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Artificial Intelligence Applications to Develop Problem-Solving Competency in Chemistry Education in Vietnam: Current Situation and Solutions

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Abstract
This study investigates the current status, perceptions, and challenges associated with the integration of Artificial Intelligence (AI) in the development of problem-solving competency (PSC) within the context of chemistry education in Vietnam. Drawing on a descriptive survey design, data were collected from 136 high school teachers across multiple provinces using structured questionnaires and analyzed through both quantitative and qualitative methods. The results indicate that while many educators have begun to use AI tools frequently for lesson planning, task design, and student engagement, disparities in access, training, and pedagogical alignment persist. Teachers largely view AI as a promising tool to enhance critical thinking and cognitive flexibility; however, concerns remain regarding students' overdependence on AI and the lack of clear instructional guidance. The findings underscore the importance of pedagogical leadership, professional development, and contextualized strategies to ensure AI serves as a meaningful contributor to competency-based education reform in Vietnam. Recommendations include expanding access to teacher training, embedding AI within a robust instructional framework, and developing policy mechanisms to support sustainable and equitable AI integration in schools.

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Introduction

The global acceleration of digital technologies, particularly Artificial Intelligence (AI), is profoundly transforming the landscape of education. AI is no longer a distant future concept but has become a present-day catalyst for reshaping how students learn, how teachers teach, and how schools operate [1]. From personalized learning environments and intelligent tutoring systems to predictive analytics and AI-assisted assessment, the potential of AI to revolutionize educational outcomes is immense. One especially critical area where AI can exert a transformative influence is the development of problem-solving competency (PSC)—a core 21st-century skill recognized across diverse educational frameworks [2].

Problem-solving competency refers to an individual's ability to navigate complex, unfamiliar, and often ill-structured problems by drawing upon analytical reasoning, creativity, and interdisciplinary knowledge[3][4]. As economies and societies become increasingly knowledge-driven and innovation-based, the ability to solve novel problems becomes essential for both personal development and national competitiveness. In response, global education systems have begun a shift from traditional content-focused instruction toward competency-based education (CBE) that prioritizes higher-order thinking skills such as critical thinking, collaboration, and problem-solving [5].

Artificial Intelligence offers unique affordances to scaffold this transformation. Intelligent systems can simulate complex problem scenarios, provide real-time feedback, adapt to learner profiles, and support data-informed pedagogy [6]. AI-enabled tools are also instrumental in equipping students with meta-cognitive strategies, enhancing self-regulation, and promoting reflective inquiry which are critical components of effective problem-solving [7]. Moreover, international initiatives such as UNESCO's AI Competency Framework for Students advocate not only for AI literacy but also for embedding AI meaningfully in curricula to foster student agency and ethical reasoning [8].

In Vietnam, the recent introduction of the 2018 General Education Curriculum [9] marks a decisive move toward CBE. This curriculum emphasizes the integration of key competencies—especially problem-solving—into all subjects, including STEM disciplines. However, despite its policy ambitions, the implementation of AI applications in Vietnamese classrooms remains modest. Studies reveal that teachers, while acknowledging the potential of AI, often lack the technical capacity, institutional support, and pedagogical guidance necessary for effective use [10, 11]. Additionally, infrastructural disparities across regions, along with a shortage of localized AI-driven educational platforms, further inhibit large-scale adoption.

Given these challenges, it becomes imperative to examine how AI technologies can be strategically mobilized to enhance problem-solving competencies in Vietnamese education. This study investigates the current landscape of AI applications in Vietnamese schools, analyzes the barriers to implementation, and proposes evidence-based solutions grounded in both global frameworks and local educational practices. Through a multi-layered inquiry, the paper seeks to inform policy, guide educators, and contribute to the evolving discourse on AI-integrated competency development in Vietnam.

Literature Review

Problem-solving competency has long been acknowledged as a foundational skill for learners to thrive in complex, unpredictable, and technology-driven environments. Within the educational domain, this competency is defined as a learner's ability to identify a problem, analyze it critically, generate alternative solutions, and apply appropriate strategies to resolve it in unfamiliar contexts. Jonassen (2000) differentiates between well-structured and ill-structured problems, asserting that the latter—typical in real-life scenarios—require learners to engage in non-linear reasoning, apply interdisciplinary knowledge, and make context-sensitive judgments. This aligns with constructivist learning theories, which emphasize active knowledge construction through authentic, meaningful tasks rather than passive information absorption [3].

The increasing prominence of problem-solving skills in curriculum reform is evident in various international education frameworks. The OECD's Education 2030 framework positions problem-solving as one of the essential "transformative competencies" that empower learners to shape a better future for themselves and[2]. Similarly, Trilling and Fadel (2009) include problem-solving as part of the "4Cs" (critical thinking, communication, collaboration, creativity) that underpin 21st-century learning [15]. These perspectives converge on the view that educational systems must shift from rote learning models toward competency-based approaches, where learners are equipped with cognitive flexibility and adaptive expertise.

