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A Study on Vocational Competency Diagnosis and Instructional Intervention Based on Learning Profiles

Lu Ke, Dengheng Zheng*, Yuxuan Li

Guangzhou Railway Polytechnic, Guangzhou, China
Email: *zhengdengheng@gtxy.edu.cn

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Abstract

To address issues in vocational education whereby the assessment of students' vocational competence overemphasizes outcomes, the identification of competence deficiencies lacks precision, and the connection between assessment results and instructional adjustments is insufficient, this study constructs student vocational competence profiles based on multi-source learning process data. It characterizes students' vocational competence from five dimensions: knowledge comprehension, task execution, problem-solving, standardized work practices, and collaborative adaptation, and establishes a closed-loop mechanism of "Learning Data—Competence Profile—Diagnostic Analysis—Instructional Intervention—Reassessment". The study selected 48 students enrolled in the core course "Application and Maintenance of Intelligent Warehousing Equipment" in the Railway Logistics Management program at Guangzhou Railway Polytechnic to participate in an 8-week teaching practice. Based on initial profiles, the study identified students' primary competency gaps, implemented differentiated instructional interventions, and continuously adjusted teaching content and training tasks through periodic profile updates. The results showed that all five occupational competency scores improved during the intervention compared with before the intervention ($P < 0.001$). Among them, problem-handling ability increased from 67.41 to 76.44 points, showing the largest change. The compliance rates for all five competencies also improved, with the attainment rate of collaborative adaptation rising from 27.08% to 64.58%, an increase of 37.50 percentage points. The profiling results effectively support the identification of competency gaps and the prioritization of instructional interventions. In the practice of this course, the profiling results provided an actionable basis for identifying competency shortcomings, determining intervention priorities, and dynamically adjusting teaching, helping to promote the shift of occupational competency assessment from outcome judg-

ment to process diagnosis.

Keywords

Learning Profile, Vocational Competencies, Competency Diagnosis, Instructional Intervention

1. Introduction

Vocational education aims to cultivate high-quality technical and skilled professionals. The development of students' vocational competencies serves not only as a key indicator of instructional effectiveness but also as an important reference for optimizing instructional design and providing targeted guidance (Rausch et al., 2024). As the digital and intelligent transformation of industries continues to deepen, the requirements for technical and skilled professionals in the workplace are gradually shifting from the mastery of knowledge and the execution of individual skills toward the comprehensive development of multidimensional competencies, including knowledge comprehension, task execution, problem-solving, standardized operations, and collaborative adaptability (Kiener et al., 2024). In contrast, the current evaluation of vocational students' professional competencies still relies heavily on theoretical exams, practical training scores, and teachers' experiential judgments. While these methods can reflect students' overall learning levels, they struggle to reveal differences among individual students across specific competency dimensions or to identify competency gaps and their underlying causes. In particular, students with similar overall grades may exhibit significant differences in their knowledge bases, operational skills, problem-analysis abilities, and collaborative skills; a single outcome-based evaluation thus fails to provide sufficient grounds for subsequent instructional adjustments (Hartmann et al., 2023). With the widespread adoption of smart teaching platforms, virtual simulation training systems, and project-based learning, students generate vast amounts of recordable and analyzable learning data through test responses, task completion, skill demonstrations, collaborative interactions, and process-based assessments. This provides a new technological foundation for the dynamic characterization and precise diagnosis of vocational competencies (Yu et al., 2020; Noroozi et al., 2022).

Learning profiles can provide a structured representation of students' knowledge, skills, and behavioral characteristics by integrating learning data from multiple sources, offering new analytical tools for identifying individual differences and competency gaps. Although the application of learning profiles has gradually expanded from showcasing learning status and visualizing outcomes to providing personalized learning support, the effective linkage between profile results and instructional decisions still needs improvement, and there remain shortcomings in the use of learning analytics to drive instructional design improvements and

validate their effectiveness (Valle et al., 2021; Paulsen et al., 2024; Drugova et al., 2024). The true value of learning profiles should not be limited to determining a student's current level; rather, it should extend to addressing questions such as which competencies are lacking, what competency types different students belong to, and what targeted instructional measures should be implemented (Wang, 2023; Khor & K, 2024). Based on this, this study centers on vocational competency development. By integrating multi-source learning process data to construct vocational competency profiles, it identifies competency levels, diagnoses gaps, and classifies students. It then translates these diagnostic results into differentiated instructional intervention strategies, forming a closed-loop mechanism of "Learning Data—Competence Profile—Diagnostic Analysis—Instructional Intervention—Reassessment," with the aim of shifting vocational competency assessment from outcome-based judgment to process-based diagnosis and from experience-based judgment to data-driven decision-making, thereby providing a practical model for precision teaching and continuous improvement in vocational education.

