

# Cultivate Innovative Talents Based on Scientific Research --- Teaching Reform of "Computer Communication and Network" Course



Ji Changpeng\*, Dai Wei, Wang Xin

School of Electronic and Information Engineering, Liaoning Technical University, Huludao 125105, China

**Abstract:** In the field of electrical and information engineering, the computer communication and network course are crucial because it lays the groundwork for students to put their professional knowledge into practice. An important step toward developing creative innovative talents is the mutual integration of scientific research and teaching. The current approaches to research and teaching integration are examined, along with the issues surrounding the teaching of computer communication and networks. Research and teaching integration strategies that can be applied to the instruction of computer communication and networks courses are also proposed, and strategies for developing students' creative thinking through scientific research projects are highlighted. The current issues in the teaching of computer networks and communication can be resolved, student research quality can be raised, and students' innovative awareness and spirit of exploration can be fostered through the integration of science and education. Students' level of computer communication network application has increased, their excitement for the courses they are taking has been stoked, and the result of raising the quality of instruction has been accomplished by fortifying their practical teaching. Contribute technical and professional skills to help build the national innovative talent team.

**Keywords:** Integration of Science and Education; Computer Communication and Network; Curriculum Construction; Innovative Talents

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## 1 Introduction

Computer communication and network is a basic professional course in communication engineering, which has an important position in the communication profession. With the arrival of the information age, whether it is the government department office, or college teaching and research, people have become more and more inseparable from the computer communication network.

Modern education is an extension of cultural heritage and innovation. In the early 19th century, Humboldt of the University of Berlin put forward the concept of integration of education and scientific research. Humboldt believes that: university teachers must adhere to scientific

research, and only by investing in scientific research can they find out the direction and entry point of teaching; only by adhering to scientific research can teachers always maintain the state of knowledge and improve the level of teaching; only by allowing students to participate in scientific research can they promote effective learning. After Humboldt put forward this point of view, the higher education sector has set off a discussion of the integration of teaching and scientific research, Burton Clarke, Newman, Boyer and other famous experts in higher education have articulated their unique views on the combination of teaching and scientific research, which effectively pro-

\*Corresponding author: Ji Changpeng, [ccp@lntu.edu.cn](mailto:ccp@lntu.edu.cn)

notes the continued development of this concept.

Although the idea of integration of the two has a long history, but in practice, but poorly. The second half of the 20th century, the United States university "research drift" phenomenon intensified [1], research is detached from the connection with the teaching, teaching quality continues to decline. In this regard, the U.S. National Science Foundation in 1997 to establish "research and teaching integration Recognition Awards" (Recognition Awards for the Integration of Research and Education) [2], rewarded in the teaching and research integration of outstanding achievements in the In 1998, the Council for the Advancement of Undergraduate Education in Research Universities published the far-reaching "Rebuilding Undergraduate Education: A Blueprint for the Development of Research Universities in the United States" (referred to as the "Boyer Report"), which called on research universities to pay more attention to undergraduate education and put forward ten recommendations for undergraduate teaching reform. The results of a follow-up survey three years later showed that the recommendations of involving undergraduates in research and integrating research and teaching were the most popular of the ten recommendations [3].

## 2 Integrating Teaching and Research

### 2.1 Reform the Philosophy of Education

Since 2001, the Ministry of Education has issued three guiding documents, namely Several Opinions on Strengthening Undergraduate Teaching in Colleges and Universities and Improving Teaching Quality, Several Opinions on Further Deepening the Reform of Undergraduate Teaching and Comprehensively Improving Teaching Quality and Several Opinions on Comprehensively Improving the Quality of Higher Education, which are aimed at effectively promoting the colleges and universities to improve the work of undergraduate teaching and the quality of talent cultivation, and to improve the quality of undergraduate teaching brought about by the expansion of enrollment and the strengthening of the research function of universities [4-7]. In order to effectively promote the improvement of undergraduate teaching work, improve the quality of talent training, improve the problems brought by the expansion of enrollment and the strengthening of the function of scientific research in

