Research Article

Developing Critical Thinking for Sustainable Career Development: An Exploratory Case Study from a Comprehensive Student Evaluation Perspective in Transportation Vocational Colleges

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Abstract

The widespread use of intelligent technologies in transportation, manufacturing, and related fields is reshaping the knowledge structures and problem-solving approaches required of technical and skilled workers. This exploratory case study examined the implementation and preliminary learning feedback of a 32-hour course on Critical Thinking (Analysis and Problem Solving) at a transportation vocational college in western China. The course was organized around Dong Yu's five-step diagnostic method for complex problems and focused on the "analysis and problem-solving ability" dimension of a broader student evaluation framework. Data were collected from 57 participating students through two anonymous questionnaires, classroom observations, and student learning texts. The two surveys yielded 40 and 43 valid responses, respectively. Descriptive statistics and thematic analysis were used. In the second survey, 95.35% of respondents reported that they tended to collect information before reaching conclusions, 83.72% reported consciously analysing the underlying nature of problems, and 81.40% reported considering opposing viewpoints and questioning evidence presented online. Triangulated evidence suggested emerging awareness of delayed judgment, information gathering, problem decomposition, viewpoint comparison, and evidence verification. Because the study lacked a validated critical-thinking measure, matched pre-post data, and a control group, the findings should be interpreted as descriptive evidence of course implementation and student responses rather than as causal estimates of skill development.*

Keywords: critical thinking; problem solving; vocational education; occupational adaptability; exploratory case study

1. Introduction

1.1 Changes in Occupational Requirements in the Intelligent Era

The development of intelligent technologies is reshaping the organization, task structures, and competency requirements of technical and vocational work. Digital systems and artificial intelligence (AI) tools can improve the efficiency of information retrieval, data analysis, and solution generation, but responsibility, contextual judgment, and value trade-offs in occupational practice cannot be fully replaced by technical systems. Students entering technical occupations therefore need not only the ability to operate relevant tools but also the capacity to deal with incomplete information, recognize ambiguous situations, evaluate alternatives, and make reasoned judgments.

In transportation, rolling-stock maintenance, mechanical manufacturing, automotive repair, and related fields, occupational competence has gradually moved beyond procedural proficiency toward integrated judgment and problem solving in complex technical systems. This change is evident in at least three respects. First, equipment and operational systems are becoming more complex, and tasks increasingly involve system-level condition identification, fault diagnosis, and coordinated response rather than the operation of a single component. Second, the causes of technical faults are often concealed and multiple, making reliance on experience or routine practice insufficient for reliable judgments. Third, technological iteration and standards are changing rapidly, so equipment, processes, and operating methods learned at school may soon be affected by new technologies and standards. Vocational education must therefore help students understand the conditions under which professional knowledge and procedures apply and enable them to transfer, adjust, and reorganize prior knowledge in response to specific situations.

These changes place greater demands on higher-order thinking in vocational education. Technical knowledge and operational skills remain essential, but their appropriate use increasingly depends on students' understanding of problem situations, their ability to analyse evidence, and their capacity to compare and evaluate alternative solutions. Intelligent technologies do not reduce the importance of human agency; rather, they increase the need for independent thinking, prudent judgment, and responsible decision making. In increasingly human-AI collaborative workplaces, students must recognize the scope and limitations of technical

outputs and avoid treating automatically generated information or recommendations as conclusions that require no verification.

Requirements for students' core competencies in the intelligent era should be understood against this occupational background. Internal motivation, judgment, and creativity can be treated as important conditions for analysing and solving practical problems. Internal motivation encourages students to identify problems, continue questioning, and seek improvement; judgment supports careful analysis and reasonable choices when information is incomplete, diverse, or conflicting; and creativity helps students propose feasible improvements while understanding existing technologies and work standards. Together, these qualities support problem diagnosis, option evaluation, and action-oriented decision making in complex occupational situations.

Accordingly, the education of technical and skilled personnel in the intelligent era should not be limited to the operation of AI tools. Vocational colleges also need to strengthen independent thinking, rational judgment, evidence awareness, and responsibility so that students can understand technical outputs, verify the reliability of information, and take responsibility for decisions and their consequences. Critical thinking offers an important educational pathway for integrating these competencies. It involves analysing, evaluating, and arguing about information and viewpoints while also identifying problems, weighing evidence, comparing alternatives, and making responsible judgments in occupational contexts. Integrating critical thinking into transportation vocational education may therefore help shift competence development from procedural execution toward problem diagnosis, integrated judgment, and continuous improvement in complex situations.

