

Design and Practice of Integrating Industry Cases into the Teaching of Big Data Courses in Higher Vocational Education

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Abstract: To address the weak connection between technical knowledge and application contexts in big data courses at higher vocational colleges, as well as students' limited ability to analyze continuous data and complex operations as a whole, a vessel navigation data monitoring case was adapted for teaching and incorporated into the course Big Data Analysis and Development. Tasks involving position determination, trajectory storage, stateful processing, and the presentation of status information guided students through requirements interpretation, solution comparison, program implementation, debugging and refinement, and improvement of project outcomes. In classroom implementation, the adapted industry case provided a constrained application context for technical learning and prompted students to make technical choices based on timeliness, data continuity, and programming conventions. Through teaching activities covering single-point position determination and continuous trajectory analysis, comparison between offline and stream processing approaches, program implementation, and result presentation, this paper summarizes methods for adapting industry cases for teaching, organizing progressive tasks, assessing process evidence, and defining instructional boundaries. The study provides a reference for reforming practice-oriented big data courses in higher vocational education.

Keywords: Industry Cases; Higher Vocational Education; Big Data Courses; Project-based Teaching; Stream Processing.

1. Introduction

Practice-oriented big data courses in higher vocational education need to connect technical learning with occupational tasks and application contexts. Constructive alignment coordinates intended learning outcomes, learning activities, and assessment tasks and has been applied in information systems course design [1]. Research on authentic learning indicates that realistic materials and tasks need to be deliberately designed around specific learning purposes and implementation conditions [2]. Meta-analytic evidence also shows that project-based learning can support academic achievement, although its effects depend on the characteristics of the learners, disciplines, and projects [3]. Studies in engineering and programming education further demonstrate that authentic project tasks can connect technical learning with solution design, implementation, reflection, and

outcome presentation [4-5]. Big data teaching based on transportation data similarly illustrates the value of placing data processing and analysis within a concrete application context [6]. Therefore, introducing appropriately adapted industry cases into a course can connect course knowledge, workplace tasks, and vocational competence.

Introducing an industry case into the classroom does not mean transferring an enterprise project directly into teaching. Real-world projects often involve large datasets, complex business rules, long development cycles, sensitive data, and industry security requirements. Without pedagogical adaptation, students may merely imitate code, while teachers may find it difficult to organize a complete learning process within limited class time. Conversely, if a case is reduced to demonstration material, the industry context serves only as an introduction, and students cannot experience the full process of requirements analysis, solution selection, troubleshooting, and result interpretation.

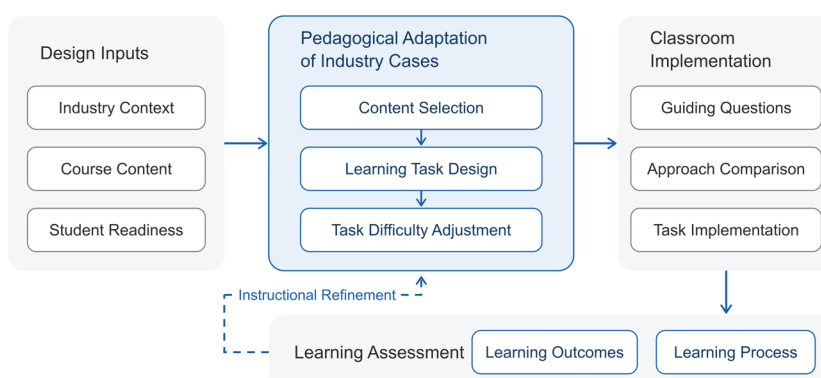


Figure 1. Framework for the Pedagogical Adaptation and Classroom Implementation of Industry Cases

Based on these considerations, this paper presents an industry-case instructional design for the core course Big

Data Analysis and Development in the Big Data Technology program. The course covers data acquisition, cleaning,

analysis, stream processing, and application development. Students have prior knowledge of Java, Linux, and databases; however, when first encountering distributed components and stream processing frameworks, they still experience difficulties with continuous data processing, state management, and program debugging. Accordingly, vessel navigation data monitoring was selected as the industry context, and position determination, trajectory storage, and state analysis were transformed into teaching tasks. This paper analyzes case content selection, task organization, classroom implementation, learning assessment, and learning support, and summarizes basic methods for adapting industry cases for teaching. Relevant business conditions were appropriately simplified for instructional purposes.

The overall framework for the pedagogical adaptation and classroom implementation of industry cases is shown in Figure 1.

2. Pedagogical Adaptation of the Industry Case

2.1. Aligning the Industry Case with Course Content

Integrating an industry case into a course requires selecting and simplifying business materials according to the course content rather than reproducing an entire industry system. Big Data Analysis and Development covers data reading, stream processing, state management, and result presentation. Vessel navigation data include fields such as vessel identifier, position, speed, course, and time, providing a coherent application context for these topics. Task-relevant fields and sample data were selected, while conditions such as geographic scope and trajectory status were appropriately simplified, enabling students to conduct data analysis and

program development after understanding the basic business requirements.

