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Exploration and research on the paradigm of innovative culture construction in local university computer laboratories and equipment

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Introduction: The culture of computer laboratories and equipment in universities is an important component of university culture. Strengthening the construction of laboratory and equipment culture is an inevitable requirement for implementing the goal of moral education, improving the level of experimental teaching, and innovating scientific research achievements.

Methods: (1) Integrating ideological and political elements into experimental teaching content to enrich students' moral and professional development; (2) Introducing a new teaching model "learning competition conjugation" to modernize equipment usage and stimulate innovation; (3) developing an open practical education platform based on the integration of science and education; and (4) establishing a science popularization education platform to inspire creativity and broaden scientific thinking.

Results: Enhanced students' professional skills, ideological awareness, and creativity. Laboratory usage became more dynamic, with improved teaching effectiveness and interdisciplinary collaboration.

Discussion: Strengthening laboratory culture through ideological integration and innovative teaching fosters a more open, holistic, and creative academic environment, offering practical guidance for university reforms.

KEYWORDS

laboratory culture construction, integration of ideological and political education, learning competition conjugation, integration of science and education, science popularization driven

1 Introduction

In the National Conference on Ideological and political work in Colleges and universities, it is emphasized that colleges and universities should pay attention to the creation of cultural campus, and cultivate healthy and positive talents of the new era with elegant style and various forms of campus cultural activities (Tissenbaum et al., 2021; Hou et al., 2022; Kelley, 2021). As an important component of the multicultural matrix in universities, laboratories are important practical places for conducting experimental teaching (Zhang Q., 2020; Goller et al., 2021; Xuegang and Yingying, 2018), scientific and technological innovation activities (Zhang et al., 2021; Yang et al., 2019; Luo, 2022), and important guarantees for moral education and social services (Zhang et al., 2020;

Rong and Gang, 2021; Li et al., 2023). The construction of laboratory and equipment culture has gradually been included in the scope of the construction of propaganda and cultural positions in major universities (Zhang Y. et al., 2022). By studying the new characteristics of laboratory culture construction, accurately grasping the direction of laboratory culture construction, actively carrying out laboratory culture construction can inject vitality into the laboratory, awaken its cultural consciousness, and form an innovative culture, thereby enhancing the ability of laboratory sustainable development (Ji, 2021; Fu, 2024; Liu et al., 2023). The construction of innovative laboratories and equipment culture has important practical and far-reaching strategic significance for the construction of university laboratories.

With the rapid development of information technology and the continuous innovation of education mode, computer laboratory is not only a place for academic research and technical experiments, but also a key platform for practical teaching and innovative training in higher education (Liu, 2021; Gao, 2023; Lin, 2021). However, at present, many university computer laboratories still face some problems in cultural construction, including outdated facilities, loose management, lack of innovation atmosphere, etc. These problems not only affect the cultivation of students' learning and scientific research ability, but also restrict the role of the laboratory as an innovation base (Sun, 2022; Sun and Wang, 2023; Zhang and Jiang, 2023).

To this end, this paper aims to take the problems existing in the cultural construction of university computer laboratory as the breakthrough point, and explore the construction methods of innovative culture of laboratory and equipment management from four aspects of spiritual culture, material culture, professional culture and popular science culture, aiming to provide an effective example for the cultural construction of university computer laboratory.

2 Problems in the cultural construction of university computer laboratories

2.1 Lack of innovation in teaching content and insufficient integration of ideological and political education

As the key link of Cultivating College Students' practical and innovative ability, experimental teaching in Colleges and universities plays an important role in improving students' practical ability, the ability to analyze and solve problems, and the scientific way of thinking (Chen and Zhai, 2024; Wang, 2020; Lin, 2024). Through experimental teaching, students can move from theory to practice, and can exercise their ability of independent thinking, innovative design and problem solving, which is very important for cultivating high-quality talents with strong practical ability. However, in reality, experimental teaching in Colleges and universities is facing many challenges, among which the limitation of teaching materials and laboratory resources often becomes one of the main bottlenecks affecting the quality of experimental teaching.

In many colleges and universities, teachers can only rely on the traditional and fixed experimental cases for teaching, and most of these cases are modular and repetitive, lacking enough innovation. Experimental textbooks and cases often lag behind the latest scientific research achievements and technological progress, and cannot be updated and expanded with the times, which makes the content and methods that students can experience in the experiment relatively limited, and can not comprehensively improve students' innovative thinking and experimental operation ability. In addition, due to the tight arrangement of experimental courses and heavy teaching tasks, it is often difficult for teachers to spare enough time and energy to design new experimental cases and teaching activities. Although some teachers are exploring how to integrate innovative and practical experimental cases into the classroom, the pace of innovation is still slow due to many factors.

At the same time, the integration of Ideological and political education is also a major problem in the current experimental teaching in Colleges and universities. The exploration of Ideological and political elements in experimental courses is not in place. Some teachers lack in-depth thinking about the combination of Ideological and political education and professional courses. They just regard it as an additional task and mechanically combine the content of Ideological and political education with experimental courses. This method is often formal and mechanized, and fails to achieve the integration of Ideological and political education and professional education in essence, resulting in the sense of separation of Ideological and political education and the sense of disconnection of experimental teaching. This practice not only weakens the overall continuity and integrity of the experimental course, but also makes students feel excluded from ideological and political education, affecting students' learning enthusiasm and initiative, thus reducing the educational effect of experimental teaching.

2.2 Course experiment equipment is outdated, which limits the cultivation of innovative thinking

At present, the computer experiment course in Colleges and universities is facing a series of problems to be solved, especially in the updating of teaching methods, experimental content and experimental resources. For a long time, many universities' computer experiment courses still use outdated teaching methods and experimental cases. The contents and forms of these courses fail to keep up with the rapid development of science and technology, resulting in a single and boring experimental teaching method, which can not meet the development needs of modern engineering technology. With the rapid progress of information technology, great changes have taken place in the computer field, and new programming languages, development tools, artificial intelligence, big data, cloud computing and other emerging technologies are emerging in endlessly. However, the traditional experimental contents and cases often can not fully demonstrate the application of these new technologies. It is difficult for students to contact these cutting-edge technologies in the experimental process, resulting in their lack of motivation for innovation and interest in practice.

In addition, the current computer experiment course also has great deficiencies in cultivating students' innovative thinking and independent design ability. Many experimental courses still rely on closed and standardized experimental steps. Students only operate according to the experimental guidance provided by teachers, lacking space for independent design and problem solving. This teaching method not only inhibits students' innovative thinking, but also easily leads to the solidification of students' thinking mode, which is difficult to deal with the challenges of future technological development. The experimental course should be an important platform to stimulate students' interest, cultivate their practical ability and improve their problem-solving ability. However, due to the old teaching content and the single experimental form, students often lack initiative and sense of participation in the experiment, and even appear perfunctory. Students lose interest in the experiment and are difficult to devote themselves to it, which further affects the effect of experimental teaching.

The lack of laboratory resources is also one of the important reasons why the computer experiment course in Colleges and universities can not be carried out smoothly. Due to the limited teaching resources, many colleges and universities tend to give priority to the allocation of funds to other fields, while ignoring the laboratory construction and the renewal of experimental resources. In some schools, the equipment of the computer laboratory is old and can not meet the needs of modern experimental teaching. Many experimental equipment and equipment can not be repaired or updated for a long time, resulting in the performance and function of the equipment becoming increasingly degraded. The computer laboratory should be the main place to cultivate students' practical ability and innovative spirit, but under the condition of resource shortage, the facilities and equipment of the laboratory can not provide sufficient support, which seriously restricts the quality and effect of experimental teaching. Due to the lack of necessary equipment in the laboratory, many complex or advanced experimental projects can not be carried out, students can not exercise their ability to solve practical problems in practice, and the innovation potential can not be effectively brought into play.

