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Applying the Delphi Method to Develop a Competency Framework for Problem-Solving and Creativity in High School Students

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Abstract
Problem-solving and creativity competence is one of the three core general competencies that must be formed and developed in high school students under the current General Education Curriculum in Vietnam. However, the integrated approach to this competence remains limited, particularly in the context of chemistry teaching. Building on both domestic and international research, our team developed a structural framework for high school students' problem-solving and creativity competence consisting of six components and ten assessment criteria. To verify its scientific validity and feasibility, the Delphi method was applied through two rounds of consultation with 20 experts and one pilot testing round. Data were analyzed using SPSS software based on the KAMET procedure, employing the Mdqi, Qqi, Mqi, and Vqi indices. The results indicate that all criteria reached a high level of consensus, with Mqi values ranging from 3.95 to 4.20 and Vqi below 10%, confirming the relevance and strong applicability of the proposed competence framework.

Keywords: Competence, Problem-Solving and Creativity Competence, Structural Framework of Problem-Solving and Creativity Competence, Delphi Method, Application of the Delphi Method

1. Introduction

Problem-solving and creativity competence is one of the three core general competencies that must be developed in high school students according to the current General Education Curriculum in Vietnam [1]. However, at the international level, studies that treat this competence as an integrated entity remain limited; most existing research approaches problem-solving competence and creativity competence as separate constructs.

In Vietnam, since the Ministry of Education and Training promulgated the 2018 General Education Curriculum [1], numerous studies have focused on developing high school students' problem-solving and creativity competencies across various subjects. Notable examples include: Le Thanh Ha (2021), who developed a framework for problem-solving and creativity competence in Biology teaching following the STEM education approach [11]; Nguyen Trong Duc (2022), who studied the development of problem-solving and creativity competence for students through Geography teaching at lower-secondary level [10]; Dang Thi Thuy Dung and Nguyen Xuan Thanh (2023), who applied Artificial Intelligence (AI) in History teaching to foster problem-solving and creativity competence in high school students [7].

In Literature teaching, Lam Tran Son, Ngoc Thien Chuong, and Tran Cong Dan (2023) developed a problem-solving and creativity assessment tool for Grade 10 students in the context of narrative text reading comprehension [22], while Nguyen Hai Nam and Le Van Giao (2023) designed a problem-solving and creativity-oriented exercise system in Physics teaching [18]. In Mathematics, Vu Dinh Chinh and Tran Thi Thu Hien (2023) implemented STEM-based teaching activities to develop students' problem-solving and creativity competence [4].

However, in the field of Chemistry education, research on problem-solving and creativity competence remains limited. Notable studies include: Trinh Le Thien, Nguyen Thu Phuong Thao, Dang Thi Thuan An, and Chu Thi Huong (2020), who explored the development of this competence through selected Grade 11 Organic Chemistry topics [23]; Nguyen Ngoc Duy (2020), who proposed measures to foster problem-solving and creativity competence for Northwest high school students in Nonmetal Chemistry [8]; Nguyen Ngoc Tuan (2021), who examined strategies to develop this competence for engineering undergraduates through General Chemistry courses [25].

A review of the past five years of research shows that developing problem-solving and creativity competence for high school students is a critical and urgent requirement in the current context of comprehensive educational reform. To effectively evaluate the development of this competence in Chemistry teaching, it is essential to establish a competence framework with clear and specific behavioral indicators or assessment criteria.

Based on this rationale, our research team applied the Delphi method to propose a problem-solving and creativity competence framework for high school Chemistry. Through an iterative expert consultation process, the framework was gradually refined and validated, ensuring scientific rigor, feasibility, and practical applicability in the current educational context.

2. Research Methods

2.1 Delphi expert consultation method

The Delphi method was first introduced in the 1950s by Olaf Helmer and Norman Dalkey of Rand Corporation [6]. The method's name is inspired by the Oracle of Delphi in Greek mythology, symbolizing foresight and wise guidance. It is a systematic approach for collecting expert opinions to achieve consensus through a series of anonymous feedback rounds.