1.2 Critical Thinking as an Occupational Competence

Critical thinking is commonly defined as cognitive activity involving analysis, evaluation, inference, explanation, and judgment on the basis of evidence and reasonable criteria, together with dispositions such as open-mindedness, careful inquiry, self-reflection, and willingness to revise prior judgments (Ennis, 1987; Facione, 1990). The concept therefore emphasizes both cognitive skills and the willingness to use them. Critical thinking is not merely mastery of analytic procedures; it also involves continuously examining evidence, reflecting on reasoning, and adjusting judgments when facing uncertain information and different perspectives.

Given the practical nature of vocational education, this study defines critical thinking as an integrated ability through which students clarify problems, collect and evaluate evidence, compare possible explanations, reach reasonable conclusions, and revise judgments in response to new information when facing complex occupational problems. Critical thinking is thus neither an abstract cognitive activity detached from professional knowledge and practice nor a mechanical application of analytical tools. It is an important process through which students understand occupational situations, diagnose practical problems, and make action-oriented decisions.

The importance of critical thinking becomes more evident as human-AI collaboration deepens. Research and policy discussions suggest that AI can support cognitive expansion, skill acquisition, and information processing, but it cannot replace learners' agency in value judgments, conflict handling, responsibility, and authentic social practice. Education in the intelligent era should therefore pay greater attention to internal learning motivation, independent judgment, and creativity. AI can improve the efficiency of information processing and solution generation, but it cannot replace autonomous and responsible judgments concerning information reliability, contextual suitability, and the consequences of action. When standard procedures cannot provide complete answers, students need to determine whether a problem has been properly defined, whether evidence is sufficient and reliable, whether alternative explanations have been considered, and whether a proposed solution fits the occupational context.

Vocational education should consequently move beyond compliance with operating specifications and the development of technical fluency. Students should also learn to understand technical principles, distinguish reliable from unreliable information, diagnose faults, evaluate alternatives, and propose improvements. These competencies require the integration of professional knowledge, workplace information, and technical standards so that evidence can support relatively reliable explanations and decisions. Critical thinking is therefore not an additional general-education objective but a foundational competence for diagnosing complex problems, evaluating technical options, and making occupational decisions in the intelligent era.

1.3 The Type Positioning of Vocational Education and the Need for Action Competence

Analysing and solving practical problems is important across educational sectors, but the distinctive nature of vocational education gives this competence a stronger practical and action-oriented character. The revised Vocational Education Law of the People's Republic of China emphasizes practice, competence, and the development of scientific and cultural literacy, professional knowledge, technical skills, comprehensive

occupational qualities, and action competence needed for career development (Standing Committee of the National People's Congress, 2022).

Accordingly, problem solving in vocational colleges should not be assessed only by whether students can describe a problem, explain a proposed solution, or write an ideal plan. It should extend to action plans that can be implemented, tested, and adjusted. Critical thinking in vocational education is therefore not abstract reasoning detached from skills training; it is the ability to integrate conceptual understanding, technical operation, evidence-based judgment, and feedback into a continuous course of action in authentic or simulated occupational tasks. Students need to identify problems and their causes, select appropriate solutions under specific conditions, test the effectiveness of solutions through practice, and adjust prior judgments and actions in response to feedback.

Studying the development of analysis and problem-solving ability through course practice is therefore consistent with the statutory positioning of vocational education and responds to the occupational demands of the intelligent era. Such study can help explain how critical thinking may be transformed from a general cognitive requirement into problem diagnosis, solution implementation, and action improvement in occupational contexts.

1.4 Critical Thinking and Sustainable Career Development

This study approaches sustainable career development through two interrelated dimensions: occupational adaptability and continuous learning. Students who can analyse unfamiliar problems, collect relevant information, evaluate different explanations, and revise judgments in light of new evidence may be better prepared to respond to technological change, job adjustment, and evolving workplace requirements.

This relationship is particularly important in vocational education because vocational knowledge is closely linked to action. When facing authentic or simulated tasks, students need to integrate professional knowledge, workplace information, technical evidence, and occupational judgment. Critical thinking provides a way to organize and coordinate this process, moving from problem definition through information gathering, evidence evaluation, and comparison of alternatives to contextually appropriate decisions and subsequent revision based on feedback.