Artificial Intelligence has emerged as a promising tool to support this shift. AI-driven educational technologies can simulate complex, dynamic problem environments that would be difficult to recreate through traditional instruction. Tools such as adaptive learning systems, intelligent tutoring platforms, and AI-supported assessment engines can personalize instruction, provide immediate feedback, and adjust learning trajectories based on individual learner profiles [16]. More importantly, AI can scaffold the development of metacognitive strategies, such as self-monitoring and reflection, which are central to effective problem-solving [7]. The ability to collect and analyze large volumes of learning data allows educators to diagnose learning gaps and intervene with precision, promoting a more responsive and learner-centered approach [17].

UNESCO's 2021 report *AI and Education: Guidance for Policy-Makers* underscores not only the importance of AI literacy but also the need to harness AI as a means to enhance competencies such as problem-solving. The framework proposes three interrelated dimensions of AI competence for students: understanding AI (AI Understand), using AI (AI Apply), and creating with AI (AI Create). These dimensions correspond to a continuum from passive interaction with AI to active innovation using AI tools. When integrated into curricula and pedagogy, they can promote deep engagement with real-world problems and foster a sense of learner agency [8].

In the Vietnamese context, the 2018 General Education Curriculum emphasizes the formation and development of key competencies, particularly problem-solving, through the integration of subject knowledge with real-life applications. However, empirical studies reveal several limitations in translating this vision into classroom practice. A study by Doan, Nguyen, and Vu (2022) found that although most teachers recognize the value of AI in enhancing student engagement and cognitive development, only a small fraction reported being confident in using AI-based tools. This is attributed to factors such as lack of digital infrastructure, insufficient training, and the absence of localized educational AI platforms [18].

Moreover, Tri et al (2021) point out that current AI applications in Vietnamese schools remain largely experimental and fragmented, with implementation varying widely between urban and rural settings [19]. While some private schools in major cities have begun to pilot AI-enhanced learning platforms, most public institutions struggle to integrate such tools due to policy ambiguity and limited resources. As a result, the potential of AI to support problem-solving competency is underutilized, and learners' experiences with AI-enhanced learning remain uneven and inequitable.

Although international research offers a wealth of evidence on the effectiveness of AI in developing higher-order competencies, localized studies in Vietnam are still in the early stages. There is a need for more systematic inquiry into how AI technologies can be adapted to Vietnam's socio-cultural and educational context, and how they can be scaled up to benefit diverse student populations. Addressing these research gaps is critical to ensuring that AI becomes an enabler—not a divider—of educational quality and equity.

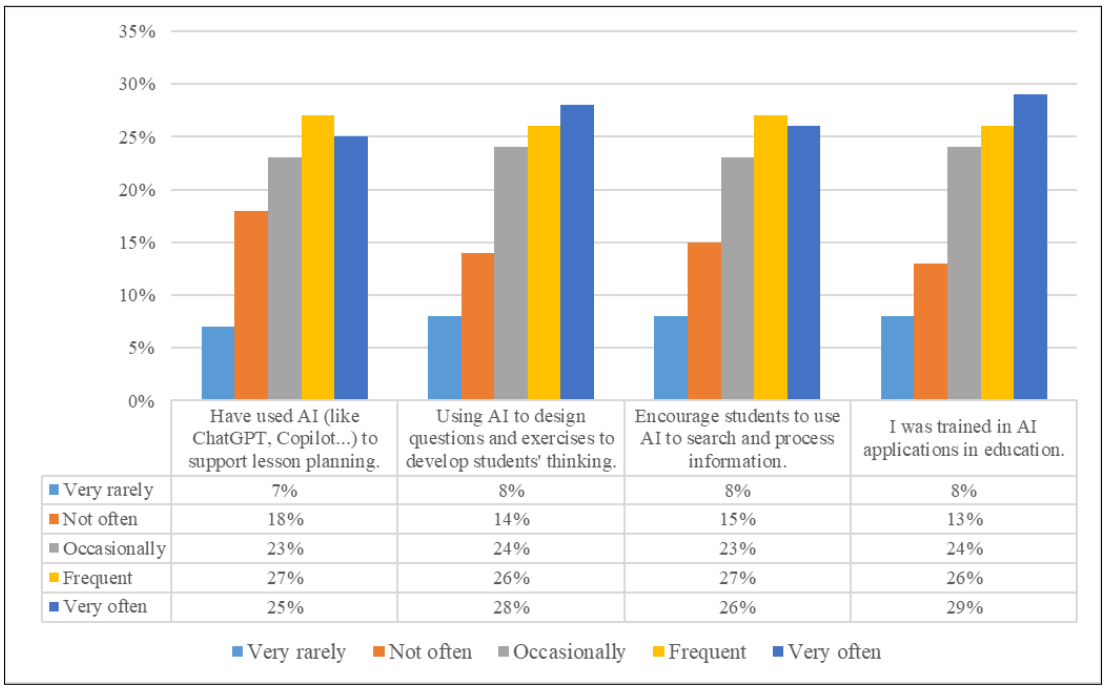
Methodology

Research design

This study adopted a descriptive survey research design to investigate the current practices, perceptions, and challenges associated with the integration of Artificial Intelligence (AI) in teaching and in fostering students' problem-solving competency (PSC) in Vietnamese general education. The survey method was chosen for its effectiveness in capturing self-reported data from a broad population of teachers across different regions and school types. This design allowed the researchers to collect both quantitative and qualitative data to obtain a comprehensive understanding of how AI is being utilized in educational settings, as well as how it is perceived in relation to the development of PSC.