2.3 Solidification of laboratory functions and the single mode of practical education

University laboratory is an important part of modern higher education, which undertakes multiple functions, including experimental teaching, scientific research and scientific and technological development (Zhang, 2024; Wu, 2022; Ling, 2023). These functions not only help students improve their practical ability, but also cultivate their scientific research literacy and promote the transformation of scientific research achievements. In this process, students can not only master professional knowledge and skills, but also obtain opportunities for independent thinking and innovation. At present, laboratory education in Colleges and universities is still confined to the traditional concept, emphasizing knowledge transfer and experimental operation, while ignoring the cultivation of innovative thinking, problem-solving ability and interdisciplinary integration. Experimental courses in many colleges and universities are still limited to traditional teaching methods, and students lack opportunities for independent exploration and innovation while completing the scheduled experimental tasks. This kind of teaching method is easy to cause students' fixed thinking mode, and it is difficult to stimulate their interest in active learning and innovation.

At the same time, the current training mode pays too much attention to the teaching of academic knowledge and theory learning, while ignoring the improvement of students' ability in practice (Shang, 2022; He, 2023; Yongliang, 2023). Although students can be exposed to certain experimental operations during the experiment, most of these operations are carried out according to standardized steps, lacking opportunities for independent design and problem solving. Therefore, it may be difficult for students to quickly adapt to the complex and changeable working environment and technical challenges in practical work. With the increasing demand for innovative and practical talents, the traditional single mode has been difficult to meet the needs of modern higher education. Colleges and universities must pay more attention to the cultivation of innovative thinking in experimental teaching, strengthen the integration of interdisciplinary knowledge, and create a more open and diverse learning environment, so as to provide students with broader growth space and comprehensively improve their comprehensive ability.

2.4 Fixed mindset of science popularization mode leads to insufficient innovation power

As the core force leading independent innovation and scientific and technological progress, high-level computer laboratories in Colleges and universities have played more and more social service functions in social openness and cultural education in recent years (Wu, 2023; Zhang B. et al., 2022; Huang and Liu, 2022). However, there are still some problems in the science popularization work of university laboratories, such as low enthusiasm for science popularization and single propaganda mode. It is difficult to mobilize students to export the professional knowledge and skills learned in the laboratory from inside to outside. It is difficult for students to change their way of thinking from passive learning to active learning, and it is also difficult to cultivate and improve their scientific quality. In addition, the science popularization activities carried out by the laboratory are less, and the publicity is not enough. It is necessary to increase the activities for science popularization, transform the scientific and technological resources into effective science popularization productivity, and give full play to the creation and innovation. With the rapid development of science and technology and the increasing demand of society, the social service function of high level laboratory in Colleges and universities, as the core force of scientific research and technological innovation, has become particularly important. In recent years, many university laboratories have achieved remarkable results in promoting independent innovation, serving the society and educating people through culture. However, although the university laboratory plays an important role in promoting scientific and technological innovation, there are some problems to be solved in its science popularization work. For example, the enthusiasm of the laboratory science popularization work is not high, the propaganda mode is relatively simple, the science popularization activities are not carried out enough, and lack of systematicness and innovation, resulting in the unsatisfactory effect and social influence of its science popularization.

Many computer laboratories' science popularization work is relatively passive. The design and organization of science popularization activities are often based on pure academic exchanges and professional display, ignoring the interaction and participation of the society and the public. This practice has led to a low degree of integration between the laboratory scientific research achievements and social needs of students and teachers, and a lack of awareness of transforming professional knowledge and skills into public understanding and application. More importantly, students often stay at the traditional level of classroom learning and experimental operation, lacking the opportunity and motivation to actively output and share the knowledge they have learned to the society. Therefore, students' thinking mode is often passive acceptance of knowledge rather than active exploration and innovation, which hinders the cultivation and all-round development of their scientific quality. Secondly, when carrying out science popularization activities in university laboratories, there are many problems, such as the number of activities is small, the form is single, and the publicity is not enough. Laboratory science popularization activities are often limited to a few senior students, and lack of extensive publicity and popularization for all teachers and students and the public. For example, the open day activities and lectures and other popular science forms in many laboratories often fail to effectively attract the attention and participation of external social groups, and also fail to fully mobilize students' initiative for innovation. Popular science activities often rely on traditional speeches and displays, which lack interactivity and attraction, and are difficult to stimulate public interest and thinking. The potential of laboratory science popularization has not been brought into full play, nor has it effectively promoted the cultivation of students' sense of social responsibility and innovative spirit. The role of social atmosphere.

3 Exploration and practice of cultural construction in university computer laboratories

The development of computer laboratory culture should closely meet the needs of the times, keep up with the pace of technological progress, and constantly improve its core competitiveness. The construction of laboratory culture is not only the simple hardware and software, but also the combination of thought and technology. Through the guidance of innovative thinking and practice, the rapid development of the laboratory should be promoted. In this rapidly changing era, the development of laboratory culture should be forward-looking and inclusive, keep pace with the times, seek breakthroughs in innovation, and promote the two-way development of technology and thought in development. Therefore, in order to do a good job in the construction of laboratory culture, this paper intends to carry out research from four aspects: enriching experimental teaching content by "Ideological and political integration", innovating and applying experimental equipment by "learning competition conjugation", creating an open education platform by "science and education integration" and creating an atmosphere of scientific and technological innovation by "science popularization drive". The specific contents of the construction of laboratory and equipment management innovation culture are shown in Figure 1.

Among them, "Ideological and political integration" is defined as integrating ideological and political education into experimental teaching to combine knowledge imparting and value cultivation through case design. "Learning competition conjugation" refers to a teaching model linking curriculum with disciplinary competitions (e.g., robotics, innovation contests) to enhance practical skills via competition. "Science and education integration" means merging research and teaching resources to build platforms for undergraduates to participate in research projects, cultivating inquiry abilities through real-scenario skills like data analysis. "Science popularization drive" denotes using activities (e.g., exhibitions, lectures) to transform lab innovations into public resources, fostering an innovative atmosphere and social responsibility for technological service.

3.1 Integrating ideology and politics, enriching the experimental teaching content of the course

The traditional experimental teaching in computer laboratory usually follows the mode of "experiment introduction → knowledge explanation → practical operation verification", focusing on the cultivation of knowledge and ability, mainly focusing on the mastery of students' skills. Although this teaching method has achieved certain results in the technical level, it often ignores the integration of Ideological and political education, and lacks the cultivation of students' life values, professional ethics and patriotism and dedication. In the current teaching practice, students usually do not realize how to combine their professional advantages and skills with social needs, so as to give full play to the value of life. For example, how to use the theoretical knowledge learned to solve the problems in practical projects and contribute to the construction of national key projects.

In order to make up for this defect, an innovative experimental teaching method is proposed, that is, based on the traditional experiment, the infrared tracking car production experiment is introduced, and the ideological and political education is carried out from multiple dimensions through this practical activity. As a technical and practical experimental project, infrared tracking car can effectively integrate ideological and political elements such as patriotism education, life value education, ideal and belief education, and form a new teaching mode. Through guiding students to think about how to combine personal professional skills with social needs, and how to make contributions to the prosperity and development of the country through engineering technology, we can not only cultivate students' professional ability, but also deepen their sense of social responsibility.

