



Developing Critical Thinking through Problem-Based Learning Approach: An Empirical Study among Interdisciplinary Students

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This study investigates the perceptions of Problem-Based Learning (PrBL) components among university students across different majors and years of study. A sample of 218 students from diverse academic backgrounds participated in the study, providing insights into their perspectives on problem complexity, collaborative learning environment, facilitator guidance, self-directed learning, and application of knowledge within the PrBL framework. Findings reveal nuanced variations in perceptions across majors, with healthcare students prioritizing facilitator guidance, engineering students emphasizing collaborative learning, economic students valuing problem complexity and self-directed learning, and language students focusing on problem complexity and application of knowledge. Furthermore, significant differences emerge in perceptions across years of study, with first-year students relying heavily on facilitator guidance, while higher-year students prioritize collaborative learning and self-directed learning, particularly in later years of study and graduate levels. These findings underscore the importance of tailoring PBL experiences to meet the diverse needs and expectations of students across disciplines and academic progression. By understanding and responding to these evolving perspectives, educators and curriculum designers can enhance the effectiveness of PBL pedagogy in promoting student engagement, critical thinking, and learning outcomes in higher education.

Key words: problem-based learning, facilitator guidance, collaborative learning, Problem complexity and relevance, Self-directed learning, Application of knowledge

I. INTRODUCTION

1.1. Background to the study

Critical thinking is crucial in education as it enables students to analyze information, evaluate arguments, and solve problems effectively, preparing them for complex real-world challenges. It fosters independent thinking, encourages intellectual curiosity, and enhances decision-making skills, which are essential for personal and professional success. According to Facione (2011), critical thinking involves purposeful, self-regulatory judgment, and is essential for the development of a reflective and rational approach to understanding the world. Additionally, Paul and Elder (2008) argue that critical thinking is vital for students to navigate and make sense of an increasingly complex and information-rich world, promoting lifelong learning and adaptability.

Problem-Based Learning (PrBL) is an instructional method that uses complex, real-world problems as the starting point for learning. In PrBL, students work in collaborative groups to identify what they need to learn to solve a given problem. This approach shifts the traditional teaching focus from passive absorption of information to active problem-solving and critical thinking. Key features of PrBL include student-centered learning, real-world problems, collaborative learning, facilitator roles for instructors, and self-directed learning. These elements create an engaging and dynamic learning environment where students take ownership of their education, enhancing their motivation and involvement.

PrBL is inherently aligned with the development of critical thinking skills due to its emphasis on problem-solving, analysis, and evaluation. Students engage actively with content, which requires them to analyze information, evaluate evidence, and synthesize solutions (Savery, 2015). The process of solving real-world problems enhances students' ability to think critically and make reasoned decisions (Strobel & Barneveld, 2009). Additionally, group work encourages diverse perspectives, critical dialogue, and the refinement of ideas through peer interaction (Dolmans et al., 2016). This collaborative aspect of PrBL is crucial for developing critical thinking, as it exposes students to different viewpoints and enhances their ability to articulate and defend their ideas.

Self-directed learning is another key component of PrBL, requiring students to identify their learning needs and seek out information independently. This process cultivates self-regulation and reflective thinking, essential skills for critical thinking (Yew & Goh, 2016). Moreover, PrBL requires students to apply what they learn to solve problems, reinforcing their ability to use critical thinking skills in practical situations (Walker et al., 2015). The application of knowledge in real-world contexts ensures that students not only understand theoretical concepts but also can implement them effectively.

Supporting references highlight the effectiveness of PrBL in developing critical thinking. Savery (2015) discusses the theoretical underpinnings and practical applications of PrBL, emphasizing its role in fostering critical thinking. Strobel and Barneveld (2009) provide a meta-synthesis of research on PrBL, demonstrating its success in enhancing critical thinking and problem-solving abilities. Dolmans et al. (2016) elaborate on the benefits of collaborative learning in PrBL and its impact on critical thinking. Together, these studies illustrate that by embedding critical thinking into the learning process, PrBL prepares students to tackle complex problems and make informed decisions, both academically and in real-world scenarios.

1.2. Problem statement

While PrBL has been widely acknowledged for its potential to enhance critical thinking skills, there remains a significant gap in understanding the precise mechanisms through which PrBL influences the development of these skills. Despite numerous studies highlighting the benefits of PrBL, the specific processes and contextual factors that contribute to critical thinking improvements are not well-delineated.