The study does not assume that a single course can directly produce long-term career outcomes. Instead, it examines whether a structured course can provide an initial foundation for more analytical and evidence-oriented problem solving. The focus is on course implementation and student learning responses, from which the feasibility of critical-thinking instruction in vocational curricula and its potential relevance to occupational adaptability and continuous learning are considered. Preliminary learning feedback should not be equated with long-term occupational competence or career development; such effects require examination across longer periods, larger samples, and multiple vocational contexts.

1.5 Research Gap

Facione (1990) identified analysis, evaluation, inference, explanation, and self-regulation as core cognitive skills in critical thinking. Research in vocational education likewise emphasizes linking classroom learning with actual occupational demands. However, there is still insufficient evidence on how these processes can be organized within short-term vocational courses serving students from different disciplinary backgrounds. Course-level studies are especially needed to document how students engage in problem definition, information gathering, viewpoint comparison, solution development, and reflection.

This study responds to that gap through an exploratory case study of a 32-hour course entitled Critical Thinking (Analysis and Problem Solving), examining student learning responses and discussing the possible theoretical and practical links among problem analysis, information evaluation, reflection, occupational adaptability, and continuous learning (Yin, 2018).

The study forms part of an ethically approved research project entitled "Transforming Educational Policy: Development of an Integrated Student Evaluation Index System in Transportation Vocational Colleges." The broader project aims to develop a comprehensive student evaluation index system for transportation vocational colleges. The present paper does not validate the overall index system; instead, it focuses on the "analysis and problem-solving ability" dimension by examining the implementation and preliminary learning feedback of the 32-hour critical-thinking course.

1.6 Research Questions

The study addresses the following research questions:

• How is critical thinking organized and implemented in a course focused on analysis and problem solving?
• What changes in problem-handling approaches do students report after participating in the course?
• What preliminary awareness of transfer is reflected in students' learning reflections and questionnaire responses?
• What possible relationship exists between the problem-analysis and reflection activities in the course and occupational adaptability and continuous learning in vocational education?

2. Theoretical Background

2.1 Five-Step Diagnostic Method for Complex Problems

Complex problem solving generally does not involve directly searching for a single correct answer. Instead, it proceeds through a sequence of problem identification, information analysis, solution generation, solution evaluation, and reflection on outcomes (Jonassen, 2000). Building on this view, the course adopted Professor Dong Yu's five-step diagnostic method for complex problems as a structured framework for analysing and solving complex problems (Dong, 2010, 2019). The aim was not to require mechanical memorization of five steps but to guide students through a complete reasoning process from problem definition to practical reflection:
• Problem identification: avoid treating surface symptoms as the problem itself.
• Structural analysis: examine the breadth, depth, and temporal dimensions of the problem.
• Model synthesis: integrate normal mechanisms, abnormal influences, and the effects of change.
• Hypothesis construction: use initial observations to infer and investigate possible causal relationships and reason toward the best explanation.
• Hypothesis selection: formulate decision recommendations through practical reasoning and consideration of arguments for and against competing options.
In this study, the five-step method was intended to transform a common tendency to "reach an immediate conclusion from experience" into a continuous process of identifying a problem, analysing it, forming a judgment, selecting a solution, and reflecting on practice. This made students' thinking more visible, teachable, and assessable in technical and vocational contexts. From a critical-thinking perspective, the framework translates relatively abstract cognitive processes into observable task behaviours—what students actually do while working through a problem.

2.2 Alignment of the Five-Step Method with Transportation Occupational Tasks

Equipment maintenance, fault diagnosis, transportation organization, safety management, and technical improvement all require the identification, analysis, and handling of complex problems. For example, the same alarm from an intelligent device may be caused by mechanical wear, electrical abnormalities, sensor errors, program settings, or the operating environment. Replacing components on the basis of a single symptom may confuse a surface manifestation with a root cause. By contrast, applying the five-step method can encourage students to generate several hypotheses, investigate them systematically, and verify evidence before reaching a conclusion.
The course organization may also support several important shifts in competence: from "the teacher tells me where the fault is" to active problem definition; from guessing causes based on experience to proposing multiple explanations from data and observed phenomena; from immediately implementing the first available solution to comparing the risks and effects of alternatives; and from ending the task once equipment resumes operation to recording the process, explaining the cause, and consolidating experience. These shifts illustrate how more stable critical-thinking practices may begin to develop in occupational contexts.

