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Research Article

Design of an Intelligent Sensor Teaching Experiment System and Measurement of Student Innovation Literacy

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Most of the experimental teaching links adopt experimental teaching, and few of them are taught through experimental simulation system. The intelligent sensor teaching experimental simulation system is a simulation measurement software system compiled by access and LabVIEW software to assist the use of sensor measurement and virtual instrument practical teaching platform, which realizes the network teaching of experimental links and carries out exploratory work. It has important practical significance for the modernization of experimental links. At the same time, the intelligent sensor experimental system can effectively improve the problems of students' low learning motivation and poor learning effect in the learning process and finally let students participate in the construction of sensor teaching experimental system, improve students' learning interest and enthusiasm, and cultivate students' autonomous learning and innovation ability. Through the establishment of intelligent sensor teaching simulation system, this paper successfully improves students' innovative literacy in teaching level, scientific research practice, teaching content, teaching methods, and intelligent lectures and greatly improves students' learning enthusiasm, learning efficiency, and teaching quality.

1. Introduction

The "sensor" course is a vital professional technology course in electronics, electrical automation technology, computer applications, and so on [1]. At this stage, colleges and universities usually provide sensors and related courses for students majoring in science and technology. Many colleges offer a specific course in the senior year called "Sensor Principles and Applications" [2–3]. There are some contradictions between learning and career development for senior undergraduate students: on the one hand, students need these courses to improve their knowledge structure, enhance their professional knowledge and skills, and develop the ability to apply their knowledge in practice; on the other hand, students at this stage are under pressure to study for graduate school, find a job, and travel abroad for English exams, among other things [4–5]. As a result, students are frequently unmotivated to pursue professional courses, and the learning effect is minimal. The learning impact is likewise quite poor, and both teachers and students have expressed their dissatisfaction [6]. A university has made certain adjustments to the teaching material, particularly to increase the experimental teaching connection, and altered the experimental teaching content, in order to boost students' motivation and teaching quality. For example, in the experimental teaching link the virtual instrument development tool LabVIEW is introduced, which allows students to autonomously design hardware and software systems and use software simulation and hardware circuits to create sensor data acquisition and control systems [7–8]. At the same time, students may exercise their practical and practical abilities, the capacity to evaluate and solve issues, and the ability of autonomous learning and creativity [9] and enhance their overall quality through experimental instructional content and the independent learning process [10–11].

This article covers classroom theoretical teaching content innovation, as well as the reform and practice of experimental teaching content in the "sensors" course [12–13]. The content of the paper has been implemented in the actual

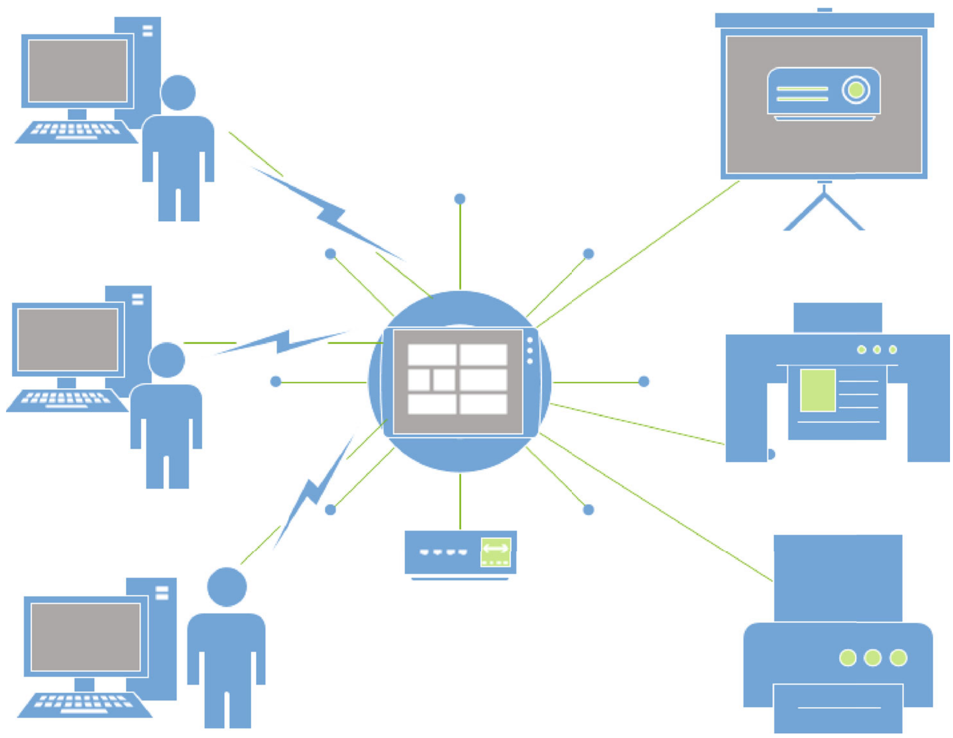

Figure 1: Conceptual structure diagram of intelligent sensor teaching experiment system.

teaching process of a university, which can significantly improve students' learning enthusiasm, and is expected to achieve good teaching results [14–15]. Relevant experience can also be used as a reference for similar courses [16–17]. The design concept diagram of an intelligent sensor teaching experiment system is shown in Figure 1.

Based on the establishment of an intelligent sensing teaching simulation system, it was incorporated into the evaluation system of students' innovative literacy [18]. Taking the innovative ability of students in 10 colleges and universities as an example, a more complete and diversified evaluation system of college students' innovative literacy is obtained.