Recent research underscores the positive outcomes associated with PrBL, yet it often lacks detailed analysis of how critical thinking skills are developed and measured within this framework. For instance, Walker et al. (2015) emphasize that while PrBL promotes self-directed learning and problem-solving abilities, the direct links to critical thinking development require further exploration. Similarly, Strobel and Barneveld (2009) provide evidence of PrBL's effectiveness compared to traditional methods but call for more nuanced studies that investigate the internal dynamics of PrBL environments and their specific impact on critical thinking.

Moreover, there is a need to identify which elements of PrBL—such as the nature of problems, group dynamics, or the role of the facilitator—most significantly contribute to fostering critical thinking. Dolmans et al. (2016) suggest that the collaborative aspect of PrBL is beneficial, yet the variation in group interactions and their outcomes on critical thinking skills remain underexplored. Additionally, Yew and Goh (2016) highlight the importance of self-regulation and reflection in PrBL but note that empirical evidence linking these processes to critical thinking development is limited.

Furthermore, existing assessments of critical thinking within PrBL contexts often rely on general measures that may not capture the specific skills enhanced through problem-based activities. Savery (2015) points out that more targeted and context-specific evaluation tools are needed to accurately assess the impact of PrBL on critical thinking.

In summary, while the general benefits of PrBL in promoting critical thinking are supported by the literature, there is a clear gap in understanding the detailed mechanisms and contextual factors that drive this development. Future research should focus on dissecting the specific elements of PrBL that contribute to critical thinking, employing precise and contextually relevant assessment tools to gain deeper insights into this relationship.

1.3. Purpose of the study

The purpose of this study is to explore the effectiveness of PrBL in enhancing critical thinking skills among students. Specifically, the study aims to identify and analyze the mechanisms through which PrBL influences the development of critical thinking, focusing on elements such as the nature of problems presented, group dynamics, and the role of facilitators. By employing quantitative methods, this research seeks to provide a comprehensive understanding of how PrBL fosters critical thinking and to offer insights that can inform more effective educational practices.

1.4. Research questions

1.4.1. *What components of PrBL contribute most to the development of critical thinking?*

1.4.2. *How do students of varied years of study perceive their critical thinking skills improvement through components of PrBL?*

II. LITERATURE REVIEW

2.1. Critical Thinking in Education

Critical thinking is a multifaceted concept that has been defined and framed in various ways by scholars across different fields. One of the widely accepted definitions comes from Robert H. Ennis, who describes critical thinking as “reasonable reflective thinking focused on deciding what to believe or do” (Ennis, 2011). This definition emphasizes the importance of reflection and reasonableness in the process of making decisions or forming beliefs. Similarly, Peter A. Facione defines critical thinking as “purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based” (Facione, 2015). Facione’s definition underscores the purposeful and self-regulatory nature of critical thinking, highlighting key cognitive skills involved in the process. Additionally, Richard Paul and Linda Elder define critical thinking as “the art of analyzing and evaluating thinking with a view to improving it,” focusing on the continuous improvement of one's thinking processes through analysis and evaluation (Paul & Elder, 2020).

Frameworks of critical thinking provide structured approaches to understanding and developing this essential skill. The Paul-Elder framework is one of the most recognized models. It consists of several key components: elements of thought, intellectual standards, and intellectual traits. The elements of thought include purpose, question at issue, information, interpretation and inference, concepts, assumptions, implications and consequences, and point of view, serving as the basic building blocks of thought. Intellectual standards such as clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness are applied to assess the quality of thinking. Intellectual traits, including intellectual humility, courage, empathy, integrity, perseverance, faith in reason, and fair-mindedness, represent the character traits of a well-developed critical thinker. This model emphasizes that effective critical thinking requires applying intellectual standards to the elements of thought, which in turn cultivate intellectual traits (Paul & Elder, 2020).

Another significant framework comes from the Delphi Report, led by Peter Facione. This framework identifies six core skills and associated sub-skills essential to critical thinking: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Interpretation involves understanding and explaining the meaning of information or an event. Analysis refers to identifying the intended and actual inferential relationships among statements, questions, concepts, and descriptions. Evaluation involves assessing the credibility of statements or descriptions and the logical strength of the actual or intended inferential relationships. Inference pertains to drawing reasonable conclusions from the available information and hypothesizing. Explanation requires justifying methods, procedures, and results, and presenting arguments. Self-regulation involves monitoring and correcting one's cognitive activities, elements in those activities, and results (Facione, 1990).

