Research on the Training Mode of Information Security Professionals in Colleges and Universities under the Background of New Engineering Disciplines

Jianguo Tang and Jianghua Wang

ABSTRACT

Combining with teaching practice, this paper studies the training mode of information security professionals in university under the background of new engineering disciplines. It is proposed to strengthen the safety awareness practice education, establish a composite curriculum system, establish an integrated practice teaching system, and improve the school-enterprise cooperation mechanism and build a composite faculty to build a training model for information security professionals.

1. INTRODUCTION

In 2017, the Ministry of Education of China issued the "Notice on the Research and Practice of "New Engineering Disciplines" by the Higher Education Department of the Ministry of Education", which proposed the concept of "New Engineering Disciplines". Its’ research content includes the new idea of Engineering education, the new structure of discipline specialty, the new mode of talent training, the new quality of education and teaching, and the new system of classified development. The development of new engineering disciplines is the need of national development strategy and the requirement to build a new competitive advantage. Therefore, new engineering disciplines is an inevitable choice for the development of higher education institutions in China in the future. Network security and informatization

Jianguo Tang, School of Artificial Intelligence and Big Data, Chongqing College of Electronic Engineering, Chongqing, Chongqing 400000, China
Jianghua Wang, School of Artificial Intelligence and Big Data, Chongqing College of Electronic Engineering, Chongqing, Chongqing 400000, China
are important strategic issues concerning national security, national development and the work and life of the broad masses of the people, maintaining information security depends on the overall quality and level of information security talents. Universities shoulder the heavy responsibility of cultivating information security talents, In order to adapt to the new requirements of talent training in the context of new engineering disciplines, exploring a more complete and efficient education model is a problem that must be considered and urgently needed in the training of information security talents in universities.

2. CURRENTLY EXISTING PROBLEMS

Information security is a new subject with strong theoretical and practical skills. At present, universities still have the following major problems in the training of information security professionals:

2.1 Lack of security awareness practice education

Only those who have experienced it personally can truly understand the significance of daily cybersecurity education. Even if students are instilled more knowledge and precautions in cybersecurity in the classroom, due to the lack of vivid application scenarios, this has little effect on cultivating students' awareness of cybersecurity. At present, in the practice teaching of information security majors in universities, there is almost a blank in the network security awareness education. This will cause the information security talents trained by universities to ignore some subtle but important security risks when they are engaged in real work, and reduce the prevention. And vigilance, etc., which may cause irreparable major losses.

2.2 Imperfect curriculum system

In order to strengthen the cultivation of inter-disciplinary talents of information security major under the new situation, colleges and universities focus on exploring and improving the curriculum and learning methods, such as expanding the scope of general education courses and providing a more flexible learning mode of elective courses, etc. However, these measures usually only enrich the channels of curriculum learning, and do not carry out the construction of a complete curriculum system, especially the lack of the construction of a complex curriculum system. This leads to the fact that although students can access knowledge outside the information security major, they do not know how to integrate these knowledge with information security specialty organically, nor how to systematically choose the courses to study, which makes information security knowledge content isolated and knowledge structure incomplete. It reduces students' interest and effect in learning.
2.3 The content of practical teaching is single

In order to better understand and master some techniques and means of information security major, students must experience and understand them in a real-world practical environment. At present, in colleges and universities of China, the existing experimental equipment and environment of information security discipline are relatively backward, most of them do not have the experimental conditions to provide simulation environment. They can only carry out some basic and simple experiments, such as encryption and decryption, firewall, intrusion detection and so on. While for the higher level of the more complex reality, the test was not involved or could not be completed under the existing conditions. In addition, comprehensive design-oriented experiments are rare, which cannot create a realistic application scenario of information security technology, and cannot motivate students to take the initiative to further study these technologies. When students enter the real working environment from the laboratory, they will feel that they are in a passive situation of learning uselessness and bewilderment.

2.4 Lack of market and industry thinking

The orientation of colleges and universities determines that they must constantly adjust themselves to meet the needs of social development for technical talents. For example, the current society urgently needs professionals in information security, artificial intelligence and big data analysis. Many colleges and universities have begun to add some related courses to meet these needs. However, although this approach seems to keep pace with the times, it may not be ideal for the training of inter-disciplinary engineering talents, and even confuse teachers, students and schools as well. The reason is that these measures to cope with the changes are often only considered from the perspective of professional knowledge and social needs, not from a higher level of market and industry to think and design, and the students trained under this mode will be difficult to become inter-disciplinary engineering talents who are suitable for future development. School-enterprise cooperation is an important starting point for colleges and universities to train students to integrate with the market and industry. For schools, they hoped that it can improve students' employment opportunities and enhance their adaptability for employment. For enterprises, they hoped that it can cultivate excellent talents for themselves. However, due to the imperfection of relevant systems and cooperation modes, there are great differences in interest demands between schools and enterprises, which makes the cooperation between them only a formal expression in many cases, lacking of substantive cooperation. Therefore, the cooperation between schools and enterprises has not played the desired effect.
2.5 Weak teaching staff

