Research on the Construction Method of the Integrated Training Room of Theory-Virtuality-practice for Engineering Majors in Vocational Colleges

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Abstract. In order to solve the common problems in the construction of integrated science and practice training rooms for engineering majors in vocational colleges, research is conducted on the methods and paths for the construction of training rooms. With the core of cultivating students' comprehensive professional abilities, the construction concept of the "integration of theory-virtuality-reality" training room with "scientific planning, demand orientation, integration of engineering and learning, open innovation, integration of wisdom, and consideration of competitions" has been proposed. Afterwards, the integrated teaching mode of theory, virtual reality and the inherent meaning of theory, virtual reality and integration were introduced. The construction path was proposed from three aspects: demand analysis, equipment procurement, training room site planning, and construction party. The construction of training room culture was discussed from two aspects: environmental culture construction and institutional culture construction.This paper proves the effectiveness of this idea through the construction of integrated training room of theory-reality-practice for new energy vehicles.

Keywords: Vocational Colleges, Engineering Majors, Integrated Training Room of Theory-Virtuality-Practice , Construction Method , new energy vehicle

1 Introduction

In recent years, vocational education has been the focus of attention, and the state has introduced a series of policies to guide the rapid development of vocational education. Vocational colleges actively carry out the “Three Educations Reform” to improve the quality of personnel training. With the deepening of vocational education reform, the concept of integrating theoretical teaching and practical teaching, which breaks the boundary between theoretical teaching and practical teaching, has been widely accepted by vocational colleges [1]. Training room is a practical training place to carry out the teaching concept of integrating science and practice and cultivate students' vocational ability and practical ability, which plays an important role in improving the quality of practical teaching, completing teaching tasks and achieving teaching objectives. There are some difficulties related to the integrated training room of theory-practice in many vocational colleges: first, the equipment price is high, the loss is large, and the university is short of funds; Second, the type and quantity of equipment are small, the equipment is old, and it is difficult to adapt to the teaching needs; Third, the structure of the some part system is complicated and difficult to understand. Fourth, the abstract principle is not clear; Fifth, some time-consuming or dangerous experiments cannot be carried out, and sixth, the construction idea of traning roon is not clear, and the

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construction of the training room is not consistent with the professional teaching needs. The construction of practical training room is a serious problem, and it is difficult to carry out the integrated teaching of theory-practice, which restricts the improvement of the teaching quality of vocational education. In order to solve the above problems, some colleges and universities began to try the “integrated teaching mode of theory-virtuality- practice” [2].

2 Analysis of “integrated teaching mode of theory-virtuality-practice”

The idea of “ integrated teaching mode of theory-virtuality-reality” is shown as figure 1. Among the integrated teaching mode of theory-virtuality-practice , the “ theory” refers to the new form of textbooks and courses developed based on the idea of "systemizing the working process", and carries out theoretical teaching in the form of flipped classroom and divided classroom. "virtuality" refers to the development of digital resources such as virtual simulation teaching software and virtual reality teaching system according to professional knowledge to assist teaching. "practice" refers to practical teaching, which is used to cultivate students' professional skills and practical operation ability. “integrated” refers to the trinity of theory-virtuality coupling, virtuality-practice fusion, theory-practice combination [3]. Using new forms of three-dimensional teaching materials, virtual simulation training software, online courses, and digital training rooms as carriers, we aim to build a digital teaching environment and achieve a shift from "teaching centered" to "learning centered". We will implement a spiral learning approach of "flipped learning", "virtual learning", and "learning by doing" to improve the quality of talent cultivation.