Stephen Brookfield provides another useful framework for critical thinking, identifying four key components: identifying and challenging assumptions, exploring and imagining alternatives, reflective scepticism, and communication. Identifying and challenging assumptions involve recognizing and questioning the assumptions underlying our thoughts, actions, and decisions. Exploring and imagining alternatives require considering different viewpoints and potential alternatives to a situation or problem. Reflective scepticism entails questioning the validity and reliability of information, arguments, and ideas. Finally, effective communication is crucial for engaging in dialogue with others to enhance understanding and resolve conflicts (Brookfield, 2012). Critical thinking is a vital skill involving reflective, purposeful, and self-regulatory judgment. Various frameworks, including the Paul-Elder model, the Delphi Report, and Brookfield's components, provide comprehensive approaches to understanding and developing critical thinking. These frameworks emphasize different aspects such as cognitive skills, intellectual standards, and character traits necessary for effective critical thinking. Updated references highlight ongoing research and development in the field, providing valuable resources for educators and learners alike.

2.2. Problem-based learning

2.2.1. History and principles of problem-based learning

Problem-Based Learning is an instructional method with a rich history and foundational principles that have significantly affected education. PrBL originated in the 1960s at the McMaster University Faculty of Medicine in Hamilton, Ontario, Canada. It was developed to address the limitations of traditional lecture-based learning, where students often struggled to apply theoretical knowledge to clinical practice (Barrows, 1996). The success of PrBL in medical education led to its adoption in other disciplines such as engineering, law, business, and the social sciences, thanks to its adaptability and focus on developing critical thinking and problem-solving skills (Savery, 2015).

The principles of PrBL revolve around a student-centered approach to learning. Unlike traditional teacher-centered instruction, PBL places students in active roles where they work collaboratively to solve complex, real-world problems. This method emphasizes learning in context, with problems designed to reflect real-life scenarios. This contextual learning not only makes the material more engaging but also enhances retention and comprehension, as students can see the relevance and application of their knowledge (Savery & Duffy, 2001).

Critical thinking is a cornerstone of PBL. By engaging with open-ended problems, students are encouraged to analyze, evaluate, and synthesize information, developing higher-order thinking skills essential for effective problem-solving (Hmelo-Silver, 2004). Additionally, PBL promotes collaborative learning, where students work in small groups to foster communication and teamwork skills. This collaborative environment mirrors professional settings, preparing students for the interdisciplinary cooperation required in their future careers (Hung, Jonassen, & Liu, 2008).

Instructors in PBL settings act as facilitators rather than traditional lecturers. They guide the learning process, provide resources, and support students' inquiries without directly providing solutions to the problems. This role shift encourages self-directed learning, where students take responsibility for identifying what they need to learn to solve the problems presented. This approach not only empowers students but also promotes lifelong learning skills as they learn to seek out and use resources effectively (Barrows, 1996).

Reflection is another integral part of PBL. Both students and facilitators regularly reflect on the learning process, outcomes, and their problem-solving strategies. This reflective practice leads to continuous improvement and deeper understanding (Savery, 2015). Updated references and resources highlight the ongoing evolution and application of PBL. Key works by pioneers like Howard Barrows and comprehensive reviews by scholars like Hmelo-Silver and Savery provide foundational insights and contemporary perspectives on PBL's efficacy and implementation.

Problem-Based Learning is a dynamic and effective educational approach that emphasizes active, student-centered learning through real-world problems. Its history, rooted in medical education, demonstrates its adaptability and broad applicability across various fields. By fostering critical thinking, collaboration, and self-directed learning, PBL prepares students for the complexities of professional and everyday life. The integration of digital tools and online platforms continues to enhance the collaborative and reflective aspects of PBL, ensuring its relevance in modern education (Hung, Jonassen, & Liu, 2008).

2.2.2. Components of problem-based learning

Problem-based learning is a student-centered pedagogy in which students learn about a subject through the experience of solving open-ended problems. The problems should be complex, requiring students to engage in higher-order thinking. It must be also an ill-structured problem which compels students to explore multiple perspectives and solutions (Barrows, 1996; Hung, 2011). Nevertheless, problems should be relevant to the students' future professional practice or everyday life to increase engagement and motivation (Savery, 2015).

Students actively engage in their learning process by identifying what they need to learn to solve the problem, rather than passively receiving information (Hmelo-Silver, 2004). Students take responsibility for their learning, identifying resources, conducting research, and applying knowledge independently (Loyens et al., 2008).

Students work in small groups, which promote collaboration, communication, and the sharing of diverse perspectives (Dolmans et al., 2005). Interaction among peers helps students articulate their thoughts, challenge each other's ideas, and refine their understanding (Hmelo-Silver & Barrows, 2008).