The research was guided by three primary objectives: (1) to explore the extent to which AI technologies are currently being used in classroom instruction; (2) to examine teachers' perceptions regarding the effectiveness of AI in developing students' problem-solving competency; and (3) to identify the obstacles and support needs teachers face when integrating AI into their pedagogical practices. The cross-sectional nature of the study provided a snapshot of the current state of AI integration in Vietnamese schools and informed policy and professional development directions.

Participants



	Have used AI (like ChatGPT, Copilot...) to support lesson planning.	Using AI to design questions and exercises to develop students' thinking.	Encourage students to use AI to search and process information.	I was trained in AI applications in education.
Very rarely	7%	8%	8%	8%
Not often	18%	14%	15%	13%
Occasionally	23%	24%	23%	24%
Frequent	27%	26%	27%	26%
Very often	25%	28%	26%	29%

Fig 1: The current status of teachers' use of AI in teaching

Research timeline of the study is from October 2024 to April 2025. The current scientific exploration study from 136 high school teachers. The survey was conducted in Ha Noi, Nghe An, Ha Nam, Thai Nguyen, and Gia Lai, which were representative educational sites in Vietnam. Teachers were selected based on their knowledge of chemistry and developing problem-solving competency for students, ensuring that they could share useful experiences with the combination of modeling and problem-solving competency development. They were active participants in gaining a better understanding of how AI applications affect learning and how it affects teaching strategies and outcomes. A questionnaire was used to collect quantitative information on participant characteristics, their previous familiarity with AI, their comfort level with educational technology, and their perceptions of the impact of AI on teaching. The participation of teachers from different locations enhanced the understanding of this research method and identified potential challenges that may arise when applying AI and modeling to teaching.

Data collection instruments and data analysis

The data were collected through the online survey with the use of the survey that had a set of criterias. The sentence items were formulated using five-point Likert scale closed-ended questions ranging from 'Strongly Disagree' to 'Strongly Agree'. The questionnaire was run for teachers and a total of 90 samples were collected. Descriptive analysis of all quantitative data was performed using the Statistical Package for the Social Sciences (SPSS) software program (version 27.0). Descriptive statistical analysis was conducted to calculate the cronbach's alpha (CA), Mean (M), Standard Deviations (SD), Exploratory factor analysis (EFA) and ANOVA for each item, assessing their respective levels.

Results

The research team conducted a survey of 136 teachers in Hanoi, Thai Nguyen, Nghe An and several other provinces and cities and obtained the following results.

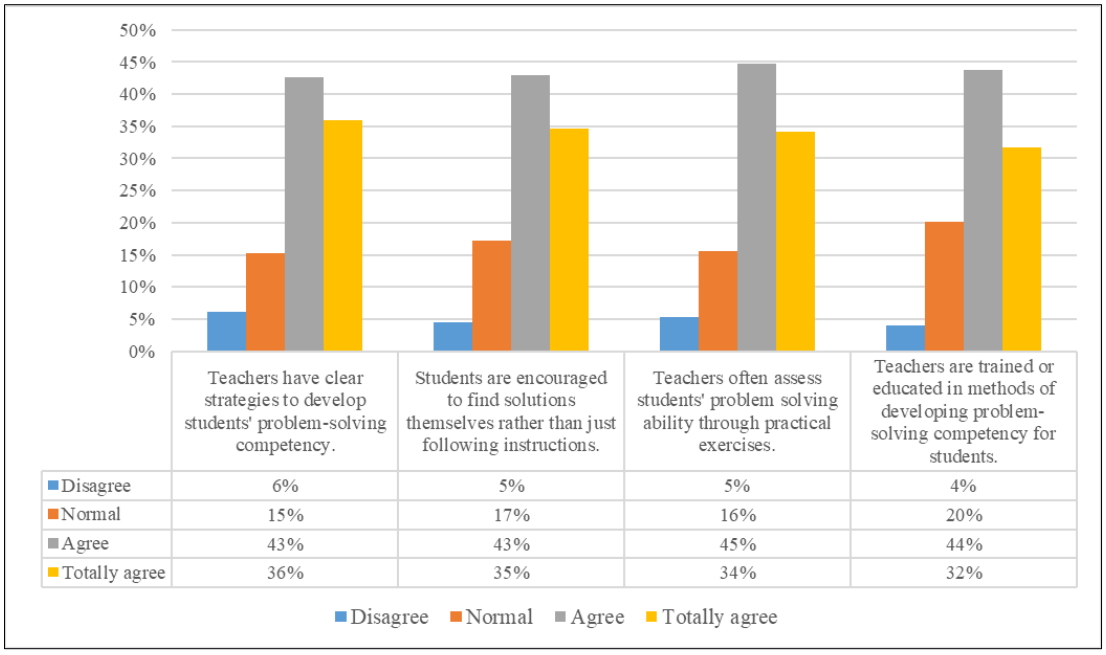
Figure 1 illustrates teachers' current engagement with Artificial Intelligence (AI) tools in classroom practice across several domains, including lesson design, task construction, and guiding students in using AI technologies. The results present a nuanced yet largely encouraging portrait of AI integration in Vietnamese high school education.

