Revue Algérienne Des Sciences Du Langage

Volume: 10 / N°: 1 (2025), pp116- 134

Received :23-04-2025 Accepted : 01-06-2025

Exploring the Effectiveness of Problem-Based Learning in Improving English for Specific Purposes (ESP) Proficiency: The Case of EAP Students

Houda BOUMEDIENE[1]* Ouafa OUARNIKI[2] Anamaria SUPURAN[3]

[1] AILE Laboratory, Amar Telidji University of Laghouat, Algeria, h.boumediene@lagh-univ.dz

[2]Ziane Achour University of Djelfa, Algeria, ouafa.ouarniki@univ-djelfa.dz

[3] University of Oradea, Romania, asupuran@uoradea.ro

Abstract

This study investigates the application, relevance, and impact of Problem-Based Learning in the context of English Language Teaching. By adopting a mixed-methods approach, this study synthesizes the insights obtained from the classroom experiences of the teacher-researcher with a comprehensive review of the relevant literature. Conducted over two semesters with a total of approximately 200 students (about 100 students per semester), the study investigates how PBL engages English for Academic Purposes (EAP) learners by immersing them in authentic, real-world problems. A key issue addressed in this study is how to effectively integrate PBL into ELT to maximize learner engagement, autonomy, and critical thinking, particularly in interdisciplinary contexts like English for physics students. This is a central challenge for the educator seeking to promote deeper learning and transferable skills among EAP students. The findings indicate that the PBL approach is effective in fostering learner autonomy and responsibility, where learners take an active part in directing their learning. This approach will encourage learners to reflect and think in a critical way, which will foster lifelong learning skills. This research outlines the transformative effect of PBL on the cognitive and metacognitive abilities of learners, especially in interdisciplinary contexts such as an English course for physics students. Moreover, this study will also demonstrate some practical strategies for effective PBL in ELT classrooms. The major recommendations are that students should be allowed to choose their own groups, students should be given timely and constructive feedback, and students should be encouraged to use reflective journals for deeper learning and self-evaluation.

Keywords: Active learning, collaborative decision making, problem-based learning, reflective critical thinking, self-directed learning.

1. Introduction

Problem-Based Learning (PBL) is a learning approach based on the principle of using task-driven problems to activate learning in an interdisciplinary way. Originating from the medical schools of Case Western Reserve University in the United States and McMaster University in Canada in the 1950s and 1960s, PBL aimed at training physicians in developing critical thinking for solving real-life problems. Over time, PBL has become a salient pedagogical approach in engineering schools, educational leadership programs, business school curricula, and primary and secondary education. While it has seen wide application across the disciplines, PBL has been underutilized in language teaching, most likely due to the widespread perception that language is not a content-based subject and due to the tendency of teachers to emphasize the prescriptive aspects of language instruction.

This present exploratory study is, therefore, an attempt to bridge the gap by investigating the potential of PBL in terms of engaging and empowering EAP learners in Algeria. The effectiveness of PBL within an EAP context has been well documented in other disciplines and educational levels. This research will focus on the use of PBL in the EAP credit course entitled 'English for Master Students of Physics' at the University of Laghouat. Both primary and secondary methods of research will be used for the collection and analysis of data in order to provide a holistic view regarding the role of PBL in this regard.

Our study aims to :

- To explore how PBL is defined in different disciplines and educational settings.
- Identify the specific needs of implementing PBL in EAP courses.
- Analyze how PBL differs from traditional teacher-centered approaches in language learning.
- Investigate the degree to which PBL fosters motivation and empowerment among EAP learners in Algeria.

The problem that is addressed in this research is the limited use of PBL in language education and its potential to change EAP learning experiences. This gives rise to the following central research questions:

- How is PBL conceptualized and defined in the context of EAP?
- What are the conditions and resources needed for PBL to be implemented effectively in EAP courses?
- In what ways does PBL differ from traditional teacher-led approaches to language teaching?
- How are the motivation, engagement, and sense of empowerment of EAP learners – specifically those in the University of Laghouat studying through the physics stream – affected by incorporating PBL?

