

# Teaching Design and Implementation of Vocational College Teaching Ability Competition: Taking “Object Detection” as an Example

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**Abstract:** Guided by the National Vocational College Skills Competition Teaching Ability Competition, this paper selects the “Object Detection” teaching unit and elaborates on the teaching design and practice process in detail from aspects such as overall teaching design, teaching implementation process, students’ learning effects, and reflection and improvement measures. By introducing real application scenarios of smart factories, it cultivates students’ craftsman spirit of striving for excellence and sense of responsibility to serve the country through science and technology, providing experience and reference for transporting high-quality technical and skilled talents for the high-quality development of the artificial intelligence industry.

**Keywords:** Teaching ability competition; Object detection; Integration of posts, courses, competitions, and certificates; Evidence-based value-added evaluation

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## 1. Introduction

In 2023, the CPC Central Committee and the State Council issued the *Overall Layout Plan for Digital China Construction*, pointing out that building Digital China is an important engine for advancing Chinese-style modernization in the digital era<sup>[1]</sup> and a strong support for building new national competitive advantages. As a core component of new infrastructure, artificial intelligence is an important driving force for the new round of industrial revolution and transformation<sup>[2]</sup>, providing strong technical support for promoting the modernization of the national governance system and governance capacity, and helping high-quality development and Digital China construction. Guided by the National Vocational College Skills Competition Teaching Ability Competition<sup>[3]</sup>, this paper selects the “Object Detection” teaching unit and elaborates on the teaching design and practice process in detail from aspects such as overall teaching design, teaching implementation process, students’ learning effects, and reflection and improvement measures.

## 2. Overall teaching design

### 2.1. Reconstructing curriculum content by penetrating work processes and integrating posts, courses, competitions, and certificates

Based on the national vocational and technical skill standards for artificial intelligence engineers<sup>[4]</sup>, professional talent training programs and curriculum standards, combined with the job requirements of artificial intelligence trainers, and aligned with production practices, new standards and specifications such as *Information Technology — Computer Vision Terminology* (GB/T 41864-2022) and *Artificial Intelligence — Data Annotation Specifications for Machine Learning* (GB/T 42755-2023)<sup>[5]</sup> are integrated into the curriculum teaching content. The catalog of the original textbook *Computer Vision Application Development* is sorted out and reorganized into four projects, and the entry work for this competition is Project 2.

This project integrates the assessment points of “requirement document analysis, data processing, model training, and prediction” from the Computer Vision Application Competition of the BRICS National Vocational Skills Competition<sup>[6]</sup> and the 1+X certificate “Computer Vision Application Development” vocational skill level standards<sup>[7]</sup>. It aligns with the latest application scenarios of smart factories, integrating four hot applications: face recognition, license plate recognition, human behavior detection, and quality inspection. Centering on the real work process of “top-level design–data preparation–model training–model application,” combined with students’ cognitive laws, the teaching content of this project is divided into eight progressive work tasks.

### 2.2. Precisely analyzing students’ learning situation based on platform data and digital intelligence technology

The teaching subjects are students of Grade 2022 majoring in Artificial Intelligence Technology Application. Before learning this project, the students’ learning situation<sup>[8]</sup> is obtained through data collection and big data analysis on the learning platform as follows.

#### 2.2.1. Knowledge and skill foundation

90% of students have a certain ability to use OpenCV;

87% of students have basic image operation capabilities and a certain foundation in image processing;

90% of students have the ability to comprehensively apply image geometric transformation and image arithmetic operations;

However, 80% of students lack knowledge and skills in image classification and image recognition.

#### 2.2.2. Cognitive and practical abilities

90% of students like hands-on operations, are good at independent learning, and have strong information application capabilities;

50% of students have active thinking and strong digital information application capabilities;

30% of students have strong abilities to apply knowledge in practice;

16% of students have insufficient understanding of image classification;

18% of students have insufficient mastery of image arithmetic operation skills;

Most students lack enterprise practical experience.

#### 2.2.3. Learning characteristics

95% of students are good at teamwork and prefer teaching methods with real scenarios;

70% of students have strong logical thinking abilities and like scenario simulation teaching methods;

42% of students are good at communication and expression and like teaching methods using information technology;

However, 13% of students have insufficient innovative design capabilities.