In each round, experts respond to a structured questionnaire. The research team then compiles and summarizes the responses and sends the synthesized feedback back to the experts for further review and adjustment in subsequent rounds. Expert opinions may evolve across rounds as participants consider new insights and the group's collective reasoning.

Multiple scholars have defined and described the Delphi method from various perspectives:

Cochran (1983) and Uhl (1983) classified Delphi as a qualitative research method with high applicability in problem-solving, decision-making, and group consensus building across multiple disciplines [24].

Skulmoski, Hartman, & Krahn (2007) described Delphi as an iterative process for gathering and refining expert evaluations via questionnaire rounds interspersed with structured feedback. Each subsequent round is adjusted based on aggregated results from the prior round, focusing on issues, opportunities, solutions, or forecasts, and continues until consensus or data saturation is reached [21].

Similarly, M. Krell and D. Kruger defined Delphi as a repeated expert consultation process using questionnaires combined with feedback, aiming to achieve consensus on predetermined research problems. The questionnaire design and feedback synthesis follow a sequential and cumulative principle, terminating once opinion convergence or research objectives are achieved [13].

In this study, we implemented the Delphi method with 20 selected experts in the field of educational sciences, including 4 Associate Professors and 16 Ph.D. holders working at domestic universities and research institutes. The Delphi procedure consisted of two main rounds and one pilot round, using online and direct questionnaires for expert consultation.

The primary objective of this consultation was to develop the core components of the competence framework and corresponding assessment criteria, while also refining the questionnaire and obtaining expert validation regarding the relevance and completeness of the proposed problem-solving and creativity competence framework for high school Chemistry.

2.2 Data synthesis, processing, and analysis

To analyze the level of expert consensus regarding the proposed competence framework, we employed quantitative statistical analysis using SPSS software.

The data processing and analysis followed the KAMET (Knowledge Acquisition for Multiple Experts with Time Scales) procedure, which evaluates the importance of each behavioral indicator/assessment criterion (qi) and eliminates less suitable items. This approach relies on a combination of statistical indices, including: Median (Mdqi), Quartile Deviation (Qqi), Mean (Mqi) Variance (Vqi) – representing the rate of expert opinion changes across Delphi rounds. The KAMET procedure and its specific analytical thresholds are presented in Table 1 [5, 14, 16, 17, 18, 27].

Table 1: KAMET Rules for Analyzing Expert Evaluations Using the Delphi Method

Condition	Round *t* for Delphi question	Round *t+1* for Delphi question
1	If Mqi ≥ 3.5 and Qqi ≤ 0.5 and Vqi < 15%, then *qi* is accepted and does not require further consultation.	
2	If Mqi ≥ 3.5 and Vqi > 15%, then proceed to round 2	If Mqi ≥ 3.5 and Qqi ≤ 0.5 and Vqi < 15%, then *qi* is accepted and does not require further consultation.
3	If Mqi ≥ 3.5 and Qqi ≥ 75%, then proceed to round 2	If Mqi ≥ 3.5 and Qqi ≤ 0.5 and Vqi < 15%, then *qi* is accepted and does not require further consultation.
4	If Mqi < 3.5 and Qqi ≤ 0.5 and Vqi ≤ 15%, then *qi* is rejected and does not require further consultation.	

In which:

Mqi: the mean value of the indicators or consultation questions (qi);

Qqi: the interquartile range;

Vqi: the variance representing the proportion of experts who changed their evaluation opinions.

After analyzing the first round of Delphi results, the evaluation criteria that did not achieve expert consensus were revised and subsequently included in the second Delphi round.

In the second Delphi round, the survey data were analyzed to calculate statistical indices, including: mean value (Mqi), standard deviation, and the proportion of experts who changed their evaluation opinions (Vqi). According to the KAMET rule, if an evaluation criterion simultaneously meets the following conditions: Mqi ≥ 3.5; Qqi ≤ 0.5; and Vqi < 15%, that criterion is considered to have achieved the necessary level of consensus and does not require further consultation in subsequent rounds.

