

Development of a Deep Collaborative Learning Strategy to Enhance Critical Thinking Skills of Grade 11 Students in a Culinary Vocational Program

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ABSTRACT

This study aimed to develop a *Deep Collaborative Learning* (DCL) strategy for Food and Beverage Service instruction to enhance the critical thinking skills of Grade XI Culinary Vocational High School students. The study was motivated by the predominance of teacher-centered instruction, students' limited critical thinking abilities, and the insufficient collaboration between teachers and industry partners (Dunia Usaha/Dunia Industri DUDI) in vocational learning. The research employed a Research and Development (R&D) approach by adopting the Borg and Gall model modified by Samsudi. The development process included needs analysis, literature review, product development, expert validation, product revision, and limited implementation. The resulting product was a *Deep Collaborative Learning* Guidebook consisting of six instructional stages: Collaborative Planning, Authentic Industry Problem Orientation, Collaborative Service Practice, Critical Service Analysis, Presentation and Industry Feedback, and Reflection and Service Improvement. The product was validated by instructional experts, subject-matter experts, and hospitality industry practitioners using a five-point Likert-scale questionnaire. Product effectiveness was evaluated through a One Group Pretest-Posttest design involving 35 Grade XI Culinary students. The findings indicated that the developed strategy achieved an overall feasibility score of 94%, categorized as highly feasible. Students' average scores increased from 64.20 on the pretest to 87.50 on the posttest, with an N-Gain score of 0.65, indicating a moderate-to-high improvement in critical thinking skills. In addition to improving critical thinking, the strategy enhanced collaboration, professional communication, problem-solving, and reflective learning through authentic industry-based service scenarios. Therefore, the *Deep Collaborative Learning* strategy fulfills the criteria of being valid, practical, and effective, offering an innovative instructional model for vocational education that aligns with hospitality industry demands and twenty-first-century competencies..

Keywords: *Deep Collaborative Learning, critical thinking skills, food and beverage service, vocational education, Research and Development*

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INTRODUCTION

Vocational education in Indonesia is currently positioned within a vortex of global disruption that demands a fundamental transformation of learning paradigms. As the primary cornerstone for developing a work-ready workforce, Vocational High Schools (Sekolah Menengah Kejuruan/SMK) are obligated to align their learning dynamics with the demands of the Industrial Revolution 4.0 and the Society 5.0 era. In contemporary reality, students are no longer merely required to achieve theoretical mastery or repetitive technical skills; rather, they must possess critical thinking skills, the capacity to solve complex problems independently, creativity, and a high capacity for social adaptation (Hadi et al. 2025). The challenges of the

modern workforce, particularly within the hospitality industry which encompasses the culinary arts specialization, exhibit rapidly shifting trend dynamics. Consequently, formal educational institutions bear a profound responsibility to reorient their learning ecosystems toward cultivating Higher Order Thinking Skills (HOTS) to ensure graduates possess full readiness to respond to workplace uncertainties (Hamzah, Hamzah, and Zulkifli 2022).

This intellectual capacity development orientation serves as a crucial instrument within the Culinary Arts Skill Program. Competence in the culinary field is no longer restricted to the art of food preparation in the kitchen, but covers a much broader spectrum, including operational management, customer satisfaction analysis, professional communication under pressure, multisectoral teamwork, and risk mitigation in real-world services. In this context, Nurjanah, Fitri, and Sa'adah (2024) assert that "collaborative learning establishes a learning environment where two or more individuals learn or attempt to learn something together through mutual interaction and shared responsibility." Through a collaborative approach, students are positioned as active subjects who construct their understanding through social dialectics, negotiation of meaning, and collective problem-solving (Junaidah et al. 2023). For vocational culinary education, collaboration must not be partially understood as mere group work among students; instead, it must be transformed into a systemic collaboration that integrates vocational (productive) teachers, general vocational teachers (languages, entrepreneurship, sanitation), and industrial partners as representatives of authentic labor market needs.