### **2.3. Determining three-dimensional objectives based on learning situation analysis and alignment with skill standards**

In accordance with professional teaching standards, professional talent training programs, and curriculum standards, and aligned with the job requirements of artificial intelligence trainers, the 1+X “Artificial Intelligence Vision Application Development Vocational Skill Level Standards,” and the assessment points of the Computer Vision Application Competition of the BRICS National Vocational Skills Competition, the teaching objectives of this project<sup>[9]</sup> are determined. The teaching key points are identified by grading and measuring the teaching objectives. According to the analysis of students’ learning situation and combined with the teaching objectives, the difficulty coefficient is determined, and the teaching difficulties are predicted.

### **2.4. Constructing three-dimensional resources and optimizing teaching strategies through “three stages and six steps”**

#### **2.4.1. Constructing the student-centered teaching strategy of “One Center, Five Strategies, Three Stages, and Six Steps”**

According to the five-level progressive training idea of students’ cognition: “Experience → Exploration → Internalization → Application → Transfer,” and based on the work process, the teaching strategy of “One Center, Five Strategies, Three Stages, and Six Steps”<sup>[10]</sup> is constructed. Combined with enterprise post tasks and requirements, guided by “scenario-based learning + task-driven” as the center, the workplace situation is created through “project, scenario, simulation, collaboration, and competition” to solve the problems of students’ “lack of exposure to work sites, lack of experience in work problems, and difficulty in imagining work tasks”; in class, action-oriented teaching is implemented in accordance with the six steps of “Clarify → Explore → Demonstrate → Practice → Display → Evaluate.” Classroom activities are interlocking, allowing students to learn by doing in competitive and interesting classroom activities, and realizing good interaction between teachers and students, and among students; after class, consolidation and summary are carried out, and craftsmanship spirit, engineering thinking, and professional quality are strengthened.

#### **2.4.2. Improving teaching organization and methods to help achieve three-dimensional objectives**

To implement the real project of smart factory object detection and achieve the teaching objectives, overall planning is carried out from teaching organization, teaching methods, and teaching process:

Teaching organization is divided into three links: pre-class enlightenment, in-class skill enhancement, and post-class expansion;

Teaching methods such as scenario experience method, task-driven method, case teaching method, and brainstorming method are adopted;

Students are divided into four groups: “Intelligence,” “Innovation,” “Craftsmanship,” and “Engineering.” In accordance with work processes and specification standards, a practical training atmosphere is created to improve students’ professional abilities.

### **2.4.3. Establishing diversified and three-dimensional teaching resources to effectively support the implementation of teaching strategies**

Multiple information means, such as online open courses, artificial intelligence collaborative innovation and development platforms, smart classrooms, artificial intelligence front-end equipment application platforms, and JupyterLab online experiment platforms, are used to establish diversified and three-dimensional teaching resources. Online teaching platforms such as Xuexitong and the National Smart Education Public Service Platform are used to effectively realize interaction between teachers and students, and among students.

Main textbooks: New integrated loose-leaf textbook *Computer Vision Application Development*<sup>[11]</sup>;

Auxiliary textbooks: National Vocational Qualification Training Textbook *Artificial Intelligence Trainer (Level 3)*<sup>[12]</sup>;

School-enterprise work manual textbooks: Enterprise project guidelines, student workbooks;

Auxiliary teaching resources: 1+X Artificial Intelligence Vision Application Development Level Standards (Intermediate), national standards, competition standards;

Information teaching resources: Online open courses on computer vision technology, digital intelligent teaching resource library.

## **2.5. Constructing an evaluation system following the principle of development and based on evidence-based practice**

Adhering to the teaching concept of fostering morality and cultivating people, in accordance with the standards of posts, courses, competitions, and certificates, and aligned with learning objectives, a “trinity evidence-based value-added” evaluation system<sup>[13]</sup> is designed. Focusing on the entire process of online and offline teaching, a trinity evaluation method combining process evaluation, result evaluation, and value-added evaluation is adopted. The evaluation content of process evaluation and result evaluation is based on teaching objectives, focusing on the comprehensive evaluation of students’ professional abilities and basic professional qualities. On the basis of following the developmental principle, the principle of unification and difference, and the scientific principle, an evidence-based value-added evaluation system based on deep learning is established<sup>[14]</sup>. Students, teachers, enterprise tutors, and competition award-winning players collaborate to achieve the whole process of data collection and real-time evaluation through the online learning platform. With the help of the evidence-based value-added evaluation system, it takes into account the starting point, process, and end point, focuses on “personal value-added,” and allows students to timely understand their personal progress through data, ensuring the comprehensiveness, timeliness, and difference of evaluation data.

