Abstract

Computer network course is a professional basic course for computer undergraduates. The practical teaching of computer network plays an important role in the whole teaching process. Practical teaching can help students improve their comprehensive quality, cultivate their innovative spirit and enhance their practical ability. This paper analyzes and discusses the main problems existing in practical teaching of computer network, which are experimental contents, experimental scheme, and experimental teaching methods. Based on talents training objectives of school and the thinking of training innovative software talents proposed by the ministry of education, the solutions to the three key problems are proposed, that is, to optimize and perfect the experimental contents, to construct the experimental environment and scheme based on simulation software, and to adopt multiple practical teaching methods.

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Keywords: Computer network; practical teaching; innovative talents.

1. Introduction

With the rapid development of computer network, software development is also beginning to develop toward networking direction. So, for the students of software engineering specialty, they must acquire the certain knowledge of computer networks. It is an important basis for them to be engaged in professional work better in the future. However, the rapid development of network technology continues to put forwards new requirements for the teaching of computer network course of universities. Upgrading of network protocols constantly, emerging of new technologies, and increasing of new knowledge points make students learn and teachers teach more and more difficult.

Computer network course is a professional basic course for computer undergraduates. It is very
theoretical and practical. The teaching of computer network should not only focus on network theory, network architecture and protocol analysis, but also emphasis on students’ ability of setting up the network, managing and maintaining networks, and developing applications on the basis of mastering the basic principles and concepts. In addition, for many theories of this course, students need to experiment and practice in order to better understand and grasp. As an important supplement to the theory teaching, practical teaching is an effective way of knowledge internalization. It helps students to gradually deepen the understanding of theoretical knowledge, optimizing students’ knowledge structure gradually, so that they are able to apply their knowledge to creative activities. Therefore, it is necessary to research on the practical teaching of computer network in order to help students better understand and master the knowledge of computer networks and develop their innovative capacity.

2. Problems in Practical Teaching of Computer Network

The purpose of computer network experimental teaching is to develop students’ abilities of network analysis, design, management and practical application, and to deepen their understanding of network theoretical knowledge, in addition to verifying the theory of classroom teaching. Presently, the practical teaching of computer network mainly has the following problems in many universities.

(1) The contents of experiment are stale and don’t meet the demands of social development for computer professionals in the new era.

At present, the experimental teaching of computer network are mainly carried out around the theory of the classroom teaching, experimental projects are set for helping students understand the contents of the classroom teaching. Because of the lack of computer network experimental knowledge, people think computer network experiments mainly are confirmatory experiments for a long time. The experimental teaching dependents on the theory teaching, the contents of experiments are not systematic and very arbitrary, and their form is also loose. So that, many students are not able to link theory and practice. Some students got high marks after completing the course, but they are unable to deeply understand the theory knowledge of computer network, especially they can’t apply their knowledge to practical application, let alone the developing of innovative ability. This shows that the traditional experiment contents haven’t been able to meet the new requirements of the new age in the era of advocating quality education and emphasizing capacity-building.

(2) The appropriate environment to carry out experiments is lacked.

Computer network experiments are usually very demanding on the experimental environment. Students need to do both software experiments and hardware experiments. Not only some separate computers but also relevant network equipments and tools are needed. In college the large classes are usually taught. The cost of hardware and maintenance are usually very high to be equipped with a laboratory that only accommodates a small class size, not to mention a large class size. Some colleges and universities can’t establish specialized network laboratory because of the shortage of funding and the lack of laboratory technicians and other factors, resulting in many network experiments can not be carried out. These make students’ understanding of network principles only stay in theory. As a result, the students can’t relate theory with practice and apply their knowledge to solve practical problems. In addition, this kind of experiment scheme entirely depending on hardware has some disadvantages, for example, experimental size is limited, it doesn’t help student to prepare before class and think and exercise over and over after class. So, we should find an effective and easily manageable experiment scheme to provide students with more opportunities to experiment and practice.

(3) The experimental teaching methods are monotonous, which is difficult to motivate the enthusiasm of students.

The practice of computer network course is a key to achieve the goals of talent training. However, in most of the traditional teaching methods, students start the experiments from the principle established
according to the certain steps and the certain means to acquire the certain results. Throughout, students rarely think independently, or even can not ask why, so it is difficult to cultivate their innovation and creativity. Therefore, reform and innovation of traditional teaching methods of computer network experiment is imperative in the new development situation.