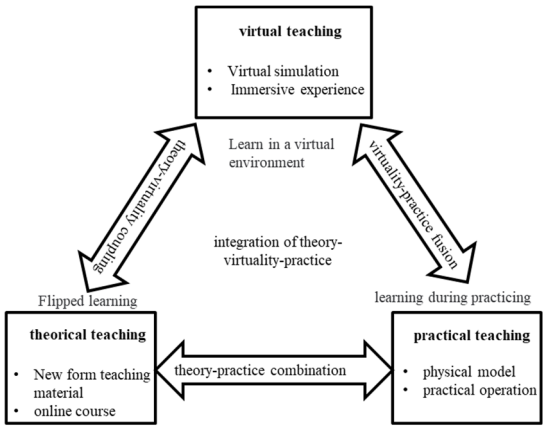

Figure. 1. integrated teaching mode of theory-virtuality-practice

The integration of theory-virtuality-practice is the extension of the integration of theory - practice, and takes virtual teaching as a bridge to set up a channel between theoretical teaching and practical teaching. Virtual systems are divided into three categories: virtual reality (VR), augmented virtual reality (AR) and mixed virtual reality (MR) [4]. VR is the use of computer simulation to produce a three-dimensional virtual world, providing users with visual, auditory, tactile and other senses of the simulation, so that users immersive. AR is the use of computer

technology to apply virtual information to the real world, and the real environment and virtual objects are superimposed into the same space in real time. MR Is a combination of real and virtual worlds to create new environments and visual 3D worlds where physical and digital objects coexist and interact in real time to simulate real objects [5].

Virtual simulation teaching plays two roles in the practical training process: the first is to assist theoretical teaching. For teaching content with complex structures, abstract principles, long experimental cycles, and high resource consumption, it can be demonstrated through virtual simulation. VR teaching system is a commonly used method. Through students operating in the VR teaching system and displaying the VR practice process on an interactive large screen, the teacher explains and the students operate, abstract problems are clarified and complex structures are concretized. The second is to assist practical teaching. Due to the limited number of practical training equipment, most colleges find that it is difficult to achieve a set of experimental equipment per person. Skill training can be conducted within the VR teaching system first, and virtual exercises can be conducted on the work steps of typical work tasks. After mastering the skills, practical operations can be carried out on real devices. This operation can not only save costs but also improve practical efficiency.

3 The construction concept of the “integrated training room of theory-virtuality-practice”

In the construction process of the integrated training room of theory-virtuality-practice in vocational colleges, full consideration should be given to the actual needs of the profession. With the idea of "scientific planning, demand orientation, Work-Study Combination , open innovation, integration of wisdom, and consideration of competitions", specific goals for the construction of the integrated training room of theory-virtuality-practice should be formulated and strengthened to ensure practical results.

3.1 Scientific planning

To break the common pattern of “purchasing equipment first, planning courses later, and separating equipment from needs”, actively combine the requirements of professional talent training programs, as well as the actual situation of school venue planning, financial support, and student numbers in the early stage of carrying out the construction of training rooms, fully analyze the requirements of the curriculum system for the training room, and reasonably plan the types, sets, and functional area division of teaching equipment, targeted selection of practical training equipment to meet the needs of teaching, scientific research, practical training, and other aspects of the college [6]. During the process of construction of the integrated training room of theory-virtuality-practice, we should have a sense of foresight, get rid of the influence of traditional experience, adhere to the system concept, fully consider the needs of the current stage and medium and long-term development of the specialty, closely combine with the new situation of the development of related specialties, reasonably plan the site, instruments and equipment, tool kits, etc., to ensure that it has a certain degree of progressiveness.

3.2 Demand orientation

It is necessary to follow the orientation of vocational education serving the local economy, adhere to the employment-oriented, and on the basis of fully investigating the development of the corresponding local industries, try to choose the teaching equipment consistent with the local mainstream products, meet the basic teaching and practical training needs, and cannot be divorced from the local reality. Based on the principle of systematization of work process, with real work tasks as the carrier, strengthen the cultivation of students' comprehensive vocational ability. After the training of “integrated theory-virtuality-practice”, students can directly apply what they have learned to work and truly apply what they have learned.