2. Classroom Theory Teaching Content Innovation

Sensor technology is one of the cornerstones of today's information technology age, and it should be given the same respect as computer and Internet technology [19–20]. With the development of wireless sensor networks, the Internet of Things, and other fields, today's information society has experienced a wave of computer and Internet technology. At present, sensor technology has become a hot spot in the field of science, technology, and industry, and variety of sensor technology have developed very rapidly. The existing "sensor" course has problems: the teaching content is somewhat old, and new sensor technology and development are less engaged [21]. At the same time, pure sensor principal teaching is rather monotonous, and students are bored. Students do not have a strong desire to study. Therefore, the content of classroom teaching has been adjusted.

2.1. Acquiring New Sensor Technology Expertise. New sensor technology information is added to the teaching content to ensure that students learn as much as possible about the cutting-edge development of sensors [22–23]. Some emerging sensor technology applications and the most recent sensing materials and devices are incorporated into the curriculum, such as Internet of Things (IoT) technology, which connects items to the Internet for information exchange and communication according to agreed protocols in order to achieve intelligent identification, positioning, and navigation [24]. Another example is a wireless sensing network, which is a multihop self-organizing network comprised of a large number of low-cost small sensor nodes distributed in the monitoring environment [25].

2.2. Schedule Classroom Discussions. Encourage students to actively participate in learning by organizing classroom discussions. The classroom discussion primarily consists of two aspects: first, for a specific sensor taught in class, let students use such sensors to complete an after-class homework, through the class to find the corresponding information, design a sensor application circuit and system, and then the teacher arranged a special discussion session, allowing students to introduce their design and communicate with other students[26–27]; and for a specific sensor taught in class, let students use such sensors to complete an after-class homework, through the class to find the corresponding information [28]. Second, for current market popular sensor technology, such as various MEMS (micro electro mechanical systems) sensors in smart phones, CCD (charge coupled device) sensors in digital cameras, fiber optic sensors, and fingerprint sensors in the field of security, online information such as technical indicators, technical advantages, and market share, and make a presentation report in the classroom, students can learn a lot of knowledge independently during the entire process[29–31].

3. The Design of Experimental Teaching Content

Experimental teaching sessions are very important for the learning of sensors. In the early experimental teaching process, we mainly use CSY sensor system experimental instrument to provide students with some verification experiments [32], in which students operate according to the experimental instruction tutorial to test the characteristics of various sensors and understand the working principle of sensors. The advantage of this experimental teaching is that it combines the classroom content and deepens the understanding of the working principle and characteristics of sensors. Its disadvantage is that students' participation is more passive and lack of innovative experimental content. In addition, the cost of the experimental system is higher, some parts are easy to be damaged, the cost of renewal and maintenance is higher, and there are usually more students and less instruments.

National Instruments (NI) launched LabVIEW, a virtual instrument development platform that offers a graphical programming language development environment with strong functionalities and a user-friendly development environment [33]. Environment that supports numerous bus and data connection interfaces, as well as sophisticated graphical control components and software panels, and powerful data and signal processing function features created a sensor experiment platform based on LabVIEW + serial communication + microcontroller, and students worked in groups to perform software and hardware simulations on this platform. Students must check the data, build their own sensor data acquisition and control system, collaborate to complete the design scheme, hardware circuit, and software system, and finally write a comprehensive experimental report.

This experimental process increases students' interest in learning while also allowing them to master sensing device selection, data acquisition, and processing skills, prompting students to actively participate in the experimental process. In order to complete the experiments, the students must conduct independent data inquiry, analysis, and discussion. This can help students gain a better understanding of the theoretical knowledge they have learned while also cultivating their own. It also develops students' broad application skills and teamwork spirit. Furthermore, the structure of the design is adaptable, making it simple to update and expand. Because the design is adaptable and easy to update and expand, the development cost is low, and it is suitable for students to complete the design and practice independently. It is appropriate for students to design and practice independently.

4. Experimental Teaching Platform Based on LabVIEW

This sensor experimental platform consists of several modules, including sensors, an analog-to-digital conversion chip, and a microcontroller to form the front-end data acquisition system (analog temperature acquisition). The digital-to-analog conversion chip will transform the sensor signal into a digital signal into the microcontroller, followed by the sensor signal to the upper computer (PC) via the communication system, which here uses a serial communication interface. LabVIEW is used to write the upper computer data processing system program, which can perform functions such as real-time dynamic temperature displayed, data storage and alarm temperature setting, and temperature analysis and processing. The interface of the experimental simulation system is shown in Figure 2, which is composed of buttons, diagrams, and other elements.

This system can be broken down into several experiments such as hardware design, software design, software simulation, hardware simulation, and circuit board development, and students complete each experimental session in turn. The specific content of each experimental session is as follows: hardware design is to design the front-end acquisition system, back-end control system, and communication interface circuit in the circuit design software (such as Proteus). Students have studied circuit development and design in previous courses and are very familiar with circuit design software, so they can complete the experiment relatively smoothly.

The software design includes the lower computer microcontroller program and the upper computer LabVIEW program. The LabVIEW platform provides students with a graphical development environment that can be mastered quickly and conveniently. The system completes the functions of data reception, processing, display, and storage and forms the control signal to the microcontroller. LabVIEW platform provides students with rich development interfaces and functional modules, and students can complete various sensor data processing functions on this platform.

