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Exploration on Task-driven Teaching Design of Industrial Robot Operation and Programming Course in Secondary Vocational Schools

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Abstract

Currently, the national goal for the training of talents in vocational colleges and universities is to cultivate high-quality skilled talents with powerful practical ability, good thinking, and in line with the needs of the manufacturing industry. For the industrial robot operation and programming, which is a comprehensive practical training course with both theory and practice, focusing on the improvement of students' Introductory operation, offline programming ability, and familiarity with the use of network communication systems and other learning objectives, it is proposed to apply the "task-driven teaching method" throughout the whole teaching process to fully mobilize students' initiative and guide them to analyze the problems and improve their practical skills from different perspectives. The article focuses on the requirements of the course and discusses how to improve the student's capacity to apply theory in practice. The article focuses on the specific teaching design ideas of the task-driven teaching method and the multi-dimensional evaluation and assessment mode in this course in combination with the requirements of the course.

Keywords

task-driven teaching method, teaching design, secondary vocational education, industrial robots, multidimensional evaluation

1. Introduction to Task-driven Pedagogy

"Task-driven" is a teaching method based on constructivist teaching theory (Gong, 2008), which transforms the traditional teaching concept of imparting knowledge into a multi-dimensional interactive teaching concept of solving problems and accomplishing tasks; transforms "reproducible" teaching into inquiry-based learning, so that students are in an active learning state, and each student can propose solutions, analyze problems, and solve problems based on his/her understanding of the current task, using common knowledge and his/her own unique experience (Guo, 2002). Teaching inquiry-based learning, so that students are in an active learning state, each student can be based on their understanding of the current task, the use of shared knowledge, and their own unique experience to propose solutions, analyze the problem, solve the problem (Guo, 2002; He, 1998; Li, 2012). Throughout this process, kids take the lead, take the initiative to study, and become self-aware of their learning. Through this process, the instructor transitions from being the center of attention in the traditional teaching mode to a supporting position in the new mode, crucial for fostering the creative spirit of the students' self-directed inquiry (Liao, 2023). The task-driven teaching method is a type of problem-solving that teaches students to consider intersectional teaching from an integrated perspective. This style of instruction can significantly enhance content-based and tedious traditional teaching by encouraging independent learning as the primary means of ensuring that students' overall development is met (Liu, 2009).

2. Current Issues and Context of the Course

2.1 Course Background

The present goal of the industrial robotics technology program is to teach professionals in industrial robot applications. Industrial Robot Operation and Programming is a professional core course offered in the fourth semester for industrial robotics students in secondary vocational colleges and universities (Liu, SU, TANG et al., 2021). To master the application of robotics, students must master the fundamental theoretical concepts of robotics, robot maintenance technology, system design, and other areas of knowledge. Graduates in industrial robotics can work in the production and application of industrial robot bodies, technical services, and other types of businesses and organizations involved in industrial robot installation and debugging, application of programming (offline programming and simulation), system operation and maintenance, equipment management, pre-sale and after-sale support, and maintenance.

2.2 Existing Problems

To develop high-quality and highly skilled personnel, it is necessary to deepen the reform of the "Three

Teachings" of vocational education, promote the unity of knowledge and practice, and instill a spirit of craftsmanship in students. These points are covered in the Outline of the Fourteenth Five-Year Plan for the National Economic and Social Development of the People's Republic of China and the Vision for 2035.