2. Construction of a Vocational Competence Diagnostic Model Driven by Learning Profiles

2.1. Logic of Model Construction

Vocational competence is not a simple aggregation of isolated knowledge or skills; rather, it is a comprehensive ability formed through the joint action of multiple elements—such as knowledge understanding, skill application, problem solving, standardized execution, and collaborative adaptation—within specific work tasks and occupational contexts (Yusop et al., 2023; Paeßens et al., 2023). Traditional assessments typically rely primarily on exam scores, practical training outcomes, or instructor evaluations. While these can reflect a student's overall learning performance at a given stage, they struggle to reveal the structural differences among the various dimensions of vocational competence or to track the process of competence development over time (Guo et al., 2024). By aggregating formative data generated during theoretical learning, project tasks, skill practice, situational handling, and collaborative interactions, a learning profile can transform what were previously relatively abstract vocational competencies into observable and comparable competency characteristics, thereby providing a more comprehensive data foundation for vocational competency diagnosis (Ifenthaler & Greiff, 2022). Therefore, the construction of a vocational competency diagnosis model requires moving beyond the approach of judging learning outcomes based on single-instance scores, extending the scope of evaluation from learning outcomes to the structure of competencies and their developmental status.

Based on this understanding, this study centers on the overall closed-loop process of "Learning Data—Competence Profile—Diagnostic Analysis—Instructional Intervention—Reassessment." Within this framework, the stages of competency profiling and diagnosis are further refined into an analytical pathway comprising

"competency decomposition—data collection—profiling generation—diagnostic identification." Based on the vocational competency requirements corresponding to course objectives and typical work tasks, the model decomposes comprehensive vocational competencies into several competency dimensions with clear definitions and observable characteristics, and establishes correspondences between each competency dimension and data from the learning process. Data from various instructional components—including the smart teaching platform, project assignments, practical training exercises, and diverse assessment methods—is standardized and comprehensively analyzed to generate a multidimensional vocational competency profile for each student. Building on this foundation, and by considering competency standards, individual differences, and group performance, the model identifies students' competency levels, areas of strength, and areas of weakness, thereby providing a basis for subsequent student grouping and differentiated instructional interventions.

2.2. Indicators and Data Representation of Vocational Competence Profiles

Vocational competence is highly comprehensive in nature, and its formation depends not only on the mastery of professional knowledge but also on task implementation, problem handling, and occupational behavior. To enable students' vocational competence to be continuously observed and analyzed, and in light of the teaching characteristics of vocational education courses, which are carried by typical work tasks, students' competence performance is characterized from the aspects of knowledge understanding, task execution, problem handling, standardized operation, and collaborative adaptation. Knowledge understanding mainly focuses on students' mastery of professional knowledge, business rules, and fundamental principles; task execution emphasizes the quality and efficiency with which students complete typical work tasks; problem handling reflects students' ability to analyze, judge, and resolve abnormal situations; standardized operation embodies students' awareness of standards, safety, and quality during operational processes; and collaborative adaptation concerns students' communication and cooperation in team tasks as well as their ability to adjust to task changes. The above content does not constitute a closed classification of vocational competence; rather, it provides a relatively stable observational scope for data collection and competence analysis in teaching, and the specific indicators can be appropriately adjusted according to course nature, task content, and job requirements.

The data for vocational competence profiles mainly come from learning records naturally generated in daily teaching processes, rather than from additional independent assessment sessions. Theoretical quizzes, assignments, and classroom exercises can reflect students' degree of understanding of knowledge content; information such as completion quality, operational results, and completion time generated in project tasks and practical training operations can relatively directly present students' level of task execution; judgment and handling performance in ab-

normal situations, comprehensive cases, and practical work orders helps identify differences among students in handling complex problems; and operational process records, teacher evaluations, and system feedback can reflect whether students complete assignments in accordance with standards. For tasks requiring team cooperation, peer evaluations, role performance, and collaboration records can also serve as supplementary information. Compared with merely using overall course scores, such data are closer to students' authentic learning and practice processes and are more conducive to revealing differences in the competence structures of different students. It should be noted that during the intervention period, the indicator system, normalization parameters, and indicator weights used for profile calculation remained unchanged; the adjustment of the collaborative adaptation dimension only involved the implementation frequency and feedback method of peer evaluation activities, and did not change its weight in the competence score, so the pre- and post-test results are comparable.

In actual processing, data from different sources need to be organized and standardized as necessary to reduce the impact of differences in measurement methods. The presentation of profiles also does not pursue an increase in the number of indicators; instead, it emphasizes the ability to relatively stably reflect students' actual state in key vocational competences. After data aggregation, students' relative performance in different aspects can be obtained, and their strengths and weak areas can be judged in light of course objectives and task attainment requirements. The learning profile thus formed is no longer merely a simple summary of learning behaviors but a comprehensive description of students' vocational competence state, providing a relatively clear basis for subsequent competence diagnosis and instructional intervention.

2.3. Generation and Diagnosis of Vocational Competence Profiles

The generation of vocational competence profiles is built upon the organization and standardization of learning process data. Since data generated by different teaching activities differ in dimension, scoring method, and evaluation subject, it is necessary to first convert the raw data onto a unified scale and then aggregate them according to the vocational competences to which they correspond. For the comprehensive score of the i-th student on the j-th vocational competence, it can be shown as:

$$S_{ij} = \sum_{k=1}^{m} w_{jk} x_{ijk}$$

Here, S_{ij} represents the score of the i-th student on the j-th vocational competence, x_{ijk} represents the k-th item of standardized observational data, and w_{jk} represents the weight of that item of data within the corresponding competence, satisfying

$$\sum_{k=1}^{m} w_{jk} = 1$$

The determination of weights should take into account course objectives, the requirements of typical work tasks, and the importance of evaluation indicators, and should not simply be distributed equally according to the quantity of data. By calculating data from aspects such as knowledge understanding, task execution, problem handling, standardized operation, and collaborative adaptation, an individual vocational competence profile for each student can be formed (Figure 1). The profile can be presented in forms such as competence scores, radar charts, and characteristic descriptions. Its purpose is not merely to pursue visual effects, but to preserve the structural differences among different competences, enabling teachers to observe students' competence development status within a certain teaching cycle.