The software simulation is performed fully on the computer and is invoked jointly by many development tools (Proteus, Keil, LabVIEW, and so on) to mimic communication between the upper and bottom computers through the virtual serial connection. The hardware simulation is based on the software simulation, and the microcontroller experiment box is used to construct the lower computer system and complete the system's operations. After all of the preceding simulation steps have been completed successfully, you may design the circuit board, acquire the necessary components, solder the circuit board, and lastly connect the PC for debugging and operating. Students with a higher learning interest and stronger hands-on ability can complete the experimental contents in the hardware simulation and PC debugging sessions independently, and the specific functions and modules in the system can be redesigned by students, and after the software simulation is successful, then enter the hardware simulation and PC debugging. The system structure has strong adaptability, and students can complete the above experimental courses in the order most suitable for their own needs. After that, students may construct their own system, replacing and extending some of the modules, as well as adding new ones. Furthermore, the overall development cost of the system is modest and does not place undue stress on instructors and laboratories.

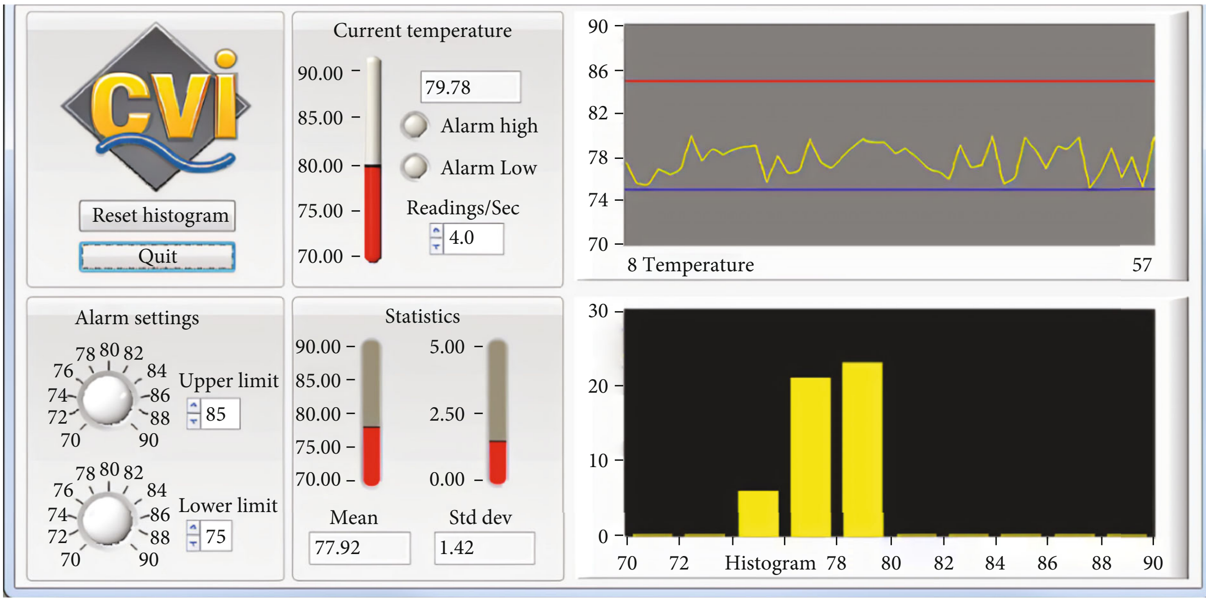

Figure 2: The experimental teaching platform based on virtual instruments.

5. Establishment of Evaluation System for Students' Innovative Ability

So far, the experimental simulation system introduced by it has only been used for sensor teaching. On the one hand, students can complete science and technology courses more effectively, comprehensively, and realistically. On the other hand, it can effectively shorten the learning cost, reduce the resistance in the learning process, and improve the teaching effect. On this basis, the undergraduate teaching is effectively connected with the research study and innovation ability training of college students, and an evaluation system for innovation literacy of college students is established. The evaluation system is described below.

Firstly, in order to establish each indicator item, an effective screening and combination was conducted through a thorough literature search, based on facts and curriculum design, and according to the specific requirements of the assessment of college students' innovation ability. Secondly, for each indicator, there is a relatively scientific and standardized definition that encapsulates the explanation and description of its definition as well as specific operational and assessment instructions. Each of these indicators has a graded description at the same time. Thirdly, according to the comprehensive scoring method, i.e., the correlation analysis of the indicator items is conducted first, then standardized, and finally the weights of each indicator are determined through expert meetings. Finally, the indicator system used the classification weight setting method; i.e., the specific classification registration of the indicators was set according to the weight proxy, level by level, and the total value of each level weight was 100%. Therefore, the weighted weighting analysis is then used to quantify effectively. The specific setting of the evaluation system of students' innovation ability is shown in Table 1.

6. Case and Discussion

Taking 10 innovative universities as an example, a multifaceted evaluation of the possible teaching of intelligent sensors around the innovation ability is conducted. The analysis is carried out by considering the three aspects of the school's teaching philosophy, teaching level, and research and practice ability. According to the evaluation system, it is divided into level I, level II, and level III. The evaluation results of intelligent sensor teaching system are organically combined with the evaluation of students' innovation ability.

6.1. Evaluation of Teaching Concept. According to the sample survey of students from the existing 10 schools, students scored the 10 universities on school orientation, training objectives, and teaching status around the educational philosophy. The idea of running a school is out of 100 points. For the major category of school orientation, it was determined whether the school considers innovation as a category for cultivating talents. The results of school orientation scores are shown in Figure 3. Among them, school orientation accounted for 20%, and all 10 schools scored more than 10 points for school orientation, with the school with the highest school orientation score basically reaching 17 points. On the other hand, cultivation goals, the main goal of the school for the development of students, innovation is one of the main factors of its goals. 10 schools have a score of more than 20% of the cultivation goals, and the college with the highest cultivation goals has a goal score of more than 28 points.