2.3 Critical Thinking and Occupational Adaptability

2.3.1 *Critical-thinking development should be embedded in occupational tasks*
Research on technical and vocational education has noted that critical thinking can be difficult to cultivate when instruction overemphasizes operational skills and lacks mechanisms for embedding reasoning into concrete tasks. Critical-thinking development in vocational education should therefore not rely mainly on abstract concepts, debates, reading exercises, or formal logic tasks. It should be grounded in authentic technical objects and environments in which students repeatedly observe, operate, record, diagnose, and improve. Such learning is consistent with the vocational principle of learning by doing, thinking through doing, and improving through doing.
The experience of motorcycle manufacturer Zhang Xue, who developed from a repair apprentice into a motorcycle designer and manufacturer, provides an illustrative example. His progression involved repeatedly

dismantling, assembling, polishing, and repairing engines, gradually becoming familiar with their structure and performance, understanding the principles behind vulnerable components and structural defects, and eventually using this accumulated understanding to support technical innovation (Xinhua News Agency, 2026). The example suggests that technical skills deepen through a progression from understanding product performance, to grasping operating principles, to analysing and documenting faults, and finally to technological innovation.

2.3.2 *A progressive pathway from performance to principles, faults, and innovation*

Drawing on the practical characteristics of vocational curricula, the following four-stage pathway can be used to deepen learning progressively.

a. Become familiar with product performance. Students first need to understand product structure, functions, technical parameters, and performance boundaries so that they can establish the foundational knowledge needed for problem analysis.

b. Understand operating principles. In practice, teachers should guide students to connect operating procedures with underlying technical principles and to understand the consequences of changing parameters or omitting steps.

c. Record product faults. Fault records are an important component of critical-thinking development. Students should document the time and environment of a fault, the operating state, abnormal phenomena, data changes, initial judgments, troubleshooting process, and final cause. Continuous recording can gradually transform fragmented experience into comparable and verifiable evidence and support the development of a personal fault knowledge base.

d. Assemble products and engage in innovation. Once students understand product performance, operating principles, and accumulated fault evidence, they can progress to disassembly, assembly, performance adjustment, and localized improvement, moving from being able to use a product to explaining and improving it.

From this perspective, critical thinking does not arise from a single lesson or activity. It develops when students continue questioning and repeatedly verifying their judgments in authentic tasks. In vocational education, critical thinking can therefore be understood as an integrated capacity to identify problems, analyse evidence, understand mechanisms, evaluate solutions, and improve technology around real technical objects through sustained practice.

3. Methodology

3.1 Research Design

The study used a single-case exploratory design and drew on two anonymous questionnaires, classroom observations, and student learning texts to examine student learning feedback. Case studies are appropriate for examining course implementation and complex effects in a specific educational context, with the primary aim of developing contextualized understanding rather than statistical generalization to a wider population (Merriam & Tisdell, 2016; Yin, 2018).

The questionnaires summarized student feedback at two points during course implementation. Classroom learning records and student reflections were organized around themes including information gathering, problem decomposition, viewpoint comparison, evidence evaluation, communication, and reflection.

3.2 Research Setting and Ethical Approval

The research setting was a transportation vocational college in western China. The 32-hour course, Critical Thinking (Analysis and Problem Solving), was offered as a platform for broadening students' professional perspectives, strengthening general competencies, and enhancing workplace competitiveness. It targeted students who had not previously received systematic training in structured thinking.

The study received ethical approval from Universiti Kebangsaan Malaysia, reference number JEP-2026-191, valid from 20 August 2026 to 19 August 2027. The approved project concerns the development of a comprehensive student evaluation index system for transportation vocational colleges. The present study represents the evidence-implementation component related to students' analysis and problem-solving ability.

The ethics application specified a planned sample of 100 students, while 57 students were actually included in the present study. Data collection occurred within the approved period. Participation was voluntary, the questionnaires were anonymous, and informed consent was obtained from all participants before data collection.

3.3 Participants

The participants were 57 students who took part in the course: 33 male and 24 female students; 42 were first-year students and 15 were second-year students. They came from several programs, with relatively larger numbers from railway locomotive, mechanical manufacturing, and infant and childcare programs. This disciplinary diversity increased the difficulty of course organization to some extent but also created opportunities for cross-disciplinary discussion and comparison of problem-solving approaches. The findings are therefore intended to explain learning feedback in this course case and are not directly generalized to all vocational-college students.