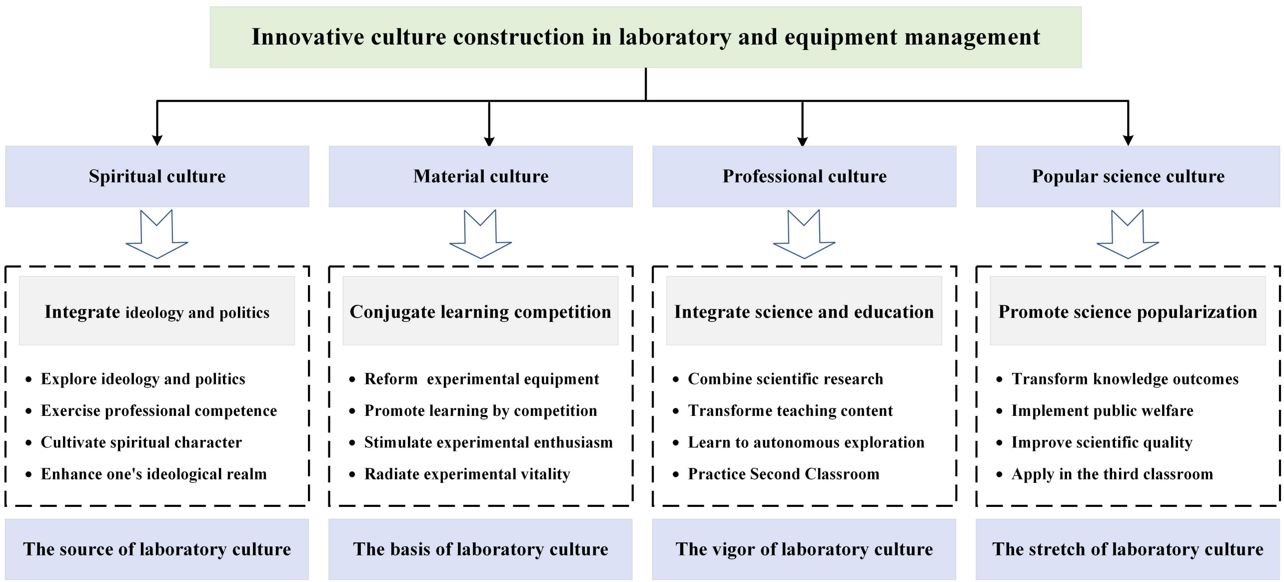

FIGURE 1
Construction content of laboratory and equipment management innovation culture.

Specifically, each component module of the infrared tracking car experiment contains rich ideological and political elements. For example, in the process of designing and making a car, students not only need to master the basic principles and applications of hardware such as sensors and drive motors, but also can deeply understand the important role of scientific and technological innovation in national development through this process, so as to further stimulate students' patriotic enthusiasm. At the same time, in the process of car debugging and optimization, students can cultivate the ability of teamwork and solving practical problems, which also helps them understand the relationship between personal value and collective responsibility. Through this practice, students can not only improve their professional skills, but also enhance their sense of mission to contribute to society in the process of solving practical problems. See Table 1 for the ideological and political elements contained in the composition module of the infrared tracking car.

Ideological and political education will always run through the whole experimental teaching. When introducing the use of each hardware module, by explaining the "neck sticking" event in the current competition between China and the United States, it points out the shortcomings of China in the relevant core areas, wakes up students' sense of crisis, and cultivates students' responsibility; When introducing asset tags and safety signs on hardware facilities, students' awareness of cherishing equipment, saving resources and sustainable development is cultivated by sharing equipment use history and safety accident examples; When summarizing the common problems of students' software and hardware self debugging and verification, cultivate the students' fighting spirit of fearing difficulties, climbing the world's scientific and technological peak, and the spirit of the times of free development, innovation and entrepreneurship.

Through the organic combination of platform experiment, physical experiment and ideological and political education, this teaching method breaks through the limitation that traditional experimental teaching only focuses on the technical level, and can achieve the goal of Ideological and political education in the whole process of experimental teaching. At the same time of imparting knowledge, cultivate students' sense of social responsibility, innovative spirit and patriotism, and ultimately promote students to become comprehensive talents with noble professional ethics and sense of social responsibility.

3.2 Conjugating learning competition, innovating and applying laboratory equipment

Professional subject competition is the medium to combine the core technology and knowledge required by the competition with professional courses, so as to realize the close integration of teaching tasks and competition contents, so as to realize the concept of "learning to promote competition". Through the concept of "learning to promote competition", students in the process of participating in discipline competitions are not only pursuing competition awards, but also constantly consolidating and improving their practical application ability and innovative thinking in the professional field. Specifically, the content of the competition often requires students to use the theoretical knowledge they have learned to solve practical problems. This task oriented learning method can promote students' deep understanding and mastery of knowledge, help them combine the theory learned in the classroom with the actual needs in the real world, and achieve higher learning effect.

TABLE 1 The ideological and political elements of the infrared tracking car module.

Infrared tracking car module	Example of entry point	Ideology and politics
Code program	Lei Feng's dedication story	Serve the society and people
Infrared tracking module	Apply chemical security	Conquer engineering poser
STC89C52RC chip	Long history of computer	Climb the technological peak
Wheel movement module	Genius Hawking's story	Tenacious personality power
Acrylic plate	National "14th five year plan"	Sustainable development
Motor drive module	Red shirt forest sand blown	Teamwork and fearlessness

In this process, teachers play the role of guides and guides, not only to provide students with the support of professional knowledge, but also to guide students how to apply these knowledge to the competition, so as to stimulate their innovative spirit and team cooperation ability. Students usually participate in the preparation work as team members. This team cooperation mode is not only a challenge to technical ability, but also to cultivate the cooperation and communication ability between students. Team members need division of labor and cooperation. When facing competition tasks, everyone should take responsibility, support and encourage each other, so as to enhance their comprehensive quality, including problem-solving ability, leadership and sense of responsibility. At the same time, in order to better support the preparation for the competition, students should focus on the skills and knowledge related to the competition in their usual course learning. Teachers can adjust and supplement the course appropriately according to the competition content, so that the course teaching and competition content are highly consistent. Through this "learning competition integration" teaching mode, students can not only obtain more solid professional knowledge, but also learn to apply it in practice, and improve their ability to deal with complex problems and practical operation ability. In this way, the course learning is not only to cope with the examination, but also to become the basis for the development of students' practical ability and innovation ability, forming a benign interaction of two-way promotion.

Solidify the construction of the laboratory platform, introduce infrared tracking car hardware and necessary equipment for production, and add independent design and competition segments to implement the practical teaching model from "learning through competition, learning through competition" to "learning through competition conjugation", as shown in Figure 2. In the physical production process, students independently explore and research the working principle of the hardware related to the infrared intelligent tracking car, integrate the Marxist philosophy of "seeing through phenomena to see essence", form their own teams to produce physical objects, connect with practical engineering knowledge, master the scientific methods of group collaboration and correct debugging, and ultimately achieve the tracking function of the car on the track. In the on-site defense stage, the participating members showcase their refined introduction to the project and their ability to respond to judges' questions on site. The defense corresponds to course design and professional comprehensive design. During the teaching process, a pre-defense is established in the same scene as the competition, and existing problems are corrected to improve the quality of the formal competition.

The "learning match conjugation" practical teaching model effectively promotes the comprehensive improvement of students' professional skills and ideological and political literacy by combining subject competition with classroom learning. Driven by the competition demand, the model enables students to have a clear goal in the learning process, carry out targeted learning, make up for the short board of knowledge, and strengthen the combination of theory and practice. In this mode, students can not only master textbook knowledge, but also apply it to solve practical problems through competition preparation. In the process of guidance, teachers guide students to connect theory with practice, build a systematic knowledge framework, and improve students' professional ability. In addition, the competition requires students to have strong autonomous learning ability and innovative thinking. In the face of complex problems, students must rely on autonomous learning and teamwork to solve them. The innovation of the competition requires students to constantly try new methods, and cultivate their innovative thinking and problem-solving ability.