colleges and universities, higher education has begun to "take the road of connotative development centered on quality improvement", and the reform of undergraduate teaching has become the focus. Against this background, many universities have emphasized the return to the way of the university, highlighting the cultivation of talents in their philosophy of running schools. For example, Peking University proposed that "to realize the goal of a world-class university, it is necessary to build a world-class undergraduate education"; Fudan University emphasized that under the guidance of the "12th Five-Year Plan" development plan objectives to adhere to the undergraduate education in the first place in the development of the University; Nanjing University proposed to "do China's best undergraduate education" to "do China's best undergraduate education". Tsinghua University has further clearly put forward the "Advantage Transformation Strategy", which converges and transforms a variety of schooling advantages into the fundamental task of talent cultivation; Shanghai Jiao Tong University has also put forward efforts to transform the advantages of disciplines and scientific research into the advantages of talent cultivation. Shanghai Jiao Tong University has also put forward efforts to transform the advantages of academic disciplines and scientific research into the advantages of talent cultivation [8-10].

### 2.2 Renewal of the Training System

Undergraduate research training is an important way for research universities to strengthen the integration of teaching and research, and it mainly consists of two forms at present: the first form is to set up special projects by the state, province and university, students apply on their own, the university selects the best projects, and the teachers give them guidance. As early as 2006, Peking University, Fudan University, Shanghai Jiao Tong University, Soochow University, Lanzhou University and National Tsing Hua University (Taiwan) six universities have adopted the "Swiss Foundation", Nanjing University through the "cultivation and cultivation of creative students' program", Shanghai Jiao Tong University through the "program", and Shanghai Jiao Tong University through the "program", and Shanghai Jiao Tong University through the "program". In 2007, the Ministry of Education issued the "Opinions on the Implementation of the Project of Undergraduate Teaching Quality and Teaching Reform in Higher Education", which officially launched the "Opinions on the Implementation of the Project of Undergraduate Teaching

Quality and Teaching Reform in Higher Education", and officially launched the "Project of Undergraduate Teaching Quality and Teaching Reform in Higher Education". In 2007, the Ministry of Education issued the "Opinions on the Implementation of the Project of Quality and Teaching Reform of Undergraduate Teaching in Higher Education", which formally proposed the implementation of the "Innovative Experiment Program for Undergraduates" (later developed into the "Innovation and Entrepreneurship Training Program for Undergraduates"). Since then, undergraduate research training programs have been rapidly expanding in colleges and universities. Chinese universities have generally set up undergraduate innovation training programs, set up corresponding management organizations, and have special funds and display platforms.

The second form is the participation of students in teachers' research projects. This model was initially developed in the form of "Early Laboratory Entry" programs, where students enter laboratories at the undergraduate level to study with faculty members and conduct scientific research. An important feature of research universities is that faculty members have more research projects and ample resources for them. Universities, including Liaoning Technical University of, explicitly mention this initiative in their quality reports.

The two forms mentioned above will partially overlap. The more common way is that the university publishes a summary of faculty research topics that are suitable for undergraduates to participate in, and students choose one of these topics based on their interest to declare as the topic for the Innovative Experimental Program for Undergraduates. After the topics are approved, students con-

duct research under the guidance of faculty members and gain appropriate research experience [11-15].

### 2.3 Realizing Research-Based Teaching

There is no stable model for realizing research-based teaching in teaching methods, but the essence is a student-centered, problem-oriented, evidence-based means to acquire knowledge. This approach can be used in classroom teaching, to "raise the issue - discuss the issue - solve the problem" as the main form; can also be applied in experimental teaching, the teacher from the scientific research to extract the experimental content, set up the problem scenarios, through the characteristics of the experimental program, to achieve a knowledge point of the exploratory verification, to deepen the students' understanding and mastery of a certain knowledge point. There is no uniform mode of research teaching, and the connotation and extension of its definition are also different, but the fundamental and commonality is that it emphasizes student-centered, scientific research support, and inquiry as the characteristics. It mainly includes seminar, problem-based learning (PBL), case study and other forms. In the teaching process, teachers of research and teaching universities have more academic freedom than those of teaching and research universities; in terms of the criteria for admitting students, research and teaching universities mainly look for suitable students based on the established academic standards and scientific research tasks, while teaching and research universities should determine the teaching standards based on the needs of the students (see Figure 1).