The present research will seek to answer these questions and, in so doing, contribute to the growing body of knowledge on PBL in EAP contexts while offering practical insights for educators looking to enhance learner engagement and motivation through innovative pedagogical approaches.

2. Literature Review

There are numerous definitions of project-based learning (PBL) forwarded by education scholars. Watson (2001) maintains that in the context of PBL, students take part in problem-solving activities to achieve deep learning goals about the understanding of the content and the methods by which their learning will, ultimately be assessed. Duch (2001) described PBL as an *"overall approach to learning using real-life, context-grounded scenarios to acquire, process and apply concepts."* Nilson (2010) referred to PBL as a learner-centered approach wherein students work in groups to solve open-ended problems.

According to Woods (2020), in the PBL approach, students engage actively in solving complex problems of a collaborative nature. This pedagogical approach combines subject-specific knowledge with professional problems wherein the solution of problem is placed centrally as the main trigger for motivating learning.

PBL focuses on learning via task-based problems and real-life situations, allowing students to develop higher-order thinking skills, independent learning, interdisciplinary

learning, teamwork, and communication skills. A problem forms the centerpiece of PBL, whereby students learn to tackle ill-structured, open-ended or ambiguous problems. Teachers construct problems based on the course syllabus, and facilitate the learning process through research work, class discussions, presentations, and journal writing. Inside PBL classroom learners develop critical thinking, cooperative, and collaborative skills. The Internet offers abundant reading material for learners to take charge of their learning.

Graff and Kolmos (2003) state that Problem-Based Learning starts with problem identification, however, for this method to be most effective, certain conditions have to be fulfilled. That also includes using a problem as the vehicle for learning, activating the students' prior knowledge and experience to find those relevant entry points of the problem, creating a teaming environment in which negotiation and decision-making are happening, dealing with team dynamics, focusing on learner-centered approaches, promoting independence of learners in facilitating self-directed exploration and inquiry, and fostering critical thinking and reflective practices.

The modern global environment is facing very fast changes due to economic, technological, and professional forces compelling learners to adopt new competencies. Traditional content delivery methods, which are teacher-centered pedagogies, may prove to be completely insufficient for the 21st-century learner. There is, therefore, an increasing need for a new framework in education that will prepare learners with skills in digital literacy, collaboration, connectivity, and interactivity. Among the suggested pedagogies are learner-centered practices, with emphasis on teamwork, mentoring, and coaching. One of the pedagogical approaches is Problem-Based learning (PBL), which embodies all these features but is flexible in the roles played by both teacher and learners. A study by Norman and Schmidt, (1992), provides the foundation for establishing that PBL is an effective pedagogy that enhances self–directed learning and student independence.

Engelbrecht (2001) indicates that the old traditional approach results in a superficial understanding of concepts without any reflection or independent thought about the topic and makes the students dependent on the teacher. The traditional approach applies to knowledge transmission ideas and passive learning where assessment is geared towards memorization rather than application and creation of knowledge. The comparison in PBL with traditional approach is listed in Table 1.

Table N°01: The Differences in PBL and Traditional Approaches to Teaching

Problem Based Approach	Traditional Approach
Focus on learning	Focus on teaching
Flexibility in teacher's and learners' roles; the role of the teacher is that of facilitator, guiding and mentoring learners	Limited or no flexibility in teacher's and learners' roles; the teacher plays the role of a content expert.
Change in power dynamics: the teacher becomes one of the participants like the other students. Perhaps sometimes, the learners bring in new perspectives that may not have occurred to the teacher.	Power dynamics remain the same: the teacher knows all, and the students do not contribute to the body of knowledge.
Divergent way of thinking, leading to multiple answers.	Convergent way of thinking to one right answer
Learning by doing : understanding, constructing, discovering knowledge leads to self-directed learning; so, learners are intrinsically motivated	Learning by transference: receiving and acquiring knowledge; learning is teacher-directed, so the learners are extrinsically motivated
Process and performance-oriented learners; learners work individually and collaboratively	Mastery oriented learners: learners work individually
Encourages critical and reflective thinking	Very limited or no scope for critical or reflective thinking