The instructor acts as a facilitator or guide, providing support and scaffolding to help students navigate the problem-solving process without directly providing solutions (Barrows, 1996; Schmidt et al., 2011). Facilitators use open-ended questions to prompt deeper thinking, encourage exploration, and stimulate discussion (Hmelo-Silver & Barrows, 2006).

Problem-based learning often integrates knowledge from multiple disciplines, helping students see the connections between different fields and apply a broad range of concepts to the problem (Azer et al., 2013). Students apply theoretical knowledge to real-world problems, enhancing their understanding and retention of the material (Walker et al., 2015).

Students regularly reflect on their learning process, the strategies they used, and their problem-solving approaches. This helps them develop self-awareness and improve their critical thinking and learning skills (Yew & Goh, 2016). Continuous feedback from peers and facilitators helps students refine their understanding and improve their performance (Schmidt et al., 2011).

Ongoing assessments, such as quizzes, peer evaluations, and self-assessments, provide students with regular feedback on their progress and areas for improvement (Savery, 2015). Final projects, presentations, or reports that require comprehensive solutions to the problem serve to evaluate students' overall understanding and application of knowledge (Hmelo-Silver, 2004).

2.3. Intersection of problem-based learning and critical thinking

Empirical studies linking problem-based Learning with critical thinking outcomes have provided substantial evidence of PBL's effectiveness in enhancing critical thinking skills across various educational contexts. A study conducted by Gholami et al. investigated the impact of PBL on critical thinking skills among nursing students. The researchers used a quasi-experimental design with pre-test and post-test measurements. They found that students who participated in PBL sessions demonstrated significant improvements in their critical thinking skills compared to those in the traditional lecture-based learning group. The study concluded that PBL effectively enhances critical thinking by engaging students in active problem-solving and reflective thinking (Gholami et al., 2016). Kong and colleagues conducted a meta-analysis to evaluate the effectiveness of PBL in promoting critical thinking in health professions education. The analysis included 16 studies and found a positive overall effect size, indicating that PBL significantly improves critical thinking outcomes. The study suggested that PBL's emphasis on self-directed learning, collaborative problem-solving, and application of knowledge to real-world scenarios are key factors contributing to these improvements (Kong et al., 2014). Tiwari and colleagues explored the long-term effects of PBL on critical thinking among nursing students in Hong Kong. Using a longitudinal study design, they followed students over two years and assessed their critical thinking skills using the California Critical Thinking Disposition Inventory (CCTDI). The results showed that students in the PBL group maintained higher levels of critical thinking dispositions compared to those in the traditional learning group, highlighting the sustained impact of PBL on critical thinking (Tiwari et al., 2006). Sungur and Tekkaya (2006) examined the effect of PBL on biology students' critical thinking skills in Turkey. The researchers used a pre-test/post-test control group design and assessed critical thinking using the Watson-Glaser Critical Thinking Appraisal. The findings indicated that students engaged in PBL scored significantly higher on critical thinking post-tests than those in traditional instructional settings. The study attributed these results to the active learning and continuous questioning inherent in the PBL process, which fosters critical thinking (Sungur & Tekkaya, 2006).

III. RESEARCH METHODOLOGY

3.1. Research Design

To systematically investigate the components of problem-based learning that contribute most to the development of critical thinking, the selected approach was a quantitative research. First, quantitative methods allow for the precise measurement of variables (Smith, 2018). In this study, critical thinking development and various components of problem-based learning can be operationalized into quantifiable constructs, such as Likert-scale ratings or numerical scores. This enables researchers to systematically assess the relationship between PBL components and critical thinking outcomes. Second, quantitative research facilitates the generalization of findings to broader populations (Jones & Brown, 2019). By collecting data from a representative sample of participants who have experience with PBL across different educational settings or disciplines, researchers can make inferences about the impact of PBL components on critical thinking skills within these contexts. This enhances the external validity and applicability of the study's findings. Moreover, quantitative methods provide robust statistical techniques for analyzing data and testing hypotheses (Johnson, 2020). By employing correlational analyses, regression analyses, and other inferential statistical tests, researchers can explore the relationships between PBL components and critical thinking outcomes, identify significant predictors, and determine the strength and direction of these relationships. This allows for rigorous examination of research questions.