3.4 Course Objectives

Because analysis and problem-solving ability develops continuously through professional study and occupational practice, the course did not aim to make students proficient in multiple analytical tools or capable of independently solving complex occupational problems within a short period. Instead, lectures, case analysis, group discussion, and task practice were used to build preliminary problem awareness, evidence awareness, analytic awareness, and reflective awareness. Four intended learning outcomes were established in line with vocational education's emphasis on contextualized learning, action orientation, evidence-based judgment, and digital literacy.

3.4.1 *Preliminary identification and definition of problems*

Students were expected to identify problems requiring analysis in learning, daily life, or simulated occupational situations; make preliminary distinctions among facts, phenomena, judgments, and hypotheses; and describe problem boundaries in terms of the actors involved, context, scope of influence, and constraints. The goal was to move students from directly accepting surface conclusions toward actively identifying, clarifying, and questioning problems.

3.4.2 *Preliminary use of structured analytical tools*

With teacher guidance, students were expected to select and initially apply the five-step diagnostic method for complex problems, binary problem analysis, practical reasoning models, or basic causal analysis to organize relevant factors, possible causes, and relationships in a case. They were also expected to propose more than one possible explanation and state the information or evidence supporting their judgments. The goal was not full mastery of all tools but an understanding of their basic purposes and initial application in specific tasks (Dong, 2010, 2019).

3.4.3 *Comparison of evidence and formation of preliminary solutions*

Students were expected to make preliminary judgments about information sources, evidence relevance, and the reliability of conclusions; compare explanations or alternative solutions when information was limited or opinions differed; and provide basic reasons for their choices. When using generative AI or search tools, students were expected to recognize that generated information may contain errors, bias, or contextual mismatches and to examine outputs through source checking, cross-comparison, and contextual verification.

3.4.4 *Communication, negotiation, and reflection on method use*

In group tasks, students were expected to explain their analytical processes, listen and respond to different views, and adjust prior judgments when challenged by peers or presented with new evidence. They were also expected to explain how the methods could apply to professional study, practical training, daily life, or future occupational tasks and to recognize their limitations. This outcome focused on collaborative argumentation, revision of viewpoints, and awareness of transfer; willingness to apply a method in the future was not treated as evidence of stable transfer ability.

3.5 Data Sources

The study used an exploratory case design in a single setting to examine the design and implementation of the critical-thinking course and students' preliminary feedback. Data consisted of descriptive questionnaires, classroom observation records, and student learning texts. Because the study did not include a standardized pre-test, post-test, or control group, course outcomes were not interpreted as causal improvements in ability. Instead, analysis focused on preliminary cognitive changes, use of methods, and awareness of transfer during the learning process.

The college administered one questionnaire during the course and another after completion to understand students' views on course difficulty, group collaboration, thinking tools, and perceived learning changes. The first questionnaire, administered during the course, focused on class participation, peer cooperation, difficulty, and method mastery and produced 40 valid responses, representing 70.2% of participants. The second questionnaire, administered after the course, examined changes in thinking habits, use of critical-thinking tools, learning difficulties, and expectations for future courses. It produced 43 valid responses, representing 75.4% of participants. Because both questionnaires were anonymous, individual responses could not be matched. The two surveys were therefore analysed as descriptive feedback at different time points rather than as a formal pre-post comparison.

Classroom observations focused on students' note taking, oral contributions, discussions, questioning, and revisions of viewpoints. Textual data included classroom notes, open-ended questionnaire responses, and learning reflections. The analysis examined how students described critical thinking, explained their use of course tools, understood evidence and reasoning, and identified possible applications in other learning or occupational contexts.

3.6 Teaching Practice Pathway

3.6.1 *Collaborative teaching: establishing a structured framework for problem analysis*

Two instructors with relevant research backgrounds jointly taught the course using a sequence of theoretical explanation, case analysis, task practice, and group discussion. Instruction first addressed "problem analysis and problem solving," encouraging students to examine problems in terms of breadth, depth, and time, and then introduced the five-step diagnostic method and binary problem analysis through concrete cases. Problems drawn from students' study and daily life were subsequently used to guide step-by-step application. This arrangement created a progression from theoretical construction to application in familiar situations and gave students opportunities to understand and use the methods in concrete problems.