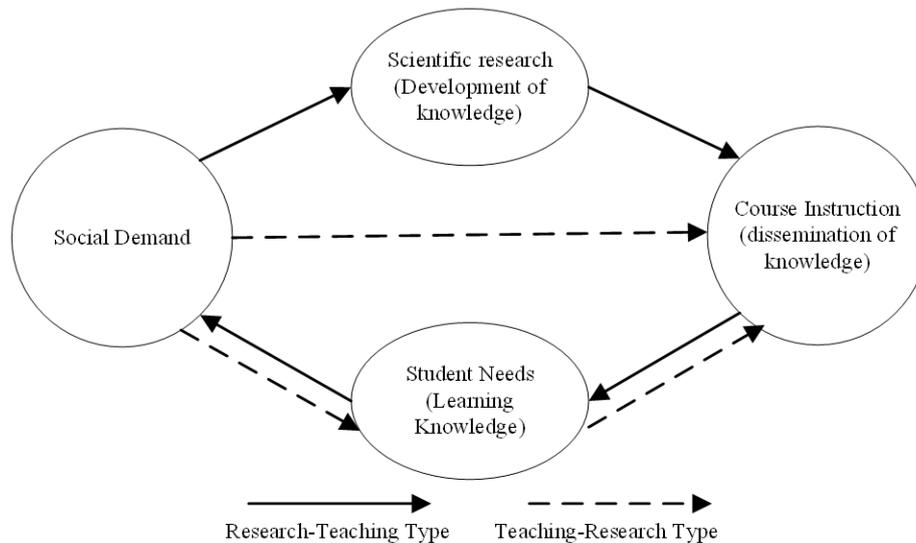


Figure 1 Relationship between research and teaching in universities of different nature

## 2.4 Professors Entering the Classroom

High-level research teachers have generally undertaken more high-level, high-quality research projects, had a large number of excellent scientific research results, and covered a wide range of disciplines, with a comprehensive knowledge and unique insights. This kind of talent into the classroom, help to play their innovative role in teaching. In addition, research-oriented teachers can also participate in teaching in various forms. In addition to classroom lectures, extracurricular guidance, lectures, seminars and other forms can be used to increase student participation and bring students into close contact with research-oriented teachers. First, professors on the podium are implemented as an important system. Generally speaking, professors have a higher academic level than associate professors and lecturers, but university professors may prefer to engage in scientific research, which has a greater degree of display and a higher rate of return, rather than teaching. In this regard, the "Opinions of the Ministry of Education on Comprehensively Improving the Quality of Higher Education" requires universities to "make undergraduate teaching duties a basic condition for the employment of professors". Domestic universities have also made it a mandatory requirement for professors to teach undergraduates.

## 3 Analysis of Teaching Problems

In recent years, in order to adapt to the society's increasingly high innovative spirit and practical ability requirements for the required talents, computer communication and network came into being, as the basic course of communication engineering specialty in undergraduate colleges and universities, occupies an important position in the training program.

As an important basic professional course for communication majors, computer communication and network course aim to cultivate students' computer communication ability and improve the practical operation level. With the rapid development of informationization in modern society, computer networks are ubiquitous, and the demand for computer network talents in all walks of life is increasing. However, the current teaching situation is not satisfactory, with too much theoretical teaching in the classroom and weak practical hands-on ability of students. Therefore, it is imperative to strengthen the research on teaching reform, improve the level of practical teaching

and enhance the students' hands-on ability.

In the teaching practice, it is found that this course has a strong logic, mainly centered on the five-layer hybrid reference model for teaching, from the lowest physical layer to the highest application layer, layer by layer, explaining the network architecture, communication protocols and data communication basics, etc., the content is relatively complex. The teaching process mainly adopts the combination of classroom lectures and experiments, which is more abstract. Students in the learning process, it is easy to know some knowledge points are not deep, resulting in misunderstanding. I try to use a variety of training measures in the actual teaching process, integrate scientific research and teaching, and solve the problems existing in the teaching of computer communication and network.