However, empirical insights from the field reveal a distinct gap (gap analysis) between expected competencies and the current reality of classroom learning. Based on a preliminary study and observations conducted with eleventh-grade students of the Culinary Arts Skill Program at SMKN 1 Sawoo, it was revealed that students' critical thinking skills in Food and Beverage Service learning remain relatively low. Daily instructional processes are still heavily dominated by conventional, teacher-centered learning approaches, wherein educators predominantly deliver material through lectures and procedural demonstrations. This condition causes students to consume information passively, resulting in learning that tends to occur at a surface level. Consequently, students focus more on memorizing the sequence of service procedures without fully understanding the underlying rationales, principles, or decision-making processes governing each stage of service according to hospitality industry standards.

Interviews with culinary vocational teachers at SMKN 1 Sawoo further substantiate these findings. The teachers reported that approximately 65% of students still encounter difficulties when prompted to analyze the root causes of service errors, handle customer complaints, or determine appropriate solutions to service issues arising during practical exercises. Furthermore, only about 30% of students actively participate in discussions, express opinions, or provide arguments during the learning process. This scenario indicates that current instructional methods have not fully succeeded in cultivating the critical thinking, problem-solving, and decision-making skills that constitute core competencies in food and beverage service. Therefore, an instructional strategy capable of integrating deep learning with tripartite collaboration among teachers, students, and the Business and Industrial World (Dunia Usaha/Dunia Industri - DUDI) is urgently required so that students obtain a more authentic, contextual, and relevant learning experience.

This situation is further exacerbated by suboptimal curriculum synchronization and a lack of collaboration within the teaching ecosystem. Instructional planning frequently operates in isolation, lacking integrative reasoning between normative-adaptive teachers and vocational teachers. General vocational teachers have not maximally linked business communication or sanitation materials with the tangible challenges students encounter during table service practices. On the other hand, the involvement of the hospitality industry in classroom interventions remains peripheral, limited to providing field industrial practice (PKL) placements without touching upon the design of daily learning syntax that challenges students' critical reasoning. The absence of an integrated strategy that triggers analytical thinking under the pressure of actual working conditions causes students' critical thinking skills to stagnate. Consequently, students become anxious and unprepared when confronted with real-world

industry scenarios, such as handling customer complaints, sudden menu alterations, or managing restaurant service orchestration under strict time constraints.

To overcome this methodological crisis, a pedagogical intervention in the form of a Deep Learning approach integrated with a multisectoral collaborative model has become an absolute urgency. Deep learning in the educational realm is defined as “an approach that emphasizes reflective, meaningful, and profound understanding by integrating three main aspects, namely mindful learning, meaningful learning, and joyful learning” (Hamida, Sein, and Ma’rifatunnisa’ 2022). Through this approach, students are trained not merely to recall facts, but to analyze information deeply, evaluate data validity, link new concepts with prior cognitive structures, and transfer this knowledge into novel and unfamiliar situations (Biggs, Tang, and Kennedy 2022). When the deep learning framework is combined with robust collaborative learning among teachers, industry, and students, it generates a new strategic formulation termed *Deep Collaborative Learning*.

The *Deep Collaborative Learning* strategy projects the formation of an instructional ecosystem that demands both high-level cognitive engagement and sharp social-relational acumen from students (Ilmudinulloh et al. 2025; Masrur and Maghfirah 2025). This strategy is operationally translated into a contextual-vocational learning syntax, which encompasses collaborative planning, authentic industry problem orientation, collaborative service practice, critical service analysis, presentation and industry feedback, and reflection and service improvement (Ejohwomu 2020). Through these stages, students are confronted with authentic hospitality industry problems that lack a single definitive answer, thereby compelling them to optimize all indicators of their critical thinking ranging from problem identification, assumption analysis, and perspective evaluation to drawing conclusions and predicting the implications of service decisions made.

Prior research has provided several empirical justifications regarding the effectiveness of project-based and collaborative components in culinary vocational high schools. For instance, Permata (2023) concluded that the implementation of the Project-Based Learning (PjBL) model integrated with process portfolios proved to exert a significant positive influence on culinary students' critical thinking skills and sense of responsibility. Furthermore, a study by Putri et al. (2021) at SMKN 2 Singaraja demonstrated that restructuring table service instruction through a project-based model was able to radically boost teamwork skills and sharpness in solving restaurant service problems. On the other hand, within the context of deep learning approaches, Maharshall and Nindiasari (2025) successfully proved that Deep Learning consistently enhances students' critical thinking capacities through a series of reflective, analytical, and structured problem-solving activities. Nevertheless, the majority of prior studies have examined these variables in isolation, relied on single-site study designs, and have not yet constructed a tripartite collaboration (vocational teachers, general teachers, and industry practitioners) into a unified deep teaching strategy within food and beverage service competencies.