3.3 Integrating science and education, creating an open practical education platform

Student education is not limited to classroom education. Extracurricular second classroom education also plays a vital role in the growth and development of students (Zhang X., 2020; Dong, 2022; Rong, 2021). Classroom education is undoubtedly the main way for students to obtain knowledge, but classroom teaching mainly focuses on the teaching of theoretical knowledge. Although experimental courses can help students obtain practical experience to a certain extent, due to the limitations of class hours and resources, students' practical ability and innovation ability are difficult to be fully exercised. Therefore, how to effectively combine the second classroom with classroom education and give full play to its complementary role in cultivating students' innovation and practical ability has become an important issue in the current education reform. In order to make up for this deficiency, more and more schools realize that the management mode of open laboratory is very important for the cultivation of students' practical ability. In the past, the laboratory management mode was usually closed, that is, it was only open in the designated experimental class hours, but closed at other times. This management mode could not meet the needs of students' Extracurricular Autonomous Learning and innovative practice. In order to solve this problem, the school began to explore a more flexible and open laboratory management mode, allowing students to independently use experimental facilities outside class, carry out research and experimental operation, so as

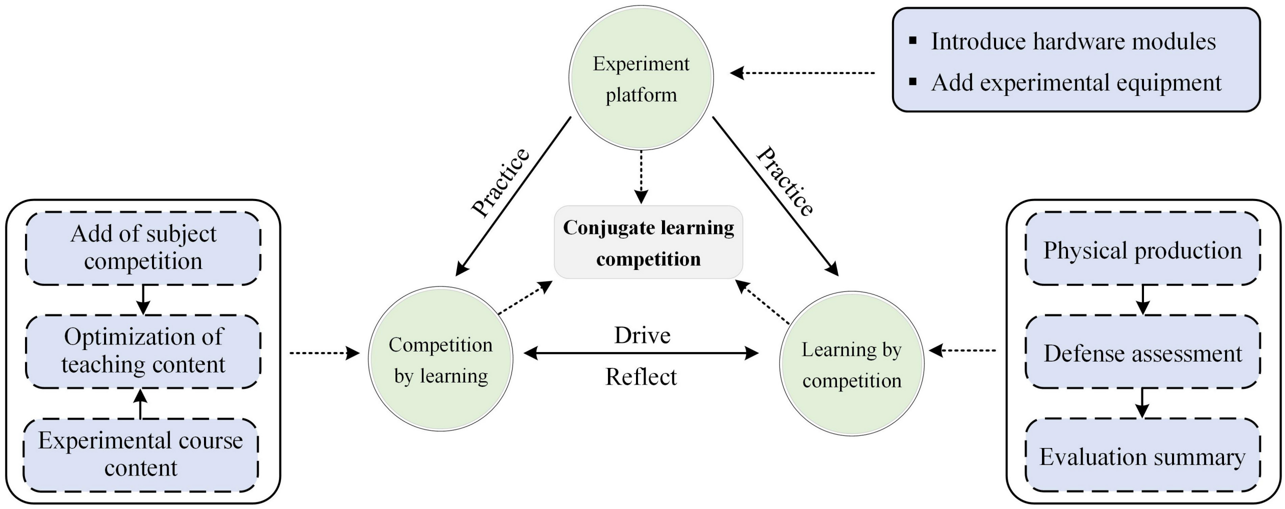

FIGURE 2
The practical teaching model of "Conjugate learning competition".

to expand their practice space and cultivate their practical ability and innovation consciousness.

In this context, the school actively promotes the construction of "science and education integration" integrated comprehensive laboratory. This kind of laboratory is not only a place for students to carry out experimental operations, but also to transform scientific research achievements into teaching contents and integrate them into students' daily learning and innovative practice. Students can not only carry out extracurricular experiments here, but also carry out independent research and exploration by participating in scientific research projects and train their ability to solve practical problems. This practice mode can not only enable students to find the lack of their professional knowledge in the process of scientific research and innovation, but also promote their active learning and improve their comprehensive ability.

At the initial stage of practice, teachers will formulate a detailed scientific research and teaching practice project plan for students, and help students identify scientific problems in the project by combining the learning methods of scientific guidance and intensive literature reading. Through this method, students can not only understand the theoretical background of the subject, but also stimulate their desire to explore and cultivate innovative thinking. In this process, students put forward assumptions through in-depth analysis of literature, and began to think about possible solutions. This training helps to cultivate their critical thinking and problem-solving ability. In the practical exploration stage, students can make physical production, prototype design and write project plan according to their understanding of the project. In this process, students will encounter various challenges and bottlenecks. At this time, they can actively communicate and discuss with teachers or classmates, and seek solutions with the collective wisdom. In this process, students can not only improve their hands-on ability, but also learn teamwork and cultivate the ability of communication and cooperation.

At the completion stage of practice, students can convert the achievements of scientific research projects into actual products or applications, and can independently participate in various discipline competitions, patent applications, software copyrights, academic papers and other activities. This stage is the display and test of students' innovative achievements. Through competition with other excellent students, students can continuously improve their academic ability and obtain recognition from the society and academia. By participating in these academic activities, students can not only consolidate their knowledge, but also cultivate the ability of independent thinking and critical analysis, thus laying a solid foundation for their future academic or career.

3.4 Driving science popularization, creating an atmosphere of scientific and technological innovation

At present, China is faced with the population aging, fewer children and the gradual extension of life expectancy and other complex demographic changes (Rui, 2021; Xu and Wang, 2022; Yafei et al., 2021). These changes have a direct impact on the sustainable development of society, especially in social security, educational resources, pension services and other aspects. In order to cope with this challenge, the state has proposed to strengthen the service security for the elderly and the upbringing and education of children. Among them, the pension needs of the empty nest elderly and the scientific education of left behind children have become the focus and difficulty in the current social development. In the process of solving this problem, scientific and technological innovation has provided a strong driving force for promoting social progress. In particular, the application of modern technology to social services can greatly improve the quality of life and growth environment of empty nesters and left behind children. Therefore,