First, the existing literature has fully affirmed the positive effects of network attack and defense simulation training courses in stimulating students' interest in independent learning, expanding students' knowledge system, cultivating the spirit of teamwork, as well as enhancing students' communication ability, analytical problem-solving ability, and resistance to frustration. Secondly, the introduction of simulation-based experiments as well as the course's teaching objectives, teaching content, teaching methods, performance evaluation methods, some specific problems encountered in the teaching process and the corresponding countermeasures were widely and deeply discussed. Once again, many players or instructors who have had the experience of participating in the competition have analyzed the winning strategies in the network confrontation match in more depth. Finally, there are a few researchers who analyze the inherent defects of the existing simulation-based experimental systems in China from the perspectives of the differences between the simulation environment and the real environment in which the real enterprises are located, as well as the contents that are not embodied in the simulation parameters, the management costs, and so on, and put forward suggestions for improvement.

Teaching and scientific research are not contradictory, but an inseparable whole. To cultivate college students with innovative consciousness, it is not enough to rely only on teaching book knowledge, but also to combine teachers' scientific research projects with teaching-related content. For colleges and universities, the main purpose of talent training has also changed to cultivate talents with innovative spirit. For this reason, colleges and universities have one after another begun to explore the fusion of scientific

research and teaching training mode, by changing the traditional teaching mode, teaching to promote scientific research, scientific research to drive the teaching, so that students can participate in scientific research, scientific research to enlighten the students' thinking, stimulate their creativity, and cultivate students' innovative ability.

## 4 Introducing Scientific Research into Teaching

Our team tries to use a variety of training measures in the actual teaching process, integrating scientific research and teaching to solve the problems existing in the teaching of computer communication and network.

### 4.1 Combining with Actual Projects

The content of teachers' lectures has changed from teaching theoretical knowledge in the past to both teaching specialized knowledge and guiding scientific research practice. For example, when I teach computer communication and network data link layer about wireless network knowledge, can be combined with my project "The project of the cable following the system development and application under remote control based on the WK-12C electric shovel," the research content, to explain the concept of data transmission channel in the wireless network, the network equipment involved and equipment. It explains the concept of data transmission channel in wireless networks, the network devices and equipment involved, the network resources consumed for data transmission, the stakeholders of the network resources and the conflict of interests among the stakeholders. Through the detailed analysis of the whole data transmission process and communication interference, on the one hand, it can deepen students' understanding of data communication; on the other hand, it can attract students with strong receptive ability to participate in scientific research, and improve their exploratory ability and innovation ability.

### 4.2 Innovation Activities Combined with Scientific Research Projects

Science and technology innovation activities are an important initiative of the university to strengthen the cultivation of undergraduate innovation ability. It is

mainly aimed at students in the lower grades, who, starting from their first entry into the school, can follow their teachers to carry out preliminary scientific research exploration according to their personal interests. Teachers can also start from the lower grades to cultivate students' research ability in the long run. For example, when I guided my students to develop the "5G+" mining construction machinery remote control system, they were required to start from the most basic circuit design, understand the nature of each component and communication module, and master the electromagnetic field transmission, and then complete the construction machinery remote control and other delicate work. Remote control of construction machinery and other fine work. During the production process, students can be inspired to explore the performance of the system under different parameters, so that they can deeply understand the key technology of "5G+". They will also learn more about the methods of analyzing and designing the actual network system of industrial and mining enterprises.

### 4.3 Thesis with Research Projects

Graduation internship, as an important practical course of university engineering study, is the final teaching course for students to formally enter the enterprise to solve complex engineering. Therefore, it is of great practical significance to optimize the teaching mode of the graduation internship course with the concept of engineering education accreditation as a guide to improve the quality of training students. Since 2023, the graduation design in the School of Electronic and Information Engineering of Liaoning Technical University usually starts in late September of the previous year and finishes in May of the next year, during which there are about 8 months, which can fully exercise the independent innovation ability of students. Teachers can select a small part of the research project in the context of the students to try to complete. For example, in my project "mining cable car intelligent control safety method research", need to mine cable car wireless control research, in order to get good remote-control effect. This part of the work is not difficult, and can be completed by the teacher to guide the students. I set up the topic of "designing the tail line take-up and put-down device of remote-control robot", so that when students have questions or other inspirations, they can communicate and discuss with teachers in time, and complete the scientific research work under the guidance of teachers. Through the graduation design to complete the

short-term high-intensity training, so that students understand the industrial field to combat wireless interference methods, but also let the students initially appreciate how the scientific research work, more conducive to stimulate the enthusiasm of the students in scientific research.