The holistic integration between the pillars of Deep Learning (meaningful, mindful, joyful) and the vocational collaborative learning architecture involving direct interventions from hospitality/restaurant industry practitioners alongside cross-disciplinary teacher collaboration constitutes the novelty and scientific significance of this study. Furthermore, this study employs a developmental research design at SMKN 1 Sawoo Ponorogo, thereby enabling researchers to conduct an in-depth exploration of the food and beverage service learning process within the Culinary Arts Skill Program. The selection of this research site was based on preliminary study findings indicating a gap between expected critical thinking competencies and classroom instructional practices. Despite possessing adequate practical facilities and partnerships with the Business and Industrial World (DUDI), SMKN 1 Sawoo still faces a primary challenge: students' low critical thinking skills in analyzing service issues, making decisions, and providing solutions to authentic hospitality cases. Therefore, this school is deemed highly representative as a site for developing a *Deep Collaborative Learning* strategy that integrates deep learning, stakeholder collaboration, and industrial contexts to elevate the quality of vocational education.

Based on these premises, this study aims to develop a *Deep Collaborative Learning* strategy for food and beverage service instruction for eleventh-grade students of the Culinary Arts Skill Program at SMKN 1 Sawoo Ponorogo. The initial phase of the research focuses on the strategy development process, which includes needs analysis, literature review, strategy design formulation, and the construction of learning syntax, instructional materials, collaborative activities, and assessment instruments tailored to cultivate students' critical thinking skills. Subsequently, the research evaluates the feasibility of the developed strategy through validation by instructional experts, subject matter experts, and industry practitioners to ensure conformity in terms of content, construct, language, presentation, and implementation feasibility within Food and Beverage Service instruction. The next phase tests the effectiveness of the *Deep Collaborative Learning* strategy through classroom implementation in the eleventh grade of the Culinary Arts Skill Program to measure the improvement in students' critical thinking skills. The outcomes of this study are expected to yield a *Deep Collaborative Learning* strategic product that satisfies the criteria of being valid, practical, and effective, thereby serving as an innovative instructional model for vocational education and providing practical contributions for principals, culinary vocational teachers, and vocational education stakeholders in designing instruction relevant to 21st-century competency demands.

METHOD

This study employed the Research and Development (R&D) method, adopting the Borg and Gall development model as modified by Siregar (2023). This method was selected because the study does not merely aim to generate descriptions of instruction, but to develop an educational product in the form of a *Deep Collaborative Learning* strategy within Food and Beverage Service instruction to enhance the critical thinking skills of eleventh-grade students in the Culinary Arts Skill Program. The developed product was subsequently tested through expert validation, practicality assessments by practitioners, and effectiveness trials via limited classroom implementation. The research procedures were executed in two major phases. The first phase comprised the research stage, which included a literature review, needs analysis, field studies, and an analysis of the factual learning models currently implemented in the Food and Beverage Service course. The second phase involved the development stage, which encompassed the structural design of the *Deep Collaborative Learning* strategy, the formulation of instructional materials, validation by instructional experts, subject matter experts, and industry practitioners, product revision based on validation feedback, and limited-scale effectiveness trials to achieve a viable hypothetical model for classroom application.

The study was conducted at SMK Negeri 1 Sawoo Ponorogo within the Culinary Arts Skill Program during the even semester of the 2025/2026 Academic Year. The site selection was based on the presence of the Food and Beverage Service course, the availability of adequate practical laboratory facilities, and the school's existing partnerships with the Business and Industrial World (DUDI) that support the implementation of the *Deep Collaborative Learning* strategy. The research was carried out from January to June 2026, spanning the preparation stage, product development, implementation, data analysis, and the compilation of the final research report. The research subjects consisted of several distinct groups corresponding to each research stage. In the needs analysis phase, the subjects included culinary vocational (productive) teachers, general vocational teachers, industry practitioners, and eleventh-grade students of the Culinary Arts Skill Program. In the product validation phase, the subjects comprised instructional design experts, Food and Beverage Service content experts, and industry practitioners. Subsequently, during the implementation and effectiveness testing phase, the research subjects were 35 eleventh-grade students of the Culinary Arts Skill Program at SMK Negeri 1 Sawoo who engaged in the instructional process utilizing the developed *Deep Collaborative Learning* strategy.