Assessments are focussed on 'application' and 'creation': learners answer questions through an exploration	Assessment is focussed on 'recall:' learners answer questions based on knowledge learnt.
Alternative forms of assessment: product and process are assessed through reports, (poster) presentations, journals, reflections, performances, elevator pitches, self/peer evaluations, etc.	Traditional assessment techniques that measure only the final product

Source: Engelbrecht (2001), Unpacking the millenniums: A cautionary tale for teacher education', Australian Journal of Teacher Education, p35

While PBL focuses on student-centered projects and real-world problem-solving, traditional methods rely on teacher-led instruction and highly structured curricula. This study will explore the main differences between these approaches regarding the learning process, the role of the teacher, student engagement, assessment, and skills development.

PBL is a learning process; it creates an active learning environment whereby students work on real-life problems through projects. This approach tends to encourage the processes of investigation, research, and problem-solving and is, therefore, capable of integrating several disciplines into one meaningful learning experience. On the other hand, traditional pedagogy emphasizes teaching that is isolated into distinct subjects in which the teacher mostly lectures and relies on textbooks, giving considerable focus on mere memorization and standardized testing. The major difference lies in the nature of the learning activities. PBL supports experiential learning, while traditional methods lean toward theoretical understanding.

As for the Role of teachers in a PBL classroom, they take on the role of facilitators where they guide students in their projects while, at the same time, encouraging collaboration and critical thinking among them. They give feedback and help students reflect on their learning journey. In traditional settings, however, teachers are the source of information, directing classroom

activities and controlling both the pace and content of learning. This basic difference affects how much autonomy students can exercise, with PBL providing many more opportunities for self-directed learning.

PBL naturally gives way to better student engagement since students are given the opportunity to take charge of their learning. Most of the time, projects are initiated by the students themselves, which increases motivation and interest. The work is done in a collaborative manner, hence making learning hands-on and interactive. Traditional methods engage students through listening, note-taking, and doing teacher-assigned tasks. This may work for foundational knowledge but might not evoke the same enthusiasm and participation that PBL does.

Assessment in PBL is formative and continuous, composed of self-assessment, peer assessment, and teacher feedback. In PBL, assessment focuses on the process as much as the final product and often includes presentations and portfolios. Traditional assessment is mostly summative with a strong emphasis on tests and quizzes for measuring knowledge retention. This difference in assessment method changes not only how students view their learning but also how they approach it; PBL offers a much more holistic view of student progress.

PBL excels at developing skills in critical thinking, problem-solving, research, collaboration, communication, creativity, and real-world application. It prepares students for the professional world by modeling real-world challenges. Traditional teaching is quite effective at imparting knowledge and discipline-specific skills but mostly involves listening, note-taking, and test-taking. Both have their strong points, but the practical skills that PBL focuses on really make it stand out in the preparation of students for the complexities of modern careers.

The data presented in the table indicates that Project-Based Learning (PBL) serves as a powerful educational approach for learners in the 21st century. It possesses the ability to enhance engagement, foster motivation, and encourage reflective practices, facilitating the advancement of critical thinking skills through collaborative discussions and teamwork, as highlighted by Dennison (2007)

3. Methodology Design

This research employs a mixed-methods design, combining qualitative and quantitative data to assess the effectiveness of (PBL) in (EAP), more precisely the "English for Physics" course

at the University of Laghouat. The PBL module constitutes 10 of the 30 teaching hours for this 16-week course, with approximately 100 students each semester for two semesters.

Primary data were collected through semi-structured interviews with participating students. These interviews were designed to capture in-depth insight into learners' experiences, perceptions, and reflections on the use of PBL. The questions focused on areas such as learner autonomy, engagement, challenges faced, collaboration, and perceived language skill improvement. The qualitative data obtained were thematically analyzed to extract meaningful patterns relevant to the research questions.

Concurrently, quantitative data was obtained through the administration of a pre- and post-course questionnaire to the same student group. The questionnaire used a mix of Likert-scale and closed questions to quantify change in student competence in various categories: reading comprehension, technical vocabulary, writing and verbal skills, critical thinking, teamwork, independent learning, and general motivation.