3. Results and Discussion

3.1 Basis for proposing competency components

The 2018 General Education Curriculum determined that the structure of **problem-solving and creative competency** consists of six core components, including [1]: (1) Identifying and clarifying problems; (2) Recognizing new ideas; (3) Forming and implementing new ideas; (4) Proposing and selecting solutions to problems; (5) Implementing and evaluating problem-solving solutions; (6) Independent thinking. Each competency component has specific evaluation criteria to assess the level of development for each aspect, helping students improve and maximize their problem-solving and creative abilities.

This competency framework has been flexibly applied by many researchers in teaching specific science subjects. For example: **Biology**: Author Le Thanh Ha built a framework of 4 components and 9 evaluation criteria based on the STEM education orientation [11]. **History**: Authors Dang Thi Thuy Dung and Nguyen Xuan Thanh proposed 6 competency components and 14 evaluation criteria for high school students [7]. **Literature**: Authors Lam Tran Son, Ngoc Thien Chuong, and Tran Cong Dan suggested a framework of 6 components and 13 criteria for teaching reading comprehension of narrative texts [22]. **Physics**: Authors Nguyen Hai Nam and Le Van Giáo identified 6 competency components with 16 specific behavioral indicators [19].

In the field of **Chemistry teaching**, several recent studies have developed problem-solving and creative competency structures with varying numbers of components and criteria: Trinh Le Thien, Nguyen Thu Phuong Thao, Dang Thi Thuan An, Chu Thi Huong (2020) proposed a framework with 6 components and 14 specific indicators [23]; Nguyen Ngoc Duy (2020) constructed a structure with 6 components and 10 criteria/indicators for high school students in the Northwest region [8, 9]; Nguyen Ngoc Tuan (2021) suggested 5 competency components and 10 evaluation criteria for university students in technical majors [25].

It can be seen that the evaluation criteria for problem-solving and creative competency proposed in the above studies largely follow the orientation provided by the Ministry of Education and Training in the 2018 General Education Curriculum.

Based on the selective inheritance of previous studies and the orientation of the general education program, we propose the structure of problem-solving and creative competency in Chemistry teaching for high school students to include six core components: (1) Identifying and clarifying problems; (2) Recognizing new ideas; (3) Forming and implementing new ideas; (4) Proposing and selecting solutions to problems; (5) Implementing and evaluating problem-solving solutions; (6) Independent thinking. The proposed competency structure is illustrated in **Diagram 1** below.

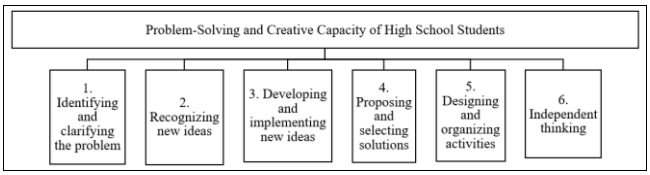

Fig 1: Framework structure of problem-solving and creative capacity of high school students

3.2 Results of Delphi round 1

We conducted an initial pilot study with six experts using the draft framework of problem-solving and creative competency, as presented in Table 2 below. The purpose of this pilot study was to collect feedback on the appropriateness of language expression and terminology usage.