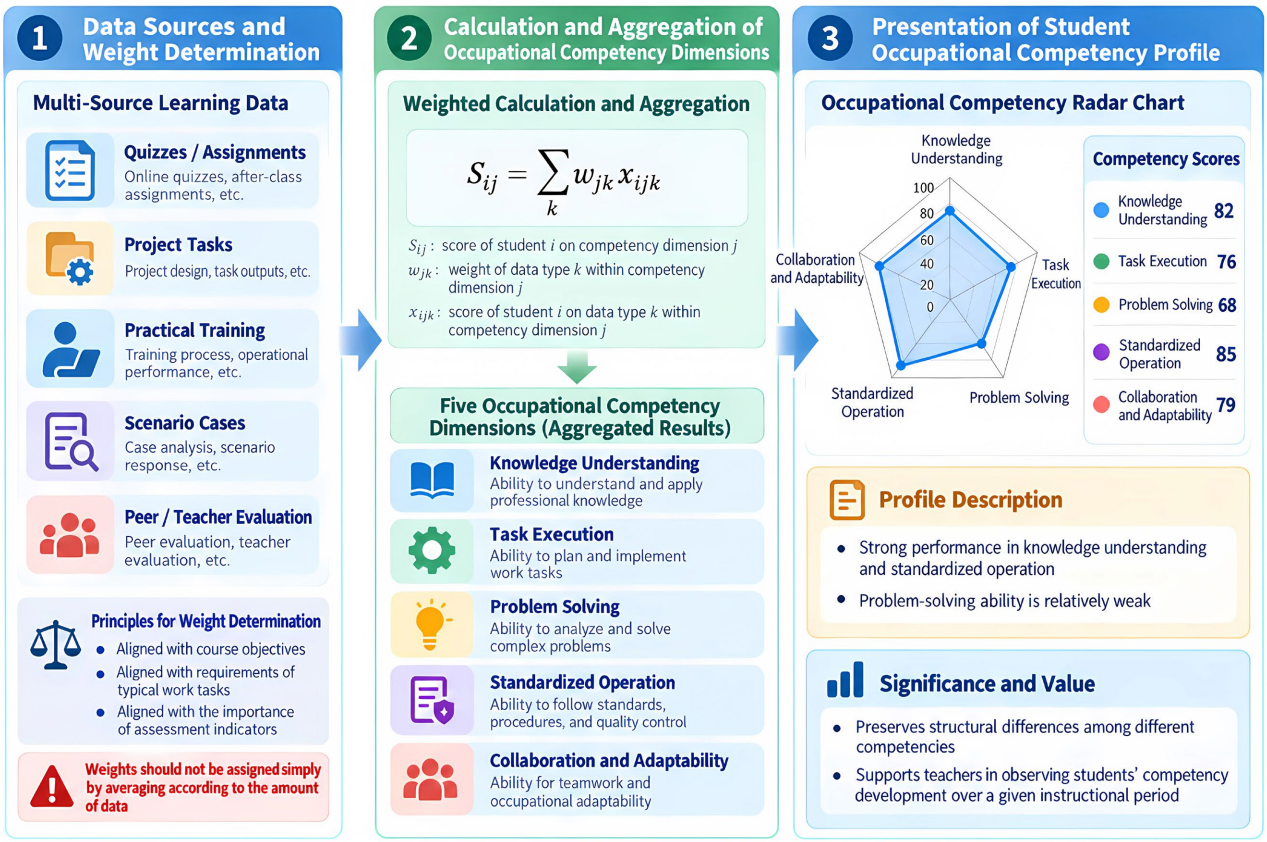

Figure 1. Generation path of student vocational competence profiles.

The diagnosis of vocational competence requires further judgment, based on the profile results, as to whether students have met the expected requirements. Let T_j be the course attainment threshold for the j-th vocational competence; then the diagnostic deviation of a student on that competence can be expressed as:

$$D_{ij} = S_{ij} - T_j$$

When $D_{ij} \geq 0$, it indicates that the competence meets the expected course requirements; when $D_{ij} < 0$, it indicates that the competence still exhibits deficien-

cies to varying degrees. It should be noted that diagnosis cannot rely entirely on fixed scores; it should also be comprehensively judged in light of the relative differences among students' different competences and their stage-by-stage changes. For example, if a student's competences all meet the basic requirements, but their problem-handling competence is noticeably lower than their levels of knowledge understanding and task execution, this competence can still be regarded as an area requiring prioritized improvement in subsequent teaching. Compared with directly classifying students' levels based on overall scores, this analysis can further reveal the imbalanced state within students' vocational competence structures.

At the same time, individual profiles also need to be analyzed within the overall learning state of the class. When a certain competence remains persistently low in only a few students, it is more likely to reflect individual learning differences; if a relatively large number of students in the class perform poorly on the same competence, further attention should be paid to whether problems exist in the design of teaching tasks, the supply of resources, or the organization of teaching itself. Thus, vocational competence profiles can not only describe students' current competence states, but also, through a comprehensive analysis of attainment deviations, individual changes, and group performance, provide a basis for subsequently determining the targets and priorities of instructional intervention. In this way, learning assessment can move beyond the simple presentation of results toward competence diagnosis with instructional orientation.