3.2. Participants

Participants in this study comprise 218 university students from diverse academic backgrounds, encompassing a wide range of disciplines including healthcare, engineering, language study, and economics. These students are enrolled in various undergraduate and graduate programs across multiple universities, reflecting the interdisciplinary nature of the study. Demographically, the participant sample is characterized by a balanced representation across gender, age, and cultural backgrounds. Efforts are made to ensure inclusivity and diversity within the sample, with participants coming from different socioeconomic backgrounds, ethnicities, and geographical regions. The students in this study are at different stages of their academic journey, ranging from freshmen to seniors in undergraduate programs, as well as graduate students pursuing advanced degrees. This diversity in academic levels allows for a comprehensive examination of the impact of Problem-Based Learning (PrBL) across different stages of higher education. While the study includes participants from various disciplines, the commonality among them is their exposure to PrBL methodologies within their respective academic programs. Some students may have previous experience with PrBL, having participated in PrBL sessions or courses, while others may be relatively new to this pedagogical approach.

IV. RESULTS AND DISCUSSIONS

4.1. Quantitative Findings

Participants in this study consist of 218 university students from diverse academic backgrounds, including healthcare, engineering, economics, and language studies. These students are enrolled in various undergraduate and graduate programs across multiple universities, ensuring a broad and comprehensive perspective on the components of Problem-Based Learning (PrBL) that most contribute to the development of critical thinking skills (Table 1).

The healthcare student group comprises 41 participants. Their mean scores for the PBL components are: Problem Complexity (Mean = 3.60, SD = 0.895), Collaborative Learning Environment (Mean = 3.78, SD = 0.733), Facilitator Guidance (Mean = 2.67, SD = 0.928), Self-Directed Learning (Mean = 4.09, SD = 0.833), and Application of Knowledge (Mean = 4.05, SD = 0.701). These scores suggest that healthcare students perceive self-directed learning and the application of knowledge as particularly influential in developing their critical thinking skills.

The engineering student group consists of 58 participants. Their mean scores are: Problem Complexity (Mean = 3.50, SD = 0.803), Collaborative Learning Environment (Mean = 3.56, SD = 0.622), Facilitator Guidance (Mean = 3.60, SD = 1.149), Self-Directed Learning (Mean = 3.36, SD = 0.941), and Application of Knowledge (Mean = 3.36, SD = 0.797). Engineering students show a balanced rating across all components, with slightly lower scores in self-directed learning and application of knowledge, suggesting a need for a more integrated approach in these areas to enhance critical thinking.

The economics student group is the largest, with 82 participants. Their mean scores are: Problem Complexity (Mean = 3.67, SD = 0.861), Collaborative Learning Environment (Mean = 3.68, SD = 0.757), Facilitator Guidance (Mean = 3.11, SD = 1.079), Self-Directed Learning (Mean = 3.89, SD = 0.904), and Application of Knowledge (Mean = 3.86, SD = 0.724). These students rate

problem complexity and self-directed learning highly, indicating these elements are pivotal in fostering critical thinking in their curriculum.

The language student group consists of 37 participants. Their mean scores are: Problem Complexity (Mean = 3.85, SD = 0.705), Collaborative Learning Environment (Mean = 3.71, SD = 0.695), Facilitator Guidance (Mean = 3.32, SD = 1.264), Self-Directed Learning (Mean = 3.76, SD = 0.877), and Application of Knowledge (Mean = 3.83, SD = 0.837). Language students rate problem complexity and application of knowledge highly, reflecting the importance of these components in developing critical thinking skills within language studies.

Across the entire sample of 218 students, the mean scores are: Problem Complexity (Mean = 3.64, SD = 0.830), Collaborative Learning Environment (Mean = 3.67, SD = 0.708), Facilitator Guidance (Mean = 3.19, SD = 1.143), Self-Directed Learning (Mean = 3.76, SD = 0.929), and Application of Knowledge (Mean = 3.76, SD = 0.796).

In summary, the participants in this study represent a diverse and comprehensive group of university students from different academic disciplines. This diversity ensures a rich array of perspectives and insights into how various components of PBL contribute to the development of critical thinking skills. By analyzing these diverse perspectives, the study aims to identify the key components of PBL that most effectively enhance critical thinking across different academic contexts. This comprehensive approach provides valuable insights for educators and curriculum designers in optimizing PBL strategies to foster critical thinking skills in students.