Table 2: Structure of problem-solving and creative competency used in the Delphi pilot round

S. No	Component of capacity	Description	Evaluation criteria
1	Identifying and clarifying the problem	Students identify problems in learning situations; analyze causes, determine the nature of the issue, and identify related factors clearly and appropriately.	1.1. Identifying and analyzing "problem situations" in learning (Criterion 1).
2	Recognizing new ideas	Students recognize and form new ideas from creative thinking, drawing from various sources and perspectives, and evaluating the feasibility and reliability of ideas.	2.1. Recognizing new ideas in new learning situations (Criterion 2).
3	Developing and implementing new ideas	Students concretize and develop new ideas into products, models, or logical plans appropriate to practical and research requirements.	3.1. Developing new ideas in learning (Criterion 3). 3.2. Proposing ideas oriented toward research (Criterion 4).
4	Proposing and selecting solutions	Students propose multiple solutions to problems, assess pros and cons, compare and select the most suitable solution to implement.	4.1. Proposing one or more appropriate solutions to the problem (Criterion 5). 4.2. Choosing the most suitable solution (Criterion 6).
5	Designing and organizing activities	Students build a plan to solve problems, identifying goals, tasks, expected outcomes, and appropriate implementation conditions.	5.1. Designing an activity plan to solve the problem (Criterion 7). 5.2. Evaluating the problem-solving plan (Criterion 8).
6	Independent thinking	Students show independent thinking, critical evaluation, and expression of personal viewpoints based on clear reasoning; they do not rely on others to analyze and solve problems.	6.1. Adjusting and expressing personal opinions in analyzing and solving problems (Criterion 9). 6.2. Accepting and evaluating others' ideas (Criterion 10).

In the initial trial round, with the participation of 22 experts, the main objective was to collect initial feedback on the structure consisting of 6 competency components and the evaluation criteria drafts for each component. After compiling the feedback from the experts, we processed and analyzed the Delphi trial round data. The results are presented in Table 3 below:

Table 3: Values of expert consultation criteria in the trial round

Criteria	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC10
Value	22	22	22	22	22	22	22	22	22	22
Error value	0	0	0	0	0	0	0	0	0	0
Mean value	3.95	3.64	3.82	3.86	3.77	4.14	3.73	3.77	3.23	3.73
Quartile deviation	0	0.5	1	0.5	0.5	0.5	0.5	1	0.125	0.5

In this context: TC1: Criterion 1; TC2: Criterion 2; TC3: Criterion 3; TC4: Criterion 4; TC5: Criterion 5; TC6: Criterion 6; TC7: Criterion 7; TC8: Criterion 8; TC9: Criterion 9; TC10: Criterion 10.

Regarding the evaluation criteria, Criteria 1 ("Identifying and analyzing 'problematic situations' in learning") and Criteria 6 ("Choosing the most appropriate problem-solving solution") received high average scores (3.95 and 4.14, respectively) with low interquartile ranges (0 and 0.5), indicating good consensus. However, some criteria had higher interquartile ranges, such as Criterion 3 ("Generating many new ideas in learning" with Q=1) and Criterion 8 ("Evaluating problem-solving solutions" with Q=1), indicating a need for refinement as expert opinions were still dispersed. Notably, Criterion 9 of competency component 6 ("Adapting and creatively applying problem-solving solutions to new contexts and situations") had the lowest average score (3.23), below the acceptable threshold of 3.5, signaling that this criterion might be inappropriate.

Based on these suggestions, the draft template was revised and finalized to be used as a survey tool in the first Delphi round, which is presented in Table 4 below:

Table 4: Structure of problem-solving and creative competency used in Delphi round 1