The selection and adaptation of case content considered three aspects. First, the problems had to align with the course objectives and support its principal knowledge and skills. Second, the difficulty had to be appropriate: data volume, number of fields, and program complexity needed to match students' prior knowledge and the available class time. Third, the scope of application had to be clarified, as the decision conditions used in class were intended primarily for instructional practice. This approach preserved the practical context of the industry case while ensuring that the teaching tasks could be implemented effectively in class.

2.2. Defining the Course Learning Objectives

The learning objectives were integrated around the outcomes that students should demonstrate after completing the industry tasks. Three interrelated objectives were defined in terms of conceptual understanding, solution implementation, and development conventions: understanding the basic principles of organizing data streams by business identifiers, managing computational state, and processing continuous trajectory data; comparing processing approaches according to timeliness and historical-information requirements and completing data partitioning, state management, and result output; and organizing data types according to programming conventions, checking programs using runtime information, and explaining the reasons for technical choices and solution adjustments. These objectives integrate what students should know, what they should be able to accomplish, and how they should complete the tasks in a standardized manner.

2.3. Designing Progressive Teaching Tasks

Table 1. Progressive Teaching Task Design for the Industry Case

Teaching task	Main question	Core technologies	Learning outcome
Position determination	How can data points within a predefined area be identified?	AIS field reading, conditional logic, and organization by vessel identifier	Back-end status messages or front-end annotation results
Trajectory analysis	How can determination reliability be improved when one position point in a trajectory is clearly displaced?	Time information, continuous data, and trajectory organization	Description of the trajectory-processing approach and decision conditions
Approach selection	How can historical information over a period of time be retained and processed?	Database queries, stream processing, and state management	Comparison record of offline and stream processing approaches
Stream processing	How can continuously arriving trajectory data be processed?	Data partitioning, state management, and time handling	Executable program, runtime records, and debugging notes
Result presentation	How can processing results be made easy to understand and verify?	Output organization, visualization, and result explanation	Runtime results, visualization pages, and project presentation

The tasks followed a cognitive progression from identifying phenomena and analyzing problems to comparing solutions, implementing programs, and presenting results. Students first made basic determinations using individual position points. They then examined continuous trajectories, analyzed the limitations of relying on a single position point, and discussed how historical information should be retained and processed. After comparing offline and stream processing approaches, they implemented the selected approach and presented the results. Rather than listing knowledge points in parallel, each task used the questions or needs arising from

the preceding task to initiate the next one, gradually increasing technical difficulty, cognitive demands, and expected learning outcomes. The teaching task design is shown in Table 1.

3. Classroom Implementation of the Industry Case

Classroom implementation of the industry case consisted mainly of problem guidance, comparison and application of solutions, and process guidance. Problem guidance

transformed existing learning outcomes into starting points for further inquiry. Solution comparison and application helped students select a technical approach according to task conditions and translate it into a program. Process guidance supported students in independently identifying, analyzing, and solving problems during implementation. These three interconnected elements formed the basic framework for classroom implementation.

3.1. Guiding and Analyzing Classroom Problems

The class began by reviewing the completed position-determination task. Different groups presented two forms of work. One displayed status information such as vessel identifier, latitude, longitude, and time in the program terminal; the other added front-end visualization to mark vessels that met the instructional conditions and display relevant fields. Instead of immediately deciding which form was better, the teacher guided students to compare their intended audiences: terminal output facilitates development and debugging, whereas visualized results are easier for users to observe. The differences between the works thus became material for discussing result presentation and user needs.

On this basis, the teacher presented a trajectory sample containing a clearly displaced position record. Students were guided to reflect on the limitations of making a determination from only one position point, analyze how positional data errors could affect the result, and recognize the role of continuous trajectory information in data analysis. The classroom question consequently shifted from whether a particular point met a condition to how a trajectory over a period of time should be retained and processed. This transition made the outcome of the preceding task the starting point of the next and connected new knowledge naturally with students' prior learning experience.

3.2. Comparing and Applying Data Processing Approaches

To address the retention and processing of historical trajectory information, students compared two approaches: offline processing and stream processing. The former stores data in an external storage system such as a database before querying and analyzing it as needed. The latter uses a stream

processing framework to perform stateful processing on continuously arriving data, retaining the trajectory information required during computation and updating the processing result as new data arrive. The teacher guided students in comparing the timing of processing, response speed, and uses of historical data so that they could understand the characteristics and applicable conditions of each technical approach.

The two approaches are not mutually exclusive. When timeliness requirements are modest and data need to be retained for a long period or queried in complex ways, storing data before analysis offers certain advantages. When a task emphasizes timely processing of continuously arriving data, stream processing is more suitable. Through this comparison, students were guided to justify their technical choices in terms of data arrival patterns, processing timeliness, and information use rather than treating a particular tool as a fixed answer.

After comparing the approaches, students translated their selected processing approach into an executable program, completing data partitioning, retention of historical information, temporal control, and result output for continuous trajectory processing. Flink can process continuously arriving records on a per-vessel basis using vessel identifiers and maintain the state information required for trajectory processing [7-8]. Rather than teaching framework interface calls as isolated knowledge points, the course guided students to understand the relationships among data organization, processing sequence, and task requirements.