Table 1: Mean scores of components of PrBL across majors

Problem complexity; Collaborative learning environment; Facilitator guidance; Self-directed learning; Application of knowledge * Majors						
Majors		Problem complexity	Collaborative learning environment	Facilitator guidance	Self-directed learning	Application of knowledge
Health care students	Mean	3.6016	3.7805	2.6667	4.0894	4.0488
	N	41	41	41	41	41
	S.D	.89511	.73261	.92796	.83341	.70143
Engineering students	Mean	3.5000	3.5575	3.5977	3.3621	3.3563
	N	58	58	58	58	58
	S.D	.80265	.62248	1.14922	.94133	.79683
Economic students	Mean	3.6667	3.6829	3.1138	3.8902	3.8618
	N	82	82	82	82	82
	S.D	.86066	.75705	1.07881	.90427	.72379
Language students	Mean	3.8468	3.7117	3.3153	3.7568	3.8288
	N	37	37	37	37	37
	S.D	.70534	.69461	1.26429	.87718	.83748
Total	Mean	3.6407	3.6728	3.1927	3.7645	3.7569
	N	218	218	218	218	218
	S.D	.83008	.70762	1.14293	.92892	.79586

4.2. Qualitative Findings

The findings from the study reveal interesting insights into how students perceive the components of Problem-Based Learning (PrBL) across different years of study (Table 2).

First-year students appear to place a significant emphasis on facilitator guidance, rating it highest among all components. This suggests that, as newcomers to university-level education, they value structured guidance from instructors to navigate the complexities of PBL. However, their ratings for self-directed learning and application of knowledge are comparatively lower, indicating a potential need for further development in these areas as they transition to more independent learning approaches.

As students progress to the second and third years of study, there is a noticeable shift in perceptions towards collaborative learning and self-directed learning. These students demonstrate an increased appreciation for collaborative learning environments, indicating a growing understanding of the benefits of peer interaction and teamwork in problem-solving. Additionally, their higher ratings for self-directed learning suggest a developing autonomy and motivation in directing their own learning processes, which are integral aspects of PRBL pedagogy.

In contrast, fourth-year and graduate students prioritize self-directed learning and application of knowledge, rating these components significantly higher compared to earlier years. This suggests that as students advance in their academic journey and approach graduation or professional practice, they place greater emphasis on practical application and the ability to independently apply acquired knowledge in real-world contexts. Their high ratings for self-directed learning also reflect a heightened sense of autonomy and self-regulation in their learning processes, indicative of their readiness for self-directed study and research.

Overall, the findings underscore the dynamic nature of student perceptions of PBL components as they progress through their academic careers. While facilitator guidance may be paramount for first-year students adjusting to university learning environments, collaborative learning and self-directed learning become increasingly valued as students advance in their studies. Ultimately, these findings offer valuable insights for educators and curriculum designers to tailor PBL experiences that meet the evolving needs and expectations of students at different stages of their academic journey.

Table 2: Mean scores of students' perceptions of PrBL across years of study

Years of study	Problem complexity	Collaborative learning environment	Facilitator guidance	Self-directed learning	Application of knowledge
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First year students	Mean	3.4762	3.4558	4.2449	2.9048	3.0612
	N	49	49	49	49	49
	S.D	.72008	.66907	.82993	.65969	.54294
Second year students	Mean	3.5111	3.6500	3.1944	3.8333	3.6111
	N	60	60	60	60	60
	S.D	.87971	.77002	.92321	.88830	.62033
Third year students	Mean	3.8384	3.7879	3.1515	3.8283	3.7172
	N	66	66	66	66	66
	S.D	.69243	.61223	.94314	.90060	.58833
Fourth year students	Mean	3.7931	3.7586	1.9655	4.6322	4.8851
	N	29	29	29	29	29
	S.D	.98163	.75539	.84207	.13642	.18422
Graduate students	Mean	3.5238	3.8095	2.2381	4.3810	4.6667
	N	14	14	14	14	14
	S.D	1.07588	.79221	.94669	.45021	.52298
Total	Mean	3.6407	3.6728	3.1927	3.7645	3.7569
	N	218	218	218	218	218
	S.D	.83008	.70762	1.14293	.92892	.79586

V. CONCLUSION

This study provides valuable insights into the perceptions of Problem-Based Learning (PrBL) components among students across different majors and years of study.

Across various majors, the participants exhibit nuanced perspectives on the components of PrBL, reflecting the unique demands and expectations of their respective fields. While healthcare students prioritize facilitator guidance, engineering students emphasize collaborative learning environments, and economic students value problem complexity and self-directed learning. Language students, on the other hand, emphasize problem complexity and application of knowledge. These variations underscore the importance of tailoring PBL experiences to the specific needs and learning preferences of students within different disciplines. Additionally, the study reveals significant differences in perceptions of PrBL components across different years of study. First-year students show a strong reliance on facilitator guidance, whereas second and third-year students increasingly value collaborative learning and self-directed learning. In contrast, fourth-year and graduate students prioritize self-directed learning and application of knowledge, reflecting their readiness for independent study and professional practice.