S. No	Component of capacity	Description	Evaluation criteria
1	Identifying and clarifying the problem	Students can identify problems in learning or real-life situations; analyze causes, define the nature of the issue, and identify related factors clearly and logically.	1.1. Identifying and clarifying problems in learning and real life (Criterion 1).
2	Recognizing new ideas	Students recognize and develop new ideas from creative thinking, drawing from various sources and perspectives; they also evaluate the feasibility and reliability of ideas.	2.1. Recognizing new ideas/problems in learning and real life (Criterion 2).
3	Developing and implementing new ideas	Students can concretize and develop new ideas into products, models, or logical plans that suit the situation and problem requirements.	3.1. Developing new ideas or problems (Criterion 3). 3.2. Implementing new ideas or problems effectively (Criterion 4).
4	Proposing and selecting solutions	Students propose multiple solutions to the problem, evaluate pros and cons, compare and select the most feasible one to implement.	4.1. Proposing and analyzing one or more solutions (Criterion 5). 4.2. Selecting the most appropriate solution (Criterion 6).
5	Designing and organizing activities	Students create a plan for problem solving with defined tasks, clear goals, expected results, and suitable implementation conditions.	5.1. Planning a solution with clearly defined tasks and goals (Criterion 7). 5.2. Organizing implementation and summarizing results (Criterion 8) 5.3. Evaluating the effectiveness of the solution (Criterion 9)
6	Independent thinking	Students express independent opinions, make judgments, evaluate logically, and affirm their viewpoints without being dependent on others throughout the problem-solving process.	6.1. Adjusting and creatively applying problem-solving solutions to new contexts and situations (Criterion 10) 6.2. Independent thinking, proposing the creative application of solutions to new situations (Criterion 11)

We designed a 5-point Likert scale to measure expert consensus on the problem-solving and creative competency framework. Each evaluation criterion was presented as a specific descriptive statement, accompanied by coding and a response scale, including: Level 1: Strongly disagree; Level 2: Disagree; Level 3: Neutral; Level 4: Agree; Level 5: Strongly agree.

The consultation form was sent to 20 experts, and responses were collected 7 days after the survey distribution. After aggregating expert feedback, we processed and analyzed the first-round Delphi data, and the results are presented in Table 5 below:

Table 5: Values of expert consultation criteria in Delphi round 1

Criteria	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC10	TC11
Value	20	20	20	20	20	20	20	20	20	20	20
Error value	0	0	0	0	0	0	0	0	0	0	0
Mean value	4.10	4.05	3.85	4.00	3.95	4.10	4.05	4.00	3.95	3.15	3.95
Quartile deviation	0	0	0.5	0	0	0.375	0	0	0	0	0

In this context: TC1: Criterion 1; TC2: Criterion 2; TC3: Criterion 3; TC4: Criterion 4; TC5: Criterion 5; TC6: Criterion 6; TC7: Criterion 7; TC8: Criterion 8; TC9: Criterion 9; TC10: Criterion 10; TC11: Criterion 11.

The results show that the terminology changes in this round generally reflect an expansion of scope or a clarification of each criterion's intended meaning, based on in-depth feedback:

- **Competency component 1. Identifying and clarifying problems:** Criterion 1 was revised from "Identifying and analyzing 'problem situations' in learning" to "Identifying and clarifying problems in learning and in life." The experts recognized that problem-solving competence should not be confined to academic settings but also applied to real-life situations; hence the broader context. The shift from "analyzing" to "clarifying" also expresses the core behavior more directly.
- **Competency component 2. Recognizing new ideas:** Similarly, Criterion 2 changed from "Recognizing new ideas/new problems in learning" to "Recognizing new ideas/new problems in learning and in life." Experts emphasized that the recognition of new ideas should also be fostered across diverse life contexts, not only in learning. The 30% opinion-change rate indicates a notable adjustment in expert views to reach higher consensus (Q = 0).
- **Competency component 3. Forming and implementing new ideas:** Criterion 3 shifted from "Stating multiple new ideas in learning" to "Forming new ideas/new problems." Experts argued that "forming" reflects a deeper and more proactive cognitive process than merely "stating multiple" ideas. Criterion 4 changed from "Proposing guiding research questions" to "Implementing new ideas/new problems," reflecting experts' views that emphasis should be placed on execution—putting ideas into action—rather than stopping at posing questions.
- **Competency component 4. Proposing and selecting solutions:** Criterion 5 was supplemented with an "analysis" element ("Propose and analyze several problem-solving solutions"). Experts suggested that proposing solutions must be accompanied by analysis to ensure feasibility and effectiveness. Criterion 6 ("Selecting the most appropriate problem-solving solution") achieved high consensus and was accepted in Round 2, so it did not need to be re-surveyed in subsequent rounds.
- **Competency component 5. Designing and organizing activities:** Criterion 7 **changed** from "Carrying out the problem-solving solution" to "Planning problem solving according to the selected solution." Experts noted that "planning" is a critical step that should be explicitly reflected in this competence, shaping actions before execution. Criterion 8 was clarified to "Evaluating the effectiveness of the problem-solving solution," with the highest opinion-change rate (45%), indicating strong expert consensus on focusing evaluation on "effectiveness." In addition, a new criterion (Criterion 9) was added: "Organizing the implementation of the problem-solving plan and presenting the results," reflecting experts' view that execution and reporting should be included as a complete part of this competence.
- **Competency component 6. Independent thinking:** Criterion 10 continued to have a low mean score and a 0% opinion-change rate. This shows that experts consistently regarded this criterion as inappropriate or already covered elsewhere, leading to its removal in Round 1. Criterion 11 was revised to "Independent thinking, proposing the creative application of solutions to new situations," indicating that experts wanted to directly link "independent thinking" with the ability to "creatively apply solutions" in a more concrete way.