3. Vocational Competence Diagnosis and Instructional Intervention Based on Learning Profiles

3.1. Identification of Targets and Priorities for Instructional Intervention

Once learning profiles are formed, instructional intervention should not simply stratify students based on overall scores; rather, it should judge their genuine learning needs by integrating the attainment status of each vocational competence dimension, the relative differences among competences, and students' trends of change across different stages. The diagnostic deviation D_{ij} constructed above can reflect the distance between a student's performance on a certain competence and the expected course requirements. When a certain competence remains persistently below the attainment level, it can be treated as a priority target for intervention; for dimensions that have already met the basic requirements but still show a marked gap compared with the student's own other competences, appropriate attention should also be given. As a result, the basis for instructional intervention shifts from a single dimension of high or low scores to an overall analysis of the competence structure, enabling teachers to distinguish between two different types of problems: insufficient overall learning level and imbalanced development of localized competences.

In specific judgment, individual profiles also need to be combined with the overall performance of the class. If deficiencies in a certain competence are mainly

concentrated among a few students, intervention should focus more on individual learning foundations, training intensity, or learning approaches; if the same competence shows low values across a relatively broad range, this may reflect common problems in the design of teaching tasks, the supply of resources, or classroom organization. To enhance the pertinence of intervention, students can be summarized, based on the main weaknesses in their profiles, into different situations such as insufficient knowledge understanding, weak task execution, deficient problem handling, inadequate awareness of standards, and poor collaborative adaptation. Such categorization is not a fixed labeling of students, but a description of their competence state at a specific teaching stage, and its results should be adjusted as the learning process and profile data are updated.

3.2. Differentiated Instructional Intervention Based on Diagnostic Results

The core of instructional intervention lies in enabling diagnostic results to directly act upon teaching content, learning resources, and task arrangements. For students with obvious deficiencies in knowledge understanding, concept comprehension can be strengthened through knowledge point tracing, micro-lecture supplementary learning, rule discrimination, and targeted exercises, so as to prevent gaps in foundational knowledge from further affecting skill operations. Students with insufficient task execution ability are better suited to increased step-by-step demonstrations, operational training, and virtual simulation practice, enhancing operational proficiency and task completion quality through repeated completion of typical work tasks. For students with weak problem-handling ability, merely increasing routine exercises is unlikely to yield noticeable results; instead, abnormal situations, complex cases, and open-ended work orders should be added, guiding them through the complete process of "identifying problems—analyzing causes—proposing solutions—verifying results," so that they gradually shift from procedural operation to situated judgment.

Intervention in standardized operation and collaborative adaptation, meanwhile, needs to be more deeply embedded in authentic or simulated work processes. Insufficient standardized operation ability typically manifests as omissions of key steps, incorrect operational sequences, and inadequate awareness of safety and quality; behavioral standards can be reinforced through comparison with standard operating procedures, reminders at key nodes, and process-based evaluation. For students with insufficient collaborative adaptation ability, opportunities for communication and cooperation can be increased in group projects through role rotation, task collaboration, and peer evaluation, enabling students to develop a sense of teamwork in the process of assuming different job responsibilities. For students whose competences in the profile have all reached a relatively high level, repetitive basic training can be reduced, and comprehensive projects, complex tasks, or extended learning content can be appropriately assigned, so that teaching resources remain matched to students' actual competence levels. Thus, learning

profiles do not directly determine specific teaching methods; rather, they provide evidence-based support for teachers in selecting learning resources, adjusting task difficulty, and changing instructional approaches.

To avoid disconnection between intervention content and students' actual needs, intervention intensity can be determined according to competence gaps. Let I_{ij} be the intervention demand value of the i-th student on the j-th competence, which can be expressed as:

$$I_{ij} = \max\left(0, T_j - S_{ij}\right)$$

Here, T_j is the expected attainment threshold for the j-th vocational competence, and S_{ij} is the student's actual score on that competence. When $I_{ij} = 0$, it indicates that the competence has met the basic requirements; the larger the value of I_{ij}, the more evident the gap between the competence and the expected target, and teaching support and training investment can accordingly be increased. The role of this indicator is not to mechanically determine resource allocation, but to provide a quantitative reference for teachers in identifying the priority order of intervention. Specific teaching arrangements still need to be comprehensively determined in light of task difficulty, students' learning foundations, and course progress.

3.3. Dynamic Feedback after Instructional Intervention

Instructional intervention is not the endpoint of vocational competence diagnosis; its effectiveness also needs to be re-evaluated through subsequent learning data. After completing targeted training, students will generate new learning data in new project tasks, practical training operations, and comprehensive situations. Reincorporating such data into the vocational competence profile allows changes in each competence dimension before and after intervention to be observed. When a previously weak competence shows continuous improvement and gradually meets the expected course requirements, it indicates that the corresponding intervention has achieved a certain effect; if a certain competence shows no marked improvement over a long period, further analysis is needed to determine whether the problem stems from the intervention approach, task difficulty, or individual differences among students, and teaching arrangements should be adjusted accordingly.

