class)

The next phase takes place in the classroom and is referred to as the Readiness Assurance phase. This phase aims to ensure that students are prepared to actively participate in group discussions and, subsequently, in practical application activities [12,24].

In preparing for this phase, the teacher should design questions that stimulate critical thinking and the application of concepts rather than mere memorization, enabling an assessment of the effectiveness of pre-class preparation [1,24]. Although the questions are generally multiple-choice, some authors suggest including a few open-ended questions to foster discussion. These require students to analyze and justify their answers, which enhances the learning process and strengthens their argumentation skills [39].

At the beginning of the class, each student takes an individual Readiness Assurance Test (iRAT) and records their responses. This test serves as a moment of self-assessment, allowing students to reflect on the effectiveness of their preparation.

After the individual test, students gather in their groups to take the same test collaboratively, known as the team Readiness Assurance Test (tRAT). During this phase, students discuss each question, justifying and debating their answers, which promotes critical thinking and strengthens collaborative work. This discussion encourages students to explain their interpretations, listen to their peers' perspectives, and develop a deeper collective understanding of the content.

Each group must select a representative (rotating this role throughout the course) to present the group's answers or questions. During group discussions, the teacher should avoid directly answering students' questions to ensure they do not interfere with the collective knowledge-building process and the collaborative efforts of the groups. However, if students encounter significant difficulties progressing with their tasks, the teacher may intervene in a guiding manner, posing alternative questions to stimulate reflection and help overcome obstacles, facilitating the advancement of the group's work.

At the end of the group discussion, each student can compare their individual answers with the group's responses and analyze any discrepancies.

Finally, the Readiness Assurance phase concludes with a teacher-led discussion, during which the teacher provides additional feedback on the groups' answers and clarifies any doubts or more complex concepts. In this activity, the teacher should focus on the questions where students made errors or on the issues they raised, optimizing classroom time.

To ensure that all students are engaged and prepared to participate actively, beyond the group representatives, the teacher should also direct questions to individual group members. This approach aims to deepen explanations, clarify reasoning, or confirm understanding.

The use of interactive tools, such as Mentimeter or VoxVote, enables students to actively participate, allowing the group to receive immediate feedback on their answers. This approach not only reinforces the learning process by addressing doubts and consolidating concepts in real time but also fosters greater student engagement, encouraging motivation and collaboration during discussions.

Additionally, these tools provide the teacher with an instant overview of the collective performance, helping to guide the class more effectively.

After reviewing the questions, the teacher can address those that proved most challenging, reinforce key points, or introduce new examples to solidify the understanding of the concepts. This final feedback is essential to ensure that all students have a common knowledge base and are prepared to move on to the practical application phase with a clear and shared understanding of the content.

3.3. Phase 3: Application activities (in and out of the classroom)

Application activities are designed to enable students to practically apply the knowledge acquired in the previous phases. The primary goal of these activities is to deepen understanding by promoting the resolution of complex problems and decision-making in contexts like those students may encounter in their professional lives.

To be effective, these activities must be carefully structured and sufficiently challenging, requiring contributions from all group members for their resolution. With a higher degree of complexity, they are designed to be worked both inside and outside the classroom, ensuring continuous student engagement in the learning process.

In the classroom, these activities focus on group discussions, problem-solving, and collaborative decision-making, with the teacher acting as a facilitator by providing immediate feedback and guiding debates.

Outside the classroom, students organize group meetings to discuss approaches, allocate tasks, and prepare reports or presentations. These efforts ensure that they arrive at the face-to-face sessions well-prepared to contribute actively, maximizing the outcomes of collaborative activities.

Finally, the effectiveness of practical application activities is closely tied to their relevance for students. In fields such as engineering, for instance, these activities can involve projects, case studies, or simulations that mimic real-world industry challenges. This alignment between theory and practice not only enhances knowledge retention but also fosters the development of skills directly applicable to professional contexts.

For example, Diniz et al. [31] adapted TBL to the teaching of telecommunications by using software-defined radio to bridge theoretical concepts with low-cost practical applications. Similarly, Vidoni et al. [35] employed the Architecture Tradeoff Analysis Method to evaluate case studies of real-world architectures. Sousa [43] illustrates the use of experiential methodologies by describing activities in which engineering students select and analyze the operations of a real company to apply management concepts. Subsequently, they present their findings in reports and propose improvements that the companies can implement. Another example can be found in the practical activities described by Ricaurte and Viloria [44], which involved the design and industrial production of ethanol.

4. Discussion: Benefits and challenges

Following the analysis of the TBL implementation structure, this section focuses on discussing its main benefits and challenges based on existing literature and pedagogical practice. The positive impacts of TBL on both students and teachers will be examined, highlighting the advantages of this methodology in developing technical and transversal skills.

Additionally, common challenges in its application will be addressed, along with strategies to overcome them. This critical analysis is essential to understanding the potential of TBL as a transformative tool in higher education, particularly in fields such as engineering education.

TBL offers numerous benefits for students, professors, and the classroom environment.