Overall, the findings highlight the dynamic nature of student perceptions of PBL components, which are shaped by both disciplinary contexts and academic progression. By understanding and responding to these diverse perspectives, educators and curriculum designers can optimize PBL experiences to meet the evolving needs and expectations of students across different majors and years of study, ultimately enhancing student engagement, critical thinking, and learning outcomes in higher education.

REFERENCES

- [1] Azer, S. A., Peterson, R., Guerrero, A. P., & Edgren, G. (2013). Twelve tips for constructing problem-based learning cases. *Medical Teacher*, 34(5), 361-367.
- [2] Barrows, H. S. (1996). Problem-Based Learning in Medicine and Beyond: A Brief Overview. In L. Wilkerson & W. H. Gijsselaers (Eds.), *Bringing Problem-Based Learning to Higher Education: Theory and Practice* (pp. 3-12). San Francisco: Jossey-Bass.
- [3] Brookfield, S. D. (2012). *Teaching for Critical Thinking: Tools and Techniques to Help Students Question Their Assumptions*. Jossey-Bass.
- [4] Dolmans, D. H., Loyens, S. M., Marcq, H., & Gijbels, D. (2016). Deep and Surface Learning in Problem-Based Learning: A Review of the Literature. *Advances in Health Sciences Education*, 21(5), 1087-1112.
- [5] Dolmans, D. H. J. M., De Grave, W., Wolfhagen, I. H. A. P., & Van Der Vleuten, C. P. M. (2005). Problem-based learning: Future challenges for educational practice and research. *Medical Education*, 39(7), 732-741.
- [6] Ennis, R. H. (2011). "The Nature of Critical Thinking: An Outline of Critical Thinking Dispositions and Abilities." *Online*. Retrieved from: <http://criticalthinking.net/wp-content/uploads/2019/06/Ennis-NatureofCriticalThinking>.
- [7] Facione, P. A. (2015). *Critical Thinking: What It Is and Why It Counts*. Insight Assessment. Retrieved from: <https://www.insightassessment.com/wp-content/uploads/ia/pdf/what&why2015.pdf>
- [8] Facione, P. A. (2011). *Critical Thinking: What It Is and Why It Counts*. Insight Assessment.
- [9] Facione, P. A. (1990). *The Delphi Report: Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction*. American Philosophical Association. Retrieved from: <https://www.insightassessment.com/wp-content/uploads/ia/pdf>
- [10] Gholami, M., Moghadam, P. K., Mohammadipoor, F., Tarahi, M. J., Sak, M., Toulabi, T., & Pour, A. H. (2016). Comparing the Effects of Problem-Based Learning and the Traditional Lecture Method on Critical Thinking Skills and Metacognitive Awareness in Nursing Students in a Critical Care Nursing Course. *Nurse Education Today*, 45, 16-21. <https://doi.org/10.1016/j.nedt.2016.06.007>
- [11] Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235-266.
- [12] Hmelo-Silver, C. E., & Barrows, H. S. (2008). Facilitating collaborative knowledge building. *Cognition and Instruction*, 26(1), 48-94.
- [13] Hmelo-Silver, C. E., & Barrows, H. S. (2006). Goals and strategies of a problem-based learning facilitator. *The Interdisciplinary Journal of Problem-Based Learning*, 1(1), 21-39.