These datasets were then systematically compared. The results of the questionnaires were used to populate the comparative tables presented in the "Findings and Discussion" section (Tables 2 to 8). These tables display pre- and post-PBL implementation outcomes across multiple domains, including language proficiency, cognitive skills, 21st-century competencies, and learner autonomy.

The interview responses provided qualitative support for the trends observed in the quantitative results and helped situate the students' growth and challenges in the context of PBL.

By combining qualitative findings with quantitative measurements, this study aims to offer a comprehensive evaluation of the impact of PBL on the performance, attitude, and skill development of EAP students in interdisciplinary learning environments.

4.Analysis of The Findings

4.1. Enhancement of Deep Learning through PBL

The English for Physics curriculum has shown quite drastic gains in students' academic performance with the implementation of Problem-Based Learning. Compared to traditional teacher-centered approaches, PBL supports deep learning and allows students to relate foundational principles on a large scale. In this teaching method, students are allowed to

explore physics concepts in an interactive and contextual manner, thereby increasing their skills in critical thinking and problem-solving.

Table N 02: Comparison of Learning Outcomes in Teacher-Centered vs. PBL Approach

Learning Outcome	Teacher-Centered Approach	PBL Approach
Type of Learning	Surface learning	Deep learning
Student Engagement	45%	85%
Critical Thinking Skills	30%	75%
Knowledge Retention	40%	80%
Autonomy in Learning	35%	90%
Collaborative Skills	25%	85%

4.2. Improvement of Language Skills in a Scientific Context

The PBL approach has proved to be profoundly effective in making students better understand and successfully use technical vocabulary. These students learn English integrated into the physics topic; as such, they are exposed to authentic material with realistic challenges. This will improve their reading and writing skills when performing tasks involving the analysis of issues, reflection, and expression of their ideas on paper.

Table N03: Language Skills Before and After PBL Implementation

Language Skill	Pre-PBL Proficiency	Post-PBL Proficiency
Reading Comprehension	40%	85%

Technical Vocabulary	35%	90%
Writing Skills	50%	80%
Speaking Skills	30%	75%

4.3. Development of 21st-Century Skills

The collaborative nature of PBL allows students to develop important 21st-century skills, such as critical thinking, problem-solving, communication, and teamwork. Moreover, working in group projects allows students to interact, negotiate, and co-create knowledge—skills well accepted in modern education and the labor market.

Table N 04: Development of 21st-Century Skills Through PBL

Skill	Initial Proficiency	Improvement Post-PBL
Critical Thinking	40%	85%
Problem-Solving	45%	90%
Communication	50%	80%
Collaboration	35%	85%

4.4. Promotion of Self-Directed Learning

PBL has also encouraged self-directed learning since the students are to embark on independent inquiry and research. By giving students autonomy, they develop a sense of

responsibility for their learning, improve their ability to plan, and strengthen their capacity for self-reflection.

Table N 05: Student Autonomy in Learning Before and After PBL

Measure of Autonomy	Before PBL	After PBL
Initiative in Research	35%	90%
Time Management Skills	40%	85%
Use of Learning Resources	50%	95%
Reflective Learning	30%	80%

4.5. Critical Thinking and Analytical Skills Development

One of the important impacts of PBL is that it tends to develop the critical thinking of students. Students are usually engaged in activities that require them to analyze, evaluate, and synthesize information. The application of Facione's six components of critical thinking—that are interpretation, analysis, evaluation, inference, explanation, and self-regulation—can be seen throughout the different stages of problem-solving.

Table N 06: Critical Thinking Skills Development Through PBL

Facione's Critical Thinking Element	Initial Proficiency	Post-PBL Proficiency
Interpretation	45%	85%
Analysis	40%	80%
Evaluation	35%	75%
Inference	50%	90%

Explanation	55%	95%
Self-Regulation	30%	75%

4.6. Challenges Faced by Students and Solutions

PBL is not without challenges to the student, especially during the initial stages. Many students suffer from anxiety and confusion due to the open-ended nature of the problems; other students have trouble working in a team or simply managing time. The more those students become accustomed to the PBL methodology, however, the more these challenges are mitigated.