For the broad category of educational philosophy, specific measures for schools to implement innovative education were identified. As shown in Figure 4, the educational philosophy accounted for 30%, and all 10 schools scored more than 20 points for school orientation, with the college with the highest educational philosophy score close to 30

Table 1: Evaluation system of students' innovation ability.

Weight	Weight	Second-level indicators	Third-level indicators	Best-in-class description
Educational philosophy 100	0.1	School orientation 50	School orientation 20	Research-oriented or innovative universities, which have scientific plans and can be implemented with notes, are more distinctive
			Training objectives 30	Emphasis is placed on the all-round development of students, with the cultivation of innovative spirit and practical and self-learning ability
		Educational philosophy 50	Educational philosophy 30	With advanced educational concepts, education cultivates students as the main body, has a strong sense of quality, and has a clear concept of innovation ability training
			Teaching status 20	Make teaching work the most important central work in higher education
Subtotal marks				
Education and teaching 100	0.5	Culture mode 35	Professional settings 10	Wide caliber training, large-scale enrollment, to achieve cross-disciplinary integration
			General education 10	General education is more numerous and more diverse, cultivating students' complete knowledge and sound personality
			Credit 15	Under the guidance of teachers, according to the needs of interest and personalized development, flexible choice of learning content, time, and method
		Course teaching 40	Curriculum system 15	Establish a multidimensional curriculum structure with functional courses as the backbone, and strengthen the practicality and selectivity of courses
			Teaching content 15	The implementation of a scientific practice course is combined with the teaching of professors
		Teaching mode 25	Teaching methods 10	Relying on the completion of intelligent sensor teaching experiments, students learn independently and cooperate, and teachers provide guidance
			Intelligent teaching 15	Many courses use intelligent sensor teaching technology to guide students to use hardware and software tools to learn
Subtotal marks				
Scientific research practice 100	0.4	Open trials	Experimental design 30	Using the intelligent sensor teaching system, a more autonomous and diverse experimental course is designed to comprehensively evaluate the students' experimental ability
			Laboratories are open 10	The lab is open for a long time, making the most of the spare time so that the intelligent sensor system covers every student
		Scientific research activities 45	Base construction 15	In the innovation base, we provide students with a good intelligent sensor teaching test system
			Project funding 15	Adequate funding for student courses
			Scientific research system 15	Mature innovation management mechanism and evaluation system, covering resource allocation, policy support, process supervision, results acceptance, etc.
		Social 15	Practical training 15	There is a stable off-campus practice base, which can better reproduce the teaching results of the intelligent sensor
Subtotal marks				
Score				

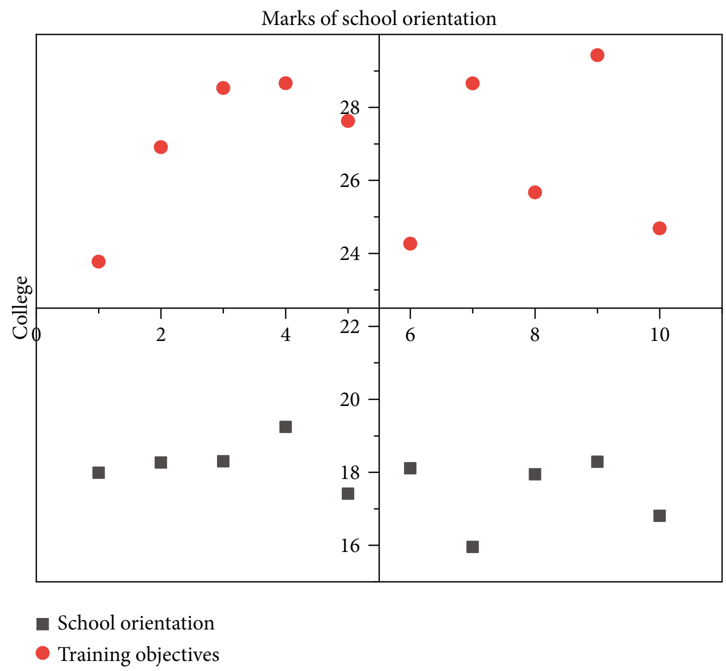

Figure 3: Marks of school orientation.

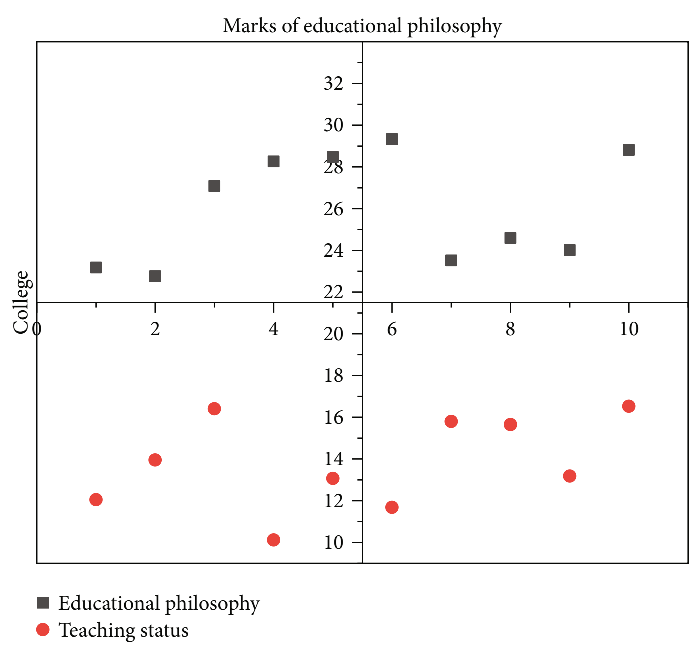

Figure 4: Marks of educational philosophy.

points. On the other hand, the educational means accounted for 20%, and all 10 schools under the educational means scored more than 10 points, with the college with the highest educational means score scoring 16 points.