Program implementation also required students to organize vessel identifiers, positions, times, and other data according to task needs and to maintain consistency among data definitions, processing logic, and result presentation. Through solution descriptions, code inspection, and runtime results, the teacher guided students in determining whether their programs accurately reflected the selected approach. In this way, project practice produced not only code artifacts but also a better understanding of the basic logic and development conventions of stream processing.

3.3. Process Guidance During Task Implementation

Table 2. Classroom Problems and Instructional Support

Classroom problem	Teacher support	Key student activities
Displaced position data affect the determination result	Present a trajectory and question the basis for determination	Analyze the limitations of single-point determination and propose a continuous-trajectory processing approach
How should historical information be retained?	Organize a comparison between offline and stream-processing approaches	Explain the approach in terms of timeliness and data flow
Program output differs from expectations	Guide troubleshooting based on the workflow, logs, and output	Explain problem localization, the basis for modification, and the verification process
Different forms of result presentation	Compare the audiences for terminal output and visualization	Improve field display and result explanation

During task implementation, program debugging was treated as a routine part of application development. Students were guided to conduct self-checks based on the task workflow, runtime logs, data structures, and output results. Groups exchanged troubleshooting approaches, while the teacher used follow-up questions to help them explain the

location of a problem, the basis for a modification, and the verification result.

The teacher observed whether students could identify causes from runtime behavior, adjust their solutions using relevant information, and verify the effects of their modifications. Debugging records, modification notes, and

verification results were included in the task requirements, shifting program debugging from teacher-provided corrections to student-led troubleshooting. After completing the task, students demonstrated the main processes of data processing, program execution, and result output, and submitted their code, runtime results, and brief explanations through the learning platform. Classroom problems, teacher support, and key student activities are shown in Table 2.

4. Learning Assessment and Support

Learning through an industry case should not be assessed solely on whether the final program runs. Project-based assessment can provide evidence of student performance through work completed in authentic tasks and can serve as an alternative to examination-based evaluation [9]. Assessment should also address the processes through which students understand the task, select an approach, implement the program, and present the outcome. Requirements analysis, solution design, program implementation, debugging and

improvement, and outcome presentation were included in the assessment, with solution descriptions, code versions, runtime records, test results, and project presentations retained as learning evidence. For group tasks, students also explained their individual responsibilities and main implementation ideas. The teacher examined their work and communicated with them in class to determine their understanding of the task requirements and technical approach.

Course assessment consisted of process assessment and outcome assessment. Process assessment addressed self-directed learning, practical application, integrated innovation, communication, collaboration, and independent thinking. Outcome assessment addressed mastery of course knowledge and completion of the integrated task. To improve assessment standardization and consistency among assessors, the rubric should be further refined, and scoring criteria should be clarified through discussion of sample student work. The specific assessment content is shown in Table 3.

Table 3. Assessment of Learning through the Industry Case

Assessment stage	Assessment focus	Assessment evidence	Use of assessment results
Requirements understanding	Ability to identify task conditions and instructional boundaries	Requirements description and field list	Correct misunderstandings of business conditions
Solution design	Ability to compare offline and stream processing approaches and justify the choice	Approach comparison table and flowchart	Improve the rationale for technical choices
Program implementation	Ability to complete data processing and result output according to the solution	Code, runtime logs, and interim results	Identify problems in conceptual understanding and task implementation
Debugging and improvement	Ability to analyze and improve the program using runtime information	Runtime records and modification notes	Develop problem-analysis and continuous-improvement skills
Outcome presentation	Ability to present results and their limitations clearly	Project work, presentations, and defense records	Improve documentation and technical communication

Assessment was used not only to determine task completion but also to inform subsequent instructional support. Based on students' performance in solution explanation, program implementation, and outcome presentation, the teacher provided learning resources at three levels: foundational, operational, and extension. Foundational resources supported understanding of core course concepts; operational resources provided program scaffolds, task prompts, and debugging guidance; and extension resources guided students in comparing different processing approaches and forms of result presentation. The level of guidance was adjusted to the difficulties experienced by each group, providing necessary support for students with weaker foundations without directly supplying a single standard answer.

5. Conclusion

Integrating industry cases into big data courses in higher vocational education requires selecting business problems according to course objectives, appropriately simplifying data and rules, and transforming them into teaching tasks that students can analyze, implement, and explain. Using vessel navigation data as the context, this study organized teaching through problem guidance, solution comparison and application, process guidance, and comprehensive assessment,

thereby connecting data reading, stream processing, state management, and result presentation within concrete tasks.

Case-based teaching needs to balance industry authenticity with classroom feasibility. Task design should incorporate professional input from industry practitioners, use compliant and de-identified data, and adjust business conditions according to the learning objectives. Based on classroom implementation, the course can continue to refine task design, instructional support, and assessment methods, and analyze the instructional effectiveness of the case using student solutions, project work, and presentation and defense records.

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