3.3 Work-Study Combination

It is necessary to fully integrate the talent training program of technical colleges and enterprises, regularly invite first-line experts from enterprises to participate in course development and formulate course standards. It constructs a modular curriculum system with career background, job demand as the basis, work task as the clue, work process as the basis, ability as the standard, learner as the center and project curriculum as the main body. After the enterprise technology update, the curriculum standard should be updated in time. Make full use of virtual simulation technology, simulate the actual working scenes of enterprises in the training room, and integrate the typical tasks of enterprises into the practical training teaching. While teaching students theoretical knowledge, teachers let students hands-on operation, so that work and learning truly integrated.

3.4 Open innovation

Some colleges also serve as local vocational education centers, providing venue support for employee training and skill competitions within the region. Therefore, when planning and constructing an integrated training room, it is necessary to consider the needs of relevant social services, comprehensively consider the construction goals of the training room, reasonably set up and arrange workstations, and balance the needs of student cultivation and social services, in order to maximize the function of the training room. The construction of training rooms can also be achieved through college-enterprise cooperation with local relevant enterprises to jointly build training rooms. colleges can provide venues, teaching staff, and enterprises can provide relevant equipment and resources. This can not only alleviate the financial pressure on schools, but also improve the utilization rate of training rooms, achieving more with one action [7].

3.5 Integrating wisdom

Technology is developing rapidly, and intelligent new technologies and methods are constantly being applied in teaching. In terms of teaching methods, flipped classroom, blended learning, online and offline, ubiquitous learning, etc. have become the new norm. Therefore, the training room should meet the needs of intelligent teaching, integrating virtuality and practice interaction, interesting digital resources such as sound and light, and provide support for conducting offline and online blended learning, course resource inquiry, and learning process evaluation, and stimulate students' interest in learning. In addition, virtual simulation has become an important auxiliary means in the training process. Introducing VR technology into teaching, adopting diverse VR technology and VR training software, conducting teaching and training activities such as structural cognition, performance testing, and skill training, improving students'

understanding of knowledge, deepening their memory of knowledge, improving learning efficiency, and reducing experimental costs. Colleges with conditions can also consider integrating teaching around the six aspects of "teaching, learning, training, integration, sharing, and colsed-loop" to create a smart and interactive "integrated training room of theory-virtuality-practice" [8].

3.6 Consideration of competitions

Skills competition has played an important role in leading the " three education reform " of vocational education, improving the training quality of technical skills talents, promoting high-quality employment, serving economic and social development, and facilitating the exchange and cooperation of vocational education between China and foreign countries. Most technical colleges attach great importance to skills competition. At present, some vocational colleges overemphasize and chase skills competitions, and constantly purchase competition-related equipment [9]. Skills competition equipment is expensive, which brings a lot of economic pressure to technical colleges. Colleges and universities should look at skills competitions rationally, not only see the important role of competitions in leading professional construction and teaching reform, but also purchase relevant equipment according to the actual situation of colleges and universities.

4 The construction path of integrated training room of theory-virtuality-practice

4.1 Requirment analysis

First of all, it is nesssary to conduct a requirnent analysis for the training room. It is necessary to fully consider the teaching requirements of the talent training program and meet the needs of the professional core course teaching for the training room in the curriculum system. The corresponding relationship between the curriculum system and the training room is diversified. It can be one-to-one, that is, a course corresponds to a training room, which has relatively high requirements for venues, equipment and funds. A one-to-one training room requires the purchase of a large number of training equipment. For colleges with limited space and funds, a one-to-many format can also be adopted, that is, one classroom can respectively meet the practical training teaching needs of multiple professional courses. This training room can maximize the use of training room and teaching equipment, improve the utilization rate. The disadvantage is that when there are more specialized courses or classes, it will bring difficulties to the course scheduling. In the requirment analysis, to be fully demonstrated, you can use the group discussion method, research method, questionnaire survey method, expert guidance method, etc.