3.3 Results of the second Delphi round

After completing the first Delphi round, the research team conducted the second Delphi round 15 days later. A total of 20 experts participated, including 16 experts from the first round and 4 newly invited experts.

Based on feedback from the first round, the consultation questionnaire was revised and finalized, ensuring clarity in content, language, and assessment criteria. This updated version served as the official survey instrument for the second Delphi round.

The Delphi Round 2 questionnaire was developed based on the problem-solving and creativity competence framework, including its competence components, conceptual descriptions, and corresponding assessment criteria. The detailed structure is presented in Table 6 below:

Table 6: Structure of problem-solving and creativity competence used in the second Delphi round

S. No	Component of capacity	Description	Evaluation criteria
1	Identifying and clarifying the problem	Students can identify problems in learning or real-life situations; analyze causes, define the nature of the problem, and determine related factors clearly and logically.	1.1. Identifying and clarifying "problem situations" in learning (Criterion 1)
2	Recognizing new ideas	Students recognize and form new ideas from creative thinking, drawing from multiple sources and perspectives; they evaluate the feasibility and reliability of those ideas.	2.1. Recognizing new ideas from "problem situations" in learning (Criterion 2)
3	Developing and implementing new ideas	Students are able to concretize and develop ideas into products, models, or logical plans appropriate to the requirements of the problem.	3.1. Developing new ideas (Criterion 3) 3.2. Implementing new ideas (Criterion 4)
4	Proposing and selecting solutions	Students propose multiple problem-solving solutions, assess advantages and disadvantages, compare them, and select the most appropriate solution to implement logically.	4.1. Proposing one or more problem-solving solutions (Criterion 5) 4.2. Selecting suitable solutions for the problem (Criterion 6)
5	Designing and organizing activities	Students design a problem-solving plan, define objectives, tasks, expected results, and appropriate implementation conditions.	5.1. Designing a problem-solving plan and solution (Criterion 7) 5.2. Organizing the implementation of the problem-solving plan (Criterion 8) 5.3. Evaluating the effectiveness of the problem-solving plan (Criterion 9)
6	Independent thinking	Students express personal viewpoints, offer critiques, reason logically, and affirm their own stance without being dependent on others during the problem-solving process.	6.1. Independent thinking (Criterion 10)

Table 7: Values of expert consultation criteria in Delphi Round 2

Criteria	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC10
Value	20	20	20	20	20	20	20	20	20	20
Error value	0	0	0	0	0	0	0	0	0	0
Mean value	4.15	4.20	3.95	4.10	4.05	4.10	4.10	4.00	4.05	3.95
Quartile deviation	0	0.375	0.375	0	0	0.375	0	0	0	0
Number of experts who revised their assessment	1 (5%)	2 (10%)	2 (10%)	1 (5%)	1 (5%)	0 (0%)	1 (5%)	1 (5%)	1 (5%)	2 (10%)

In this context: TC1: Criterion 1; TC2: Criterion 2; TC3: Criterion 3; TC4: Criterion 4; TC5: Criterion 5; TC6: Criterion 6; TC7: Criterion 7; TC8: Criterion 8; TC9: Criterion 9; TC10: Criterion 10.