For students, one of the primary benefits is the development of skills that go beyond mastering technical subjects, combined with a significant increase in their engagement and motivation in the learning process. By requiring students to take a central role in their own learning journey, this methodology fosters a greater commitment to studying and encourages more active participation in classroom activities [1,9,27]. Pre-class preparation and practical application activities promote long-term knowledge retention by strengthening the connection between theory and practice, replacing the superficial memorization often associated with traditional methodologies [11,45,46].

Additionally, TBL fosters the development of transversal skills such as communication, teamwork, problem-solving, and decision-making. These skills are crucial for addressing the challenges of the job market, particularly in fields like engineering, where collaboration and critical analysis are central to professional success [8,31]. The group work model in TBL also promotes a sense of individual responsibility while fostering cohesion and collaboration among team members [27]. Another noteworthy benefit is the opportunity for the practical application of knowledge, allowing students to consolidate theoretical content through real or simulated challenges and situations. Additionally, since TBL promotes immediate and continuous feedback, both individually and in groups, it helps students quickly correct mistakes and improve their performance throughout the process.

For professors, TBL offers significant advantages, particularly the opportunity to act as facilitators of learning rather than merely knowledge transmitters. This shift enables professors to focus on identifying and addressing students' specific difficulties through immediate and targeted feedback [24]. It provides a clearer understanding of students' difficulties and learning gaps through the analysis of individual and group responses during the Readiness Assurance phase and the practical application phase. This real-time diagnostic enables more effective pedagogical interventions [1]. By reducing the need for detailed lecture-based sessions, TBL allows for the optimization of time dedicated to planning practical activities and monitoring students' progress [7,47].

The higher levels of student participation in class, which make the teaching experience more interactive and dynamic, not only enhances student motivation but also stimulates teacher motivation [24]. This increase in student participation and the resulting improvement in their performance make the teaching experience more rewarding for teachers [11].

Finally, it significantly contributes to improving the classroom environment, transforming it into a more collaborative and dynamic space, in contrast to the monotony and boredom often associated with the lecture-based method [2]. It can also help reduce individual student anxiety by creating an environment where they feel comfortable participating, learning from mistakes, and contributing to collective success without fear of excessive judgment [8].

Absenteeism in classes has become increasingly frequent, representing a growing concern for higher education institutions [48]. Attendance rates in TBL classes are significantly higher than those observed in traditional lecture-based classes. This increase is largely attributed to the active engagement of students and the promotion of individual responsibility, factors that play a decisive role in fostering greater class attendance [49]. TBL transforms the classroom into a practice-oriented space by prioritizing the application of knowledge in real-world contexts. This connection between theory and practice makes learning more relevant and motivating, contributing to a positive and enriching learning environment [35].

Finally, one of the key benefits of TBL is its contribution to improving academic outcomes, including higher pass rates and better student grades [1,50,51].

Despite the identified benefits, implementing TBL presents challenges for both students and teachers.

One of the main obstacles to implementing TBL is student resistance to the teaching-learning method. This resistance can stem from various factors, often attributed to the shift in study habits. TBL requires students to complete pre-class preparation, contrasting with the traditional model where study occurs after the class. Many students are unaccustomed to this more autonomous approach, which can lead to feelings of discomfort and frustration, particularly during the early stages of implementation [52]. The shift in mindset can be challenging without proper guidance and a gradual introduction to the methodology [53].

Another factor contributing to student resistance is the collaborative nature of TBL. Students who prefer to work independently may feel uncomfortable with group work, as it requires sharing opinions, defending ideas, and negotiating with peers. These situations can be particularly intimidating for more introverted students or those with lower confidence in their abilities [54].

Additionally, some students may perceive TBL as an excessive workload. The demands of pre-class reading, active participation in discussions, and responsibility for the group’s performance can be seen as more demanding than traditional methodologies. This perception may lead to demotivation, making it harder for students to adapt to the method [55].

From the teachers perspective, implementing TBL can be a complex challenge [56]. Accustomed to a predominantly lecture-based role focused on direct content delivery, for which they already possess well-established skills, teachers must transition to a model that prioritize active and collaborative learning facilitation. This paradigm shift requires a different set of competencies, such as the ability to manage group dynamics, foster meaningful discussions, and provide immediate and targeted feedback [55,57]. This situation can be further exacerbated by a lack of specific training and limited time for teachers to adapt to this new methodology [54].

For teachers, TBL also demands significant effort, as preparing study materials, readiness tests, and practical application activities can be quite time-consuming [55].

Finally, effective time management in the classroom can be a significant challenge. Ensuring that all stages of TBL, from readiness tests to practical activities, are completed effectively within the available time can be particularly difficult, especially in large classes or when unexpected questions and delays arise [53].

An additional challenge is the noise generated by group interactions in TBL, especially in large classes, as it can hinder concentration and communication for both students and teachers. Studies show that high noise levels can impair information retention and cognitive performance, while also increasing the workload for teachers in managing the classroom environment [58]. Effectively managing noise is essential to maximizing the benefits of TBL without compromising its effectiveness.