#### 4.4 Building Teaching Resources

Teaching resources are an important foundation for teaching. Teaching resources are mostly teaching materials accumulated by teachers in long-term teaching practice, and the construction of teaching resources plays a pivotal role in course teaching. Good teaching resources must have a three-dimensional, all-round resource structure, which not only facilitates teachers to teach, but also facilitates students to learn, meets the needs of students, and expands the scope of students' knowledge. The construction of computer communication and network teaching resources is carried out collectively by the course team, division of labor, and jointly completed, and the person in charge of the course coordinates and coordinates the resources, timely supplementation of new course resources, and the addition of new resource modules. In addition, it should be noted that the construction of computer communication and network resources, not a simple collection of information, but all the resource modules should be organically unified, constituting a perfect whole, the modules are internally unified and synergistic relationship, all for the same teaching objectives. In our development of teaching resources, the basic modules are: 1) course knowledge introduction, mainly to explain to students the knowledge of each chapter and the need to master the important knowledge; 2) teacher's handouts, is the class with the teaching materials, provided to the students before class, so that the students in the self-study time to study in advance to prepare for the study in advance; 3) Practice problems, is the spare time of the students to do practice with the materials, students do some exercises. Practice question sets for students to practice in their spare time, so that they can have a deeper understanding of what they have learned; 4) Reference answers for students to refer to after practicing, so that they can understand what they have done wrong and where they have gone wrong; 5) Online testing and automatic scoring system for examination papers, which has a randomized database of examination papers, and the topics of the papers are different for each time, but the examination papers are the same in terms of types of topics and difficulty, and the examination papers are also scored by automatic judging

after finishing the examination papers, so that the students can understand what is still insufficient for them; 6) Animation demonstration, some of the more abstract issues, the form of animation to show the abstract problem specific, image, intuitive display to the students, so that the content of the teaching is more easily understood and accepted by students; 7) Computer communication and network teaching case library, including from the actual construction of the project extracted from the relevant computer communication and network engineering cases, the students through the study of engineering teaching cases, can more deeply appreciate the relevant computer communication and network engineering cases, the students will be able to learn more about the project teaching cases, the students will be able to learn more deeply about the project teaching cases. The students, through studying the engineering teaching cases, can more deeply appreciate the application of related computer communication and network technology in the actual engineering; 8) Course-related new technology lectures collection, we organize the course team teachers, some of the latest advances in computer communication and network technology, in the form of academic presentations, introduced to the students, so that the students are up-to-date with the latest technological advances related to the course, and keep up to date with the latest developments in the relevant technology [16-18].

#### 4.5 Establish Online Learning System

Establish an online learning system to facilitate students' independent online learning. The course construction team utilizes the campus network of Liaoning Technical University to establish an online learning system through the on-campus server. The content of the online learning system is not a simple repetition of the classroom teaching content, but a further expansion and deepening of the relevant content on the basis of the classroom teaching content. The online learning system provides great convenience for students to learn independently, students with higher learning level may not be satisfied with the content introduced in the textbook, but also want to learn more in-depth knowledge, they can go to the online learning system for independent learning. At the same time, according to the process provided by the simulation platform, we comprehensively use the knowledge in the courses of Computer Communication and Networks or Software Engineering, Artificial Intelligence and Visual Programming Languages to complete the development of

a simple "large pretrained language model" (large pretrained language model) for network security, and then we will develop a large pretrained language model for network security. We will complete the development of a simple "large pretrained language model" for network security, and organize and write the development process of the system into teaching cases for students to learn.

## 4.6 Evaluation of Accomplishment

The evaluation of course grades is a crucial part of accomplishing the teaching task of a course. We have also reformed the evaluation of course grades. The idea of reform is to strengthen the assessment of students' learning process, increase the weight of the usual grades, and reduce the weight of the final exam score in the overall score. We will increase the proportion of the usual grades from the original 20% to 30%~50%, and reduce the weight of the final exam score in the overall score to 50%~70%, and usually arrange some big assignments (such as completing a small paper or network program design), so as to stimulate the students' enthusiasm for learning, so that the students pay more attention to the classroom learning, and improve the efficiency of classroom learning.

