A Study on the Teaching Reform of GIS Courses in Higher Vocational Engineering Surveying Based on Work Process Orientation

Tang Yan *

Luzhou Vocational and Technical College, Luzhou, China

* Corresponding Author Email: 573898586@qq.com

Abstract. To cultivate students' professional skills, enhance their practical ability, exploratory skills, and spirit of cooperation, this paper, through extensive research, adopts a work process-oriented curriculum design method to analyze the GIS course for the higher vocational engineering surveying major. The course content is reconstructed to align with the job requirements of data processing engineers, and typical work tasks are determined based on the actual work process.

Keywords: Geographic Information System (GIS), Typical Work Tasks, Vocational Education.

1. Introduction

The goal of higher vocational education is to train managerial and operational personnel who are application-oriented for the front lines of production and service. Therefore, in higher vocational education, it is necessary to construct a work process-oriented teaching method aimed at integrating the teaching process of vocational education with the work process. This enables students to confidently handle action scenarios that are meaningful to their careers, livelihoods, and society. The teaching of courses using the work process-oriented approach should be action-driven, learning for the sake of action, and learning through action. The work process-oriented teaching method focuses on students as the main actors, uses the action process in professional contexts as the pathway, and employs cooperative action through interaction between teachers and students to develop students' comprehensive vocational abilities, which consist of professional skills, methodological skills, and social skills. This approach prepares them to face new societal demands and adapt to employment directions in the field of engineering surveying.

To achieve a work process-oriented curriculum design, it is first necessary to determine the professional goals and clarify the job positions based on extensive research. In the area of curriculum development, professional teachers at schools, industry experts, and relevant personnel from enterprises collaborate. The curriculum development is divided into two levels: professional work analysis and teaching analysis. Typical work tasks are broken down into typical subtasks, and these typical subtasks are further divided into smaller tasks. This process achieves the transformation from work tasks to action domains and from action domains to learning domains. Meanwhile, learning scenarios are broken down into tasks, adopting an "action-oriented" teaching approach.

2. Analysis of the GIS Course for Higher Vocational Engineering Surveying

Through professional teachers conducting research in enterprises and organizing seminars with industry experts, the "social profession" corresponding to the engineering surveying major is analyzed. This determines the vocational positions and job competencies for the GIS course in the higher vocational engineering surveying major (see Table 1), analyzes the learning domains, and translates these domains into typical work tasks, employing an "action-oriented" teaching method in the work tasks.

Table 1. Job Competencies Corresponding to the Geographic Information System Course

Position	Professional ability	Professional competence	Composition of knowledge
Data processing engineer	Charting ability	Ability of field mapping; Internal calculation ability; Ability to read maps; The ability to draw maps	Surveying knowledge; Cartography knowledge; Knowledge of cartography
	GIS principle and application ability	The ability to develop geographic information systems oriented to various objects based on professional software and in high-level languages	Introduction to remote sensing; Introduction to GIS; Mapinfo software application; ENVI software application; ArcGIS software application
Geographic information system development engineer	Ability of GIS secondary development	Application ability of GIS professional software	Knowledge of GIS design and implementation; Principle and application ability of WebGIS
	GIS platform creation ability	Programming languages (including C#, C++, Java, VB, Delphi) Programming ability; Computer diagram Image and database (including SqlServer, Oracle, Access) application and development capabilities	Knowledge of programming languages, data structures, principles and algorithms of computer graphics, database operations, etc

As shown in Table 1, the application of Geographic Information Systems (GIS) can be divided into two levels. The first level involves the development of various applied GIS. This level requires students to possess surveying and mapping professional knowledge as well as advanced knowledge in computer science, data structures, and other related fields. Clearly, in this level of application, it is challenging for higher vocational education students majoring in surveying to be fully competent. The second level involves the use of specialized GIS software to digitize spatial data or convert data formats to enable data sharing across different GIS platforms. This level of application represents the primary employment direction for students in higher vocational surveying education, and it also serves as an employment advantage for these students. Firstly, this level of application focuses on processing spatial data, requiring workers to have specialized knowledge in surveying. Secondly, the level of computer skills required does not need to reach the level of program development; students majoring in surveying in higher vocational education can achieve the required competencies by learning basic computer courses and software related to GIS. Therefore, the analysis of the learning domains corresponding to the GIS course for the higher vocational engineering surveying major focuses on selecting data processing engineers as the target job position (see Table 2).