We must continue the dynamic arrangement of the curriculum system and gradually adapt to the improvement of talent standards because there is an increasing demand for professional talent in industrial robotics technology. The needs of the local economy and social development are met by talent training to keep up with company demand and industry development. "Industrial Robot Operation and Programming" is not only a theoretical and practical course, but it is also one of the most directly related to the needs of industry roles. The present demand for highly competent workers is still very urgent. These issues—optimized teaching content, a single teaching mode, an ineffective teaching evaluation system, and a lack of teaching resources—mainly show that there is still a gap between the talents developed by this course in vocational colleges and the demands of businesses. For example: the teaching content arrangement is unreasonable, the theory is divorced from practice, due to the late start of China's industrial robotics teaching, the relevant teaching experience is insufficient, in the actual teaching work, many technical colleges and universities to theoretical teaching is the main focus of the heavy theoretical courses compression of the students' practical application of the time, the students have a lot of theoretical knowledge, less practical skills can not meet the social demand for industrial robotics front-line operating personnel; technical Teachers in technical colleges and universities in the teaching mode, focusing on knowledge teaching, teacher-centered, passive students to accept knowledge, the classroom atmosphere is low, the lack of thinking and interaction opportunities; teaching evaluation to the level of knowledge is the main, in the context of such an assessment, the students focus on the theory of the light practice, and the social positions focus on the hands-on ability of the talent is contrary to the. To solve the current problems, teaching should break the traditional curriculum system characterized by the logic and completeness of subject knowledge, determine the curriculum based on the work tasks, design the curriculum according to the actual needs of the work process, and integrate the theoretical and practical course content with the work tasks; the course content should be in line with the actual needs of the enterprise's production and service and the work tasks, and be carried out by the principle of conducive to the cultivation of students' vocational ability. Reasonable selection and sequencing, to design teaching activities with typical products or work tasks as the carrier, and to organize the theoretical and practical integration of teaching content in an action-oriented teaching manner. Thus, to better align talent, skills, and specializations with market demand and the demands of the enterprise's workforce, as well as to enhance the practical and scientific nature of education, it is essential to investigate the reform of secondary school industrial robotics operation and programming courses using the foundation of task-driven instructional design methodology.

3. The Significance of Applying Task-driven Approach in the Course

3.1 Implications for Students

These three factors characterize the current academic environment in secondary schools: first, cultural knowledge reserves; most students enrolled in secondary vocational colleges and universities have weak basic cultural knowledge and a discrete state of cultural knowledge; second, learning ability level; most students have low learning ability, low self-control, and no subjective initiative in learning; and third, affective attitudes and values (Liu, 2018). According to the present level of secondary students' learning, constructivist teaching is used in the theoretical courses to introduce the task-driven teaching style. By asking students to apply their own knowledge stores to real-world problem solving, this strategy aids in the testing, strengthening, and reconstruction of knowledge. Second, the inquiry teaching style, which stresses independent learning and inquiry throughout the educational process, incorporates the task-driven approach, which gently fosters students' imagination and creativity. Finally, based on the student's cognitive, motor, and mental development traits, the task-driven strategy splits the content of demanding learning tasks and the task rhythm. As a result, there is less fear of learning, less boredom from studying, and a continued emphasis on learning and recognition. Students can progressively conquer their learning obstacles and feel a feeling of success.

3.2 Implications for Teaching

The intricate, spiral cycle that sets apart task-driven teaching style from standard, single-phase instruction is its distinguishing feature. Task-driven learning differs from traditional training in several ways: First, to create a systematic knowledge system, the teacher should modify the customary knowledge acquisition goals through lectures and convert them to the students through structured knowledge modules integrated into the lesson preparation. Additionally, assigning tasks before the lesson can assist students in creating a plan of study before the lesson and ultimately help them to complete the lesson's learning objectives. Students who receive the task list before the session may find it easier to prepare a study schedule in advance and meet the lesson's learning objectives more quickly. Second, traditional teaching methods are boring and make it hard to get students interested in learning. To address this, teachers should change their approaches and give students more control over their education by guiding and inspiring them to engage in independent study, group projects, simulations, and practice while analyzing and solving problems to gain new knowledge and skills. Third, in terms of learning enthusiasm, students in traditional classrooms need to be supervised in learning, while task-driven classrooms follow students' cognitive development, construct learning tasks based on student's existing knowledge and experience, make students become the real masters of the classroom, take the initiative to participate in the learning process and give full play to their subjective initiative when completing corresponding learning tasks. Contribute to the improvement of comprehensive capabilities and breakthroughs in recent development areas.Fourth, in terms of assessment and evaluation, students' understanding of the connections between the modules is strengthened, and their intermittent accomplishment of the goals of the sense of achievement is improved. This is achieved by

converting the summative assessment of the primary evaluation model into a process evaluation. Increase the variety of assessment subjects and techniques utilizing educational resources, and promptly assess students' learning progress throughout the learning process. The task-driven learning method shifts the conventional teaching mode of "teachers speak, students listen, full of irrigation," which greatly improves the teaching effect (Ren, WEI, & SHI, 2014). It also highlights the teaching characteristics of the "student as the main body," which is conducive to the interaction between teachers and students.