6.2. Evaluation of Education and Teaching. According to the analysis results of the sample survey of students in 10 existing schools, students scored 10 schools around the evaluation of education and teaching in three categories: training mode, curriculum teaching, and teaching mode. Seven aspects of curriculum system, teaching content, teaching methods, and intelligent teaching.

For the large category of cultivation mode, it was determined to include the intelligent sensor teaching system, which is mainly divided into three parts: professional setting, general education, and credit system. The results are shown in Figure 5; among them, professional setting and general education accounted for a smaller 10%, and the scores of all 10 universities were greater than 5 points less than 10 points. The credit system, on the other hand, can include

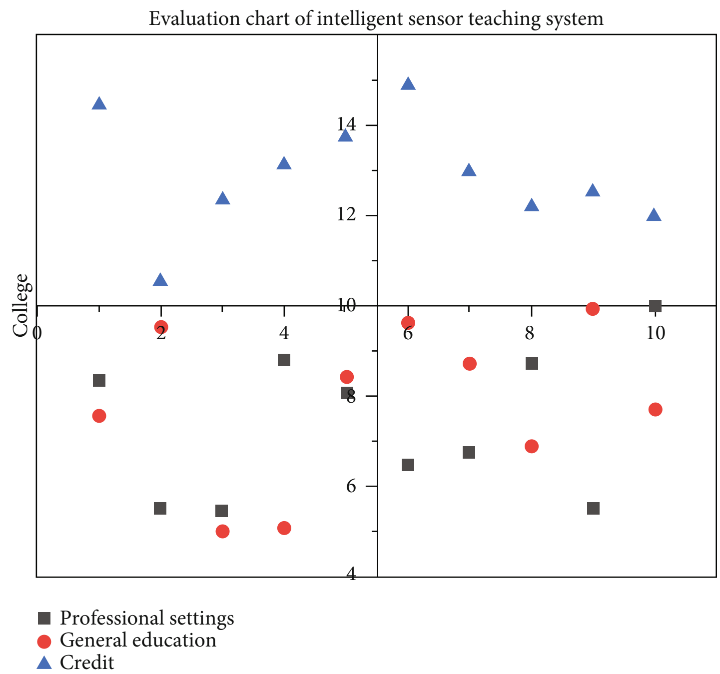

Figure 5: Evaluation chart of intelligent sensor teaching system.

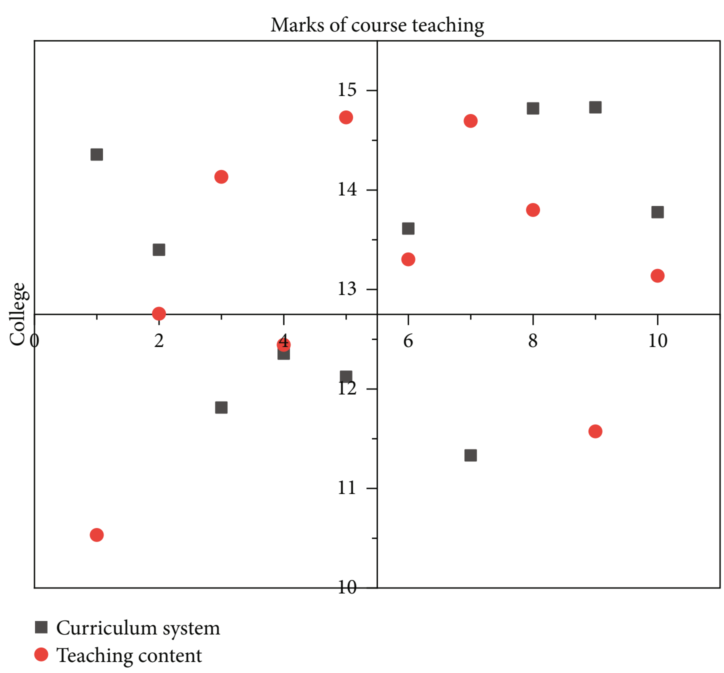

Figure 6: Marks of course teaching.

specific innovative courses, accounting for 15%, and the scores of all 10 colleges and universities are greater than 10, and the score of the college with the best implementation of the credit system is 15.

For the large category of curriculum and teaching, it is mainly divided into two parts: curriculum system and educational content, both of which should be planned into the intelligent sensor teaching system. The results of course teaching results after inclusion are shown in Figure 6, where the abscissa represents the university and the ordinate represents the score. On the whole, the trend of course system and teaching content is good. Curriculum system and educational content both account for 15%; 10 universities in these two scores are greater than 10 points, where the highest score of the curriculum system is 15 points, and the highest score of the teaching content scores 14.5 points. For the large category of teaching models, it is mainly divided into two parts: teaching methods and intelligent delivery. As shown