To reflect competence changes before and after instructional intervention, the change in a student's performance on a certain vocational competence can be used for description:

$$\Delta S_{ij} = S_{ij}^{post} - S_{ij}^{pre}$$

Here, S_{ij}^{post} and S_{ij}^{pre} respectively represent the scores of the i-th student on the j-th vocational competence before and after instructional intervention. When $\Delta S_{ij} > 0$, it indicates that the competence has improved after intervention, and its value can be used to observe the degree of improvement in different competence dimensions. In actual evaluation, interpretation should also be combined with the

overall changes of the class, students' individual growth trajectories, and specific task performance, so as to avoid judging the effectiveness of intervention solely on the basis of a single pre-test and post-test difference.

Through the continuous updating of profiles, vocational competence assessment shifts from a one-time judgment of status to dynamic feedback that runs throughout the teaching process. Teachers can re-identify weak areas based on the new profiles and adjust subsequent teaching content and training tasks, while students can also intuitively understand their own competence structure and changes. In this way, the overall logic of "learning data—competence profile—diagnostic analysis—instructional intervention—reassessment" can operate continuously in real teaching processes, so that vocational competence assessment no longer remains at the level of recording results, but gradually transforms into a process-oriented tool that supports instructional adjustment and students' competence development.

4. Teaching Practice and Analysis of Intervention Effects

4.1. Teaching Practice Design

To examine the application effects of learning profiles in vocational competence diagnosis and instructional intervention, a teaching practice was carried out in the core course "Application and Maintenance of Intelligent Warehousing Equipment" for the Railway Logistics Management major at Guangzhou Railway Polytechnic, with 48 students from the same administrative class as the research subjects and a practice period of 8 weeks. Course teaching was mainly carried by typical work tasks and project training, and process data generated by students in knowledge learning, task completion, situational handling, standardized operation, and collaborative interaction were continuously collected in combination with the smart teaching platform, the practical training system, and classroom evaluation records. Vocational competence profiles were then generated according to the five aspects determined above: knowledge understanding, task execution, problem handling, standardized operation, and collaborative adaptation. Each competence dimension was scored on a 100-point scale, and 75 points was set as the basic attainment threshold, which served as the reference standard for identifying students' competence weaknesses and determining the focus of subsequent intervention.

Before the implementation of instructional intervention, an initial vocational competence profile was formed based on students' prior learning data (**Figure 2**). The results showed that the average scores of the five competences—knowledge understanding, task execution, problem handling, standardized operation, and collaborative adaptation—were 73.41 ± 5.94, 71.91 ± 7.80, 67.41 ± 9.35, 76.10 ± 7.07 and 71.51 ± 7.40, respectively. Among them, problem handling had the lowest average score, 8.69 points lower than standardized operation and 6.00 points lower than knowledge understanding. According to the 75-point attainment

standard, 19 students met the requirement for knowledge understanding, accounting for 39.58%; 16 students attained the standard for task execution, accounting for 33.33%; only 10 students attained the standard for problem handling, accounting for 20.83%; 25 students attained the standard for standardized operation, accounting for 52.08%; and 13 students attained the standard for collaborative adaptation, accounting for 27.08%. The initial profile indicated that there were obvious differences in the development of the class's students across the five vocational competences. In particular, in terms of problem handling and collaborative adaptation, the number of students who did not meet the standard reached 38 and 35, respectively, making these the areas requiring key attention in subsequent instructional intervention. The relevant framework is shown in Figure 2.