4. Strategies for Using Task-Driven Approach in Teaching and Learning

4.1 Integrate the Teaching Content of the Course and Set Goal Tasks Based on Outcome Orientation

The "task" is the main focal point for the development of all instructional activities when using the task-driven teaching approach. The work should be "spiral upward, meandering and interspersed," according to its design. The secret to putting task-driven learning into practice is to set reasonable tasks (Shen & Han, 2016). The four components of industrial robotics professional aims and "industrial robot operation and programming" courses at secondary vocational colleges and universities are curriculum objectives, teaching objectives, training objectives, and educational objectives. Secondary vocational colleges and university curricula must support China's socialist modernization while also fostering the general growth of morality, intellect, physical fitness, and aesthetics; they must also foster comprehensive vocational ability, high-quality laborers, and skilled personnel working in the production and service line, and the goal of education. The standards of employee education across all levels and types of establishments, as well as the specific requirements and manufacturing firms that align with the actual demand gap, must all be considered in the cultivation goals (Wang, YU, & FU, 2018). When completing a task, an educated individual is expected to demonstrate visible behavior, i.e., to meet requirements or bring about expected changes. When it comes to teaching objectives, there is an obvious relationship between the direction of instruction and the accomplishment of results. Curriculum objectives are the specific goals and intentions to be realized by the curriculum itself based on determining curriculum content, teaching objectives, and teaching methods. In a way, the basis and intermediary for the accomplishment of educational goals are the curriculum objectives. With the four components of educational purposes, training objectives, teaching objectives, and course objectives centered on learning outcomes to form a closed loop, the idea of outcome-oriented teaching task design is thus depicted in Figure 1.

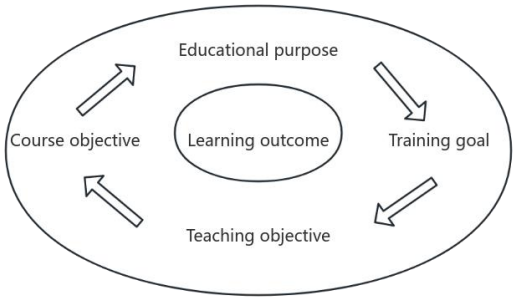

Figure 1. Instructional Design Idea Chart

Tasks should be set up in line with the new era of the country for the comprehensive development of high-quality workers in practice and application, but also to reflect on the needs of enterprises, design tasks to effectively connect the actual jobs, effectively reduce the low satisfaction of enterprises with the industrial robotics talents cultivated in secondary schools. At the same time, the task needs to be integrated into the curriculum and teaching objectives. To create the best task possible that satisfies the requirements of the course teaching, learners in the teaching process must become proficient in knowledge analysis, knowledge analysis, and integration in the task. The procedure of gradually breaking down the student learning objectives and ensuring that they are implemented, verified, and realized is known as the learning outcomes-oriented design of the task objectives (Wu, 2011).

4.2 Specific Implementation of Task-driven Pedagogy in Teaching and Learning

The interplay between teachers, students, and tasks is always balanced in a task-driven learning environment. Active interaction occurs between the subject position of the students and the leadership role of the teacher. Using the task-driven secondary curriculum for "Industrial Robot Operation and Programming," educators must assist students in completing tasks in learning scenarios, identifying issues and posing questions in nearly real-world work setups, gaining new skills via collaboration and communication, and gradually developing their critical thinking skills to build knowledge systems. Preceding, during, and post-class are the three primary phases of the teaching procedure. Figure 2 depicts the particular process of instructional implementation.

4.2.1 Pre-course: Pedagogical Preparation Phase

Before classes, teaching cases are distributed. On the one hand, determine the teaching content, analyze the learning situation considering the difference of students' knowledge and cognitive ability, determine the project tasks before class, decompose the identified project tasks into step and procedural learning tasks, and finally draw up the task and publish the list of learning tasks; On the other hand, combined with the full use of online equipment before class, such as Superstar learning, upload relevant course ideological and political resources (Taking the basic teaching content of industrial robot control system as an example, relevant teaching ideological and political resources can be selected from the "Beidou" navigation system, Jiaolong deep-sea exploration, Moon landing program, and other related current

events and policies) and import industrial robot competition cases corresponding to the project mission, skill evaluation standards and enterprise processing operation procedures. Through the above two aspects, students can accept learning tasks and carry out independent learning before class. With the use of online learning data, educators may keep an eye on students' progress in real-time and modify their lesson plans accordingly. Through independent study before class, students can familiarize themselves with the course material ahead of time and find solutions to issues by reviewing the work list. At the same time, ideological and political elements compatible with the teaching content can enhance students' cultural self-confidence, stimulate students' national pride, and improve students' learning interest in robot-related knowledge.