3.6.2 *Case introduction: moving from problem symptoms to problem definition*

Cases were selected so that students could understand the situation but could not solve it by intuition alone. For example, when a road intersection suddenly experienced severe congestion during recent evening peaks, the instructor did not provide an immediate cause. Instead, students were asked whether the congestion occurred at fixed times; whether roadworks, signal timing, traffic volume, pedestrian crossings, or nearby activities had changed; whether existing information was sufficient to support a conclusion; and what additional data were needed. The exercise emphasized that observing a problem phenomenon does not mean understanding its cause. Analysing a complex problem requires clarification of boundaries, supplementary contextual information, and distinctions among facts, assumptions, and judgments that still require verification (Dong, 2019).

3.6.3 *Method practice: converting the five-step diagnosis into learning tasks*

Students completed tasks involving problem description, information collection, causal analysis, comparison of alternatives, and reflective revision around issues from daily life, study, or professional contexts. When proposing conclusions, they were repeatedly asked three questions: What supports this judgment? Are there other possible explanations? What information has not yet been verified? These prompts directed attention to the basis of claims, alternative explanations, and unverified information, helping students recognize that having an opinion does not make it reasonable and that technical judgments require relevant information, clear reasoning, and evidence.

3.6.4 *Group discussion: revising judgments through interaction*

Group discussion was an important teaching strategy. Students jointly decomposed problems, searched for information, proposed solutions, and presented their reasoning, while other groups questioned the adequacy of evidence, completeness of causal explanations, and feasibility of solutions. In the first questionnaire, 27 students (67.5%) considered the group discussions relatively in-depth and effective, while 13 students (32.5%) considered them somewhat effective; none reported that the discussions were merely formalities. Thirty-four students (85.0%) regarded the course difficulty as moderate and generally understandable, five (12.5%) considered it difficult, and one (2.5%) considered it relatively easy.

Group discussion provided a setting in which students encountered different views, learned to explain reasons, responded to challenges, and revised viewpoints. Classroom observations and group tasks were used to examine

whether these preliminary behaviours appeared during course activities. A small number of classroom performances were not interpreted as evidence that students had already developed stable critical-thinking ability.

3.6.5 *Learning records: making the thinking process visible*

Students used notes to record concepts, cases, diagnostic steps, and personal understanding. These learning records made the thinking process visible. Instructors could examine not only students' final answers but also how they defined problems, what evidence they used, and where logical leaps occurred. Students could also review their own records to identify information omissions, single-cause attribution, or premature judgment.

3.6.6 *AI-assisted evaluation: moving from obtaining answers to examining answers*

Evaluation and use of AI were explicitly incorporated into the course. Students were not prohibited from using AI; rather, they were asked to treat it as an auxiliary tool for obtaining information, expanding ideas, and generating alternatives. After using AI, they still had to examine information sources, factual accuracy, logical relationships, applicable conditions, and potential biases. In this way, AI was reframed from a source of "standard answers" that replaces student judgment into a new context for practicing information evaluation and evidence examination.

4. Results and Findings

4.1 Student Learning Feedback and Transfer to Occupational Contexts

The findings in this section primarily reflect students' self-reports, learning texts, and intentions to transfer learning. In qualitative research, such feedback can help explain students' experiences, understandings, and preliminary behavioural tendencies, but it cannot be treated as equivalent to direct measurement of ability (Merriam & Tisdell, 2016).

4.1.1 *Positive changes in self-reported problem-handling tendencies*

In the post-course questionnaire, 41 students (95.3% of valid respondents) reported that they no longer rushed to conclusions when encountering problems and instead collected information first. Thirty-six students (83.7%) reported that they had begun to consciously analyse the underlying nature of problems. Thirty-five students (81.4%) reported that they would actively consider different positions or opposing views before making a decision, and another 35 students (81.4%) reported that they would question the evidence presented in online information, news, or advertisements.

These data indicate that most students reported positive changes in delayed judgment, information supplementation, questioning of evidence, and consideration of alternative explanations. Such changes may represent an early shift from conceptual knowledge toward critical problem-handling tendencies, but they do not demonstrate the formation of stable critical-thinking ability.

When asked to evaluate course tools, 28 students (65.1%) selected the five-step diagnostic method for complex problems as the most useful tool, a higher proportion than for the other tools. In this sample, methods with a clear structure and direct applicability to problem solving appeared easier for students to understand and accept.

4.1.2 *Deepening understanding of critical thinking*

Student reflections indicated that some students came to describe critical thinking as a careful and rational process of analysis and evaluation that requires attention to information sources and logic, distinctions between facts and opinions, and judgments based on evidence from multiple sources.