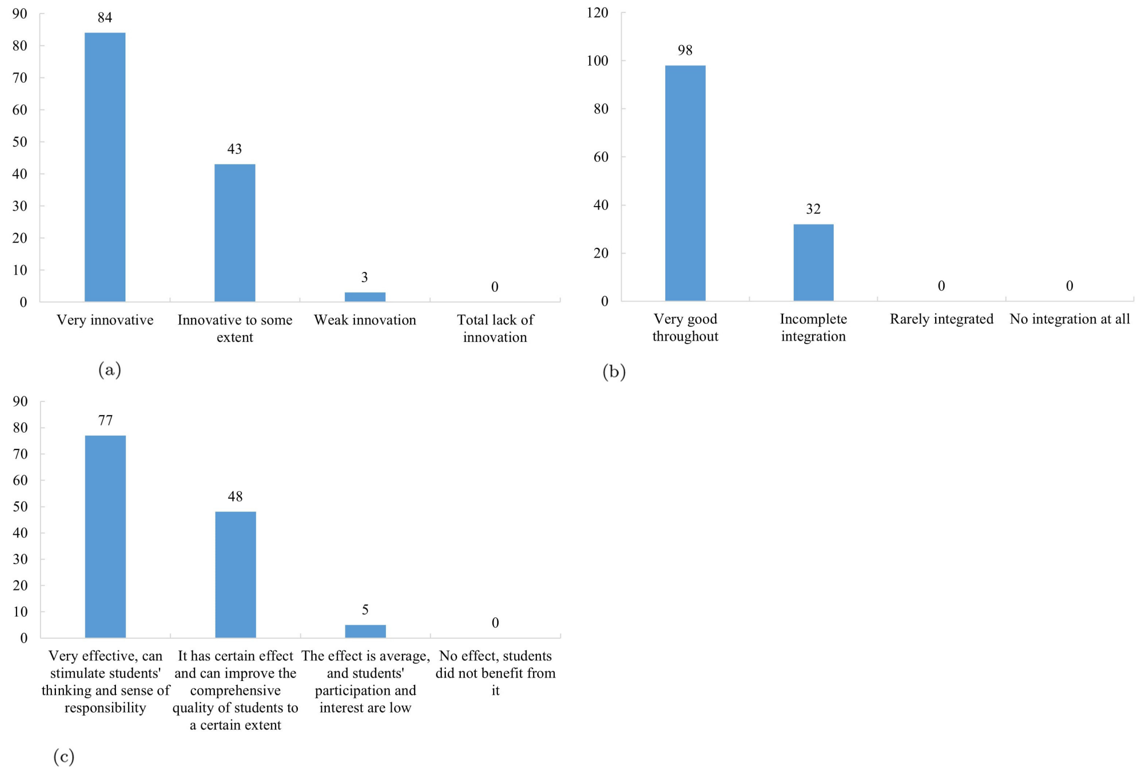

FIGURE 3
Results of enriching experimental teaching content with "Integrate ideology and politics". **(a)** Is the current teaching content innovative? **(b)** How are the ideological and political elements integrated? **(c)** How effective is the "integrate ideology and politics"?

focusing on the current "one old and one young" problem, our goal is to build the laboratory into a popular science practice center, relying on self-developed scientific and technological products, to help empty nesters enjoy a happier life in their later years, and to promote the scientific and technological education of left behind children through the promotion of artificial intelligence science popularization. The implementation of this innovative model can not only help students broaden their fields of practice and research, but also provide strong support for community and social development.

For the empty nest elderly group, investigating and understanding their actual needs is the premise of designing suitable smart elderly care products. Empty nesters often face problems such as lonely life, difficult health management, and inconvenient travel. Therefore, using modern technology, students can design and produce smart technology products for the elderly through professional knowledge. For example, smart home system can help the elderly to remotely control household appliances and improve the convenience of life; Intelligent health management devices, such as blood glucose monitors and intelligent bracelets, can monitor the physical condition of the elderly in real time and remind them to take medicine or seek medical treatment on time. These technological products can effectively alleviate the inconvenience of empty nesters' daily life and enhance their sense of security and happiness.

For the education of left behind children, technological innovation can also provide effective solutions. As some left behind children live in remote areas, they often face problems such as lack of educational resources and teachers. Through the distance education platform, using the Internet and intelligent devices, students can obtain a wider range of knowledge and high-quality educational resources through online courses. In addition, AI and big data technology can help teachers better understand the learning situation of each child and provide targeted guidance and support. In this way, we can not only improve the quality of children's education, but also make up for the gap between urban and rural education and realize the fairness of educational resources.

In this process, the cooperation of the government, enterprises, schools and all sectors of society is crucial. Only by forming a joint force and integrating various resources can we provide better life and education security for the empty nest elderly and left behind children. As an effective means, scientific and technological innovation provides us with new ideas to solve these complex social problems, and also contributes an important force to the construction of a better society.

3.5 Implementation process, resource preparation, and challenges

In the early stage of model implementation, educators must prioritize three key areas of resource preparation. First, technical infrastructure is critical: this includes procuring advanced

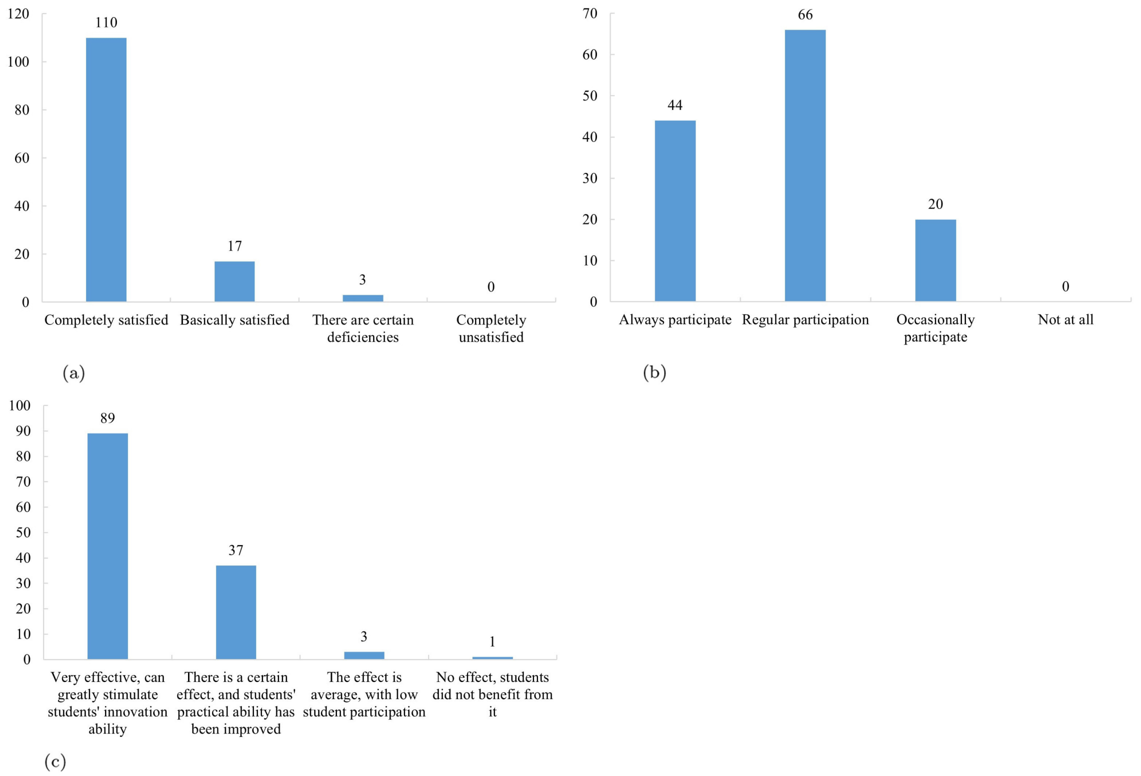

FIGURE 4
Results of enriching experimental teaching content with "conjugate learning competition". **(a)** Does the equipment meet the teaching needs now? **(b)** Are you involved in the discipline competition? **(c)** How effective is the "conjugate learning competition"?

experimental tools and cloud-based laboratory management systems to support autonomous student research and competition training. Second, faculty capacity building requires targeted workshops to integrate ideological and political elements into technical curricula, helping instructors identify meaningful educational connections. Third, cross-sector collaboration is essential for expanding the laboratory's social impact: partnering with local governments and community organizations ensures the science popularization platform gains practical relevance and policy support.

Challenges in implementation may emerge in two primary forms. Resource constraints pose a significant hurdle: outdated computer equipment and limited funding for hardware upgrades require a phased approach, where critical projects receive priority while older systems are gradually replaced. Additionally, pedagogical resistance may arise from faculty unfamiliarity with integrated teaching models. To address this, pilot programs in select courses can demonstrate effective integration, while a curated "ideological and political element library" provides actionable guidance for seamless curriculum design.