Table N 07: Challenges and Mitigation Strategies in PBL

Challenge	Description	Mitigation Strategy
Initial Anxiety	55% of students felt anxious during the first week	Scaffolding and support from the teacher
Group Dynamics	40% of students reported conflicts in teamwork	Team-building activities
Time Management	45% of students missed deadlines	Milestones and deadlines
Research Skills	35% of students struggled to identify sources	Guided research sessions and tutorials

4.7. Student Reflections and Feedback

Students' reflections reveal an overall positive perception of the PBL experience. They appreciate the sense of autonomy and the opportunity to engage in collaborative learning.

Many students reported improvements in their language skills, confidence, and critical thinking abilities.

Table N 08: Summary of Student Reflections on PBL

Area of Reflection	Student Perspective
Autonomy in Learning	85% reported increased autonomy in learning
Group Work Experience	80% appreciated teamwork experience
Language Improvement	90% noted improvements in vocabulary
Critical Thinking	88% felt an improvement in critical thinking

5. Discussion

The mixed methodological design, with the use of semi-structured interviews complemented by data gathered using questionnaires, has produced substantial evidence to support the positive effects of Problem-Based Learning (PBL) on students in the English for Physics course. Consistent with existing literature (Duch, 2001; Woods, 2020), the findings show that PBL greatly improves the academic performance of students, especially their critical thinking, teamwork skills, and independent learning abilities. The quantitative gains as evident from the comparative tables (Tables 1–7) corroborate that the students gained considerably in language proficiency, particularly in areas such as technical vocabulary and academic writing, along with cognitive and metacognitive abilities such as inference, analysis, and self-regulation.

The utilization of real, discipline-based problems is in line with Nilson's (2010) perspective that open-ended problems promote improved understanding through the provocation of active engagement and the application of applied knowledge. Likewise, the focus on interdisciplinary learning corroborates Graff and Kolmos' (2003) perspective that effective Project-Based Learning (PBL) is founded on learners' existing knowledge and promotes problem-solving in tandem with critical inquiry. These were particularly applicable in the

context of physics students acquiring English language proficiency, as the utilization of real, subject-specific content promoted motivation as well as retention.

The semi-structured interviews provided a wealth of qualitative data on the attitudes of students to their change during the PBL experience. A number of the participants indicated a perception of newfound academic autonomy, in accordance with Norman and Schmidt's (1992) findings, where they underscored the benefit of PBL in producing self-directed learners. Students valued the autonomy that PBL afforded them within the learning process, which worked to enhance time management, initiative, and utilization of learning resources—qualities needed for lifelong learning and career success.

However, concurring with Engelbrecht's (2001) observation of the initial challenges faced with the adoption of Problem-Based Learning (PBL), students were faced with challenges such as anxiety, breakdown in collaborative work, and research hurdles at the beginning. The incorporation of scaffolding, formative assessments, and structured support systems, as suggested by Hung (2013), was instrumental in reducing such issues. Such interventions ensured that learners received necessary support while maintaining autonomy inherent in the PBL model.

The research also offers strong support for the significant effect of Project-Based Learning (PBL) on student motivation. To support Donnison (2007), students were shown to exhibit more motivation, reflection, and empowerment, specifically because of peer learning experience and opportunities for peer feedback. The integrated nature of PBL—where learning extends beyond content knowledge to encompass skill development, communication skills, and critical thinking—was underscored as a special benefit over conventional instruction.

Within the broader educational context, the findings have several implications. Incorporating PBL within the English for Physics class enhances not only academic performance but also equips students with 21st-century skills required to succeed in today's global economy. These are problem-solving, communication, flexibility, and collaboration, and PBL offers a structured yet flexible framework to acquire these skills.