## **3. Teaching implementation process**

### **3.1. Implementing teaching process with “Three Stages, Six Steps, and Four Evaluations” to help achieve objectives**

Taking the application scenarios of computer vision technology in smart factories as the project carrier, guided by the real work processes of top-level design, data preparation, model training, and model application, combined with enterprise post tasks and requirements, students are trained to use reasonable tools for project requirement analysis, data collection and processing, model training and application through completing the eight tasks of this project<sup>[15]</sup>, and guide students to build engineering thinking. The teaching links are divided into three stages: pre-class enlightenment, in-class skill enhancement, and post-class expansion, with eight links: independent inquiry, task clarification, new knowledge exploration, demonstration guidance, practical training,

presentation and report, evaluation and summary, and ability expansion. Teachers' leadership and students' subjectivity proceed in parallel. A "trinity evidence-based evaluation" system is adopted, with the whole process of data collection through the learning platform. Timely reflection and diagnosis and improvement are carried out according to data analysis to form a teaching closed loop. Curriculum ideology and politics run through the entire teaching process to implement efficient teaching, integrating morality and skills and combining work and study.

### **3.2. Integrating ideological and political education based on work processes**

Based on real work processes, guided by the national governance principles for the new generation of artificial intelligence, focusing on the principle of developing "responsible" artificial intelligence, a main line of ideological and political education of "one spirit, two thinking modes, and three awarenesses" is constructed<sup>[16]</sup>. The ideological and political content of "craftsmanship spirit, AI thinking, engineering thinking, ethical awareness, standard awareness, and responsibility awareness" runs through the entire teaching process:

Cultivate students' sense of responsibility by introducing smart factory application scenarios;

Cultivate students' AI thinking and engineering thinking through the whole work process of "top-level design–data preparation–model training–model application";

Cultivate students' ethical awareness and standard awareness through data set preparation tasks;

Cultivate students' craftsman spirit and standard awareness through model training tasks.

### **3.3. Integrating advantageous resources to overcome key and difficult points through school-enterprise dual-element co-research**

Relying on the second phase of the Ministry of Education's supply-demand docking employment and education project—the targeted talent training program of the Computer Vision Technology Training Class, schools and enterprises jointly develop school-based loose-leaf work manuals to realize the timely connection of teaching content with new industry standards, technologies, and specifications;

Rely on online teaching platforms and student data collection systems to analyze students' horizontal and vertical value-added growth and accurately grasp students' learning situation;

Use information means and resources such as JupyterLab online experiment platform and online open courses to efficiently implement teaching strategies and effectively solve the problem of "abstract and difficult-to-understand theories";

Use the artificial intelligence front-end equipment application development platform, combine software and hardware to realize the integration of theory and practice, and solve the problem of "difficult to improve composite skills";

Align with the standards of posts, courses, competitions, and certificates, invite enterprise experts to clarify post requirements, award-winning players of competitions to give accurate demonstrations, align with 1+X certificates to clarify ability standards, strengthen the process of intensive code research, and effectively solve key points and break through difficult points.

## **4. Students' learning effects**

### **4.1. Integrating ideological and political education into teaching content to significantly improve professional quality**

Students complete the smart factory object detection project in accordance with national industry standards,

cultivating their ethical awareness of protecting data security, craftsman spirit of striving for excellence, innovative and efficient AI thinking, systematic and comprehensive engineering thinking, and a sense of responsibility to serve the country through science and technology. Students' professional quality has been significantly improved.

## **4.2. Integrating learning and doing to master knowledge points and effectively achieve knowledge goals**

Guided by the “smart factory object detection” project, theoretical knowledge runs through the entire work process from the formulation of project requirement reports to data set preparation, data processing, model selection and training, and model deployment and calling. Students learn by doing and do by learning, master knowledge points, truly take students as the main body, break through the key and difficult knowledge in work tasks, and improve their ability to connect theory with practice. Through pre-test comparison of each task, students have made obvious progress in knowledge mastery, and knowledge goals have been effectively achieved.