Table 2. Learning Domains Corresponding to the Geographic Information System Course

<table>
<tr><td>Area of study: Geographic Information Systems applications</td><td>Time: Semester 3</td><td>Credit hours: 64</td></tr>
<tr><td colspan="2">Target Position: Data Processing Engineer

Description of Professional Activities:

Based on surveying standards, use Geographic Information System (GIS) software to digitize topographic maps, cadastral maps, and add thematic attributes to produce geographic information data for applications such as urban development and in-car navigation systems.</td><td>Professional qualification certificate: None</td></tr>
<tr><td colspan="2">Learning Objectives:
1. Proficiently master the basic operations of GIS application software, such as ArcGIS.
2. Be able to perform data entry, mapping, spatial queries, and analysis.
3. Create thematic maps to deeply understand and master the basic functions of GIS.
4. Be capable of raster-to-vector data conversion.
5. Be able to interpret and read maps.
6. Be able to conduct data checks and demonstrate team collaboration skills.</td><td>Teaching Methods:
Project teaching
Task driven method
Case teaching method
Live teaching method
Practice while speaking
Method of discussion</td></tr>
<tr><td colspan="2">Learning Content:

1. Graphic Input and Editing
(1) Point editing, line editing, area editing, and topological processing
(2) Error correction

2. Establishing a GIS Database
(1) Designing a GIS database
(2) Building a GIS database

3. Spatial Query
(1) Calculating graphic area and perimeter, buffer analysis, and spatial overlay analysis
(2) Network path analysis and raster data overlay analysis

4. Spatial Analysis
(1) Calculating graphic area and perimeter, buffer analysis, and spatial overlay analysis
(2) Network path analysis and raster data overlay analysis

5. Basic Operations and Function Combinations of GIS Software (ArcGIS)</td><td>Carrier selection is determined as follows:
Project analysis
Task breakdown
Functional analysis
Plan of operation
Teaching scheme
Inspection and evaluation</td></tr>
<tr><td colspan="3">Assessment Method:
A combination of basic theory and knowledge assessment, basic skills assessment, specific skills assessment, and comprehensive ability assessment. The final grade is determined based on the completion of tasks during the learning process through self-assessment, peer assessment, and teacher evaluation. Core skills are jointly assessed by the school and the enterprise.</td></tr>
</table>

The selection of teaching content is divided into two aspects. The first aspect is the principles of Geographic Information Systems (GIS), which serves as a bridge between the study of surveying and GIS software. This part focuses on learning concepts and fundamental principles, while avoiding detailed explanations of specific GIS development algorithms. The second aspect is the operation and use of GIS software. During the teaching process, an action-oriented teaching method is used to complete various typical tasks. Furthermore, collaboration between the school and enterprises can be pursued, placing students in real company projects to engage in data processing work (see Table 3).

Table 3. Overall Framework of Course Design

Course modules	Geographic Information System					
	Task 1 (Credit hours)	Task 2 (Credit hours)	Task 3 (Credit hours)	Task 4 (Credit hours)	Task 5 (Credit hours)	Task 6 (Credit hours)
Module 1 Preparation for work (4 credit hours)	GIS software environment Settings (2 credit hours)	GIS Software Installation (2 credit hours)				
Module 2 Storage of spatial data (20 credit hours)	Raster image stitching and cropping with ArcGIS (4 credit hours)	Register Raster images by ArcGIS (4 credit hours)	Property data structure setup (4 credit hours)	Spatial data acquisition and editing (4 credit hours)	Attribute data entry (4 credit hours)	
Module 3 Spatial data quality checking (16 credit hours)	Topology checking of spatial data (4 credit hours)	Topology correction of spatial data (4 credit hours)	Attribute data modification and update (4 credit hours)			
Module 4 Spatial analysis (16 credit hours)	Analyze the purpose, conditions, and methods of spatial analysis (4 credit hours)	Selection of spatial Analysis Methods (4 credit hours)	Implementation of spatial analysis Scheme (8 credit hours)			
Module 5 Thematic map making (8 credit hours)	Select the thematic map type (2 credit hours)	Determining statistical values (2 credit hours)	Custom thematic maps (2 credit hours)	Map decoration and output (2 credit hours)		

In this way, the teaching process and the production process are fully connected, the working process of the data processing engineer is designed as a learning process, and the learning process is carried out in the context of professional practice. The docking between the production process and the learning process is shown in Figure 1.