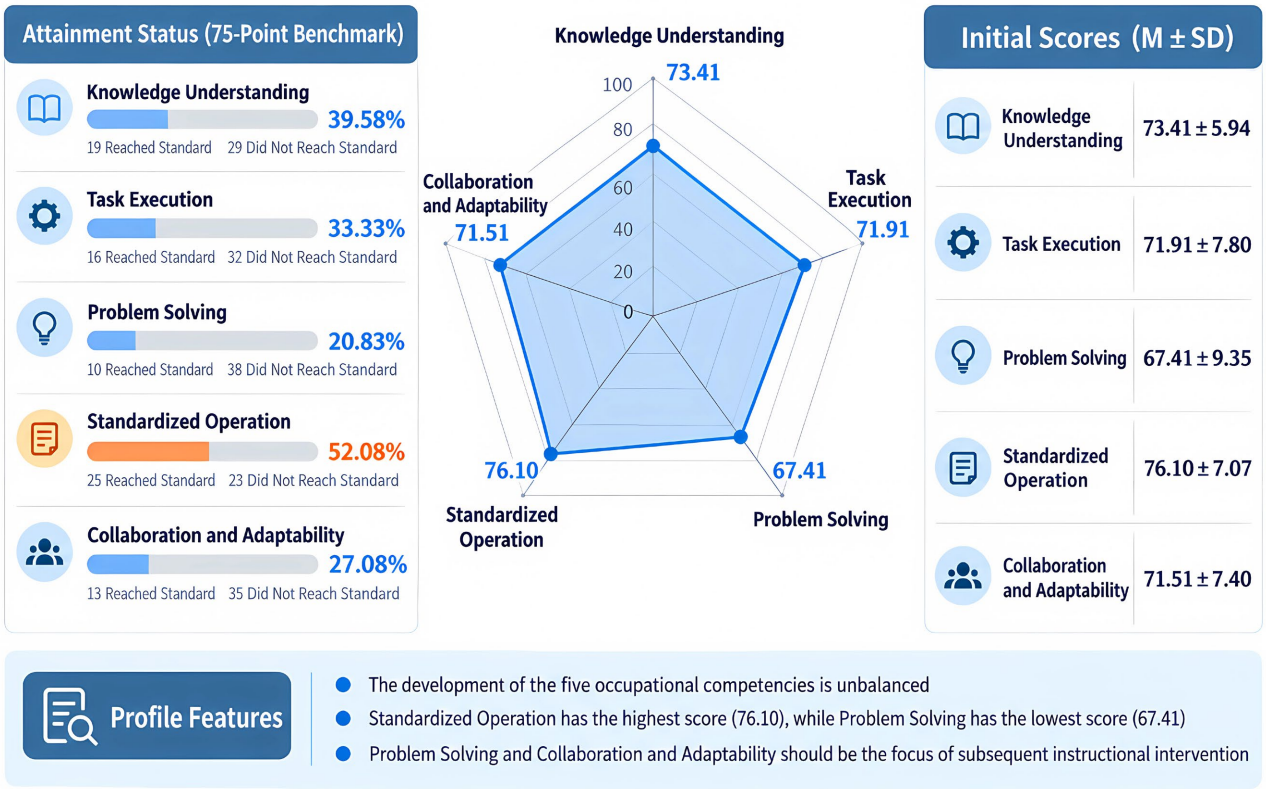

Figure 2. Initial vocational competence profiles of students before instructional intervention.

4.2. Implementation of Instructional Intervention and Profile Updating

Based on the initial vocational competence profiles and the gaps between each dimension and 75-point attainment threshold, students' main weak competences were identified. Considering that some students may have multiple competence weaknesses simultaneously, instructional intervention did not directly classify students according to the number of those failing to meet the standard for a single item; instead, the dimension with the largest gap from the attainment threshold and the weakest performance in the individual competence structure was deter-

mined as the main direction of intervention. Among the 48 students, 9 had knowledge understanding as their main weak item, 8 had task execution as their main weak item, 14 had problem handling as their main weak item, 5 had standardized operation as their main weak item, and 9 had collaborative adaptation as their main weak item. The remaining 3 students had all five competences meeting or approaching the course requirements, and were mainly assigned extended learning tasks. This classification was used only to determine the focus of phased teaching support and did not serve as a fixed label for student types; it was subsequently adjusted dynamically according to changes in the profiles.

In response to different competence weaknesses, instructional intervention was embedded in the normal course implementation process. For students weak in knowledge understanding, the focus was on increasing the tracing of key knowledge points, rule discrimination, and targeted quizzes, with two sessions of targeted learning and feedback arranged each week. For students weak in task execution, task decomposition, operational demonstrations, and virtual simulation training were increased, with two reinforcement tasks matching course progress completed each week. For students weak in problem handling, who were the key targets of this round of intervention, two abnormal-situation cases and one comprehensive work order were added each week, requiring students to complete problem identification, cause analysis, solution selection, and result review. For students weak in standardized operation, operational standards were reinforced through standard operating procedure checklists, key-step inspections, and immediate teacher feedback. For students weak in collaborative adaptation, role rotation, task collaboration, and peer evaluation were implemented in group projects. For the 3 students with a relatively solid competence foundation, repetitive basic training was reduced, and comprehensive projects and higher-difficulty tasks were arranged to maintain a match between task requirements and students' competence levels. The corresponding instructional intervention arrangements for the different competency weaknesses are summarized in Table 1.

Table 1. Instructional intervention arrangements for different vocational competence weaknesses.

Main Weak Competence	Number of Students	Main Intervention Content	Implementation Method
Knowledge understanding	9	Knowledge tracing, rule discrimination, targeted quizzes	Twice-weekly supplementary learning and feedback
Task execution	8	Task decomposition, operational demonstration, reinforcement training	Two training tasks per week
Problem handling	14	Abnormal cases, situational simulation, comprehensive work orders	Two cases + one comprehensive task per week

Continued

Standardized operation	5	SOP comparison, key-step inspection, immediate feedback	Embedded in each practical training task
Collaborative adaptation	9	Role rotation, group collaboration, peer evaluation	Embedded in group projects
Extended enhancement	3	Comprehensive projects, open-ended tasks	Arranged according to teaching progress

Instructional intervention was not completed in a single instance. However, vocational competence profiles were continuously updated as learning data accumulated (Figure 2). During the 8-week teaching practice, the first two weeks mainly involved initial data collection and profile generation, differentiated instructional intervention was implemented from weeks 3 to 7, a phased profile update was conducted in week 5, and the post-test and final profile generation were completed in week 8. The phased update showed that after the first half of the intervention, the class average scores for knowledge understanding, task execution, problem handling, standardized operation, and collaborative adaptation increased from 73.41, 71.91, 67.41, 76.10, and 71.51 to 75.62, 73.84, 71.56, 78.43, and 74.12, respectively. Among them, problem handling improved by 4.15 points but remained below the 75-point attainment threshold; therefore, abnormal work orders and complex situational tasks continued to be added in subsequent teaching. Collaborative adaptation improved by 2.61 points, but some students still exhibited insufficient role participation; thus, the frequency of role rotation and the proportion of peer evaluation were further increased. The classification results are presented in Figure 3.