4.2 Equipment purchasing

Practical training equipment is an essential part of the integrated classroom. The practical training equipment is divided into physical equipment, analog equipment, virtual equipment, etc., as shown in Table 1.

Table 1. Equipment type and comparison

Equipment Form	Equipment Type	construction cogniti ving	Demonstration of princ iple	performance testing	skill training	Site requirement	feeling	cost
physical	Real parts, systems or complete equipment	√	√	√	√	√	real	high
simulative	A teaching model made with reference to real equipment	√	√	/	/	√	intuition	mediu m
virtual	Computer simulation models, various virtual reality devices, including VR, AR, MR	√	√	√	√	√	Strong immersi on	mediu m

In addition to the above equipment, the convenience of teaching and operator safety should also be considered, and labor protection products should be equipped, including insulation caps, masks, goggles, acid and alkali protective gloves, insulating gloves, insulating shoes, etc., to protect the operator from electrical injury, corrosion, physical injury, electromagnetic radiation and other injuries. Conditional colleges can also consider purchasing smart teaching systems, including cloud platform cameras, training cameras, interactive training hosts, central control system sound systems, electronic whiteboards, multimedia large-screen machines, etc.

4.3 Site planning and the construction of the " integrated traning room of theory-virtuality-practice"

According to the actual training teaching need, manage the actual integrated training rooms should have: The multimedia teaching area, discussion area, VR teaching area, experimental area, operation area, instrument and equipment area, teacher work area, etc. are shown in Figure 2.

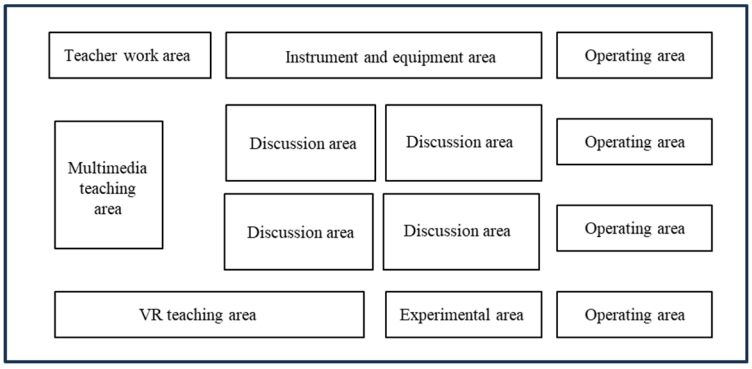

Figure. 2. Design of functional area of the integrated training room

In the picture, the multimedia teaching area is the area where teachers play teaching courseware and teaching resources, usually placing computers and multimedia large-screen all-in-one

machines. Discussion area is a place where students listen to lectures and discuss. Students are usually divided into 4-6 groups, and each group sits together to discuss knowledge and make plans. In the VR teaching area, students or auxiliary teachers can operate and project corresponding content onto a large screen, making it easier for students to understand the teaching content intuitively. Students can also use the VR teaching system for cognitive and skill training in groups. Several teaching equipment and instruments are placed in the experimental area to facilitate the verification of the correctness and feasibility of theoretical knowledge through experiments. Key and important teaching equipment is placed in the operation area, where students engage in practical operations to improve their hands-on abilities and cultivate key skills. Store testing instruments, disassembly tools, etc. The instrument and equipment area stores testing instruments, dismantling tools, etc., providing support for practical operations. Teachers prepare for classes and review work orders in the teacher's workspace. The above seven areas are the basic elements of the integrated training room of theory-reality-practice, and can be adjusted according to actual situations.

During the construction of the training room, it is necessary to carry out the decoration and construction of the training room according to the actual needs in accordance with the principles of safety and reliability, reasonable layout, satisfying demand and saving cost. The ground of the training room should be treated in a targeted manner, and the needs of anti-slip, insulation and anti-corrosion should be fully considered, and a reasonable ground treatment program should be selected. It is also necessary to analyze the electricity demand of teaching equipment and carry out circuit construction transformation. Regional planning should also consider the requirements for equipment access to the training room and fire safety requirements.