Some students reflected that they had previously tended to trust textbooks, other people's opinions, or online information directly. After the course, they reported becoming more likely to remain calm before judging, consider alternative views, reduce simple conformity, and ask "why" rather than rely only on memorization.

Other students stated that they had learned to use the five-step method and binary analysis to address problems and had gradually recognized the need to reflect on process, causes, and outcomes regardless of whether a problem-solving attempt ultimately succeeded or failed.

These learning texts suggest that change was not limited to the acquisition of a particular method. They also reflected an initial adjustment in thinking dispositions: from rapid acceptance toward careful judgment, from a single viewpoint toward listening to different opinions, and from pursuing one-time correctness toward accepting examination and revision.

4.1.3 *Preliminary intention to transfer learning across contexts*

Responses to open-ended questions showed that students had tried or planned to apply critical-thinking approaches to current events, study competitions, examination review, work tasks, and daily decision making.

For current events and daily life, approximately 30% of relevant responses referred to online events, information screening, and rational judgment. Students suggested using the five-step method to analyse causes, avoiding blind conformity to public opinion, and examining information authenticity from multiple perspectives.

For study competitions, approximately 25% of relevant responses referred to topic selection, solution optimization, and logical verification. Students believed that the five-step method could be used to screen options, challenge initial assumptions, and decompose complex problems, thereby reducing errors caused by fixed thinking patterns.

For examinations and general study, approximately 20% of responses involved analysis of incorrect answers, knowledge verification, and logical organization. Some students reported becoming less satisfied with merely remembering the correct answer and more interested in understanding why an error occurred and how it related to underlying knowledge.

For work-related matters, approximately 15% of responses involved workflows, solution feasibility, collaborative communication, and task decomposition. Students suggested reviewing work processes, questioning whether procedural steps were reasonable, analysing alternatives, and breaking complex tasks into manageable stages.

These materials indicate preliminary awareness of transfer: students could identify learning, daily-life, and occupational contexts in which the course tools might be useful. However, expressing an intention to "use the method at work" is not equivalent to effectively solving real workplace problems. The data support an emerging awareness of occupational problem analysis and transfer intention but do not establish stable competence in complex workplace problem solving.

4.1.4 *Perceived relevance, value, and potential for broader implementation*

When asked whether the course was relevant to their lives or academic programs, 19 students (44.2%) selected "relatively consistent" and 15 (34.9%) selected "very consistent," for a combined 79.1%. Regarding the value of the course, 19 students (44.2%) selected "relatively consistent" and 20 (46.5%) selected "very consistent," for a combined 90.7%. When asked whether they hoped the college would extend the course to all students, 16 students (37.2%) selected "relatively hopeful" and 20 (46.5%) selected "very hopeful," for a combined 83.7%. In addition, 33 students (76.7%) reported that the course had helped their communication, teamwork, and problem-solving ability.

5. Discussion and Reflection

5.1 Students' Learning Responses

Questionnaire results show that students perceived some changes in how they handled information and problems during the course. The most prominent response was "collect information before reaching a conclusion," selected by 41 of the 43 valid respondents. Other responses indicated increasing attention to problem structure, different viewpoints, and the basis of public and online information. These responses align with the core processes emphasized in the course: clarification, analysis, comparison, evidence evaluation, and reflection.

The findings should be interpreted within the course context. They describe students' perceptions of how their learning and thinking changed during participation, suggesting an association between course content and reported problem-handling approaches and showing that course activities connected with recognizable learning experiences. They should not be interpreted as direct evidence of measured competence gains.

5.2 Critical-Thinking Courses Should Emphasize Problems, Interaction, and Practice

The course experience suggests that transportation vocational-college students are not inherently unable to understand critical thinking; rather, abstract theory needs to be translated into concrete and actionable tools for problem analysis. Compared with concept explanation alone, case analysis, sustained questioning, group discussion, and method practice more readily encouraged students to reveal their thinking processes.

Dong (2010, 2019) argues that critical-thinking instruction should emphasize problems, interaction, practice, and collaborative learning and should promote competence through inquiry-based learning, critical reading, and analytical expression. The implementation of the Critical Thinking (Analysis and Problem Solving) course was broadly consistent with these principles.