Data collection was executed using several instruments aligned with the research phases. Interviews were conducted during the needs analysis stage to obtain comprehensive information regarding baseline instructional conditions, strategy development requirements, and the distinctive characteristics of Food and Beverage Service learning. Questionnaires were

utilized to gather product validity data from instructional experts, content experts, and industry practitioners. Observations were performed during the strategy implementation to obtain empirical data regarding the execution of the learning syntax and student activities, while documentation was used to supplement data in the form of instructional materials, photographic records of activities, and other supporting documents. The effectiveness of the strategy was measured through testing, specifically utilizing a pretest and posttest of critical thinking skills before and after the application of the *Deep Collaborative Learning* strategy. The research instrumentation comprised interview guides, expert and practitioner validation questionnaires, instructional execution observation sheets, documentation guides, and critical thinking skills tests. Product validity was evaluated through content validity and construct validity by assessing aspects of content congruence, instructional syntax, the integration of deep learning, collaboration mechanisms, linguistics, and product presentation (Maryam et al. 2026; Purwanti et al. 2026). The assessment utilized a five-category scale ranging from very poor to very good, thereby yielding structured information regarding the feasibility level of the developed product.

Data analysis was carried out in accordance with the characteristics of developmental research. Data from the preliminary study were analyzed descriptively to construct a factual model as the baseline for strategy formulation. Validation data were analyzed through descriptive quantitative analysis using mean scores to determine the product's validity level. Furthermore, implementation data were analyzed by comparing the critical thinking skills pretest and posttest results to evaluate the effectiveness of the developed *Deep Collaborative Learning* strategy. The entirety of the analysis results served as the foundation for iterative revisions until a final product was achieved that satisfied the criteria of being valid, practical, and effective for deployment in Food and Beverage Service instruction.

The research framework of this study is illustrated in the following diagram:

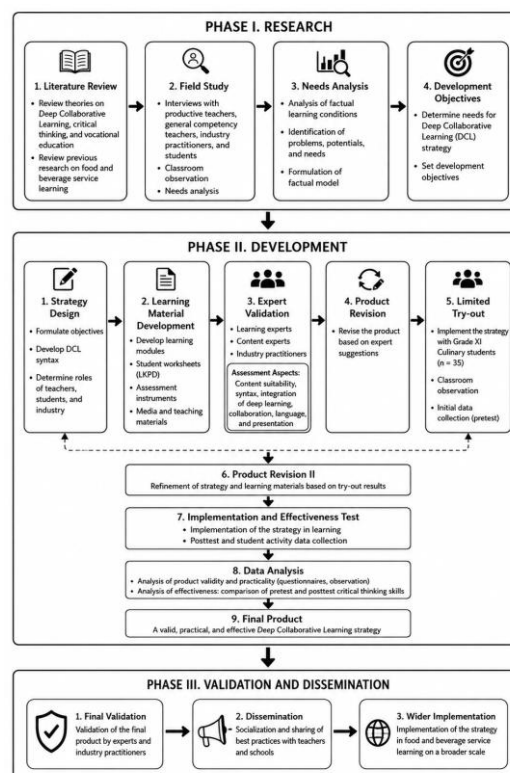


Figure 1. The R&D Research Framework

The final product generated in this study is a comprehensive implementation manual of the *Deep Collaborative Learning* strategy, designed for culinary arts teachers within Food and Beverage Service instruction. This manual encompasses the conceptual framework,

instructional syntax, learning materials, illustrative implementation scenarios, critical thinking skills assessment rubrics, and guidelines for instructional execution and evaluation. By utilizing this manual, teachers are expected to possess a systematic and practical reference to implement the *Deep Collaborative Learning* strategy, thereby rendering the instructional process more structured, collaborative, and effective in cultivating students' critical thinking skills.