4.2.2 During the Lesson: Cooperative Inquiry Stage

(1) Constructing instructional scenarios. While the task-driven teaching approach is quite different from other teaching approaches in many ways, its primary distinction is that it demands more conditions be met when creating instructional scenarios. Constructivism advocates learning in An actual setting in order to narrow the distance between knowledge and problem-solving and pay more attention to the transfer of knowledge. Thus, educators use multimedia, hands-on training tools, and other teaching aids to imitate real-world settings for their lessons. That allows for the execution of learning activities in a particular setting, immersing students in a highly simulated learning environment while piquing their interest and assisting them in swiftly entering the learning state (Wu, 2011). A good learning situation can intuitively stimulate the association of students' relevant knowledge and experience so that students will be related to the integration of knowledge and experience and new knowledge, a systematic view of the fresh knowledge, the teacher guides the students to enter the learning situation with the problem, the students will be the old and the new knowledge of learning to migrate with the situation related to the actual problem solving, in order to obtain the practical ability.

(2) A new lesson is introduced, and the assignment is made clear. Students at universities and secondary vocational schools struggle with low attention spans, so introducing a fresh learning environment is crucial. Done well, it may double the impact of a lesson with half the work. There are various ways to present anything; for example, you can use images, movies, games, animations, and news articles about industrial robots. Beginning with the introduction of the new lesson and ending with the task clarification, teachers must assign students to groups based on their varying levels of cognitive development and needs, choose a group leader, and then require the group to clarify and finish the task, foster a positive team environment, balance each other's strengths and weaknesses, and advance as a unit. Consequently, in the production of the scenario, pre-designed groups will assign learning assignments to each student group that are directly relevant to the newly acquired knowledge. Every student will be compelled to confront an urgent problem that has to be handled since different assignments will be assigned to students at distinct skill levels.

(3) Guiding the doubt, analyzing the task. This link is to explore new knowledge, initially, the teacher leads the students to break down the task, analysis, research, and talk, so that groups of students can

accurately grasp the fundamental content of the learning task, the basic requirements, the basic problem, the operation of the path, and unambiguous completion of the tasks required knowledge and knowledge acquisition channels. Through the decomposition of the jobs and the clarification of the channels of access, the tasks are more effortlessly operated, which satisfactorily reduces the students' negative feelings and gives them the confidence they need to finish learning new material. The teacher guides the students by breaking down the tasks and setting up problem situations for each sub-task to inspire them to think. In this section, the teacher takes the problem as the guide and leads the students to learn independently through cooperative inquiry and group interaction. During this time, the teacher plays the role of a learner's helper.

(4) Internalization of knowledge and autonomous innovation. This stage is to carry out similar tasks at the same level independently after the end of the basic sub-tasks about the new knowledge. By learning from the same type of tasks, the goal of solidifying the learned knowledge must be accomplished. The teacher's circuit guidance, the link between the students and independent practical operation, the process of strict control, and the guidance when issues arise. Remember that during practical exercises, if students encounter an obstacle or appear lost, do not immediately provide the solution. Instead, provide guidance, inspiration, and support to enable the students to approach the problem in multiple ways, analyze it, and determine the best solution.

(5) Check the results and summarize the task. In the task-driven teaching mode, checking and assessment is also an extremely effective means of evaluating students' learning, Additionally, providing a basis for formulating the teaching objectives of the next stage. Before the end of the task-driven teaching method, it is generally necessary to set aside time for evaluation and feedback on students' independent learning. The process of executing this session is as follows: the work is reviewed and graded within and between small groups; the teacher revises and adds to the student's comments. This session once again enhances students' ability to exercise their aesthetic sense, language expression, and ability to cooperate and explore. Finally, summarizing the completion of the task, the teacher formed a process evaluation.

4.2.3 After School: Consolidation and Mutual Progress after School

Utilize online learning software to complete the final steps of the assignment study. Upload the exercises corresponding to each sub-task to Super Star Learning Pass and specify the time limit for completing the assignment. Teachers can view students' accuracy rates and grade rankings through the Super Star Learning Pass back office. Effectively focus on students' easy-to-error points and reinforce relevant knowledge points in subsequent lessons. At the end of the student quiz, the teacher publishes the evaluation feedback form for each student in Super Star Learning Pass, which forms three-dimensional and diversified evaluation feedback by referring to the multi-dimensional evaluation before, during, and after the class; online and offline multi-level evaluation; and intra-group, inter-group and multi-angle evaluation by the teacher, and the evaluation is a good opportunity for the exchange of ideas, knowledge and wisdom between teachers and students, which can play a role of

mutual enlightenment and mutual promotion for both teachers and students.