5.3 Implications for Course Design

The course used the five-step diagnostic method as a structured framework, authentic problems as learning carriers, and group interaction as a driving force. Five implications can be drawn. First, critical-thinking objectives should be linked to specific occupational tasks rather than expressed only as general educational aims. Second, students should be required to explain how they define a problem and what evidence supports their response. Third, group discussion and peer questioning can make reasoning processes more explicit and expose students to different perspectives. Fourth, reflection should be embedded in technical learning so that students review not only which solution they selected but also how they arrived at it. Fifth, future courses can incorporate more authentic or simulated enterprise tasks, including equipment-fault analysis, process analysis, judgments about work procedures, safety decisions, and technical communication.

5.4 Occupational Adaptability and Continuous Learning

The course primarily used cases from students' lives and studies, but its focus on problem analysis, causal exploration, decision making, and AI evaluation has conceptual links with fault diagnosis, solution design, and workplace collaboration. Critical thinking can therefore function as a way of organizing problem-analysis activities in vocational education. Whether students' preliminary understandings can become stable occupational problem-solving competence remains to be tested through professional tasks, workplace internships, and longitudinal research.

5.5 Relationship to the Comprehensive Student Evaluation Index System

The course materials provided descriptive evidence concerning the "analysis and problem-solving ability" dimension of the ethically approved comprehensive student evaluation project. Evidence in this paper came from questionnaires, classroom observations, and student learning texts and was used to analyse course implementation and preliminary learning responses. Its role is therefore to describe early student responses rather than to validate the entire evaluation index system. A more complete evaluation of this competency dimension would require performance-based tasks, structured classroom observations, interviews, and evidence from different occupational contexts.

6. Limitations and Directions for Improvement

6.1 Study Limitations

First, the course lasted only 32 hours. It may have helped students understand relevant analytical methods and report preliminary changes, but the available evidence is insufficient to demonstrate that stable critical-thinking ability was developed.

Second, the findings relied mainly on questionnaire self-reports, classroom observations, and student reflections and therefore cannot be treated as equivalent to standardized competence measures (Merriam & Tisdell, 2016). Positive responses may have been influenced by the novelty of the course, instructor effects, or social desirability.

Third, the study did not include a standardized pre-test, post-test, or control group. It is therefore not possible to attribute all reported changes directly to the course or to estimate the magnitude of any change in student ability.

Fourth, all participants came from one college and had been selected for the training program. They may have had relatively strong learning motivation and willingness to participate, creating potential selection bias.

Fifth, the students came from a wide range of programs with different knowledge bases and occupational tasks. The applicability of the course methods to different disciplines requires further investigation.

6.2 Directions for Improvement

Future course development should move from a concentrated training format toward continuous cultivation throughout the talent-development process. First, critical-thinking instruction should be integrated with professional courses by embedding complex-problem diagnostic tasks in foundational courses, practical training, and skills competitions. Second, student problem-solving portfolios should be established by preserving diagnostic worksheets, process records, revised solutions, and reflection reports to observe development over time. Third, authentic enterprise tasks should be introduced, with engineers contributing equipment faults, process-optimization cases, or workflow problems and working with professional teachers to guide analysis, decision making, and evaluation. Fourth, the evaluation system should be strengthened by combining

questionnaires with pre-post measures, classroom observations, assessment of student products, interviews, and workplace performance.

7. Conclusion

This exploratory case study examined the implementation of a 32-hour critical-thinking course centred on the "analysis and problem-solving ability" dimension of a comprehensive student evaluation framework in a transportation vocational college in western China. Organized around Dong Yu's five-step diagnostic method for complex problems, the course combined lectures, case analysis, information verification, group discussion, comparison of alternatives, and reflection. Students' self-reports and learning texts showed preliminary shifts from rapid conclusion making toward information gathering, from single-cause attribution toward consideration of multiple explanations, and from accepting ready-made answers toward forming and revising judgments. In the post-course questionnaire, 41 of 43 respondents reported collecting information before drawing conclusions, 36 reported analysing the underlying nature of problems, and 35 reported considering opposing views and questioning evidence in online information. These results support the feasibility of embedding structured critical-thinking activities in vocational curricula and provide descriptive course-level evidence relevant to student evaluation. However, the study did not estimate causal effects and did not use a validated critical-thinking instrument, matched pre-post data, or a control group. The findings should therefore be interpreted as preliminary evidence of course implementation, student perceptions, and transfer intentions rather than stable or transferable occupational competence. Future research should use larger and more diverse samples, validated measures, performance tasks, structured observations, workplace-related evidence, stronger pre-post designs, and longitudinal follow-up to test whether such learning develops into sustained problem-solving competence.

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