RESULT AND DISCUSSION

The Development Process of the *Deep Collaborative Learning* Strategy

This study yielded a final product in the form of the *Deep Collaborative Learning* (DCL) Strategy, which is operationalized within the *Implementation Manual of Deep Collaborative Learning for Food and Beverage Service in the Culinary Arts Skill Program*. The development of this strategy followed the Research and Development (R&D) phases modified from the Borg & Gall model, which was executed through two major phases: the research phase and the development phase (UntoroSeto and Triayudi 2023). The product was meticulously developed based on the needs analysis of teachers, students, and the Business and Industrial World (Dunia Usaha Dunia Industri - DUDI), ensuring that the resulting strategy aligns precisely with the distinctive characteristics of the vocational education context.

The initial phase commenced with a comprehensive needs analysis conducted through classroom observations and structured interviews with vocational (*productive*) teachers, general vocational teachers, industry practitioners, and students. The results of this analysis indicated that food and beverage service instruction was still heavily dominated by demonstration and lecture methods, which restricted students from acquiring critical thinking experiences when encountering real-world service issues. Furthermore, cross-disciplinary collaboration among vocational teachers, general teachers, and industry practitioners had not yet been integrated into a unified, coherent instructional scenario.

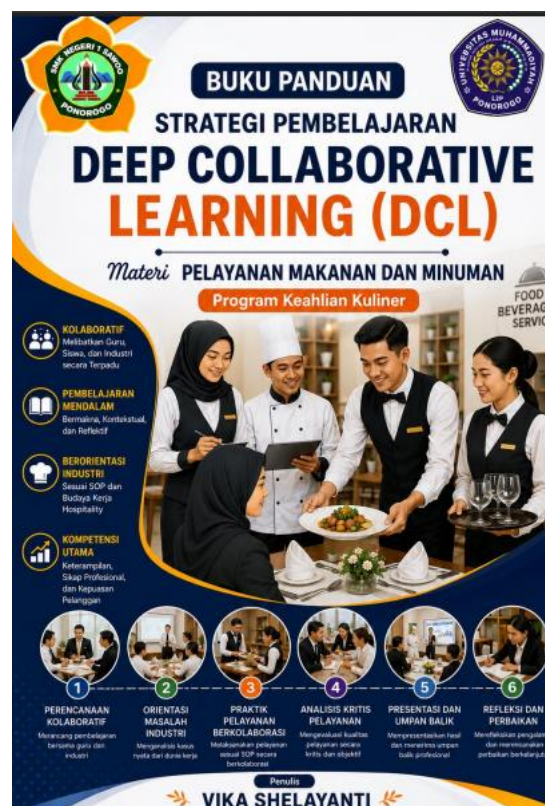


Figure 2. The *Deep Collaborative Learning* Guidebook can be accessed at

<https://drive.google.com/file/d/1VKV569Xi6DJOIf1z9tpD4FKJ4tJBZXA/v/view?usp=sharing>

These findings served as the foundation for designing the *Deep Collaborative Learning* strategy, which integrates the principles of meaningful learning, mindful learning, and joyful learning, as well as collaboration among teachers, students, and industry practitioners. Subsequently, instructional instruments were developed, including an implementation manual, teaching modules, jobsheets, service SOPs, observation sheets, critical thinking assessment rubrics, and reflection tools.

The resulting final product is the *Deep Collaborative Learning* Manual, which encompasses six primary instructional syntaxes, as outlined below:

Table 1. Syntax of the *Deep Collaborative Learning* Strategy

Syntax	Core Activity	Output
Collaborative Planning	Joint planning involving teachers and industry partners	Teaching modules, SOPs, jobsheets
Authentic Industry Problem Orientation	Case analysis of hospitality industry issues	Problem analysis reports
Collaborative Service Practice	Collaborative service execution	Practical performance outcomes
Critical Service Analysis	Service performance evaluation	Analytical reports
Presentation and Industry Feedback	Presentation of practical performance	Industry-vetted feedback
Reflection and Service Improvement	Reflection and follow-up actions	Learning portfolios

These six syntaxes are holistically integrated to form a systematic learning flow, spanning from collaborative planning to continuous reflection. This blueprint aligns with the contents of the DCL Manual, which positions vocational (productive) teachers, general vocational teachers, students, and industry practitioners as collaborative partners throughout the instructional process.

Product Blueprint Specification

The research output is not merely a conceptual framework, but a ready-to-implement educational product tailored for classroom instruction..