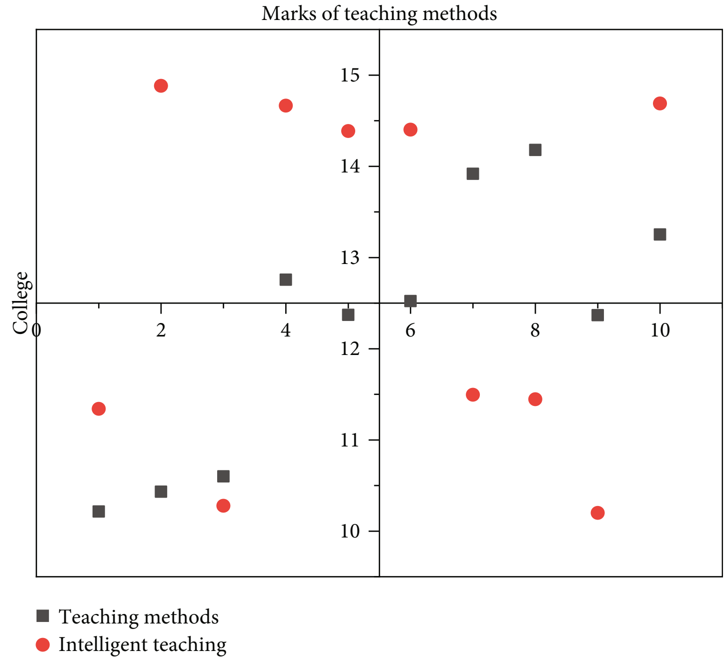

FIGURE 7: Marks of teaching methods.

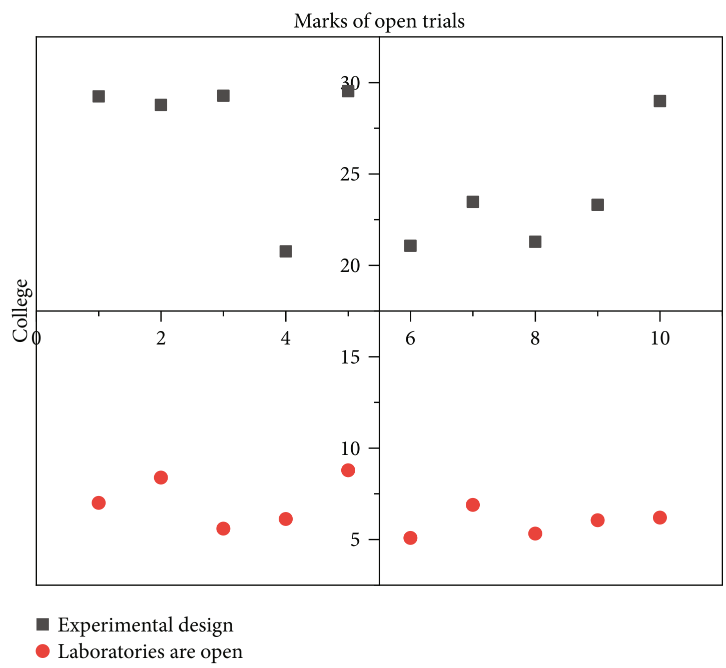

FIGURE 8: Marks of open trials.

in Figure 7, among them, teaching method accounts for 15%, and teaching method itself covers the application of smart sensor teaching system, and all 10 universities have scored more than 10 points in this item, and the highest university has 14 points. On the other hand, intelligent teaching itself can be narrowly understood as intelligent sensor teaching system, and this part accounts for 15%, and all 10 universities have scored more than 10 points in this item, and the highest university can even reach a full score of 15 points.

6.3. Evaluation of Education and Teaching. According to the results of the analysis of a sample of students from the existing 10 schools, the students scored 10 schools around the research practice on the three categories of open experiments, research activities, social practice, experimental design, laboratory opening, base construction, project funding, research system, practical training, 6 major categories. In the open design category, the intelligent sensor teaching system itself is the main part of the experimental design. As shown in Figure 8, the

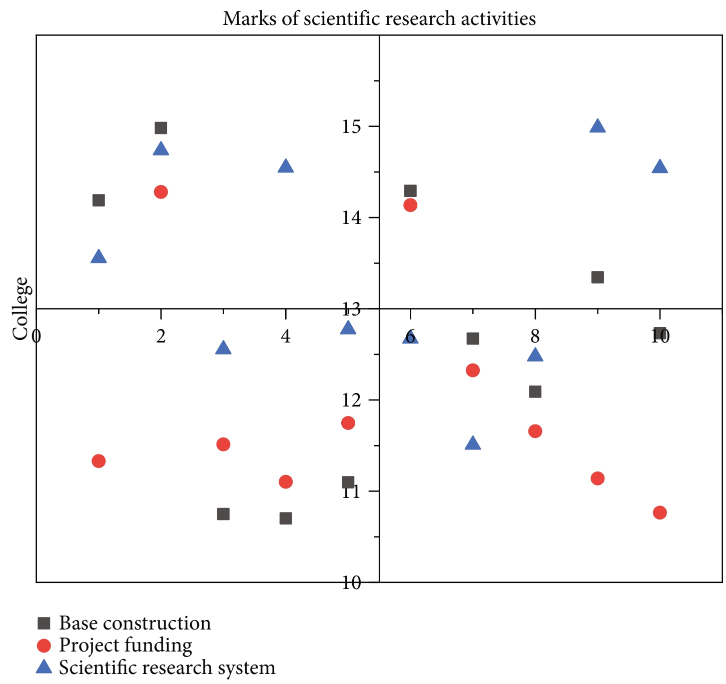

Figure 9: Marks of scientific research activities.