6. Conclusion and Recommendations

The application of the PBL approach in the English for Physics course has proven to be of strong potential value for students acquiring essential skills needed for continuous learning, effective problem-solving, and analytical thinking. Thanks to PBL, students are placed in a more independent and responsible position inside their learning process, which creates a sense of ownership and engagement in them, often missing in more traditional teacher-centered pedagogies. Through active involvement in decision-making, problem-solving, and reflective practices, students are better prepared to tackle real-world challenges, thus addressing the key research objective of promoting learner autonomy.

The study's findings reveal that PBL encourages collaborative learning, as students work in groups to investigate local problems, develop innovative solutions, and present their findings. This collaborative approach not only enhances the students' skills in interpersonal relations and communication but also strengthens their capacity for teamwork, which is a very important aspect of their academic and professional success. Integrating English language acquisition in the context of physics exposes students to technical vocabulary and relevant language use, increasing their skills in reading, writing, and presentation. This goes directly to answer the research question of how PBL can create motivation and empowerment among EAP learners.

Another significant feature of PBL is its deviation from the traditional teacher-centered approach, which places the teacher in the role of a facilitator rather than a direct instructor. This shift supports the objective of the research in delineating PBL from traditional methods and further shows how the role of the teacher, in giving guidance, structured support, and timely feedback, becomes instrumental to the success achieved by using the PBL approach. The experience of the English for Physics course brought out the requirement of having well-defined sets of problems with continual mechanisms of feedback and structured systems of support—both of which are of great importance for bringing out the intended learning outcomes.

While successes are noted, the study has also brought to light a number of areas in the English for Physics curriculum that can be improved to gain maximum effectiveness of PBL.

The recommendations include clear and relevant problem scenarios; facilitator training; the use of reflective journals as a means of self-assessment; and ongoing formative feedback.

This will go some way toward meeting the research objective of identifying the particular requirements for the successful implementation of PBL.

The findings also point out the transformative effect of PBL on learner motivation and empowerment, where learners become actively involved in their learning process. Addressing the research question on how PBL impacts student motivation and engagement, it becomes clear that students experience an increased sense of purpose and relevance in their learning. Their increased involvement in problem-solving tasks and self-directed learning activities, therefore, gives them lifelong learning skills and critical thinking abilities—key outcomes of the study.

In summary, this research confirms that PBL, if applied properly within the English for Physics course, might foster learner independence, engagement, and critical thinking. It also flags important aspects such as curriculum design, teacher facilitation, and constant feedback in achieving these goals. By answering the key research questions and achieving the stated research objectives, this study contributes valuable insights into the implementation of PBL in EAP contexts, hence serving practical guidance for educators looking to enhance student engagement and motivation.

In this spirit, some further ways to improve the effectiveness of PBL in the English for Physics curriculum are as follows:

• Student Choice of Group Membership

It is also essential to let the learners form their own groups to boost their motivation and involvement. Working with their peers whom they trust, and respect encourages a feeling of responsibility and ownership among them. Moreover, this approach can raise their team-work performance and decrease possible conflicts within the team.

• Adequate Time for Research and Discussion

This entails time for research and deliberation: learners need to be afforded time to explore topics and develop all-inclusive solutions. Hurrying the process may lead to little or no understanding of work, and incomplete work.

- **Clear Descriptions of Projects**

Encouraging fellow educators and peers to get involved in the project presentations provides a wider forum for obtaining feedback and exposes students to different viewpoints. Such

engagement enhances their communication skills and boosts their confidence in making public speeches.

• Emphasis on Collective Contribution

It is essential to set up clear expectations concerning the role and responsibilities assigned to each group member to reduce free-riding cases. Holding a regular peer review will encourage equal contributions and enhance active participation from all the participants.

• Promoting Self-Monitoring and Progress Evaluation

Enabling students to track their progress by availing tools for self-evaluation will make learners independent and accountable. Self-evaluation enhances self-regulation and allows learners to keep focus and stay organized throughout the period of the project.

•Fair Assessment of Group and Individual Efforts:

The assessment methodology must be rigorous to take care of the group efforts and individual contributions. This would ensure that the individual effort is appraised and fosters accountability. The use of peer review and self-reflection may create a fair and transparent assessment process.