4 Reform results

In order to investigate students' acceptance of the construction of computer laboratory equipment and innovative culture, the laboratory management teachers' group carried out relevant research and analysis. The activity was conducted by means of anonymous online questionnaire survey combined with student interview. With the help of "questionnaire star" software, the questionnaire was released and the results were analyzed. There are 12 questions in this questionnaire, which mainly focus on four aspects of laboratory culture construction: first, "Ideological and political integration" enriches the experimental teaching content; Second, "learning match conjugation" innovative application experimental equipment; Third, "integration of science and education" to create an open education platform; Fourth, create an atmosphere of scientific and technological innovation driven by science popularization. The questionnaire focuses on students' cognition, participation, satisfaction and suggestions for improvement. During this period, 135 questionnaires were distributed to a convenience sample of students from computer science and related majors, and 130 valid questionnaires were collected, with a response rate of 96.3%. Among the respondents, there were 87 undergraduates, accounting for 66.9%. Among them, 54 were male undergraduates and 33 were female undergraduates. Additionally, there were 53 postgraduates, making up 33.1%, with 31 male postgraduates and 22 female postgraduates. Before starting to fill out the questionnaire, participants are required to read a standardized ethical statement. They are also informed that participation is voluntary, and their responses will be treated anonymously.

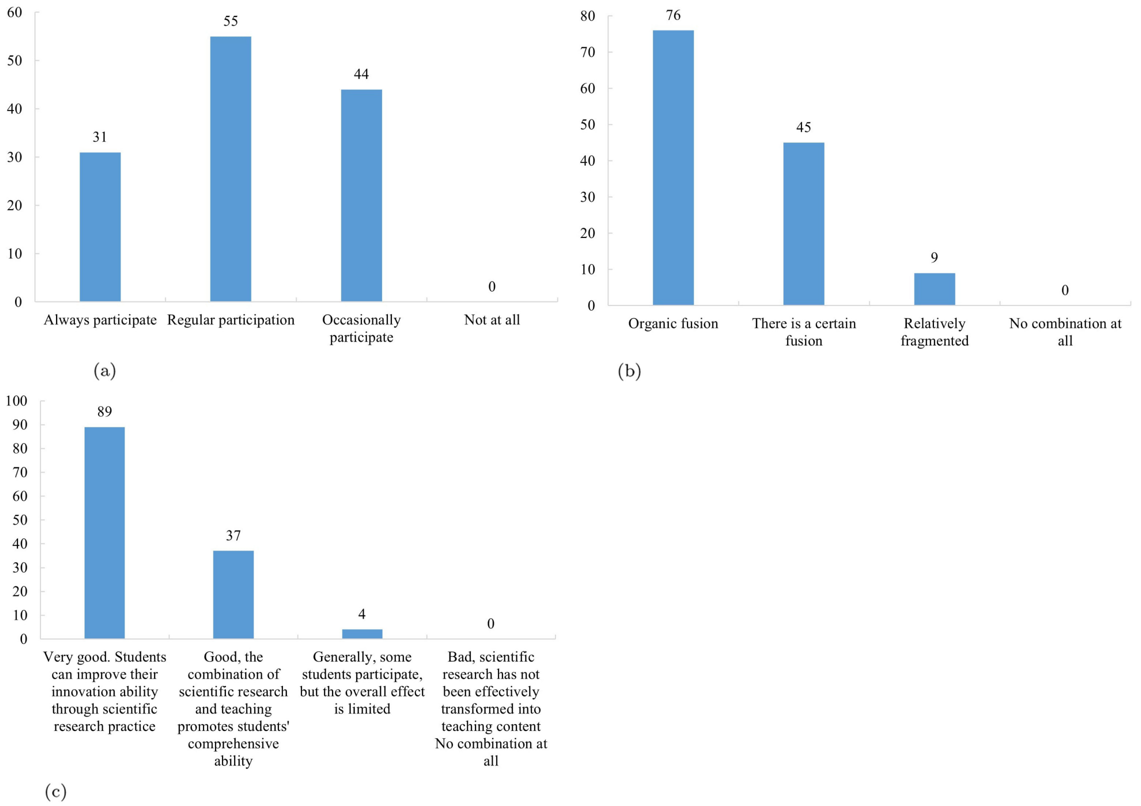

FIGURE 5
Results of enriching experimental teaching content with "Integrate science and education". **(a)** Have you participated in relevant projects? **(b)** Do well in the combination of research and teaching? **(c)** How effective is the "integrate science and education"?

When submitting the questionnaire, they need to check the consent box.

During the interview process, we purposefully selected 15 students from the participants of the questionnaire survey to ensure diversity in terms of academic level (10 undergraduate students, 5 graduate students) and gender (9 males, 6 females). We sent out emails to invite the respondents and briefly introduced the purpose of the study to them. The respondents who agreed to participate provided written informed consent. Semi-structured interviews were conducted online, each lasting 5 to 10 minutes, asking them about the reasons for choosing this option.

4.1 "Integrating ideology and politics" enriches the experimental teaching content

According to the survey results, integrating ideological and political elements into the construction of laboratory and equipment innovation culture not only ensures the coherence and completeness of experimental teaching itself, but also gives teaching content a certain degree of innovation. Most students believe that this model not only enriches the experimental content, but also encourages them to spontaneously expand their understanding of ideological and political knowledge while mastering experimental skills, thereby achieving the ideological and political education goal of the entire experimental teaching process, as shown in the Figure 3.

4.2 "Conjugating learning competition" innovative application experimental equipment

According to the survey results, students believe that through the "Conjugate learning competition" mode of learning, they can improve their ability of problem analysis, autonomous learning, problem solving and summary, and play a positive role in improving their experimental practice and communication skills. At the same time, it enables students to have an in-depth understanding of their own professional discipline competitions and lay a good foundation for future participation or learning, as shown in the Figure 4.

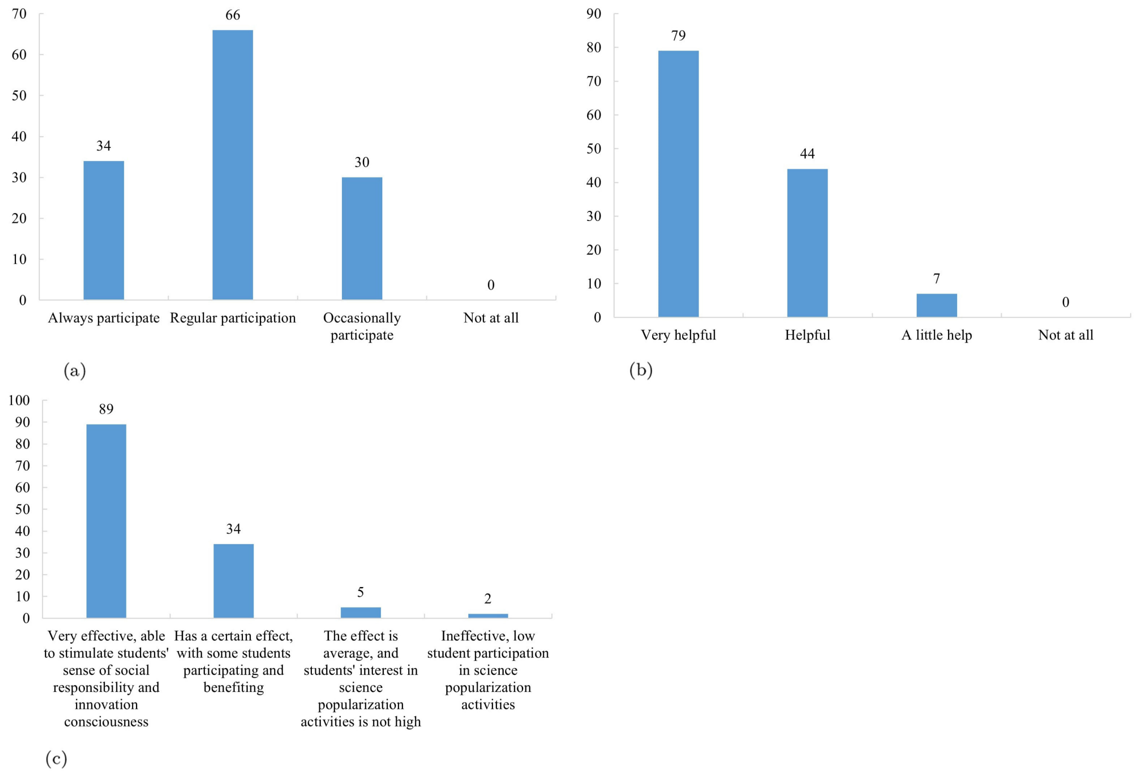

FIGURE 6
Results of enriching experimental teaching content with "promote science popularization". **(a)** Have you ever joined in popular science activities? **(b)** Do you think popular science activities are useful? **(c)** How effective is the "promote science popularization"?