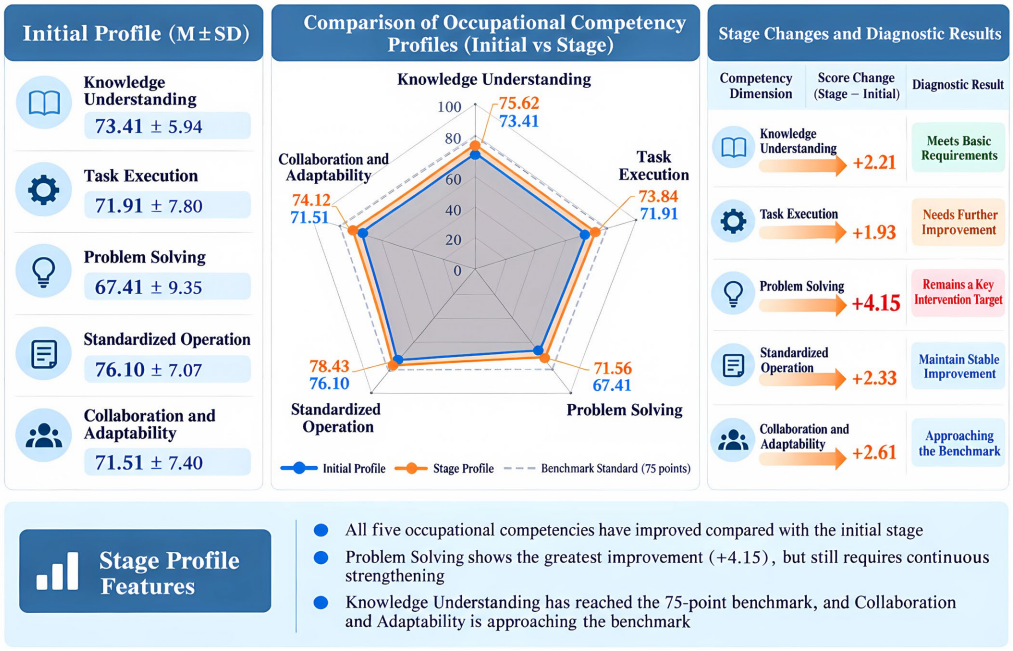

Figure 3. Phased updating results of vocational competence profiles during the teaching process.

Profile updating was used not only to observe overall changes in the class, but also to adjust the intervention focus for individual students. For example, some students had already met the course requirements in knowledge understanding, but their task execution remained below the attainment threshold; their subsequent learning focus therefore shifted from knowledge remediation to operational training. Some students who were weak in problem handling showed marked score improvement after the earlier training, but standardized operation emerged as a new relative weakness; accordingly, repetitive abnormal-situation training was reduced, and standard procedures and key-node inspections were increased. Thus, vocational competence profiles were no longer a one-time diagnostic result obtained before teaching began, but a dynamic basis continuously revised along with the learning process, enabling teaching support to be adjusted according to changes in students' actual competences. Through phased profile updating, the teaching process formed a continuous feedback loop of "diagnosis—intervention—updating—readjustment." Compared with implementing uniform teaching based on overall scores, this approach can more specifically determine which competence teaching support should focus on, what form of tasks should be adopted, and when the intervention focus should be adjusted. It also provides relatively complete process evidence for subsequently comparing changes in vocational competence before and after intervention.

4.3. Analysis of Intervention Effects

After the 8-week teaching practice, students' scores on the five vocational competences were recalculated according to the same evaluation criteria used in the initial assessment, and a paired sample t-test was used to compare the changes before and after the intervention (**Figure 3**). The results showed that all five competences—knowledge understanding, task execution, problem handling, standardized operation, and collaborative adaptation—improved to varying degrees, and all pre-post differences reached a significant level ($P < 0.001$). Among them, problem handling increased from 67.41 to 76.44 points, with an average increase of 9.03 points, a greater improvement than that of the other competence dimensions; collaborative adaptation, knowledge understanding, and standardized operation increased by 5.55, 5.36, and 5.13 points, respectively, while task execution increased by 4.97 points. In combination with the phased profile at week 5, it can be seen that problem handling increased from the initial 67.41 to 71.56 points, and further rose to 76.44 points after subsequent intensified training with abnormal situations and comprehensive work orders, indicating that sustained situational training could effectively respond to the competence weaknesses identified in the initial profile. The implementation process is illustrated in **Figure 4**.

Comparing average scores alone is insufficient to determine whether students' overall competencies meet the course requirements; therefore, further statistical analysis was conducted to assess competency attainment using a 75-point threshold. Following the intervention, the number of students meeting the standards