Several strategies can be developed to overcome these challenges. One possible strategy is the gradual introduction of TBL, starting with its application in pilot classes or specific parts of courses, such as modules. A phased implementation allows teachers and students to familiarize themselves with the methodology and make necessary adjustments before scaling it up. Additionally, this strategy helps minimize initial resistance, promoting a smoother adaptation and more effective implementation [24].

Teacher training is a fundamental strategy for successfully adopting this methodology, as well as other active methodologies. It is essential that teachers are prepared for the transition, acquiring the skills needed to adequately prepare materials, manage group dynamics, and control classroom time effectively. Specific training programs, such as workshops or mentoring sessions, have proven effective in boosting teachers' confidence and facilitating the transition to TBL [59].

The integration of supportive technologies also makes implementation more appealing and efficient. Platforms such as Moodle and Microsoft Teams streamline the organization and distribution of materials, while tools like VoxVote and Mentimeter provide immediate feedback, enhancing student engagement and optimizing the learning process in both in-person settings [60] and online modalities [61].

Thus, although TBL offers numerous advantages, its implementation requires careful preparation, adequate teacher training, and effective management of resources and time to overcome the identified challenges and maximize the success of the methodology.

Regarding the assessment of the effectiveness of applying this methodology in engineering, several studies have demonstrated its efficacy. For instance, its application in large mechanical engineering classes resulted in a significant increase in academic performance, particularly among students with lower performance levels, in addition to fostering engagement and interaction among students [62]. This study observed an increase of 5% to 10% in final exam scores.

In the field of civil engineering [63] demonstrated that the implementation of the methodology promoted the development of collaboration and communication skills, which are essential for teamwork.

Another study, focused on technical writing skills in engineering courses, demonstrated that the methodology enhanced the retention of technical skills and promoted students' academic confidence, with a positive impact on final grades [64].

Finally, a meta-analysis concluded that, on average, TBL produces superior results, corresponding to nearly 0.5 standard deviations above traditional pedagogical methods [65].

5. Future perspectives

Team-Based Learning holds vast potential as an innovative teaching-learning methodology, capable of adapting to new contexts, integrating emerging technologies, and effectively addressing the growing needs of higher education.

One of the priority areas for expanding knowledge and further developing TBL is conducting longitudinal studies that examine its impact on knowledge retention, the development of transversal skills, and students' professional performance. These studies could explore how skills acquired through TBL, such as collaboration and problem-solving, translate into competitive advantages in the job market, particularly in technical fields like engineering or health [1].

Furthermore, it is essential to study the adaptation of TBL to new academic contexts. While it has been widely applied in fields such as health sciences and engineering, there is significant scope to expand its use to areas like social sciences, humanities, and the arts. These disciplines could benefit from methodologies that promote collaboration and the practical application of concepts, particularly in analyzing case studies or solving complex problems [66].

The use of emerging technologies is another promising area. Integrating artificial intelligence enables the personalization of the learning process by tailoring materials and challenges to the profile and performance of each student [67]. Similarly, virtual and augmented reality tools can be integrated into TBL, enabling the simulation of realistic scenarios that enhance practical activities [68]. For example, in engineering courses, virtual reality can be used to simulate complex projects, while in health courses, it can recreate clinical scenarios for practical training.

The development of hybrid approaches allows for the combination of TBL with other active methodologies, such as gamification and Problem-Based Learning (PBL). These combinations can further enhance the learning experience by fostering a dynamic, interactive, and student-centered environment.

Gamification can make practical activities more engaging, encouraging students to participate more actively and competitively. Meanwhile, PBL can complement TBL in activities that require more exploratory and open-ended investigation [17].

Finally, a future line of research could focus on exploring the cultural dimensions of TBL, analyzing how cultural diversity influences the effectiveness of this methodology in different educational contexts. This perspective could contribute to adapting TBL to local specificities, ensuring its inclusivity and effectiveness in educational institutions with diverse student populations.

6. Conclusions

This study highlighted the potential of Team-Based Learning (TBL) as an effective pedagogical approach in higher education, particularly in engineering contexts where the integration of technical and transversal skills is essential. By analyzing its theoretical foundations, implementation structure, and benefits, it became evident that TBL promotes not only academic success but also the development of critical skills such as collaboration, critical thinking, and problem-solving.

Although challenges exist in adopting this methodology, such as initial student resistance and the demands for teacher training, well-designed strategies, including the gradual introduction of TBL, the use of supportive technologies, and continuous professional development for educators, can mitigate these obstacles.

The future development of TBL requires a multidimensional approach that integrates scientific research, technological innovation, and adaptation to different academic contexts. The success of TBL as a teaching-learning methodology is linked to its ability to evolve and meet the increasing demands of higher education. Its relevance is particularly evident in fostering essential skills for today's world. Thus, TBL stands out as a promising pedagogical approach, with the potential to redefine educational paradigms and prepare students for the challenges of a globalized and constantly evolving job market.

Continued and in-depth research on TBL is therefore indispensable to ensuring its effectiveness and adaptation to diverse academic and cultural contexts.

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