## 4.7 Enhance Hands-on Ability

Computer communication and network course is a professional basic course with strong practicality. For the current students generally feel that the lack of hands-on ability, after research and analysis, we believe that computer communication and network is a technology-based courses, and the hardware basis of this technology is the computer, the tool for communication is also a computer, the terminal of the network is still a computer. Therefore, first of all, it is necessary to strengthen students' understanding of computer hardware, so that they can master the structure of computer hardware and can solve some basic computer problems in real life. To this end, in order to strengthen students' understanding of the router in the computer communication and network course, we have dedicated some old desktop computers and some network cards in the laboratory to provide students with multi-network computer disassembly and reassembly practice activities, in this kind of practice activities, we require that disassembly practice of the students must be placed in the correct position in the list of computer parts for each disassembled computer component, and at the same time,

we must understand the function and precautions of each computer device. On the other hand, the students who install the computer are required to check the computer parts list first to see if there are any missing computer devices, and then follow the correct assembly order to assemble the work. After the assembly was completed, the power was applied and tested. If the assembled computer could not simulate the operation of the router, the reason was found out until the computer simulated the normal operation of the router. Students like this practical activity very much, work with high enthusiasm, watching their own hand-assembled computer simulation router finally normal operation, showing the joy of success. Students are more motivated to learn the computer communication and network course, which greatly improves the teaching quality of the course.

## 5 Problems and Causes Analysis

First, individual teachers do not invest enough in curriculum construction. Because curriculum construction is a long-term work, it takes a lot of time and produces results slowly. Teachers in colleges and universities are generally under pressure of scientific research and promotion, and they need to publish a considerable number of high-level academic papers, so individual teachers put more energy into scientific research. Although scientific research will feed the teaching to a certain extent, it will still have an impact on the construction of quality courses due to the lack of efforts invested in course construction.

Secondly, in terms of students' learning initiative and motivation, it has not yet been developed; students' inherent potential is huge, but it is far from being developed. The reason is mainly in the students' learning state and learning style. Students are used to rote memorization and lack independent thinking and active thinking. Years of exam-oriented education and full of irrigation, duck-type teaching methods, so that the students' interest and passion for learning has been greatly damaged, students passive learning, coping with the phenomenon of learning or even reluctance to learn is still very common, which is a fatal problem for improving the quality of personnel training. Therefore, we are improving the teaching method and teaching mode, and encouraging teachers to stimulate education in teaching.

Thirdly, from the point of view of students' participation in the open experiment, there is still the problem of students' enthusiasm for participation and the proportion

of participation being lower than expected. At present, the computer communication and network course combines the scientific and technological innovation training program for college students of Liaoning Technical University and students' independent personalized credit learning to offer optional experiments within the teaching plan, including open experiments guided by teachers, open experiments chosen by students independently, and experimental projects such as independent innovation research for college students, with two teachers participating in the guidance. According to the experimental arrangement, the computer communication laboratory is fully open to students after school hours, but the proportion and enthusiasm of students' participation is lower than expected. The reasons for this are, firstly, the students' course schedule is tense and spare time is less; secondly, there is no effective incentive mechanism, which has no effect on the students' usual grades of the course; thirdly, the open experiments are difficult and time-consuming. Therefore, in the future, we need to design open experiments more reasonably and take certain incentives to encourage more students to participate.

## 6 Conclusion

The integration of research and teaching is the main direction of future teaching reform. We add research training module in the training system and realize the integration of research and teaching in the teaching method; solve the problems of "emphasizing on theory, neglecting on practice, and shortage of experimental facilities" in the teaching of computer communication and network course; and put forward the method of applying to practical teaching to cultivate students' innovative ability.

Computer communication and network is an important basic course for communication majors, in order to improve the quality of teaching, our course construction team has carried out a new design and reform of this course from the syllabus to the specific student practice and so on. Through these reforms, we have established a whole set of curriculum construction and teaching reform system, set up an online system for students' independent learning, reformed the teaching resource library, and increased the introduction of many new technologies and knowledge. We have also carried out important reforms in improving students' hands-on ability training, strengthening students' practical teaching, improving students' computer communication network application level, promot-

ing students' enthusiasm for course learning, and achieving the effect of improving teaching quality.

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