A total of 52% of respondents reported using AI either

"frequently" (27%) or "very frequently" (25%) for lesson planning. This finding indicates that over half of the participating teachers are no longer passive observers of technological change, but rather are actively adopting AI to augment their teaching strategies. Given that lesson planning is a cognitively demanding and time-consuming activity, this usage trend suggests a recognition among teachers that AI can streamline preparation processes and support pedagogical creativity. The use of AI at this level reflects a transition from viewing AI as a novelty to perceiving it as a routine pedagogical support tool.

Interestingly, the rate of AI usage increases further in the domain of task and exercise development: 54% of teachers indicated frequent or very frequent use of AI to design learning activities. This is particularly significant, as it suggests a deeper pedagogical application of AI—beyond content delivery—toward fostering students' cognitive engagement. The increased reliance on AI for constructing assignments may also be linked to its potential for personalized learning, allowing teachers to tailor questions and activities according to individual student profiles, ability levels, and learning needs. This trend aligns with existing research that positions AI as a mechanism for adaptive and differentiated instruction [13, 7].

In terms of student interaction with AI, 53% of teachers reported that they "frequently" or "very frequently" encourage students to use AI tools such as ChatGPT, Bing AI, or Microsoft Copilot to search for and process information. This suggests that AI is being introduced not only as a tool for teachers but also as a digital literacy resource for students. However, this shift is not without concern. A minority (8%) of teachers rarely encourage such use, potentially reflecting apprehensions about students' overdependence on AI, accuracy of AI-generated content, or fears that AI might undermine students' self-directed learning and critical thinking. These concerns echo broader discussions in educational literature regarding the ethical and cognitive implications of overreliance on generative AI [1].



	Teachers have clear strategies to develop students' problem-solving competency.	Students are encouraged to find solutions themselves rather than just following instructions.	Teachers often assess students' problem solving ability through practical exercises.	Teachers are trained or educated in methods of developing problem-solving competency for students.
Disagree	6%	5%	5%	4%
Normal	15%	17%	16%	20%
Agree	43%	43%	45%	44%
Totally agree	36%	35%	34%	32%

Fig 2: The current situation of developing problem-solving competency for students of teachers

Teacher training emerged as another critical dimension. While 55% of respondents indicated they had received AI training at a high frequency, a non-negligible proportion (8%) had little to no exposure to professional development in this area. This disparity suggests systemic gaps in access to AI-related professional learning opportunities. Without equitable and sustained teacher development programs, the risk of uneven AI implementation across schools—particularly between urban and rural or high-resource and low-resource contexts—remains substantial.

In summary, Figure 1 indicates that AI integration in teaching is advancing, but with disparities in both frequency and depth of use. While a significant number of teachers are leveraging AI for planning and student interaction, consistent and scalable professional support remains essential to ensure meaningful and pedagogically sound adoption across educational contexts.

Figure 2 presents teachers' reported strategies for developing students' problem-solving competency (PSC)—a cornerstone of competency-based education and a critical outcome in 21st-century learning frameworks [2]. The findings show strong alignment between teacher practices and the goals of fostering independent, inquiry-based, and context-responsive learners.

An overwhelming 79% of teachers affirmed that they had a clear pedagogical strategy for developing students' PSC, with 43% strongly agreeing. This high rate of consensus indicates that problem-solving is not merely an implicit or secondary goal in teaching practice, but rather a deliberate instructional objective. It suggests that a large proportion of educators are not only aware of the importance of problem-solving but are also making conscious efforts to embed it in their classroom methodologies.

Moreover, 78% of respondents stated that they encourage students to find their own solutions rather than following prescribed instructions. This pedagogical approach aligns with constructivist theories of learning, which emphasize student agency, exploration, and the co-construction of

knowledge. Encouraging independent solution generation allows students to develop not only domain-specific understanding but also transferable cognitive and metacognitive strategies essential for lifelong learning.

The trend continues in assessment strategies. Seventy-nine percent of teachers reported using real-world, authentic tasks to assess students' problem-solving capabilities, with nearly half (45%) strongly agreeing. This reflects a clear shift away from traditional rote assessment methods toward performance-based evaluation, where students are required to apply knowledge in complex, meaningful contexts. Such assessments not only provide a more accurate picture of student competence but also motivate deeper engagement and practical thinking.

However, challenges remain. Although 76% of teachers have received training on how to develop PSC, 4% have never been exposed to such programs. Additionally, 5–6% of teachers reported that they seldom apply these methods in practice. This small but significant minority may reflect contextual constraints such as overloaded curricula, exam-oriented teaching pressures, or lack of institutional support for innovative pedagogy. These findings underscore the need for targeted interventions—including curriculum restructuring, teacher mentoring, and time allocation policies—to support more consistent implementation of problem-solving pedagogy.

Collectively, the results from Figure 2 depict a promising but incomplete picture of PSC development in schools. While the majority of teachers demonstrate both awareness and action, sustaining these efforts at scale will require systemic support, policy alignment, and continued professional learning.