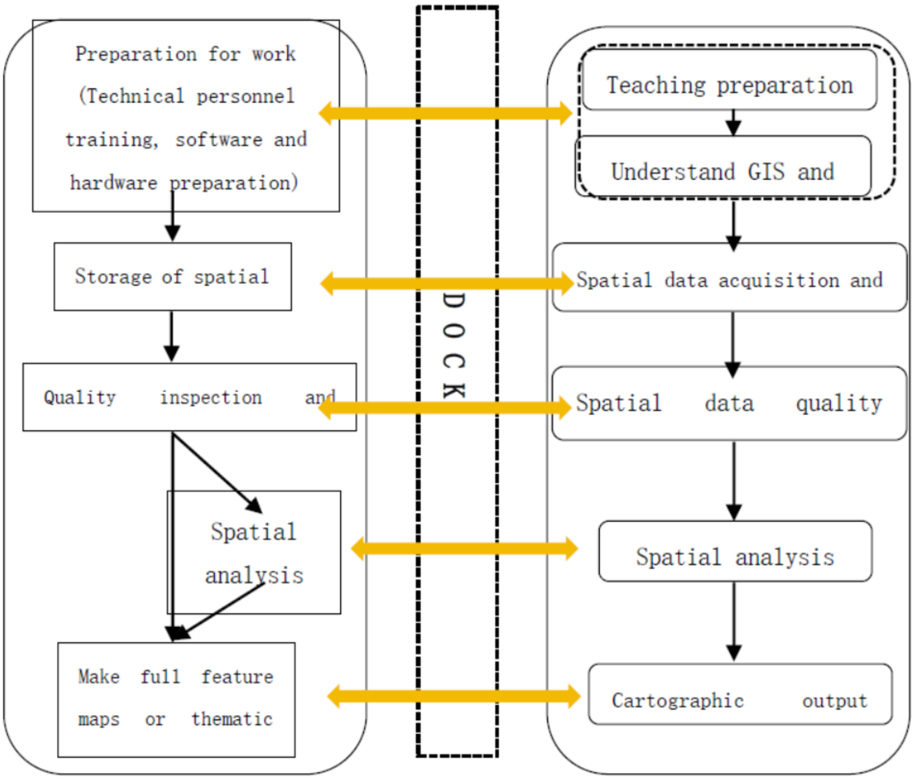

Figure 1. Integration of the Teaching Process with the Production Process

3. Example of Teaching Design: Spatial Analysis

The action-oriented teaching design for the spatial analysis module begins by breaking down the corresponding work processes in the spatial analysis module. This is followed by project-based teaching design using a work process-oriented teaching method (Table 4).

(1) Project Carrier: Selection of housing in urban areas. This involves identifying suitable locations based on homebuyers' requirements for geographical location or, on this basis, conducting a regional residential suitability grading.

(2) Teaching Project Design:

3.1. Project Analysis

Basic Data: Urban spatial data in shape format, including maps of urban traffic networks, distribution of commercial centers, distribution of renowned high schools, and park distribution data.

Using spatial analysis to find residential areas that offer a good environment, convenient shopping, and easy access to schools for children, identifying the most suitable housing locations. The entire urban area is graded as follows: Level 1 if four conditions are met, Level 2 if three conditions are met, Level 3 if two conditions are met, Level 4 if one condition is met, and Level 5 if none of the conditions are met.

3.2. Task Breakdown

This project is divided into the following tasks: defining the purpose, conditions, and methods of spatial analysis; selecting a spatial analysis method and determining an implementation plan; and executing the spatial analysis plan.

3.3. Function of Each Step

Defining the Purpose, Conditions, and Methods of Spatial Analysis: Analyze the purpose of spatial analysis based on decision-making tasks.

Work Process: Check the completeness of basic data, clarify the decision-making tasks, and analyze the purpose, conditions, and outcomes of spatial analysis.

Selecting a Spatial Analysis Method and Determining an Implementation Plan: Choose a suitable spatial analysis method based on decision-making tasks, establish a specific analysis plan, and translate it into corresponding software operation steps.

Work Process: Select an analysis method based on conditions (buffer analysis, overlay analysis, network analysis) and clarify the implementation logic.

Executing the Spatial Analysis Method: Familiarize with GIS software operations and gradually implement the analysis steps according to logic to obtain the analysis results.