Teachers are not only the imparters of knowledge, but also the executors of various teaching measures in schools. Teachers' knowledge structure and ability level will directly affect the teaching effect and the effectiveness of various teaching reforms in schools. With the rapid development of science and technology, the update cycle of knowledge in the field of information security is also shrinking, and various new knowledge are constantly emerging. In order to adapt to social development, colleges and universities are constantly adjusting the professional curriculum system of information security. The addition and elimination of courses have become normalized, which puts new and higher requirements on the depth and breadth of teachers' professional knowledge. However, many teachers are already struggling to cope with their own professional curriculum adjustments. It is difficult to invest time and energy in other professional courses, which makes the teaching effect of interdisciplinary subjects greatly reduced. Therefore, the construction of a composite faculty team is an important issue that needs to be strengthened urgently for all colleges and universities.

In addition, according to the relevant survey data [6], the talent gap in information technology industry will reach 7.5 million in 2020. In 2025, the gap will further expand to tens of millions, and the talent gap in other engineering categories is not optimistic. The result of these realistic talent gaps is a significant increase in the salaries of relevant talents. Because colleges and universities are constrained by limited funds, it is difficult to compete with social companies to absorb talents. This further aggravates the current situation of the lack of teachers in Colleges and universities. According to the faculty of the author's college, there are currently more than 4,500 students in the college, and the number of full-time teachers is 110, and the teacher-student ratio is nearly 41:1. According to the total number of 2879 colleges and universities in China, the gap of IT talents allocated to each school will be about 3470 by 2025. According to the ratio of teachers to students stipulated by the state at 14:1, we can get the talent gap as shown in the following figure (take our school as an example).

![Figure 1. Information Talents Gap in China.](image-url)
3. RESEARCH ON TALENT TRAINING MODE

3.1 Enhancing practical education of safety awareness

As a worldwide topic, network security has been paid more and more attention by all countries in the world [1]. Especially, the content of network security awareness education is also particularly important for our country's network security management. Security awareness is one of the essential qualities for information security professionals. Good security awareness is helpful to detect and prevent potential security risks in the network in time and effectively. Therefore, in practical teaching, we should pay attention to the practical education of students’ safety awareness, and design the corresponding training content of safety consciousness according to the experiment of different subjects of information security specialty. Because the information security issues of different courses are different, it is recommended to consider the course of information security laws and regulations to design the practical teaching content of safety awareness education for these courses, so that students can experience various hidden security dangers in the actual scene and understand the possible losses caused by these hidden dangers. This will make them have a deep understanding of the importance of safety awareness.

3.2 Establishment of inter-disciplinary curriculum system

In order to better meet the needs of social development, information security specialty has presented the characteristics of inter-disciplinary integration. In the process of constructing the curriculum system of information security specialty under the background of new engineering disciplines, it is necessary to study the construction of inter-disciplinary knowledge system from three main aspects: professional curriculum system, general education curriculum system and inter-disciplinary curriculum system, so as to lay a solid foundation for the training of inter-disciplinary engineering talents. The inter-disciplinary curriculum system needs the integration of multi-disciplinary courses, but it should not only simply pile up the different professional courses, but need to be considered comprehensively from the aspects of the relationship and connection point between the information security major and its related majors, and to set up the courses in an orderly and systematic manner. By learning these courses, students can not only master multi-disciplinary knowledge, but also how these professional knowledge can be integrated and interacted.

3.3 Establishing an integrated practice teaching system

There are several core foundation courses in the information security profession. Although the content of these courses is independent of each other, there are some internal connections between them. In order to cultivate excellent information
security talents, it is necessary to integrate all courses, which requires an integrated and comprehensive design of practical teaching content. The experiments of each course are both sequential and intersectional, which integrates different knowledge. For this reason, a combination of “modular teaching” and “practical base teaching” can be used [2-3]. Modular teaching can fully stimulate students' interest in learning. Practice base teaching is conducive to training students' practical and innovative abilities. For example, the core curriculum cryptography, coding theory, computer network and network confrontation and defense in the information security profession can be considered together. And then a hierarchical, integrated and integrated practical teaching system is designed in term of the order of the courses, the relevance of knowledge and the characteristics of each course.

The arrangement of experimental content in practical teaching is not only to deepen students' understanding of the theoretical knowledge they have learned from books, but also to enhance students' comprehensive learning and understanding of the use of these knowledge and its possible shortcomings, so as to know both what they are and why they are. To this end, the experimental program design should be hierarchical, from basic experiments, curriculum design experiments, innovation experiments to project experiments, to gradually cultivate students' learning knowledge skills and literature.