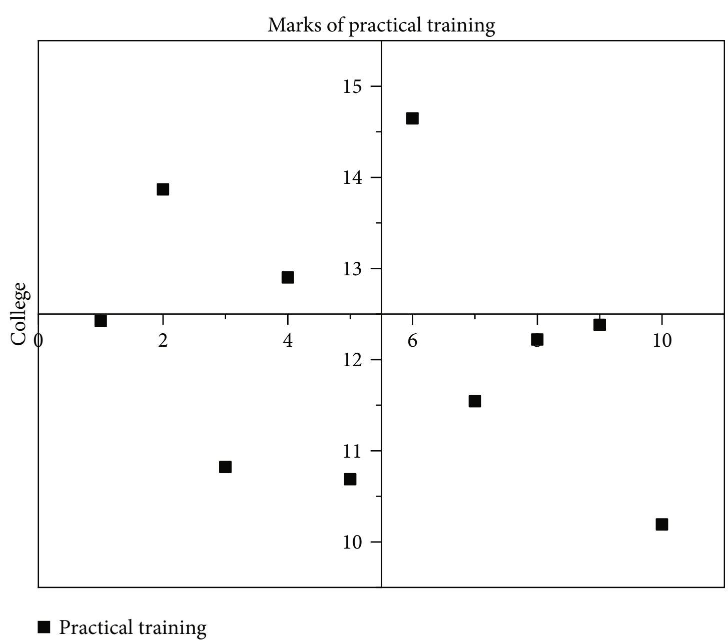

Figure 10: Marks of practical training.

score of experimental design accounts for about 30%, the scores of 10 universities are more than 20, and the highest score is 39. On the other hand, the degree of openness of the laboratory, accounting for 10%, sufficient open time helps students to improve their self-learning and innovation ability, with the highest score of 10 points in the university.

In the broad category of research activities, there are three main parts, base construction, project funding, and research system. The study is shown in Figure 9. The percentage of these three research activities is all 15%, and all three provide infrastructure, financial support, and evaluation system for intelligent sensor teaching system. 10 universities have three scores of 10 or more, and the highest scores are 15, 14, and 15, respectively.

The last major category is social practice. The intelligent sensor teaching system is essentially a simulation system, and the use of learning in a stable off-campus internship base can deepen and consolidate this piece of knowledge. The results are shown in Figure 10. The percentage of this

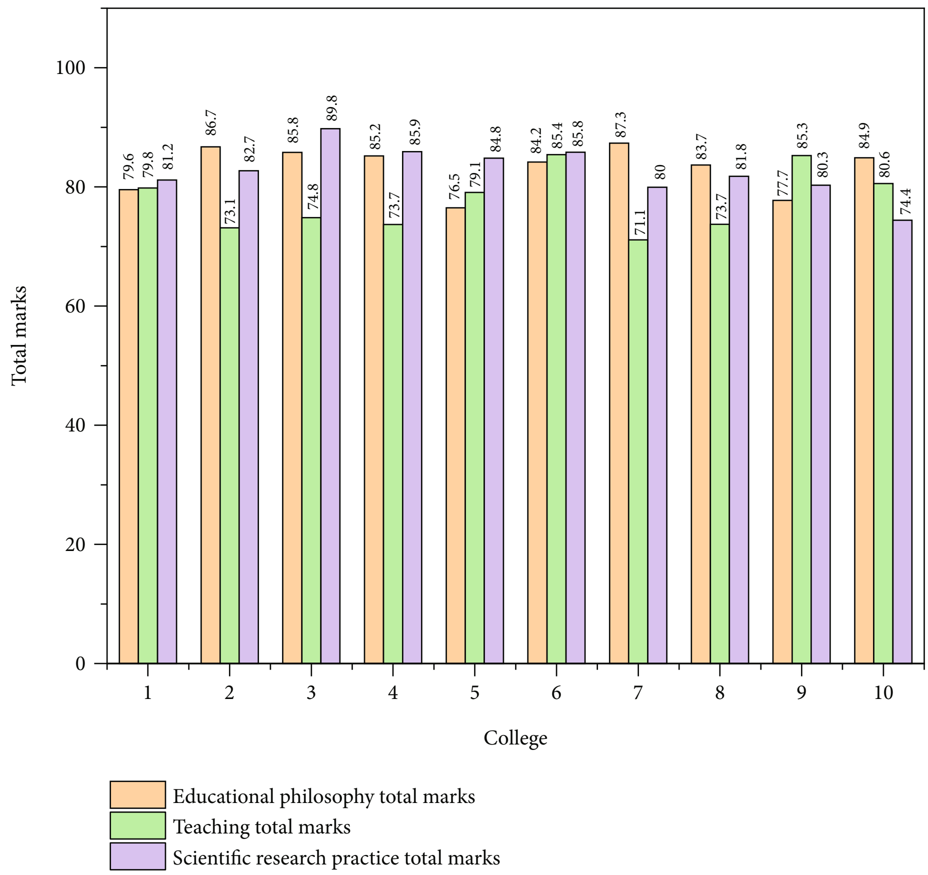

Figure 11: Total marks of educational concept, teaching level, and research practice.