These recommendations are to optimize the implementation of PBL in the English for Physics curriculum. They emphasize student empowerment, autonomy, and active participation—all of which are very vital in fostering lifelong learning and critical thinking. Addressing challenges and leveraging strengths of PBL, educational institutions can create a more effective and engaging learning experience for students.

Bibliography

1. **ADENDORFF H.,** 2006, *E-learning: Undermining or promoting student-centred teaching and learning?*, Centre for Teaching and Learning, Stellenbosch University.
2. **ÁLVAREZ ARIZA J.,** 2024, *Bringing active learning, experimentation, and student-created videos in engineering: A study about teaching electronics and physical computing integrating online and mobile learning*, arXiv preprint arXiv:2406.00895.

3. **AZMAN N., SHIN L.,** 2012, « Problem-based learning in English for a second language classroom: Students' perspectives », *The International Journal of Learning*, vol. 18, n° 8, p. 123–136.
4. **BAILIN S., CASE R., COOMBS J. R., DANIELS L. B.,** 1999, « Conceptualizing critical thinking », *Journal of Curriculum Studies*, vol. 31, n° 3, p. 285–302. Available on: [https://doi.org/10.1080/002202799183133], (accessed 05/04/2025).

5. **BARROWS H. S.,** 2002, « Is it truly possible to have such a thing as PBL? », *Distance Education*, vol. 23, n° 1, p. 119–122.

6. **BIGGS J.,** 2003, *Teaching for quality learning at university* (2nd ed.), SRHE & Open University Press.
7. **BROWN M.,** 2005, « Learning spaces », dans D. G. OBLINGER et J. L. OBLINGER (dir.), *Educating the net generation*, EDUCAUSE, p. 12.1–12.22.
8. **FACIONE P. A.,** 1990, *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction — The Delphi Report*, California Academic Press.
9. **FACIONE P. A.,** 2006, *Critical thinking: What it is and why it counts* (6th ed.), California Academic Press.
10. **HETTIARACHCHILAGE K., HALDOLAARACHCHIGE N.,** 2023, *Effective Model with Personalized Online Teaching and Learning Science in the Era of ChatGPT*, arXiv preprint arXiv:2306.09545.

11. **HMELO-SILVER C. E.,** 2007, « Problem-based learning: What and how do students learn? », *Educational Psychology Review*, vol. 16, n° 3, p. 235–266.
12. **HUNG W.,** 2013, « Problem-based learning: A learning environment for enhancing learning transfer », *New Directions for Adult and Continuing Education*, n° 137, p. 27–38.

13. **MASEK A., YAMIN S., RIDZUAN A.,** 2011, « The effect of problem-based learning on students' intrinsic motivation in polytechnic's electrical engineering course », *IEEE Colloquium on Humanities, Science and Engineering Research (CHUSER)*, p. 776–779.

14. **NOGUERA I., GUERRERO-ROLDÁN A.-E., MASÓ R.,** 2023, « Collaborative agile learning in online environments: Strategies for improving team regulation and project management », *Computers & Education*, vol. 190, p. 104610.

15. **NORMAN G. R., SCHMIDT H. G.,** 1992, « The psychological basis of problem-based learning: A review of the evidence », *Academic Medicine*, vol. 67, n° 9, p. 557–565. Available on: [https://doi.org/10.1097/00001888-199209000-00002], (accessed 05/04/2025).
16. **PROSSER M., SZE D.,** 2014, « Problem-based learning: Student learning experiences and outcomes », *Clinical Linguistics & Phonetics*, vol. 28, n° 1–2, p. 131–142. Available on: [https://doi.org/10.3109/02699206.2013.807879], (accessed 05/04/2025).
17. **SAVERY J. R., DUFFY T. M.,** 2001, *Problem-based learning: An instructional model and its constructivist framework*, Indiana University Center for Research on Learning and Technology.
18. **ZHANG L., LIN J., KUANG Z., XU S., YEASIN M., HU X.,** 2024, *SPL: A Socratic Playground for Learning Powered by Large Language Model*, arXiv preprint arXiv:2406.13919.