Work Process: Complete the specific steps of spatial analysis according to the implementation plan determined in the previous step.

3.4. Assignment Plan

Execute the spatial analysis plan by identifying suitable locations based on homebuyers' requirements for geographical location or conducting a regional residential suitability grading on this basis.

Buffer Analysis Operation in ArcGIS Software: Perform buffer analysis for a feature at a certain distance, a portion of a feature, or a feature based on a certain field.

Overlay Analysis Operation in ArcGIS Software: Operations such as intersect, erase, and merge.

Intersection: An operation to find the intersection of two datasets. For example, intersect the buffer layers of the influence ranges of commercial centers, renowned high schools, and parks.

Erase Operation: Remove overlapping parts of the erase data in the polygon (s) of the erased data. For example, use the noise buffer zone of the main road to erase the intersection of the other three areas obtained.

Merge Operation: Retain all operations of the two layers. For example, perform a union operation on the four buffer layers when conducting regional residential suitability grading.

3.5. Teaching Organization

Focus on spatial analysis of urban spatial data to identify suitable locations based on homebuyers' geographical requirements or conduct regional residential suitability grading. Teaching organization should involve explaining, demonstrating, and training the professional skills, methodological abilities, and social competencies required to complete the project and each of its phases. Students are grouped into teams of four, and tasks such as researching materials, developing assignment plans, determining methods and workflows, and implementing the assignment process are all carried out as a group.

Table 4. Spatial analysis work process breakdown

Process of work	Time (min)	Tasks of work	Organization of teaching	Medium
Information	180	Analyze the purpose, conditions, and methods of spatial analysis	Provide instruction books and teachers to guide learning ArcGIS spatial analysis methods and specific operations	Multimedia, software operation demonstration
Decision making	45	Determine the spatial analysis plan	Group discussion	ArcGIS operation manual, basic data
The plan	45	Understand the basic data, select the spatial analysis method, formulate the work flow, and define the division of labor	The faculty guided the group to determine spatial analysis methods and processes	School-based textbook, ArcGIS operation manual
Implementation	360	Operation implementation: The workflow is implemented and the analysis results are generated	Under the actual environment, work in small groups, teacher demonstration guidance	Task books, work plans, school-based textbooks
check	45	Check the results, check the operation process	Teacher inspection, group report	Checklist (self-evaluation, mutual evaluation, teacher evaluation)
Evaluation	45	Evaluate the results of the assignment and the completion of each student's task, and evaluate the team cooperation	Teacher evaluation, homework group mutual evaluation, improvement	Evaluation form

The selected project is representative, and training focused on completing the project enables students to develop relevant skills in spatial analysis and application.

By deeply understanding the core concepts of vocational education and grasping the essence of curriculum and teaching reform in vocational education, the author has conducted research and exploration into the curriculum design reform of the Geographic Information System course for the vocational engineering surveying program. The work process-oriented teaching model integrates theory into practical training projects, with clear learning objectives. Students actively participate, showing a significant increase in their interest in learning, and are able to quickly assume the role of data processing engineers. In this teaching approach, the learning process is the production process, allowing students to master job workflows proficiently. The results are assessed by industry experts according to industry standards, which fosters a serious, meticulous, and disciplined work attitude among students, enhancing their craftsmanship and professional qualities. Tasks are completed by students in groups, which helps develop organizational and coordination skills and further strengthens the spirit of division of labor and teamwork.

References

[1] Du Shoujian, Li Yuzhi. "Construction and Practice of the 'Industry-Local Enterprise-School' Collaborative Talent Cultivation Model" [J]. Vocational and Technical Education, 2016 (36).

[2] Jiang Dayuan. Exploration and Practice of Work Process-Oriented Curriculum Development in Vocational Education [M]. Beijing: Higher Education Press, 2008.

[3] Dai Shihong. Curriculum and Teaching Reform in Vocational Education [M]. Beijing: Tsinghua University Press, 2007.

[4] Zhu Shiming, Wu Wenjie. "Five Alignments: Path Selection for the Connotative Development of Modern Vocational Education" [J]. Vocational Education Forum, 2014 (27).

[5] Li Yuzhi, Feng Cuijie, Du Shoujian. "Research and Practice of Curriculum Teaching Mode in Vocational Colleges under the Integration of Industry and Education—Taking the Geographic Information System Application Technology Course as an Example" [J]. Journal of Shanxi Institute of Economic Management, 2019 (27).