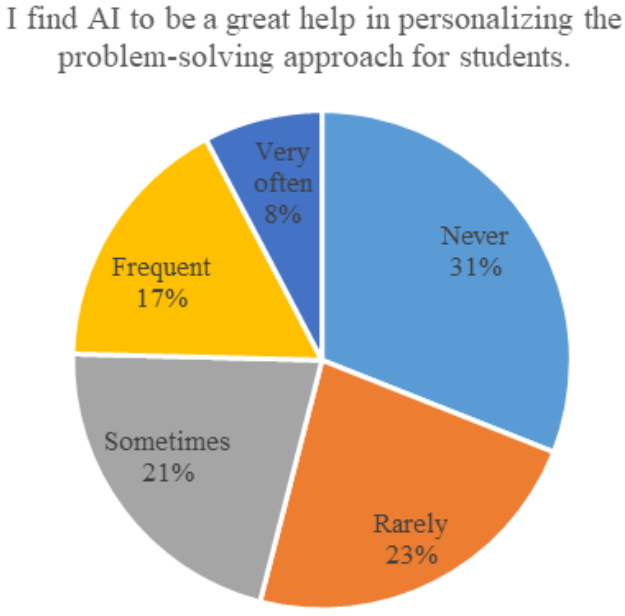


Fig 1: Teachers' Perceptions of AI in Personalizing Problem-Solving Approaches

This chart explores teachers' views on the extent to which AI supports the personalization of problem-solving approaches for students. The results reveal that only a small proportion of teachers—8%—reported using AI "very often" for personalization, with 17% selecting "frequent." Meanwhile, a notable 31% indicated that they "never" use AI for this purpose, and 23% said they "rarely" do so.

These results point to a significant underutilization of one of AI's most promising affordances in education: its ability to adapt tasks and support to individual learner profiles. Personalization has been widely recognized as a strength of AI-based systems, particularly in fostering differentiated learning pathways and accommodating diverse cognitive styles (Luckin et al., 2016). The data suggest that while some educators recognize this potential, many remain hesitant or lack the capacity to implement AI-driven personalization effectively. This hesitation may stem from concerns about data accuracy, lack of training, or the absence of clear instructional models.

Without proper support and integration strategies, AI's capacity for personalization risks being relegated to a theoretical advantage rather than a practical pedagogical tool. Thus, increasing awareness and competence in AI-enabled personalization is an urgent area for teacher professional development.

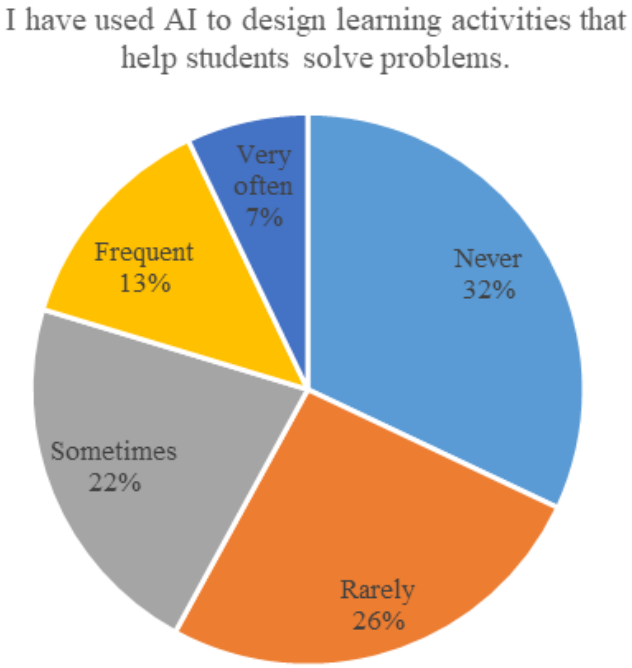


Fig 2: Use of AI in Designing Problem-Solving Activities

This chart indicates teachers' actual implementation of AI in designing learning activities that promote problem-solving. Only 7% reported "very often" using AI for this purpose, and 13% indicated "frequent" use. In contrast, 26% reported "rarely" doing so and 32% claimed they "never" use AI for activity design.

This data paints a concerning picture: despite the perceived potential of AI to support instructional design, the majority of teachers are either not engaging with AI in this capacity or are doing so infrequently. Compared to more general uses of AI in education, the task of designing activities that specifically target problem-solving appears more complex and possibly more intimidating for educators.

The relatively low use could be explained by several factors: lack of access to suitable platforms, insufficient understanding of how AI can be embedded into inquiry-based activity design, and unclear curriculum alignment. Yet, as scholars such as Holmes et al. (2022) emphasize, the value of AI in education lies not only in delivery or assessment, but

also in instructional co-design, where teachers and AI collaboratively shape meaningful learning experiences. These results thus highlight the need for capacity building focused on AI-supported instructional design, especially in STEM fields like chemistry where problem-solving is central.