### TABLE I. MULTI-LEVEL EXPERIMENTAL DESIGN.

<table>
<thead>
<tr>
<th>Experimental type</th>
<th>Experimental content</th>
<th>Experimental effect</th>
</tr>
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<tbody>
<tr>
<td>Basic experiment</td>
<td>Verification of basic theory</td>
<td>Help students to strengthen their understanding and mastery of basic theories</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Develop the students' ability to think independently and apply theory to practice</td>
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<tr>
<td>Course design experiment</td>
<td>Application of basic theory</td>
<td>Improving students’ practical and innovative ability</td>
</tr>
<tr>
<td>Innovative experiment</td>
<td>Design of small application system</td>
<td>Cultivating and improving students' innovative awareness and collaborative ability</td>
</tr>
<tr>
<td>Project experiment</td>
<td>Self-selected topics, team work division and collaboration</td>
<td></td>
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### 3.4 Improve the school-enterprise cooperation mechanism

A good cooperation model should achieve a win-win result, as well as school-enterprise cooperation. In the school-enterprise cooperation, in addition to schools and enterprises, the participating entities also have an important entity that is students. All parties involved in the cooperation have different demands. Schools hope to cultivate excellent inter-disciplinary engineering talents to enhance their influence and competitiveness. Enterprises hope to obtain talents suitable for their own development to strengthen themselves, while students hope to become useful
talents to society and find a good job easily. Although they have different pursuits, all of them can be traced back to the same problem, that is, how to cultivate excellent inter-disciplinary engineering talents, whose "talents" are ultimately reflected by the "technologies" mastered by them. Therefore, it is necessary to improve the school-enterprise cooperation mechanism and build a "technology-oriented" inter-disciplinary engineering talents training mode that can benefit all parties.

The information security training base aims to cultivate students' practical ability to adapt to the future work environment. Therefore, we need to design a set of scientific and reasonable training base construction and management system, which can not only realize the purpose of practical teaching, but also guarantee the continuous improvement and development of the training base in the later period. The training base includes on-campus training base and the off-campus training base, in which the in-school base has a strong practical feasibility, and the out-of-school base can actively construct [4-5] through the development opportunity of school-enterprise cooperation. The training base has an important influence on the training of students and the construction of practical teaching team. Therefore, the construction plan of the training base should contain both how to build the training base inside and outside the school and the training of students and the construction of teachers' team.

3.5 Construction of inter-disciplinary teacher team

The new engineering disciplines pay attention to the cultivation of talents' characteristics such as innovation, pluralism, integration and system. In order to meet these new requirements, teachers need to constantly improve their own knowledge structure, which requires teachers to take the initiative to learn new knowledge, but also schools and secondary colleges to provide a set of reasonable methods and systems to guide and encourage teachers to improve their ability in these aspects. Especially in Colleges and universities, it is necessary to emphasize the accumulation of teachers' experience in engineering practice and strengthen teachers' engineering ability.

With the continuous development and popularization of network and information technology, information security is facing more and more challenges, and its form and content are constantly changing. So it is necessary to constantly update students' knowledge to adapt to the changes of the times. On the one hand, it is necessary to constantly update the experimental content to keep up with the development of the times and strive to maintain experimental training in sync with the real environment. On the other hand, as the leading role in the teaching process, teachers should first update their knowledge dynamically, which requires the establishment of a long-term mechanism for knowledge updating to ensure it. Teachers should always pay attention to the latest developments in the field of information security, which can ensure that students access and learn the latest
information, so as to realize the seamless connection between practical teaching and the real environment.

In addition, as the communicator of knowledge, teachers also need to have the quality of inter-disciplinary professional knowledge, not only their own professional knowledge. Information security is an inter-disciplinary subject, and the construction of teaching team should be diversified. Firstly, team members should have multi-disciplinary knowledge background such as computer, information management, big data and artificial intelligence. Secondly, many policies are introduced by Chinese government to encourage the cooperation between universities and enterprises, which suggests that school should absorb some engineering and technical personnel from enterprises to enrich the teaching staff. At the same time, teachers should be required to enter relevant enterprises to learn new information security technologies and improve their practical and innovative abilities, so as to better guide students to adapt to the realistic work environment in the future. Finally, teachers need to continuously improve their professional and practical skills for a long time due to the rapid updating of knowledge in the field of information security. Schools can appoint teachers to study in well-known universities and research institutes at home and abroad on time to improve teachers' professional quality and ability.

4. CONCLUSIONS

The rapid development of computer network and information technology has posed new challenges to information security. As the main position of cultivating information security talents, colleges and universities need to continuously strengthen practical education of security awareness, develop inter-disciplinary curriculum system, establish integrated practical teaching system, improve school-enterprise cooperation mechanism and build inter-disciplinary teaching staff. Through the efforts in these aspects to construct the training mode of information security professionals under the background of new engineering disciplines. By using this mode, the information security professionals with comprehensive technology, strong sense of security and innovation and strong practical ability would be cultivated for the society.

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