Thus, how to integrate and optimize the experiment contents and design the experiment projects suitable for different level students, how to use limited resources to build a scientific and reasonable experiment teaching platform, and how to motivate the interest of students as much as possible, etc., these are problems that should be solved. As a result, it is necessary to reform the current practical teaching mode of computer network and explore the practical teaching mode meeting the needs of social development, so as to lay a solid basis for training software talents with engineering quality and innovation capability.

3. Reform of Practical Teaching Mode of Computer Network

In the era of rapid development of computer network technology, how to teach computer network experiments is a common problem that many colleges are facing. Based on the characteristics of computer network course and the current problems existing in computer network practical teaching, through the experience on practical teaching in the past few years, I think the following aspects of computer network practical teaching should be reformed first.

3.1 To optimize and perfect the experimental contents

First of all, we should orient the talent training goals of a school to design the experiment projects, optimize and integrate the traditional experiment contents, and add designed experiments and comprehensive experiments depending on the concrete situations. In addition, the experiment projects should be classified and rated, so that students can study based on their characteristics and degree, that is personalized learning.

Now, in most of colleges computer network course is taught according to the hierarchical network model, one way is to use the top-down approach, and the other way is to use the down-top approach. I adopt the top-down hierarchical approach to teach this course, so the experiment projects are also set up in accordance with hierarchical network architecture. Through optimizing and improving the experiment contents in recent years, I chose the following experiment projects to set up as shown in Table I.

<table>
<thead>
<tr>
<th>No</th>
<th>Network layer</th>
<th>Experimental projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Application layer</td>
<td>Protocol analysis of HTTP and DNS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Configuration and management of DNS server</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Socket programming (optional)</td>
</tr>
<tr>
<td>2</td>
<td>Transport layer</td>
<td>Protocol analysis of TCP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TCP retransmission analysis</td>
</tr>
<tr>
<td>3</td>
<td>Network layer</td>
<td>Protocol analysis of IP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Configuration of static and dynamic routing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use of ICMP protocol in ping and tracert command</td>
</tr>
<tr>
<td>4</td>
<td>Data link layer</td>
<td>Protocol analysis of ARP</td>
</tr>
<tr>
<td>5</td>
<td>Physical layer</td>
<td>Making network cable and networking</td>
</tr>
</tbody>
</table>

From the above table, we can see there are three types of experiments in the application layer, which are the configuration and management of network server, protocol analysis, and Socket programming. In transport layer two protocol analysis experiments are set up. In network layer the routing configuration is
set up in addition to two protocol analysis experiments. In data link layer a protocol analysis experiment is set up. In physical layer the experiment of making network cable and networking is set up. All experiments of this course can be divided into four types, from hard to easy as follows: programming experiment, protocol analysis experiment, network configuration and management experiment, and networking experiment. Among them, the programming experiment is relatively more difficult for the students new to high-level programming, which may be optional based on the syllabus and class hours. For other experiments, students are required to complete them in principle. But the teacher may require different requirements of different students.

3.2 To construct the experimental environment and scheme based on simulation software

The network environment is a key factor to implement the network experiments. In order to make up the shortage of hardware conditions, we can design the scheme of network experimental teaching based on simulation software in the existing environmental conditions of the lab, and combine the scheme based on simulation software with other teaching schemes to construct the new network experiment scheme, so that students can easily participate in experiments and cooperative research.

In recent years, some companies have developed some network equipment simulation software which provides a good support platform for the network experiments. For example, Dynamips is a Cisco equipment simulator written by Christophe Fillot from French University of Technology Compiègne, which can simulate many types of Cisco router hardware platforms. Users can directly load and run the real IOS image, which makes Dynamips can successfully simulate more than 99% functions of IOS and ensures that the results obtained is same to the results with the real equipments in most cases. NetSim is a kind of software simulating Cisco routers and switches, developed by American Boson. It consists of Network Designer and NetSim, the former is used to draw customized network topology, the latter is used for device configuration experiments. It supports diverse network equipment and complete order, and can give the user the greatest freedom space on the operation. In addition, it also provides users with multi-level tutorial. It is one of the most powerful network device simulator software at present.