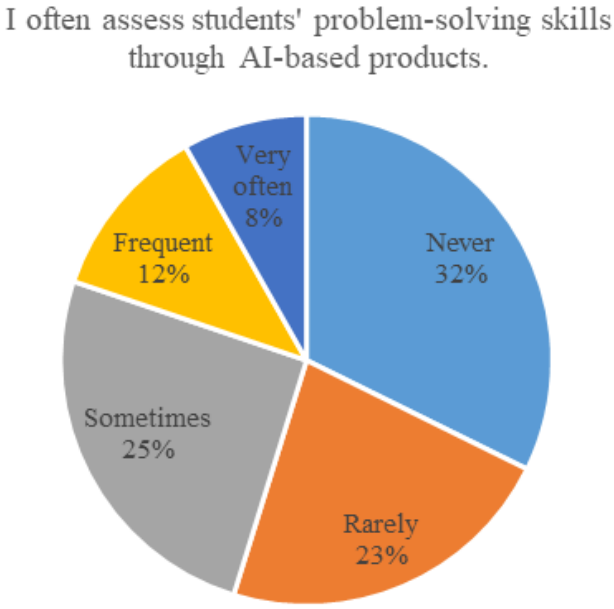


Fig 5: AI-Based Assessment of Problem-Solving Competency

In this chart, teachers were asked how often they assess students' problem-solving skills using AI-based products. A majority of respondents reported limited application: 32% answered "never," 23% chose "rarely," and only 8% selected "very often."

This limited uptake of AI in assessment reflects a critical implementation gap. AI offers unique advantages in formative and performance-based assessments, such as real-time feedback, adaptive testing, and automated analysis of student work. Yet, this potential is far from being realized in the surveyed context. The hesitancy may be due to concerns about fairness, validity, and the transparency of AI assessment algorithms—issues that have been widely debated in the literature (UNESCO, 2021).

Moreover, educators may lack access to tools that are both reliable and tailored to local curricula. The low adoption rates suggest that AI-based assessment is not yet institutionalized, and teachers may not view it as a legitimate or practical option. To bridge this gap, efforts must be made to develop context-appropriate assessment platforms, accompanied by ethical guidelines and teacher training.

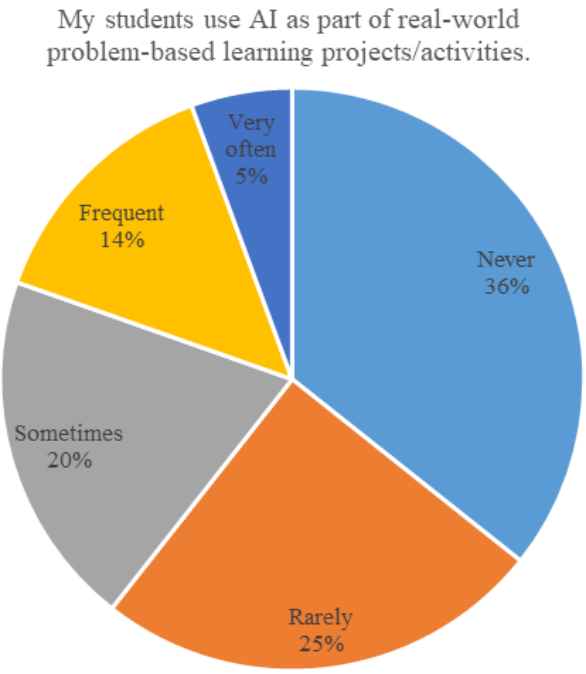


Fig 3: Guiding students to use AI for real-life problem solving

This figure addresses how frequently teachers guide students in using AI to analyze and solve real-life problems. Only 9% of teachers selected "very often," and 14% chose "frequent," while a significant 32% reported "never" doing so.

This result reflects a critical disconnect between the educational potential of AI and its practical application in fostering authentic problem-solving—a cornerstone of competency-based education. Real-life problems, by definition, are complex, interdisciplinary, and require students to transfer classroom knowledge to new situations. AI tools, if properly introduced, could support students in this transfer through data analysis, modeling, and scenario simulations. However, the data suggest that such practices are not yet widespread.

This underuse may be linked to a lack of available scaffolds for students to engage meaningfully with AI, or a perception among teachers that students are not ready for autonomous use of AI tools. These barriers underscore the need for curricular models and classroom routines that integrate AI in applied contexts, with teacher support gradually fading as student competence grows.