Table 2. Product Specifications of *Deep Collaborative Learning*

Product Component	Description
DCL Manual	A comprehensive implementation guide for the instructional strategy
Teaching Module	Case-based modules anchored in the hospitality industry
Service SOP	Operational standards for restaurant table service
Jobsheet	Frameworks for collaborative practical activities
Critical Thinking Rubric	Assessment tools to measure students' analytical capabilities
Observation Rubric	Instruments to track teacher and student engagement
Reflection Instrument	Tools for continuous instructional evaluation

These products are structured to provide teachers with a practical implementation guide to seamlessly integrate deep learning with the rigorous demands of the hospitality industry.

Strategy Feasibility

The product's feasibility was evaluated through validation by instructional design experts, subject matter experts, and industry practitioners utilizing a five-point Likert scale instrument. The evaluation encompassed content congruence, strategy construct, linguistics, presentation, syntax feasibility, and relevance to industrial needs.

Table 3. Expert Validation Results

Validator	Score	Maximum Score	Percentage	Category
Instructional Expert	94	100	94%	Highly Feasible
Subject Matter Expert	92	100	92%	Highly Feasible
Industry Practitioner	96	100	96%	Highly Feasible
Average	94	100	94%	

The percentage calculation was determined using the following formula:

$$\text{Percentage} = \frac{\text{Earned Score}}{\text{Maximum Score}} \times 100\%$$

$$\frac{94}{100} \times 100\% = 94\%$$

The average validation score reached 94%, indicating that the product satisfies the “Highly Feasible” criteria and is ready for classroom deployment following minor revisions. These adjustments included refining the industrial case examples, adding a collaboration observation rubric, and simplifying the linguistic phrasing within the manual.

Strategy Effectiveness

The effectiveness of the strategy was tested through a limited implementation involving 35 eleventh-grade students of the Culinary Arts Skill Program, utilizing a One-Group Pretest-Posttest design in accordance with the research methodology. Prior to the intervention, students were given a critical thinking pretest, followed by six sessions of instruction utilizing the DCL strategy, and concluded with a posttest.

Table 4. Pretest and Posttest Results

Statistic	Pretest	Posttest
Number of Students (n)	35	35
Minimum Score	52	76
Maximum Score	79	96
Mean	64.20	87.50

The results demonstrate a mean score increase of $87.50 - 64.20 = 23.30$. To evaluate the magnitude of this improvement, the *Normalized Gain* (N-Gain) score was calculated

Table 5. N-Gain Calculation

Pretest Mean	Posttest Mean	N-Gain	Category
64,20	87,50	0,65	Medium-to-High

The N-Gain score of 0.65 demonstrates that the *Deep Collaborative Learning* strategy successfully shifts students' critical thinking skills within a medium-to-high improvement category. Beyond the test score gains, classroom observations confirmed that the teacher executed the entire syntax successfully.

Table 6. Strategy Implementation Feasibility

Component	Percentage
Collaborative Planning	95%
Problem Orientation	94%
Collaborative Practice	96%
Critical Analysis	92%
Presentation & Feedback	95%
Reflection	93%
Average	94.17%

The observational data reveal that all operational stages of the strategy were consistently executed in alignment with the blueprint detailed in the manual. Student engagement also increased noticeably, particularly in their ability to identify service discrepancies, articulate arguments rooted in industry SOPs, collaborate effectively within teams, and engage in self-reflection regarding their practical performance. Based on the expert validation results (94%), instructional implementation feasibility (94.17%), and the learning improvement represented by an N-Gain of 0.65, it can be concluded that the *Deep Collaborative Learning* Strategy satisfies the three core criteria of developmental research: validity, practicality, and effectiveness. The final product, the *Deep Collaborative Learning* Strategy Manual, is highly viable as an operational framework for food and beverage service instruction in the Culinary Arts Skill Program and strongly supports the development of students' critical thinking skills to match contemporary industrial expectations.

DISCUSSION

The findings of this study demonstrate that the Deep Collaborative Learning (DCL) strategy offers a novel contribution to vocational hospitality education by systematically integrating deep learning principles, collaborative learning, authentic industry engagement, and reflective practice into a single instructional framework. Unlike previous studies that primarily focused on project-based learning, collaborative learning, or Teaching Factory implementation separately, this study develops a comprehensive six-stage instructional syntax that connects authentic workplace problems with collaborative inquiry, critical reflection, and continuous professional feedback. This integrated framework extends the practical application of constructivist and deep learning theories within vocational education while strengthening the link and match between schools and industry.