Experimental teaching based on network simulation software is a better solution for computer network course, which has many advantages, for example, it is rarely restricted by the hardware resources and can be used in cooperation with other laboratory equipment; experimental scale is easy to extend, it is easy to manage and upgrade and to combine with other hardware and software together to form a complete network experimental teaching system. Because more than one computer is usually needed in network experiments, we can coordinate Virtual Machine software with other tools together to complete the experiments. For example, for some more complex comprehensive experiments, virtual machine (such as VPC) can be used to cooperate with Dynamips to complete them; for simple service configuration experiments, virtual machine with windows server 2003 can be used to complete the configuration; for the protocol analysis experiments, we may use Ethereal (a protocol analysis software) and the virtual machine to complete. This experiment scheme can not only save a lot of equipments, but also facilitate students to repeatedly practice after class. Consequently, it can effectively solve the main issues of the current network laboratory construction and improve the quality of network teaching.

3.3 To adopt multiple practical teaching methods

Practical teaching methods will affect the attitude of the students for experimental class, their hands-on ability and the cultivating of innovative consciousness. In the process of experimental teaching, the reform and innovation of teaching methods should be paid special attention to especially. We should break through the traditional practical teaching methods, design the scientific and targeted practical teaching process, and integrate the cultivating of students’ innovative ability into the practical teaching; multiple practical teaching methods should be used to guide students to participate in course studying
actively, so that all students can be trained based on their own conditions, and thus to maximize their development.

At present, many universities have begun to reform the practical teaching methods of the traditional computer network, the main teaching methods include task-driven approach, grouping experiment approach, network teaching approach, case teaching approach, and so on. In actual practical teaching, these methods can be intertwined to use depending on the specific circumstances. How to organize these teaching methods scientifically and effectively will directly affect the effectiveness of experimental teaching.

- Participation teaching approach, also known as task-driven approach. Teachers first set several themes or issues according to the teaching purposes and teaching contents, organize students to discuss them to find the ways to complete the tasks; then students apply their knowledge to experiment, afterwards introduce their solutions to the experiment issues in class; finally teachers review and explain the experiment results that students obtained. This teaching approach allows students to fully participate in the teaching process, thus greatly enhance the students’ enthusiasm for participating in the practical teaching.

- Grouping experiment approach. For some experiments, especially those related to a variety of laboratory equipments and tedious repetitive operation, this approach can be used. Teachers set the experiment topics, students form their own groups freely, and each group elects a leader, who is responsible for team research. This approach, on the one hand, solves the problem of the shortage of network equipments. On the other hand, it also cultivates the team spirit of students and enhances the ability of adapting to work in the future.

- Network teaching approach. Teachers organize students to refer to the related technologies, methods and applications of network products, network applications, network management software and network development tools on the Internet to find the solutions to experimental problems. This teaching approach can develop the good independent study habits of students and improve their ability of applying the knowledge to solve practical problems independently.

- Case teaching approach. Network technology is very practical and every network project is a good teaching case. Teachers demonstrate and explain the specific operational experiment case, and enable students to master the methods of operation and the methods of design through the case analysis and demonstration. The approach can enhance student perceptions related to operations and methods and improve the effectiveness of teaching.

Currently, problem-driven methods are mainly adopted to organize the practical teaching of computer network courses, that is, to enable students to solve problems and answer questions through experiments. In addition, the methods of grouping experiment and discussion are also adopted in some experiments. For the knowledge related to the experiment contents, I adopt network teaching approach, enable students find the answer through looking up information on the Internet, such as the functions and use of Ethereal and TTCP. During the course of experiment, we should fully reflect that students is its main participants, so that students can obtain successful experience of capability and emotion through active participation and cooperative research, thus build their confidence and experience the fun of exploration and creation. Comprehensive application of these teaching methods not only greatly stimulate the enthusiasm of students, improve their hands-on abilities, and train the students’ ability of analyzing and solving problems, but also cultivate their spirit of innovation and cooperation. Of course, due to the differences of individual students, these methods have different effects on different students. Therefore, we also need to explore the experimental teaching methods adapting to the students with different characteristics, fully stimulate the study enthusiasm of the students, help as many students as possible to understand the classroom knowledge deeply, and develop their engineering quality and innovation ability.
4. Conclusions

The practical teaching of computer network courses is a necessary way to achieve the teaching goals. It plays a special role in improving the comprehensive quality of students, training the creative spirit of students and enhancing the practical ability of students. With the rapid development of computer network technology, the reform of computer network experimental teaching will have a long way to go. We must adopt new ideas and keep learning and exploring in order to keep up with the pace of development of the times and to train more practical and innovative computer talents for society.

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References