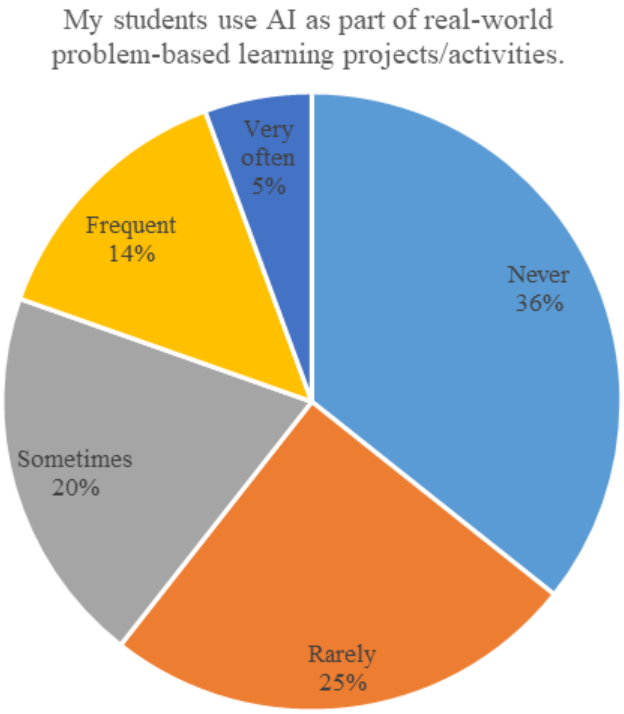


Fig 4: Student Use of AI in Problem-Based Learning Activities

This chart reports on whether students use AI as part of real-world, problem-based learning (PBL) activities. Among the respondents, 36% reported "never," 25% "rarely," and only 5% "very often."

This is the lowest rate of AI use reported across all surveyed practices, suggesting that authentic integration of AI into student-led learning scenarios remains highly limited. PBL is considered one of the most effective pedagogical models for developing problem-solving competency because it situates learning in real-world contexts and fosters collaboration, inquiry, and innovation. However, the minimal student engagement with AI in PBL settings points to a missed opportunity.

Possible explanations include the lack of structured AI tools aligned with PBL frameworks, logistical barriers (e.g., hardware limitations), or insufficient teacher confidence in managing open-ended learning environments involving AI. This highlights a need not only for technical infrastructure,

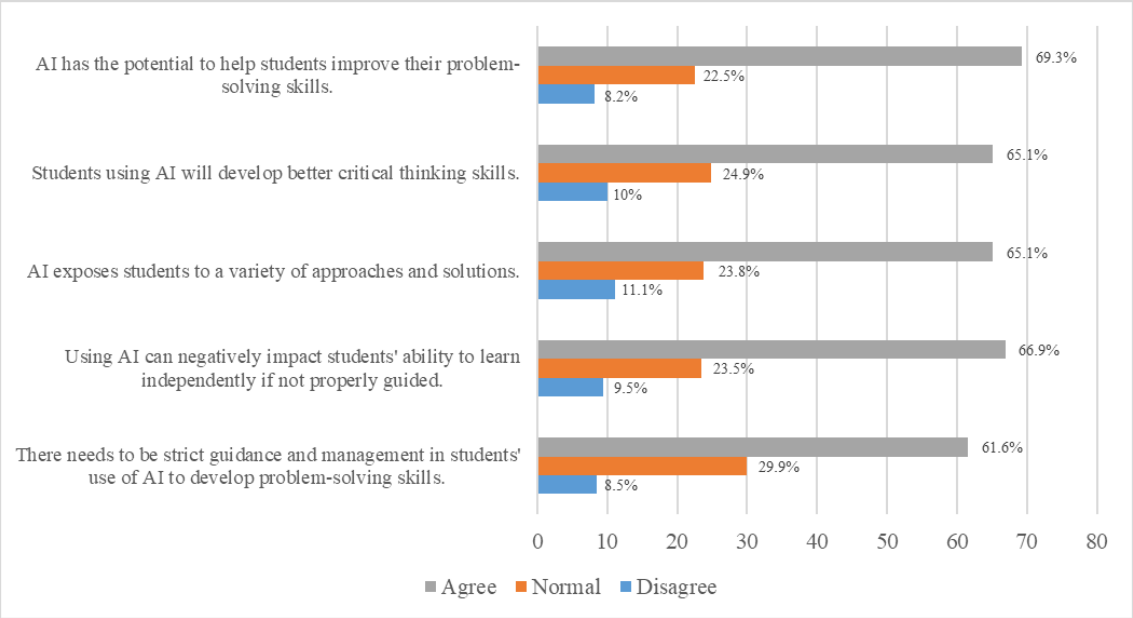


Fig 5: Opinions on using artificial intelligence (AI) to develop students' problem-solving skills

but also for pedagogical innovation that bridges AI functionalities with inquiry-based models like PBL.

Figure 8 explores how teachers perceive the potential of AI to enhance students' problem-solving competency. Overall, the data reveal a cautious optimism. Teachers largely recognize the transformative potential of AI but also voice concerns regarding its implementation and impact on learner autonomy.

A total of 69.3% of participants agreed that AI can support the development of problem-solving skills, suggesting a strong belief in its pedagogical utility. Similarly, 65.1% believed that AI contributes to students' critical thinking and creative reasoning. These perceptions are consistent with global findings on the cognitive affordances of AI-based learning environments, particularly those involving simulation, feedback loops, and scenario modeling [15]

An identical 65.1% of teachers noted that AI helps students access diverse approaches to problem-solving. This highlights one of AI's most unique capabilities: providing multiple solution pathways, examples, and feedback, thus promoting cognitive flexibility and strategy diversification—both crucial in ill-structured problem contexts [3].

However, caution is evident in the responses as well. Approximately 66.9% of teachers expressed concern that unsupervised or unguided AI use may negatively affect students' self-regulation and independent learning abilities. This is a critical observation, as it points to the double-edged nature of AI: while it can empower, it can also enable passivity if not appropriately scaffolded. Moreover, 61.6% emphasized the necessity for structured guidance and management when integrating AI into instruction. This indicates a demand for pedagogical frameworks that position AI not as a substitute for teaching, but as a complement that enhances well-planned instructional design.