The results confirm that the developed strategy satisfies the three essential criteria of educational product development, namely validity, practicality, and effectiveness. The high validation scores indicate that the instructional design is theoretically sound and practically applicable, whereas classroom implementation demonstrates that the strategy effectively improves students' critical thinking skills, collaborative competencies, and professional readiness. These findings support Biggs et al. (2022), who argued that deep learning enables students to construct meaningful knowledge through conceptual understanding and authentic application. Likewise, the improvement in students' learning outcomes indicates that integrating industrial contexts into classroom instruction promotes more meaningful and student-centered learning experiences.

The present findings are generally consistent with previous international studies. Xu et al. (2022) reported that work-integrated learning significantly improves professional competence and workplace readiness, while Bećirović et al. (2022) demonstrated that collaborative learning strengthens teamwork, communication, and academic achievement. Similarly, Alzubi et al. (2024) found that cooperative learning enhances student participation and interaction, whereas Ardito et al. (2020) highlighted its positive impact on collaborative problem-solving. Zhang and Li (2014) also emphasized that interaction quality strongly influences learning outcomes, and Molintas et al. (2023) identified teamwork as a core competence in hospitality education. These studies reinforce the current findings that authentic collaboration and industrial engagement significantly enhance vocational learning quality.

The consistency between the present findings and previous studies can be explained by their shared theoretical foundation in constructivism, authentic learning, and collaborative learning, all of which position students as active participants in constructing knowledge through meaningful experiences. Nevertheless, this study differs from previous research because it integrates deep learning, collaboration, authentic industrial cases, structured reflection, and professional feedback into a unified instructional model. Earlier studies generally examined these instructional approaches independently. Differences in research methodology, vocational context, participant characteristics, industrial involvement, and instructional design may therefore explain the variations reported across previous investigations.

From a theoretical perspective, this study extends Biggs' deep learning framework by demonstrating that meaningful learning can be strengthened through systematic collaboration among vocational teachers, general teachers, students, and hospitality industry practitioners. The findings also enrich vocational education literature by showing that authentic workplace experiences combined with structured reflection encourage the simultaneous development of higher-order thinking skills and professional competence. Therefore, the DCL strategy fills an important gap in vocational education research by providing a validated instructional framework rather than isolated learning activities.

Overall, the findings indicate that the DCL strategy contributes not only to improved academic performance but also to the transformation of vocational learning into a more authentic, collaborative, reflective, and industry-oriented process. These findings are consistent with Indarsih et al. (2026), Chollet and Chollet (2021), Chollet et al. (2022), and Ennis (2015), who concluded that authentic learning environments integrating collaboration, critical thinking,

creativity, and communication effectively prepare students for twenty-first-century workplaces. Consequently, the DCL strategy provides practical guidance for vocational teachers, contributes to curriculum development that strengthens school-industry partnerships, and offers a theoretical foundation for future studies investigating its implementation across different vocational disciplines, educational contexts, and learning outcomes.

The principal novelty of this study lies in the development of the Deep Collaborative Learning (DCL) strategy, which systematically integrates deep learning principles with structured collaboration among vocational teachers, general education teachers, students, and hospitality industry practitioners within a single instructional framework. Unlike previous vocational learning models that mainly emphasize project-based learning, teaching factory, or collaborative learning separately, the DCL strategy combines these elements into six interconnected instructional syntaxes that continuously connect authentic industrial problems, collaborative practice, critical analysis, professional feedback, and reflective improvement. This integrated design represents a new instructional approach for hospitality vocational education by simultaneously promoting critical thinking, collaboration, authentic learning, and industry engagement.

The findings demonstrate that the developed DCL strategy fulfilled the three fundamental criteria of educational product development, namely validity, practicality, and effectiveness. Expert validation showed that the instructional strategy was highly feasible for implementation, while classroom implementation confirmed consistent execution of all instructional syntaxes. Furthermore, students experienced a substantial improvement in critical thinking skills after participating in the DCL learning activities, indicating that integrating authentic workplace problems with collaborative learning creates more meaningful learning experiences than conventional teacher-centered instruction. These findings reinforce the importance of instructional strategies that closely connect vocational education with actual industrial practices.