4.3 "Integrating science and education" to create an open education platform

According to the survey results, students believe that the implementation of the "Integrate science and education" mode has significantly improved the openness and educational effect of experimental teaching. By introducing the cutting-edge content of scientific research into the teaching process and building an open education platform integrating experimental teaching, scientific research and innovative practice, students' independent inquiry ability and innovative thinking have been effectively exercised. At the same time, this mode promotes the interdisciplinary and resource sharing, so that students can deeply understand the application value of professional knowledge in practice and improve their comprehensive quality, as shown in the Figure 5.

4.4 "Promoting science popularization" creates an atmosphere of scientific and technological innovation

According to the survey results, students believe that the implementation of the "Promote science popularization" mode has enabled them to experience the examples of science and technology changing life, promoted the spread of scientific spirit, enabled students to understand scientific principles, master innovative methods, and improve their ability to think independently and solve problems in practice, as shown in the Figure 6. Through this process, students have a deep understanding of the close relationship between the power of science and technology and social needs, laying a solid foundation for the cultivation of future scientific and technological talents with social responsibility and innovative spirit.

It is important to acknowledge that this study has inherent limitations. The survey sample comprises 130 students from specific Chinese universities, which may result in insufficient representativeness due to the small sample size and regional concentration. These factors introduce two key challenges: (1) The limited sample size diminishes statistical power to identify subtle patterns or significant variations in student perceptions, potentially yielding unstable or overestimated effect sizes; (2) The focus on Chinese institutions may introduce cultural and educational system biases, as laboratory management practices and curricular frameworks differ substantially across nations.

4.5 Data analysis and implementation considerations

The one-sample *t*-test is employed to evaluate whether students' responses to the 12 survey questions significantly

TABLE 2 Results of the single-sample *t*-test.

Question number	Mean value	Standard deviation	*t* value	*p* value
Q1	2.62	0.52	25.46	<0.001
Q2	2.85	0.35	40.00	<0.001
Q3	2.54	0.56	18.93	<0.001
Q4	2.86	0.41	33.17	<0.001
Q5	1.95	0.78	6.54	<0.001
Q6	2.69	0.53	22.73	<0.001
Q7	1.62	0.81	1.54	0.125
Q8	2.54	0.55	18.93	<0.001
Q9	2.68	0.52	21.85	<0.001
Q10	1.71	0.83	2.77	0.006
Q11	2.63	0.51	24.81	<0.001
Q12	2.65	0.54	23.08	<0.001

deviated from a neutral threshold. This method helps determine if the observed mean scores on dimensions like "ideological and political integration" and "innovation perception" are statistically higher than a baseline level of indifference, providing empirical support for the effectiveness of laboratory culture construction models. All 12 questions are scored on a 4-point scale (0 = Strongly Disagree, 1 = Disagree, 2 = Agree, 3 = Strongly Agree). The analysis results are shown in Table 2.

From the table data, it can be seen that the average scores of students on 11 out of 12 questions are significantly higher than the neutral threshold of 1.5 ($p<0.05$), indicating that students generally approve of most dimensions of laboratory culture construction. Among them, "cultivating an atmosphere of scientific and technological innovation driven by science popularization" has the highest average score, reflecting that this model is most recognized. The average score of "open laboratory convenience" is 1.62 and $p = 0.125$, which does not reach the significant level, suggesting that students have certain dissatisfaction with laboratory procedures or resource allocation.

Although the overall evaluation is positive, the dissatisfaction of some students mainly stems from two aspects. First, the uneven distribution of resources. For example, questions 5 and 7 show that equipment updates and laboratory convenience are insufficient, which may be due to the incomplete elimination of old equipment or the complex design of the open reservation system, leading to limited student experience. Second, individual needs vary. For instance, the low average score of "interdisciplinary cooperation effectiveness" in question 10 reflects that some students have insufficient adaptability to new interactive models or prefer traditional learning methods. In addition, the integration of ideological and political elements with technical content in some courses is not natural enough, resulting in weak participation among a few students.

5 Conclusion

The cultural construction of computer laboratories in the universities is of great significance for improving the quality of applied talent cultivation, promoting teaching and research work, and promoting campus cultural construction, constantly demonstrating new characteristics such as comprehensiveness, openness, and multi-level networking. This paper closely combines the actual situation of universities and conducts research from four aspects: enriching experimental teaching content through the integration of ideological and political education, innovating experimental equipment through the combination of learning and competition, creating an open education platform through the integration of science and education, and creating a scientific and technological innovation atmosphere through the drive of science popularization. It explores the cultural construction paradigm of computer laboratories and equipment innovation in local universities, and improves the cultural construction of laboratories in terms of spirit, material, professionalism, and science popularization. Keeping pace with the times, keeping up with the country's needs for talent and technological innovation, and creating a good environment for cultivating talents through innovative development of laboratory culture construction, play an important role in the strength of the country and the progress of social civilization. In future research, longitudinal studies could be conducted to systematically track students' long-term learning outcomes. Comparative experiments may also be carried out to deeply analyze the specific impact of each sub-model. Additionally, multi-institutional collaborative research can further validate the model's universality across diverse contexts.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

DL: Software, Conceptualization, Writing – review & editing, Formal analysis, Methodology, Writing – original draft. JL: Writing – original draft, Investigation, Software, Visualization, Validation. ZH: Resources, Writing – review & editing, Validation, Supervision, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Chen, Y., and Zhai, W. (2024). Study of ideological-political education in foreign literature curriculum group. *Int. J. Educ. Humanit.* 13, 101–104. doi: 10.54097/m5czr046

Dong, H. (2022). Teaching design of "three-dimensional" blended ideological and political courses from the perspective of deep learning. *Secur. Commun. Netw.* 2022:6046243. doi: 10.1155/2022/6046243

Fu, J. (2024). Research on impact of ideological and political theories teaching in all courses of finance on enhancing students' sense of social responsibility. *Front. Educ. Res.* 7:70519. doi: 10.25236/FER.2024.070519

Gao, H.-W. (2023). Innovation and development of ideological and political education in colleges and universities in the network era. *Int. J. Elect. Eng. Educ.* 60, 489–499. doi: 10.1177/00207209211013470

Goller, C. C., Srougi, M. C., Chen, S. H., Schenkman, L. R., and Kelly, R. M. (2021). Integrating bioinformatics tools into inquiry-based molecular biology laboratory education modules. *Front. Educ.* 6:711403. doi: 10.3389/feduc.2021.711403

He, Z. (2023). Research methods of ideological and political education: Reflection and transcendence. *J. Soc. Sci. Humanit. Liter.* 6, 28–31.