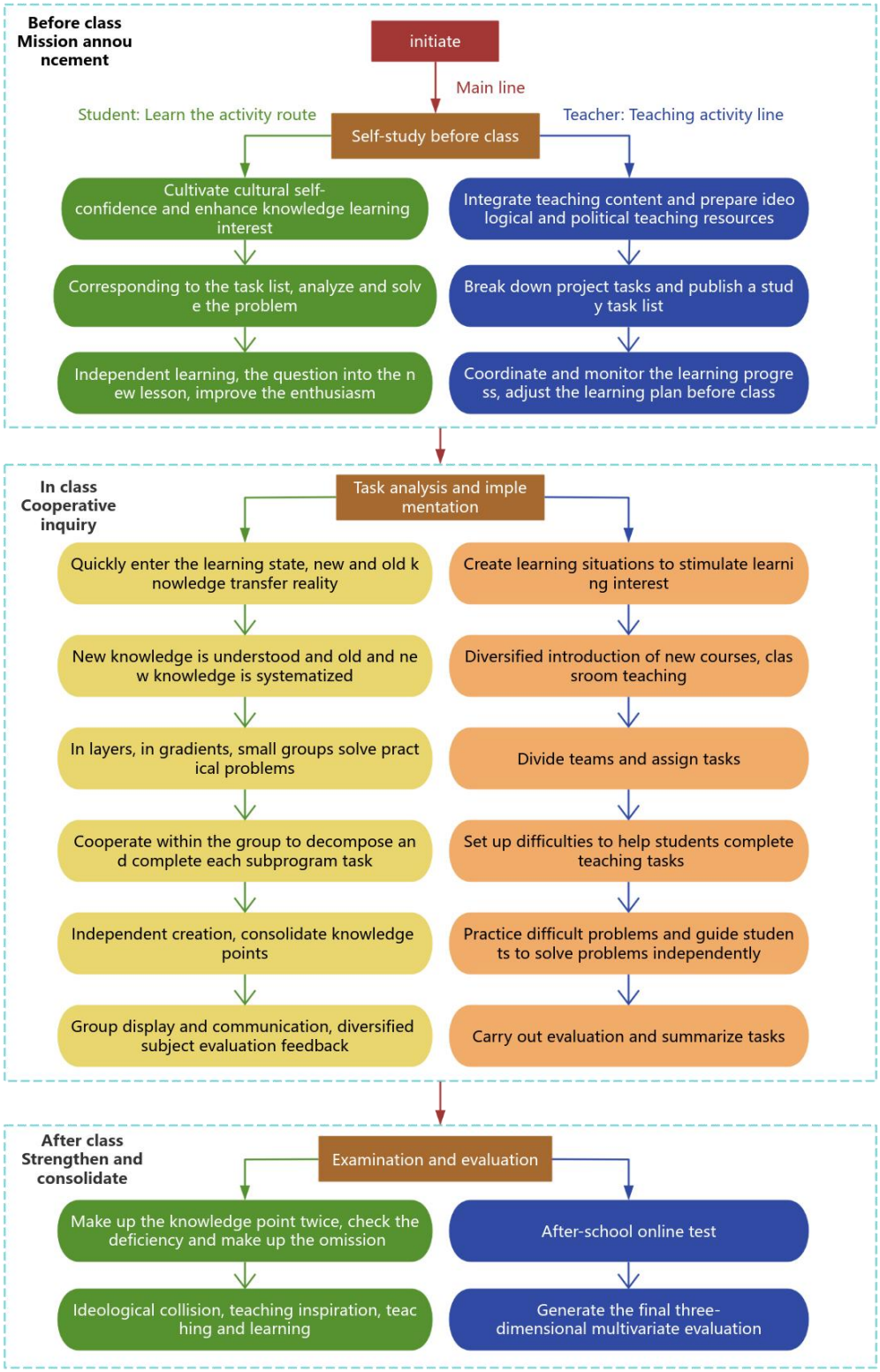

Figure 2. Teaching Implementation Process of "Industrial Robot Operation and Programming" in Secondary School Based on Task-Driven Teaching Methodology

4.3 Three-Dimensional Evaluation

The theory of multiple intelligence proposed by the American psychologist Gardner argues (Xin, 2011) that teachers should conduct diverse assessments of students, focusing on both students' academic performance and whether they have improved their ability to think independently and link theory to practice in the learning process. The traditional evaluation, with a simple process and single method, cannot comprehensively examine students' gains and performance in the procedure for task completion. Therefore, the comprehensive and systematic process evaluation system based on the task-driven teaching method (as shown in Table 1) incorporates the evaluation of basic skills, learning attitude, participation, learning ability, practical ability, and comprehensive ability into the course assessment system, pays more attention to the students' subjectivity, and establishes a three-dimensional evaluation model with multi-dimensional, multi-level, and multi-angle.