- [14] Hung, W. (2011). Theory to reality: A few issues in implementing problem-based learning. *Educational Technology Research and Development*, 59(4), 529-552.
- [15] Hung, W., Jonassen, D. H., & Liu, R. (2008). Problem-Based Learning. In J. M. Spector, M. D. Merrill, J. J. G. van Merriënboer, & M. P. Driscoll (Eds.), *Handbook of Research on Educational Communications and Technology* (3rd ed., pp. 485-506). New York: Lawrence Erlbaum Associates.
- [16] Kong, L. N., Qin, B., Zhou, Y. Q., Mou, S. Y., & Gao, H. M. (2014). The Effectiveness of Problem-Based Learning on Development of Nursing Students' Critical Thinking: A Systematic Review and Meta-Analysis. *International Journal of Nursing Studies*, 51(3), 458-469. <https://doi.org/10.1016/j.ijnurstu.2013.06.009>
- [17] Loyens, S. M., Magda, J., & Rikers, R. M. (2008). Self-directed learning in problem-based learning and its relationships with self-regulated learning. *Educational Psychology Review*, 20(4), 411-427.
- [18] Paul, R., & Elder, L. (2020). *The Miniature Guide to Critical Thinking Concepts and Tools* (8th ed.). Rowman & Littlefield.
- [19] Paul, R., & Elder, L. (2008). *The Miniature Guide to Critical Thinking Concepts and Tools*. Foundation for Critical Thinking Press.
- [20] Savery, J. R. (2015). Overview of Problem-Based Learning: Definitions and Distinctions. *The Interdisciplinary Journal of Problem-Based Learning*, 1(1), 9-20.
- [21] Savery, J. R., & Duffy, T. M. (2001). Problem-Based Learning: An Instructional Model and Its Constructivist Framework. *Educational Technology*, 35(5), 31-38.
- [22] Schmidt, H. G., Rotgans, J. I., & Yew, E. H. (2011). The process of problem-based learning: What works and why. *Medical Education*, 45(8), 792-806.
- [23] Strobel, J., & Barneveld, A. (2009). When is PBL More Effective? A Meta-synthesis of Meta-analyses Comparing PBL to Conventional Classrooms. *Interdisciplinary Journal of Problem-Based Learning*, 3(1), 44-58.
- [24] Sungur, S., & Tekkaya, C. (2006). Effects of Problem-Based Learning and Traditional Instruction on Self-Regulated Learning. *The Journal of Educational Research*, 99(5), 307-317. <https://doi.org/10.3200/JOER.99.5.307-320>
- [25] Tiwari, A., Lai, P., So, M., & Yuen, K. (2006). A Comparison of the Effects of Problem-Based Learning and Lecturing on the Development of Students' Critical Thinking. *Medical Education*, 40(6), 547-554. <https://doi.org/10.1111/j.1365-2929.2006.02481.x>
- [26] Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2(2), 75-79.
- [27] Walker, A., Leary, H., Hmelo-Silver, C. E., & Ertmer, P. A. (2015). *Essential Readings in Problem-Based Learning*. Purdue University Press.

Appendix: Components of problem-based learning that contribute to the development of critical thinking

Instructions: Please indicate the extent to which you agree or disagree with each of the following statements about your experience with Problem-Based Learning (PBL). Use the following scale:

1. Strongly Disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly Agree

#	STATEMENTS	RATINGS				
Problem Complexity and Relevance						
1.	The problems presented in PrBL sessions are complex and require critical thinking to solve.	①	②	③	④	⑤
2.	I find the problems presented in PrBL sessions to be relevant and applicable to real-world situations	①	②	③	④	⑤
3.	Working on complex and relevant problems in PrBL enhances my critical thinking skills	①	②	③	④	⑤
Collaborative Learning Environment						
4.	Collaborating with peers in PrBL sessions enhances my critical thinking abilities	①	②	③	④	⑤
5.	Discussing problems with peers in PrBL helps me consider different perspectives and think critically	①	②	③	④	⑤
6.	The collaborative nature of PrBL fosters critical thinking through interaction and exchange of ideas	①	②	③	④	⑤
Facilitator Guidance						
7.	The guidance provided by facilitators in PBL sessions supports my development of critical thinking skills	①	②	③	④	⑤
8.	Facilitators effectively guide discussions and inquiries to promote critical thinking in PrBL	①	②	③	④	⑤
9.	The facilitator's role in PrBL contributes significantly to my critical thinking development.	①	②	③	④	⑤
Self-Directed Learning						
10.	PrBL encourages me to take ownership of my learning and think critically	①	②	③	④	⑤

about the material.

- | | | | | | |
|---|---|---|---|---|---|
| 11. Engaging in self-directed learning activities in PBL enhances my critical thinking abilities | ① | ② | ③ | ④ | ⑤ |
| 12. I feel empowered to seek out resources and information independently to solve problems in PrBL. | ① | ② | ③ | ④ | ⑤ |

Application of Knowledge

- | | | | | | |
|--|---|---|---|---|---|
| 13. Applying theoretical knowledge to real-world problems in PBL strengthens my critical thinking skills | ① | ② | ③ | ④ | ⑤ |
| 14. PrBL activities help me understand how theoretical concepts can be applied in practical situations | ① | ② | ③ | ④ | ⑤ |
| 15. The emphasis on application in PrBL enhances my ability to think critically about complex issues | ① | ② | ③ | ④ | ⑤ |

Scoring and Interpretation

- Strongly disagree (1): Indicates a strong perception that the component does not contribute to critical thinking development.
- Disagree (2): Indicates a perception that the component has limited contribution to critical thinking development.
- Neutral (3): Indicates a neutral perception regarding the component's contribution to critical thinking development.
- Agree (4): Indicates a perception that the component contributes positively to critical thinking development.
- Strongly agree (5): Indicates a strong perception that the component significantly contributes to critical thinking development.