These findings suggest that successful AI integration for problem-solving development depends not only on access to technology but also on pedagogical leadership and curriculum alignment. Teachers do not reject AI—they welcome it, but they call for strategic, informed, and ethically guided implementation.

Discussion

The findings of this study offer valuable insights into the current landscape of Artificial Intelligence (AI) integration in Vietnamese high schools, particularly regarding its role in fostering students' problem-solving competency (PSC). The results reveal a promising trajectory, yet also highlight several challenges and disparities that must be addressed to ensure equitable and pedagogically meaningful adoption of AI technologies in education.

Firstly, the high frequency of AI use reported by teachers—especially in lesson planning and task design—reflects an increasing confidence and operational familiarity with digital tools. This aligns with international trends indicating that teachers worldwide are beginning to shift from passive technology consumers to active pedagogical designers leveraging AI for instructional support [16]. Importantly, the fact that AI is not only used to create content but also to develop learning tasks suggests a deeper level of integration, wherein AI supports not just efficiency but also pedagogical innovation and cognitive engagement.

However, despite this general trend, the data also reveal variability in usage and access. A subset of teachers reported minimal use of AI and limited exposure to training opportunities. This disparity is consistent with previous research highlighting uneven digital transformation across educational systems in developing countries, where infrastructure and professional development often lag behind policy intentions [16]. If left unaddressed, such gaps risk reinforcing inequities between schools, especially between urban and rural areas.

In relation to the development of problem-solving competency, the findings underscore a strong commitment among Vietnamese teachers to incorporate student-centered and inquiry-based approaches. The high percentage of respondents who use real-world tasks and promote autonomous learning indicates a shift in pedagogical mindset, one that resonates with constructivist and competence-oriented learning paradigms [2, 3]. Nevertheless, the small percentage of teachers who have not yet embraced these methods calls attention to enduring systemic constraints, such

as lack of time, overemphasis on examination preparation, or insufficient support from school leadership.

The study also highlights teachers' perceptions of AI's role in developing PSC. While most educators recognize the positive cognitive impact of AI—especially in enhancing critical thinking and providing diverse solution pathways—they also express concern about student dependency, ethical ambiguity, and the absence of structured pedagogical guidance. This reflects a globally emerging discourse in which AI in education is seen as a powerful but "ambivalent" force: it has the potential to amplify learning but also to trivialize it if not grounded in sound pedagogy [8, 17].

What emerges from this duality is the necessity for pedagogical leadership and institutional frameworks that position AI as an enabler—not a substitute—for deep learning. Simply introducing AI tools into classrooms is not sufficient. Teachers must be equipped with instructional models, ethical guidelines, and context-sensitive resources that help them use AI in ways that support metacognitive growth and student agency [19]. In this regard, professional development plays a crucial role—not just as technical training but as pedagogical formation. As seen in the data, a lack of access to such training is directly correlated with lower usage and more cautious attitudes toward AI [20, 21].

Furthermore, this study sheds light on the evolving relationship between teacher autonomy and AI systems. While AI offers automation and predictive analytics, it is the teacher who remains the critical decision-maker in how these tools are integrated, interpreted, and leveraged in classroom settings [22]. As such, AI should be seen not as a solution in itself, but as part of a broader ecosystem of learning innovation—one that includes curriculum reform, policy alignment, and a cultural shift toward open-minded, reflective teaching [23].

In conclusion, the findings affirm the transformative potential of AI in developing problem-solving competency but also signal a pressing need for policy coherence, capacity-building, and pedagogical recalibration. As Vietnam continues its transition toward competency-based education, it is imperative to ensure that AI integration is driven not by technological determinism but by educational intentionality—where technology serves the learner, guided by the expertise and values of the educator.

Conclusion

This study offers empirical evidence on the emerging role of Artificial Intelligence in enhancing problem-solving competency in Vietnamese high school chemistry education. The findings suggest that while AI is increasingly being used by teachers to support instructional design and student learning, its integration is still uneven and often lacks structured pedagogical support. Teachers demonstrate both optimism and caution—acknowledging AI's potential to promote creativity, critical thinking, and personalized learning, yet also expressing valid concerns about ethical use, student dependency, and insufficient guidance.

The research reinforces the idea that AI, when embedded thoughtfully within educational practice, can serve as a powerful enabler of competency-based learning [24]. However, the effectiveness of such integration depends largely on the teacher's ability to align AI tools with learning objectives, student needs, and contextual realities. Addressing the current barriers—especially in terms of professional development, policy clarity, and infrastructure—is essential for achieving meaningful and scalable impact.

As Vietnam continues to reform its education system toward competency-oriented models, AI should be viewed not merely as a technological solution but as part of a broader pedagogical shift. Success will require coordinated efforts from policymakers, school leaders, teacher training institutions, and educational technology providers to ensure that AI is used not as a replacement for human instruction, but as a catalyst for deeper, more effective learning.

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