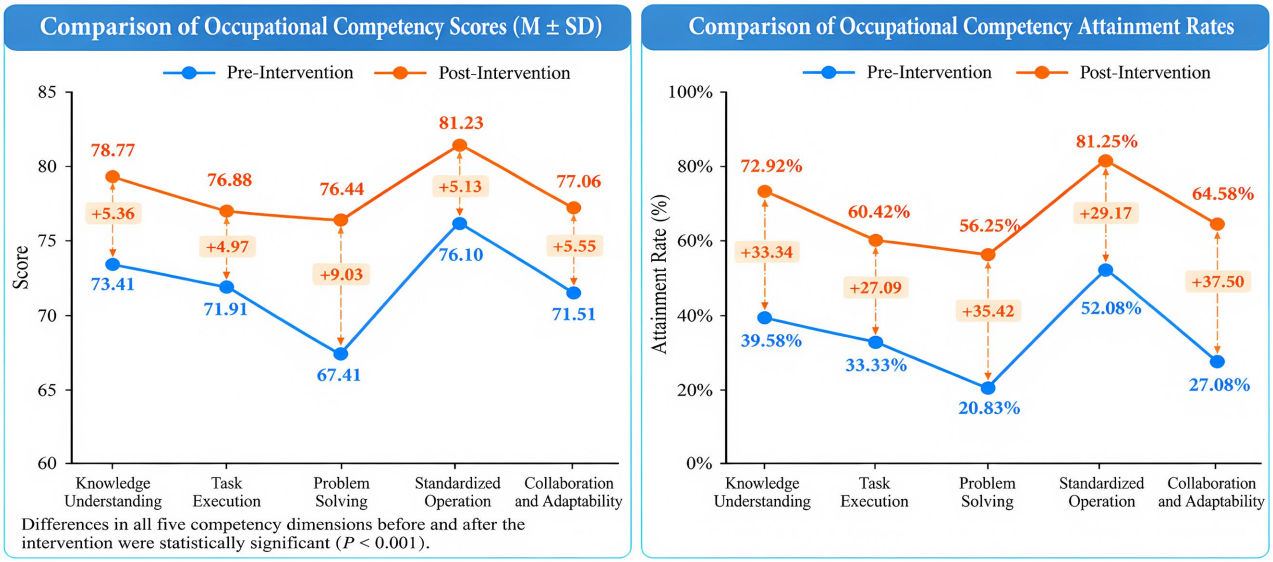

Figure 4. Comparison of vocational competence scores and attainment before and after instructional intervention.

for all five vocational competencies increased. Specifically, for "Knowledge Comprehension," the number of students meeting the standard rose from 19 to 35, and the attainment rate increased from 39.58% to 72.92%; task execution rose from 33.33% to 60.42%; problem handling increased from 20.83% to 56.25%; standard procedure compliance rose from 52.08% to 81.25%; and collaboration and adaptability increased from 27.08% to 64.58%. In terms of the magnitude of change, the compliance rates for "Collaborative Adaptation" and "Problem Handling" increased by 37.50 and 35.42 percentage points, respectively, which is largely consistent with the focus of the intervention on team collaboration, judgment in complex situations, and handling of abnormal tasks during the teaching process. Looking at the structural changes in the final competency profile, the gaps between students' vocational competencies have narrowed. At the class level, the range of the mean scores of the five competencies narrowed from 8.69 points before the intervention (76.10 - 67.41) to 4.79 points after the intervention (81.23 - 76.44). This indicator reflects the dispersion of class means across the five competencies, indicating a certain reduction in the overall disparity among competencies. The changes did not manifest as synchronous, equal-magnitude growth across all five competencies; rather, the initially weaker competencies showed more pronounced improvement, with the enhancement in problem-handling ability being particularly notable. This demonstrates that learning profiles can reveal relative weaknesses in students' competency structures beyond their overall grades, enabling teaching resources and training tasks to be directed more specifically toward the competency areas requiring reinforcement.

It should be noted that although the average scores for problem-solving and task completion after the intervention exceeded 75 points, the corresponding pass rates were only 56.25% and 60.42%, respectively. This indicates that an improvement in the class average does not mean that all students have met the course

requirements; there are still relatively significant differences among individual students. This further illustrates that the assessment of vocational competencies cannot rely solely on class averages but must continue to utilize individual student profiles and implement dynamic diagnostics. Overall, following the instructional intervention, positive changes were observed in the students' five vocational competencies in terms of average scores, compliance rates, and competency structure. It also preliminarily shows that the "learning data—competence profile—diagnostic analysis—instructional intervention—reassessment" mechanism is operable in this course; however, its generalizability still needs to be tested in more courses and over longer periods.

5. Conclusion

This study addressed the challenges of accurately identifying students' vocational competencies in vocational education and the lack of alignment between evaluation results and instructional adjustments. It established a closed-loop mechanism comprising "learning data—competence profile—diagnostic analysis—instructional intervention—reassessment" and validated its effectiveness through practical course implementation. The findings indicate that competency profiles can clearly illustrate the structure of students' vocational competencies and their dynamic changes, providing data-driven support for identifying competency gaps and implementing differentiated instruction.

1) Learning profiles enhance the precision of vocational competency diagnosis. By examining dimensions such as knowledge comprehension, task execution, problem-solving, adherence to standards, and collaborative adaptation, they overcome the limitations of single-metric assessment, enabling a more intuitive identification of students' strengths and weaknesses across different competencies and providing a basis for subsequent instructional interventions.

2) During the intervention, all five occupational competencies improved compared with before the intervention ($P < 0.001$), with problem-handling ability increasing from 67.41 to 76.44 points, the largest change. Because no control group was set, these changes can only be regarded as improvements observed during the intervention and cannot yet be attributed solely to the profile-driven teaching intervention.

3) Dynamic profiling helps ensure that assessment results continuously inform instructional improvements. Periodic updates to the profiles enable instructors to promptly adjust resources, assignments, and instructional priorities based on changes in students' competencies, thereby shifting vocational competency assessment from merely recording outcomes to process-based diagnosis and dynamic feedback. Further validation of its stability and applicability is needed across a wider range of majors, courses, and longer instructional cycles.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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