5. The connotation construction of the integrated training room of theory-reality-practice

The connotation construction of the training room includes the environment culture construction and the system culture construction of the training room. Good training room culture is conducive to improving the quality of training teaching.

5.1 Culture construction of training room environment

The culture construction of training room environment helps to create a good learning atmosphere, stimulate students' desire to explore, cultivate students' learning habits and innovative spirit, and improve students' professional quality. Contents of culture construction of training room environment were shown in table 2:

Table 2. content of culture construction of training room

item	contents	function
System palte	It mainly includes teachers' instructions, students' rules, administrators' duties and so on.	Lay the foundation for the normal operation of the training room, make the equipment of the training room be effectively used, managed and maintained, and ensure the safe and efficient operation of the training room.

Publicity board	Essential information of the traning room such as area and function, equipment list, social service situation, achievement, award certificate, etc.	Introduce the basic situation of the training room of "integration of theory, virtual and real".
Culture propaganda	Professional technology development history, famous historical figures, classic case posters, etc	To carry forward professional culture, cultivate students' sentiment, build healthy personality, and comprehensively improve students' quality.

5.2 Construction of system culture of " integrated training room of theory-reality-practice"

Scientific management and operation mechanism is conducive to giving full play to the maximum use efficiency of teaching equipment and venues [10]. It is necessary to formulate perfect rules and regulations of the practical training room to provide institutional guarantee for students' personal safety and the smooth implementation of practical training. The management system is formulated for teachers, students and administrators of the training room respectively. The main contents of the relevant system are shown in table 3.

Table 3. Management systems and their main contents

system name	contents
Instruction for teachers	Use of training room, management of the students, equipment operation, teaching management, communication with administrators, etc.
student rules and regulations	To the students on attendance, listening management, class discipline, equipment use, training room health duty, communication with the administrator, etc.
Job responsibilities of management personnel	Classroom borrowing, training equipment inspection, student management, material management, key management, health management, safety management, etc.

6 An example of the construction of "integrated training room of theory-reality-practice" for new energy vehicles

The construction of the training room includes four parts: the purchase of teaching equipment, supporting equipment, site layout and cultural construction of the training room.

6.1 Teaching equipment

When purchasing teaching equipment, it is necessary to fully consider the teaching requirements of the talent training program, and cover all new energy vehicle professional courses as far as possible. The equipment should also meet the requirements of hierarchical training of basic skills, core skills and comprehensive skills. The list of teaching equipments are shown in Table 4.

Table 4. List of teaching equipments

equipment type	equipment schedule
key component assembly	Power battery assembly, drive motor and reduction drive axle assembly, anatomy motor model (switched reluctance motor, permanent magnet synchronous motor, AC asynchronous motor, wheel rail motor), motor controller, DC/DC teaching AIDS, PTC heater, heat exchanger assembly, electric scroll compressor, swing plate compressor, refrigerant filler, vacuum pump, EPB motor reduction device teaching AIDS, 3 Integrated charging and distribution teaching AIDS, 4-in-1 high-voltage electronic control teaching AIDS, vehicle charger, high-voltage control box, EPS assembly, electronically controlled braking system, hydrogen fuel cell trolley, cardiopulmonary resuscitation dummy, etc.
experiment bench	motor control practice test platform battery management practice test platform vehicle control training platform charging management practice testing platform
vehicle protection and warning kit	fender cloth, car maintenance interior five sets warning fence, warning signs
general utility tool	Battery disassembly platform, jack, SKidar tool set (including hexagonal socket, 12-angle socket, ratchet, wrench, etc.)
testing instrument kit	Battery internal resistance tester, insulation resistance tester, multimeter, oscilloscope, current clamp, ground resistance tester, freezing point tester, manifold pressure gauge
new energy vehicle	Classroom borrowing, training equipment inspection, student management, material management, key management, health management, safety management, etc.