Hou, Y., Kenderdine, S., Picca, D., Egloff, M., and Adamou, A. (2022). Digitizing intangible cultural heritage embodied: state of the art. *J. Comp. Cultu. Herit.* 15, 1–20. doi: 10.1145/3494837

Huang, Y., and Liu, F. (2022). A research on the path of ideological and political education in agricultural colleges and universities to promote rural revitalization. *J. Contemp. Educ. Research* 6, 69–73. doi: 10.26689/jcer.v6i7.4095

Ji, L. (2021). Research on the essence of interaction relationship of ideological and political education based on spiritual communication in the era of big data. *Int. J. Higher Educ. Teach. Theory* 2:4. Available online at: http://www.acadpubl.com/ijhett.aspx

Kelley, E. W. (2021). Lab theory, hlab pedagogy, and review of laboratory learning in chemistry during the covid-19 pandemic. *J. Chem. Educ.* 98, 2496–2517. doi: 10.1021/acs.jchemed.1c00457

Li, K., Jing, M., Tao, X., and Duan, Y. (2023). Research on online management system of network ideological and political education of college students. *Int. J. Elect. Eng. Educ.* 60, 377–388. doi: 10.1177/0020720920983704

Lin, B. (2021). Importance of ideological and political education in teaching fine arts education in higher vocational colleges. *J. Contemp. Educ. Res.* 5, 86–89. doi: 10.26689/jcer.v5i5.2144

Lin, K. (2024). Chinese ideology in the political education of students: how does ideology-based teaching impact students' consciousness. *J. Knowl. Economy* 16, 4496–4515. doi: 10.1007/s13132-024-02164-9

Ling, Z. (2023). Integration of ideological and political education into college English teaching. *Int. J. New Dev.* 5:52125. doi: 10.25236/IJNDE.2023.052125

Liu, G. (2021). The ways and methods of ideological and political education for postgraduates. *Adv. Educ. Technol. Psychol.* 5, 80–87. doi: 10.23977/aetp.2021.53012

Liu, X., Xiantong, Z., and Starkey, H. (2023). Ideological and political education in Chinese universities: structures and practices. *Asia Pacific J. Educ.* 43, 586–598. doi: 10.1080/02188791.2021.1960484

Luo, S. (2022). Construction of situational teaching mode in ideological and political classroom based on digital twin technology. *Comp. Electr. Eng.* 101:108104. doi: 10.1016/j.compeleceng.2022.108104

Rong, L. (2021). Design of ideological and political multimedia network teaching resources integration system based on wireless network. *Scient. Program.* 2021:4293771. doi: 10.1155/2021/4293771

Rong, Z., and Gang, Z. (2021). An artificial intelligence data mining technology based evaluation model of education on political and ideological strategy of students. *J. Intellig. Fuzzy Syst.* 40, 3669–3680. doi: 10.3233/JIFS-189401

Rui, L. (2021). International economics curriculum ideological and political education realization path exploration. *J. Front. Educ. Res.* 1, 14–19. doi: 10.23977/avte.2021.030304

Shang, W. (2022). Job stress and burnout among ideological and political education teachers during the Covid-19 pandemic: a moderated mediation model. *Front. Psychol.* 13:1008854. doi: 10.3389/fpsyg.2022.1008854

Sun, W., and Wang, H. (2023). Discussion on the curriculum qrganization and teaching method for curriculum ideological and political education. *Front. Educ. Res.* 6:62309. doi: 10.25236/FER.2023.062309

Sun, Y. (2022). Strategies for ideological and political education in colleges and universities based on deep learning. *Comput. Intell. Neurosci.* 2022:5322677. doi: 10.1155/2022/5322677

Tissenbaum, M., Weintrop, D., Holbert, N., and Clegg, T. (2021). The case for alternative endpoints in computing education. *Br. J. Educ. Technol.* 52, 1164–1177. doi: 10.1111/bjet.13072

Wang, P. (2020). Realization of the effectiveness of discourse in ideological and political education. *World Scient. Res. J.* 6, 308–311. doi: 10.6911/WSRJ.202004_6(4).0029

Wu, C. (2023). Exploration on the innovation path of college English teaching from the perspective of curriculum ideological and political education. *Front. Educ. Res.* 6, 1–6. doi: 10.25236/FER.2023.060901

Wu, X. (2022). Research on the reform of ideological and political teaching evaluation method of college english course based on "online and offline" teaching. *J. Higher Educ. Res.* 3, 87–90. doi: 10.32629/jher.v3i1.641

Xu, J., and Wang, Y. (2022). A study on the integration of traditional Chinese culture into college english education under the context of course-based ideological and political education. *J. Contemp. Educ. Res.* 6, 39–44. doi: 10.26689/jcer.v6i4.3831

Xuegang, R., and Yingying, P. (2018). Construction of university computer laboratory based on intelligent desktop virtualization. *Exp. Sci. Technol.* 16, 193–197. doi: 10.3969/j.issn.1672-4550.2018.05.044

Yafei, W., Peng, G., Longzhao, L., Dongmiao, L., Yang, T., Mo, L., et al. (2021). Practice and exploration of ideological and political education mechanism from the perspective "three-wide education"—constructing of xinglin growth tutor program. *Med. Educ. Managem.* 7:656. doi: 10.3969/j.issn.2096-045X.2021.06.014

Yang, Y., Reniers, G., Chen, G., and Goerlandt, F. (2019). A bibliometric review of laboratory safety in universities. *Saf. Sci.* 120, 14–24. doi: 10.1016/j.ssci.2019.06.022

Yongliang, W. (2023). Organic integration of ideological and political education and entrepreneurship education based on artificial neural network. *Learn. Motiv.* 84:101933. doi: 10.1016/j.lmot.2023.101933

Zhang, B., Qi, Q., and Li, L. (2022). Influence of ideological and political education strategies on college students' entrepreneurship based on wireless network and artificial intelligence knowledge map. *Wireless Commun. Mobile Comp.* 2022:5726099. doi: 10.1155/2022/5726099

Zhang, N., Chen, X., and Yin, H. (2020). Significance and possibility of vr technology embedded in the teaching of ideological and political theory course in colleges and universities. *IEEE Access* 8, 209835–209843. doi: 10.1109/ACCESS.2020.3023151

Zhang, Q. (2020). Innovative research on improving the construction and management level of computer laboratories in application-oriented universities. *J. Contemp. Educ. Res*. 4:1451. doi: 10.26689/jcer.v4i8.1451

Zhang, W. (2024). Research on practical teaching of ideological and political education based on vr technology in the information age. *Appl. Mathem. Nonlinear Sci*. 9, 1–16. doi: 10.2478/amns.2023.1.00332

Zhang, X. (2020). Influence of ideological and political education on mental health of college students under media convergence. *Revista Argentina de Clínica Psicológica* 29:1156. doi: 10.24205/03276716.2020.165

Zhang, Y., Jiang, L., Yang, Q., Liu, D., and Gu, S. (2021). Exploration and practice of the curriculum system construction of laboratory safety knowledge. *Int. J. Social Sci. Educ. Res*. 4, 1–4. doi: 10.6918/IJ0SSER.202104_4(4).0001

Zhang, Y., Liu, T., and Ru, B. (2022). Effect evaluation and student behavior design method of moral education in colleges and universities under the environment of deep learning. *Scient. Program*. 2022:5779130. doi: 10.1155/2022/5779130

Zhang, Z., and Jiang, T. (2023). Practical paths in the construction of curriculum ideological and political in colleges and universities. *Curriculum Teach. Methodol*. 6, 89–95. doi: 10.23977/curtm.2023.060813