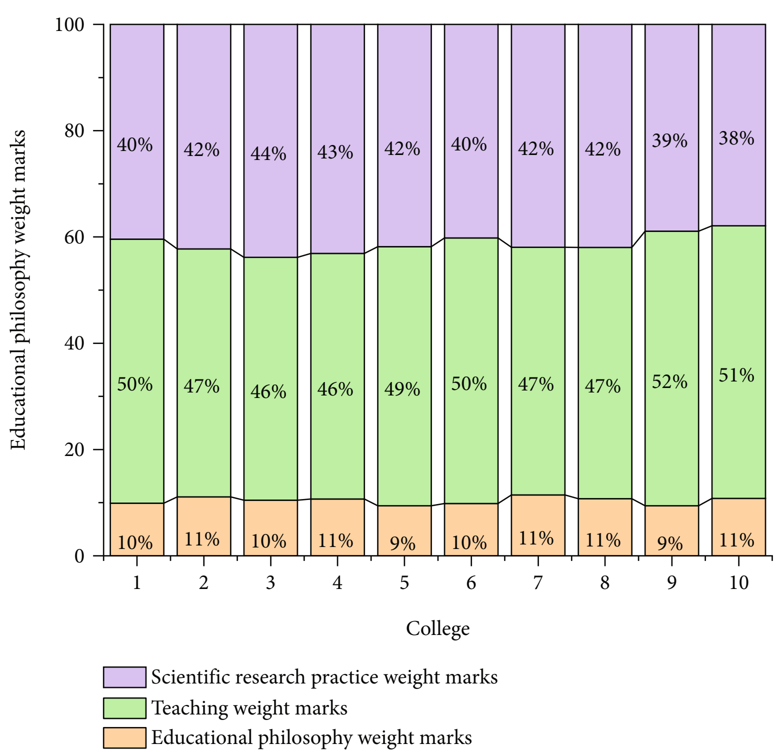

Figure 12: Total marks of weight percentage of educational concept, teaching level, and research practice.

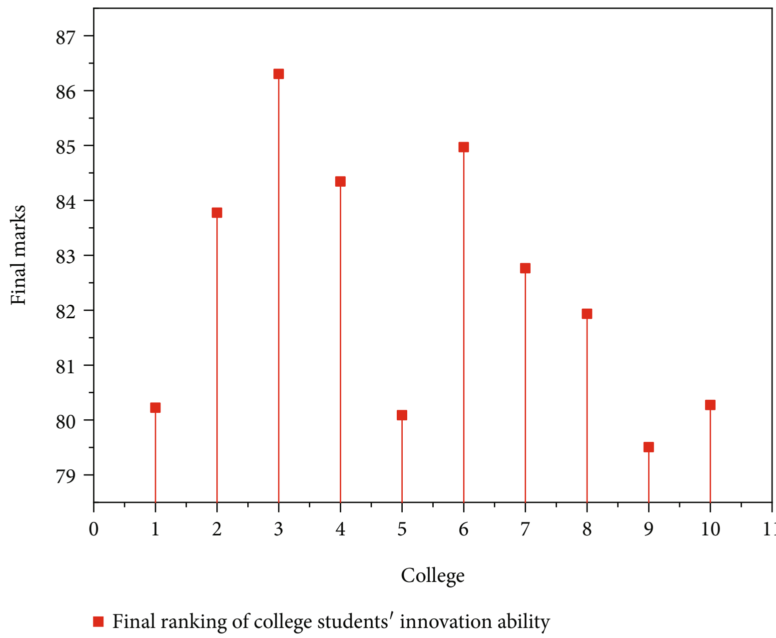

Figure 13: Innovation literacy ranking of students from the 10 universities.

part is 15%, and the highest score of the university scores more than 14.5 points.

6.4. Total Evaluation of Student Innovation Literacy. The three parts of educational philosophy, teaching level, and research practice, which evaluate the educational level of school students, were weighted and integrated according to the ratio of, 0.1 : 0.5 : 0.4, to obtain the total score of the assessment of students' innovative quality in 10 universities, which also reflects the highly relevant degree of implementation of the intelligent sensor teaching experiment simulation system.

It is expressed by the evaluation of three parts: educational philosophy, teaching level, and scientific research practice; the result is shown in Figure 11. It can be found that the scores of all colleges and universities exceed 70 points in each of them, while the average score reaches 80 points. The highest scores of educational philosophies, teaching level, and research practice are 87.3, 89.8, and 89.8, respectively, which are all close to 90. It also shows that teaching level and research practice are more important for the comprehensive assessment of students' innovation literacy in each university, compared with educational philosophy.

In terms of percentage share, according to the established ratio of 0.1 : 0.5 : 0.4 and weighted integration, the results are shown in Figure 12. Their share is basically stable, and a part of the more prominent universities, the score of research practice can reach 44%, and the share of educational average can reach more than 52%. At the same time, the average score of educational philosophy will not account for more than 11%.

Integrating the innovation literacy of students from the 10 universities can be obtained, the results are shown in Figure 13. It can be found that the highest score is 86.5, and there is only one college with a score lower than 80. From the figure, it can be found that the degree of implementation of intelligent sensor teaching experiment simulation system in each university is relatively close, and the innovation literacy of students in each university is concentrated in the range of 80 to 85 points. At the same time, 85 points is a threshold, and only one college has students' innovation ability significantly more than 86.5 points.

7. Conclusion

This article describes the reform of several theoretical teaching components and student literacy evaluation in the course "sensors," as well as the incorporation of the LabVIEW virtual instrument creation platform into the experimental teaching. Based on the establishment of intelligent sensor teaching simulation system, it is incorporated into the evaluation system for evaluating students' innovation literacy; the innovation ability of students in 10 colleges and universities is achieved.

Students can strengthen their comprehension of the theoretical information they have studied via independent analysis and mutual debate, as well as build their comprehensive application ability and teamwork spirit. It has been demonstrated that incorporating the aforementioned teaching materials and approaches into the actual teaching process dramatically increased students' learning passion, learning efficiency, and teaching quality.

Intelligent sensor teaching simulation system has a great promotion effect on improving students' innovative literacy, mainly reflected in the improvement of teaching level and research practice. For teaching level, the successful application of the system is mainly reflected in teaching content, teaching methods, and intelligent lecture areas. For research realization, the successful application of the system is mainly reflected in the laboratory construction, incentive construction, and project funding. In short, through the intelligent sensor teaching simulation system, students' innovation ability has been greatly developed.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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