After fully compiling the feedback from the experts, we proceeded to process and analyze the data from Delphi round 2. The detailed results are presented in Table 7 above:

The data analysis from the second Delphi round indicates that the mean values (Mqi) of the criteria evaluated by experts ranged from 3.95 to 4.20. At the same time, both the quartile deviation (Qqi) and the rate of change in expert opinions (Vqi) remained below the 10% threshold. This demonstrates that, even with the participation of four new experts in the second round, a high level of consensus was maintained across all criteria within the proposed problem-solving and creativity competence framework for high school students.

According to the KAMET procedure, all assessment criteria achieved the necessary level of expert agreement, and therefore, a third Delphi round was not required.

4. Discussion

The findings of this study suggest that applying the Delphi method to construct a competency framework for problem-solving and creativity among high school students achieved a high level of expert consensus. This confirms both the validity of the proposed framework and the effectiveness of the Delphi process in gathering expert opinions in educational contexts (Oxley *et al*., 2024).

Firstly, it is important to note that the competency framework—with six components and ten criteria—was developed in close alignment with the 2018 national curriculum for general education in Vietnam. This alignment ensures both continuity with educational reforms and contextual relevance. Similar research has used Delphi to create indicator frameworks of higher-order thinking validated by international expert panels.

A notable strength of the study is the two-round Delphi validation involving twenty experts. All criteria received an average score above 3.95, with interquartile range (Qqi) and the rate of changed responses (Vqi) below 10%, indicating strong consensus. The robustness was further reinforced by adding four new experts in the second round while retaining overall agreement. This protocol mirrors findings from Oxley, Nash & Weighall (2024), who reported consistent consensus-building across rounds in educational research using Delphi.

Another methodological contribution is the use of the KAMET rule for data processing. In contrast to studies that rely solely on descriptive statistics, KAMET allows for objective elimination of criteria lacking sufficient consensus, resulting in a streamlined and highly applicable set of indicators (author, year). Although literature on KAMET in educational Delphi studies is still emerging, its use in related decision-analytic contexts supports its value.

Nevertheless, some limitations warrant discussion. First, while the Delphi method yielded high consensus, it remains dependent on expert judgment, which can be subjective. As Oxley *et al*. (2024) caution, Delphi panels vary in composition and consensus thresholds, potentially affecting reliability. Therefore, practical validation of the framework through large-scale classroom experiments across diverse contexts is necessary. Second, although the framework suits Chemistry instruction, further research is needed to validate its applicability to other subject domains, promoting interdisciplinary integration. Third, the assessment criteria remain somewhat abstract; thus, future efforts should focus on developing specific, reliable measurement instruments tailored to different student groups.

5. Conclusion

Based on a comprehensive review and analysis of both domestic and international studies on the problem-solving and creativity competence of high school students in recent years, our research team conducted expert consultations through one pilot round and two Delphi rounds. The consultation results indicate a high level of consensus among experts regarding the proposed problem-solving and creativity competence framework, confirming its relevance and scientific foundation within the context of contemporary Vietnamese education.

The problem-solving and creativity competence framework for high school students is structured into six components and ten assessment criteria. This framework is designed to support researchers and teachers in identifying, monitoring, and evaluating students' competence development during the teaching and learning process, particularly in high school Chemistry education.

To further determine the feasibility and practical applicability of this competence framework in real educational settings, our research team plans to conduct pedagogical experiments. These experiments are intended to assess the extent to which students' problem-solving and creativity competence can be developed, using the established assessment criteria throughout the Chemistry teaching process at the high school level.

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