6.2 Corollary equipment

The list of supporting equipments are shown in Table 5.

Table 5. List of supporting equipments

equipment type	equipment schedule
Vehicle protection and warning kit	fender cloth, car maintenance interior five sets,warning fence, warning signs
labour protection appliance	insulation cap, face mask, goggles, acid and alkali protective gloves, insulation gloves, insulation shoes
lifting machine	Double column lift
New energy vehicle VR teaching system	VR equipment (helmet, locator, workstations, etc.) new energy cars geely VR teaching system, Volkswagen new energy vehicle VR teaching system
Intelligent teaching system	cloud platform camera, training camera, interactive training host, central control system sound system, electronic whiteboard, multimedia large-screen all-in-one

6.3 Training room site planning and construction

According to the actual practical training teaching needs, the functional area division of the integrated practical training room is shown in Figure 2.

Insulate the floor. Because the new energy vehicle has a high voltage system, when the high voltage live operation is carried out, the current may form a circuit through the human body and the earth, resulting in electric shock accidents. Therefore, in the planning or construction of the new energy training room, the ground can be designed as an insulated ground under the premise of sufficient funds. If the construction funds are insufficient, it is also possible to lay insulation MATS with an insulation grade of more than 1000V in the areas involved in high-voltage operations to avoid electric shock during teaching and training.

In order to ensure the normal use of the training vehicle, its battery power should be maintained. If the electric vehicle is not charged in time during the winter and summer holidays or when there is no class for a long time, its battery may be permanently damaged due to overdischarge. Therefore, the charging and maintenance of new energy vehicles should be an important work. Before the construction of the new energy vehicle training room, consider the factors of charging and maintenance of new energy vehicles, and design and arrange the lines of the training room in advance. Charging is divided into two forms of slow charging and fast charging, and the college can choose the charging form according to the characteristics of the training room.

In the practical training and teaching of new energy vehicles, it is often necessary to lift the vehicle in order to disassemble the chassis components and high-voltage batteries, and the lift machine is an essential auxiliary equipment. In order to facilitate the disassembly of the power battery, the column elevator is generally selected. When installing the lift, be sure to check the ground load conditions.

6.4 connotation construction of integrated training room of theory-reality-practice" for new energy vehicles

The connotation construction of the training room of new energy vehicles mainly includes the construction of the environment culture of the training room and the construction of the system culture of the training room. Good training room culture is conducive to improving the quality of training teaching.

According to the characteristics of the teaching of new energy vehicles, the training room environment and culture construction and system construction have been carried out, and the new energy vehicle training room system plate, training room publicity column and automobile culture publicity column have been formulated, respectively, the management system has been formulated for teachers, students and training room administrators.

6.5 New energy vehicle course teaching practice

The integrated training room of "theory-reality-practice" for new energy vehicles supports the teaching of four core professional courses of the new energy vehicle engineering major such as power battery and management system, drive motor and control system, new energy vehicle control system, and new energy vehicle fault diagnosis. These courses are taught in a single class. Arrange 4 class hours each time, the first 2 class hours teach theoretical knowledge, and arrange students to study and discuss in groups. In the last two class hours, students are arranged to carry out VR experience and practical operation. For structural cognition, some functional test projects and fault diagnosis projects, new energy vehicles and test benches can be used for practical operations. For risky test box projects and practical training projects that require repeated disassembly, students are arranged to give priority to VR experience. Through the

integrated teaching mode of theory-reality-practice, students' interest in learning can be improved, their mastery of theoretical knowledge can be deepened, their practical skills can be enhanced, and it is also conducive to safer and more efficient use of teaching resources.