The present findings are consistent with numerous international studies reporting the effectiveness of deep learning and collaborative learning in vocational education. Biggs et al. (2022) argued that deep learning enables students to develop conceptual understanding and transfer knowledge into unfamiliar contexts. Similarly, Xu et al. (2022) demonstrated that work-integrated learning significantly enhances professional competence and work readiness. Bećirović et al. (2022) found that cooperative learning improves academic achievement, communication, and teamwork, while Alzubi et al. (2024) reported that collaborative learning strengthens student interaction and active participation. Likewise, Ardito et al. (2020) concluded that collaborative instructional design enhances students' engagement and problem-solving abilities. The findings also support Molintas et al. (2023), who emphasized that teamwork constitutes one of the most essential competencies in hospitality education. However, unlike these previous studies, the present research develops and validates a comprehensive instructional strategy that simultaneously integrates deep learning, authentic industrial problems, structured collaboration, and industry participation into one cohesive instructional model.

The similarities between the present findings and previous studies can largely be attributed to the common theoretical foundations of constructivism, authentic learning, and collaborative learning, all of which position students as active participants in knowledge construction. These approaches naturally encourage critical thinking, communication, and problem-solving through real-world learning experiences. Nevertheless, several differences distinguish this study from earlier research. Most previous studies examined either collaborative learning, project-based learning, or work-integrated learning independently, whereas this study combined these approaches into an integrated instructional syntax specifically designed for hospitality vocational education. Furthermore, differences in research context, educational level, industrial involvement, instructional design, and the Research and Development methodology employed may also explain variations in findings across studies.

This study contributes both theoretically and practically to vocational education literature. Theoretically, it extends deep learning theory by demonstrating that meaningful

learning can be strengthened through systematic collaboration involving multiple educational stakeholders and authentic industrial engagement. The study also enriches constructivist perspectives by proposing an instructional framework that explicitly connects reflection, collaboration, and workplace learning. Practically, the developed DCL strategy provides vocational teachers with a validated instructional guide complete with learning syntax, teaching modules, standard operating procedures, assessment rubrics, and reflection instruments that can be implemented consistently in hospitality education.

The findings have important implications for vocational schools, curriculum developers, and educational policymakers seeking to strengthen the link and match between schools and industry. The DCL strategy may serve as an instructional reference for developing industry-oriented learning environments that foster higher-order thinking skills and professional competencies required in the Industry 5.0 era. Academically, the study expands current knowledge regarding the integration of deep learning and collaborative learning within vocational education. Future studies are recommended to implement the DCL strategy across different vocational disciplines, larger participant populations, and diverse educational settings using quasi-experimental or longitudinal research designs. Further investigations may also examine its impact on creativity, communication skills, employability, and long-term workplace performance.

CONCLUSION

This study has successfully developed the Deep Collaborative Learning (DCL) strategy for food and beverage service instruction tailored for eleventh-grade students of the Culinary Arts Skill Program through a Research and Development (R&D) approach, adapting the Borg and Gall model modified by Samsudi. The developed strategy yielded a tangible product in the form of the *Deep Collaborative Learning Manual*, which encompasses six core instructional syntaxes: *Collaborative Planning*, *Authentic Industry Problem Orientation*, *Collaborative Service Practice*, *Critical Service Analysis*, *Presentation and Industry Feedback*, and *Reflection and Service Improvement*. Validation results from instructional design experts, subject matter experts, and industry practitioners demonstrated that the product falls within the "Highly Feasible" category, with an average score of 94%, thereby satisfying content validity, construct validity, and practicality aspects for deployment within vocational food and beverage service instruction.

The implementation of the Deep Collaborative Learning strategy is proven effective in enhancing students' critical thinking skills, as evidenced by the increase in the mean score from 64.20 on the pretest to 87.50 on the posttest, yielding a Normalized Gain (N-Gain) score of 0.65 (medium-to-high category). Beyond upgrading cognitive outcomes, this strategy successfully strengthens collaborative capacity, professional communication, problem-solving skills, and reflective practices through the resolution of authentic cases that involve vocational (*productive*) teachers, general vocational teachers, and the Business and Industrial World (DUDI). Consequently, the Deep Collaborative Learning strategy satisfies the criteria of being a valid, practical, and effective instructional model, and significantly contributes to reinforcing the implementation of vocational education oriented toward contemporary industrial demands and 21st-century competency standards.

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