There are two primary approaches to evaluating education and teaching in terms of form: one involves adopting a specific instructional architecture system directly, even though the other includes using instructional design in connection to the curriculum. Through numerous methods, including questionnaires, model assignments, post-class activities, post-class feedback, and related assessments, a thorough examination of the teachers' own in-class teaching abilities took place.

In terms of teaching content, in classroom teaching practice, in order to improve the overall quality of students, its evaluation is mainly divided into the assessment of students' learning outcomes and the evaluation of learning behavior. Learning outcomes evaluation from the class before, during and after the three stages, giving full play to the advantages of the combination of process assessment and summative assessment. Enterprise 7S management requirements, hygiene, fulfillment, teamwork, safety, discipline, and learning behavior evaluation are all included. Among these, the learning behavior evaluation's share of enterprise 7S management standards should be steadily raised to guarantee that "safety is no small matter, responsibility is greater than heaven" and the instillation of professional ethics—such as diligence, teamwork, and cooperation—into the day-to-day operations.

In the main body of teaching, the three-dimensional teaching assessment is primarily composed of teacher, group, and student assessments, as well as student self-evaluation. As a result, the evaluation can accurately reflect the entire instructional process.

Table 1. Process Evaluation System based on Task-driven Pedagogy

Course total score composition and proportion	Assessment link	Specific assessment content	Target score	Evaluation rules
Formative evaluation results (60% of the total score)	Pre-class assessment	clocking-in	50	The main test is the attendance rate of students
		e-learning	50	Assess students' online ideological and political resource learning, and sort out problems against the task list
	In-class assessment	Practical operation assessment	60	The main assessment is to assess the operation standards of each equipment, the results of tasks and the quality of practical operation works (including the completion time, accuracy and standard of the results) during the practical training of students.
		Learning behavior	15	Assess students' ability of safe operation of equipment, discipline and teamwork during practical operation
		Enterprise 7S management standard	25	To assess students' comprehensive on-site management ability under the background of real enterprise
Final evaluation of achievement (40% of the total score)	After-school assessment	Final comprehensive design analysis report	100	The main test is to evaluate students' comprehensive application of professional knowledge to complete design analysis and application questions

4.4 Teaching and Learning Resources

The task-driven teaching method tests the strength of teaching resources more than traditional teaching. The distribution of teaching resources mainly includes hardware and software. In terms of hardware, through in-depth school-enterprise cooperation with robotics companies, we have created “school in the factory” and “factory in school” training and practice education bases, which provide new ideas for integrated teaching (Yang, 2011)—construction of ABB experimental training center, industrial robotics virtual simulation laboratory, and intelligent manufacturing laboratory. Excellent hardware resources to meet the teaching process, teachers across the theoretical teaching and practical teaching, through the “teaching while doing, learning while doing” so that students achieve “knowledge and action”, “learning and doing together!” Theory and practice teaching. In terms of software, we take “Internet+” technology as a means to make full use of digital network course resources with the characteristics of the times, such as micro courses, “rain classroom”, MOOC, etc., and reasonably develop digital teaching resources in line with the learning situation, to realize personalized teaching through online teaching—Independent pre-study and review.

5. Summary

In conclusion, the task-driven teaching mode has been refined as an effective educational tool to further the secondary vocational course teaching reform. The innovation of this teaching mode is a “task-oriented line, through the teacher students”, the traditional passive teaching mode has been transformed, innovative to learn to teach, students active participation, and teachers to help guide the

new learning mode. Teaching through the “practice - understanding - practice - understanding” cognitive law, the organic integration of theory and practice, guides students to take the initiative to complete, analyze, resolve issues, and solve problems while completing the task. It is a further challenge for teachers and students to meet the higher standards of the task-driven teaching mode, which calls for more research and development. As this is true whether the task follows directions by teacher assistance or student-initiated collaboration.

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