A questionnaire was designed to investigate the traditional theory teaching mode and the relevant investigation of using the integrated teaching mode of "theory-reality-practice" in the training room. A total of 63 questionnaires were issued and 61 documents were recovered, with a recovery rate of 96.8%. Questionnaire survey dimensions include difference perception dimension (under the two teaching modes), teacher's teaching evaluation dimension (4 items, It includes teaching attitude, teaching design, teaching content and teaching behavior), classroom atmosphere dimension (5 items, including learning interest, concentration, learning efficiency, classroom enthusiasm and teacher-student communication) and ability cultivation dimension (6 items, including independent learning ability, independent thinking ability, innovative thinking ability, knowledge understanding ability, practical operation ability and team cooperation ability)[11]. A 5-level scoring method was adopted for the items in the scale. The options of the items were strongly disagree, disagree, indeterminacy, agree, strongly agree, which were calculated as 1, 2, 3, 4 and 5 points respectively. The survey results are shown in Table 6.

Table 6. List of survey results

dimensionality	item	strongly agree	agree	indeterminacy	disagree	strongly disagree	average score
perceiving differences	obvious difference	41.0%	50.8%	3.3%	3.3%	1.6%	4.3
Teacher's teaching evaluation	more positive teaching attitude	42.6%	49.2%	4.9%	1.6%	1.6%	4.3
	more diverse eaching design	41.0%	50.8%	3.3%	3.3%	1.6%	4.3
	more suitable teaching content	39.3%	50.8%	3.3%	3.3%	1.6%	4.2
	more efficient teaching behavior	47.5%	45.9%	1.6%	1.6%	3.3%	4.3
classroom atmosphere	improve learning interest	44.3%	50.8%	1.6%	1.6%	1.6%	4.3
	easier to concentrate	45.9%	45.9%	4.9%	3.3%	1.6%	4.4
	easier to improve learning efficiency	45.9%	50.8%	3.3%	3.3%	1.6%	4.5
	easier to increase classroom enthusiasm	47.5%	47.5%	0.0%	1.6%	3.3%	4.3
	promoting teacher-student communication	52.5%	41.0%	4.9%	1.6%	0.0%	4.4
ability training	promoting independent learning ability	42.6%	50.8%	3.3%	1.6%	1.6%	4.3
	promote independent thinking ability	44.3%	50.8%	1.6%	1.6%	1.6%	4.3
	promote innovative thinking ability	37.7%	42.6%	9.8%	6.6%	3.3%	4.0

promote knowledge understanding	39.3%	44.3%	8.2%	4.9%	3.3%	4.1
cultivate practical operation ability	54.1%	42.6%	3.3%	0.0%	0.0%	4.5
strengthening the teamwork ability	41.0%	52.5%	3.3%	3.3%	0.0%	4.3

As shown in Table 6, 91.8% of the students have obvious feelings about the difference between traditional teaching mode and the integrated teaching mode of "theory-reality-practice". Compared with the traditional teaching mode, the students' recognition degree (strongly agree + agree) for each item is more than 90.0%. The average score is more than 4 points, which indicates that students have a high degree of recognition of the integrated teaching mode of "theory-reality-practice", and the teaching effect has been significantly improved. In the dimension of teacher's teaching, the item with the highest recognition is "more positive teaching attitude" (91.8%). On the dimension of classroom atmosphere, the item with the highest degree of recognition is "promoting teacher-student communication" (93.5%). In terms of ability cultivation, the item with the highest degree of recognition is "cultivate practical operation ability" (96.7%). According to the results of the questionnaire, the construction of training room and the teaching effect of the integrated teaching mode of "theory-reality-practice" meet the project construction expectations.

7 Conclusion

The integrated teaching of theory-virtuality- practice is a new attempt to integrate theoretical teaching, virtual simulation teaching and practical teaching, and is an important starting point to deepen the connotation construction of colleges and universities and improve the precision of talent training. However, the research on the integrated teaching mode of theory-virtuality-practice is still in the preliminary stage. This paper focuses on the general ideas and methods of the construction of practical training room under this mode. Each college and specialty has its own unique talent training, so a training room construction plan that meets the development needs of the college should be formulated based on the professional development situation of the school, the size of students, venues and funds.

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