## **4.3. Realizing different application recognition and effectively achieving ability goals**

Based on the OBE teaching concept, combined with enterprise post tasks and requirements, in accordance with new national industry standards and industry specifications, teachers take the lead in implementing task-driven teaching, and students deeply participate in the project as the main body. Four groups have completed the entire work process of face recognition, license plate recognition, human behavior detection, and quality detection, respectively, which have been recognized by school-enterprise cooperative enterprise tutors. The work goals of the project have been successfully achieved, and the ability goals have been effectively achieved.

# **5. Reflection and improvement measures**

## **5.1. Characteristics and innovations**

### **5.1.1. Aligning with new vocational post capabilities and practice 1+X teaching practice**

Align with the digital new vocational capability requirements of artificial intelligence engineers, focus on the post capability standards of artificial intelligence trainers, and integrate the 1+X “Computer Vision Application Development” vocational skill level (intermediate) standards into the course of Artificial Intelligence Vision Technology and Application. Through the course learning, students are trained in the vocational skills of 1+X image application services, helping students adapt to the new requirements of vocational posts as soon as possible and improving their employability and professional quality.

### **5.1.2. Aligning with new quality productivity requirements and practice evidence-based teaching evaluation**

Innovate evaluation methods using advanced technologies such as big data and deep learning. Guided by literacy, gather and analyze subjective data and objective data in the teaching implementation process into evidence, quantify core literacy, making literacy evaluable and traceable. Empirical data comes from process data and result data in teaching activities. Through logical deduction and optimization, feedback is given to student learning analysis, and then teaching activities are reflected and improved, forming an iterative cycle of students' literacy improvement such as knowledge and ability, practice and norms, improvement and decision-making. Realize real-time tracking and data analysis of students' learning processes, so as to more accurately evaluate students' learning effects and ability development, and promote the transformation of evaluation

towards the unity of science and systematization.

### **5.1.3. Aligning with new national industry standards and infiltrating responsible curriculum ideology and politics**

Guided by the national governance principles for the new generation of artificial intelligence, based on the requirements of developing “responsible” artificial intelligence, tested by the refined AI new technologies, and acted by the exploratory engineering thinking, align with new national industry standards, and integrate ideological and political elements into the entire work process. Taking real work projects as carriers and centering on real work processes, cultivate students’ sense of responsibility and engineering thinking in top-level design, maintain rigorous standard awareness and craftsmanship spirit of striving for excellence in practical training, and cultivate students’ ethical awareness and AI thinking in project realization. Curriculum ideology and politics run through the entire course, realizing the extension of professional course teaching to multi-dimensional education of ideal and belief education, excellent skill training, and social responsibility cultivation.

## **5.2. Reflections and improvements**

### **5.2.1. New technologies and new specifications require continuous iteration and update of digital and intelligent resources**

Existing problems: As artificial intelligence is an emerging industry, and new technologies and specifications develop rapidly, resources need to be iterated and updated with the development of new technologies.

Improvement measures: Rely on deeply cooperative enterprises, co-construct and share computer vision and digital and intelligent resources, continuously update in accordance with industry development trends and enterprise application needs, integrate new technologies such as large models, and make them meet the needs of teaching, training, and certification at the same time.

### **5.2.2. Students’ individual differences require an in-depth hierarchical creation of extended tasks**

Existing problems: There are differences in students’ learning foundations and abilities. With the deepening of course difficulty, students’ mastery of the same skill point shows big and weak differences, and teachers’ differentiated guidance needs to be improved.

Improvement measures: Strengthen the training of extended tasks of different difficulties after class, improve students’ skills in a spiral and progressive manner, and reduce the differences between students.

### **5.2.3. Evidence-based value-added evaluation requires multi-modal data support**

Existing problems: The value-added evaluation data is not comprehensive enough. To more accurately depict individual students’ learning and growth, reveal development laws, and reflect the educational effect of curriculum teaching, it is necessary to synchronously collect, integrate, and analyze multi-modal data such as students’ physical and physiological data, interactive behavior data, and physical environment data.

Improvement measures: Start with multi-modal data such as students’ language, expressions, and actions in classroom teaching, try to use artificial intelligence technology to collect, sort out, and analyze them, and integrate them into the data category of the evaluation system.

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