Research on training mode of information security application-oriented personnel on the basis of engineering practice in China

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Abstract

Information security is now a key component to maintain national security, social security and economic security, and the training of high quality information security personnel is urgently needed. This paper would start from analyzing purposes and current situations of information security personnel training in China, and then discuss about training mode of China information security personnel from aspects of optimizing curriculum system, cultivating outstanding teachers, constructing engineering practice system, and regulating personnel training evaluation system.

Keywords: CDIO, Information Security, Engineering Practice, Curriculum Optimization

1 Introduction

Information security is a vital strategic resource of social development. International conflicts on obtaining, using and controlling of information are intensified. Information security is now proved to be a central issue to maintain national security and social stability, every country has put a lot of energy and resources on this topic. Network information security is now an urgent key issue which influences the national overall situation and the long-term interests, it does not only guarantee the exerting of high efficiency and high benefit brought by the information revolution, but also defense against information aggression. The assurance of information security is an important component of the comprehensive national strength, economic competitive power and viability in the 21st century, as a commanding elevation that every country climbs at the turn of the century. The attacking and defending of information network is the confrontations between high-quality talents [1]. However, China is in the initial stage of systematic training of network information security talents and national information security education, the large gap between the supply and demand of professional network security talents, especially the paucity of senior strategy talents and specialized technical personnel, cannot satisfy the development and demand of the modern society informationization. At the same time, in addition to the demand of advanced network security personnel by military and the police, the development of new Internet business models such as electronic commerce, electronic government and electronic finance has taken higher demand for the information security personnel training [2]. Management personnel who only know how to configure the network firewall are unable to satisfy the need of the social development. Therefore, it is a long-term, overall and strategic task to train high-quality, professional network information security team and enhance the national consciousness of information security [3].

2 Current situation of information security talents training in China

2.1 CHARACTERISTICS OF INFORMATION SECURITY

Information security is a cross-science concerning computer, communication, mathematics and other subjects, the research contents of which include cryptography, information security, network and system security, network attacking and defending, trusted computing .etc. The purpose of a country to develop information security is to guarantee the safety of information and system for all professions and trades, and ensure the smooth developing of informatization. As an undergraduate major, information security has distinctive features such as comprehensive, significant, and strong practical [4].

Comprehensiveness: theoretically, with contents such as mathematics, artificial intelligence, information theory,

computational complexity theory, cybernetics, system theory .etc, information security has a broad theoretical basis and strong comprehensiveness. Practically, information security includes designing and manufacturing of information security equipments, designing and realizing of security software, applying of network security products and information opposability technology. Therefore, students are required to possess program designing, electronic equipment researching and developing, network system relative hardware equipment operating and other comprehensive abilities.

Significance: information security is a significant component of national security. In Jan 2003, the president of the United States of America has produced the network strategy to attack computer systems of enemies when necessary, which makes Internet a new battlefield, information systems of power, water supply, oil and natural gas can all be targeted. The development of information security technology is considered to be a matter of national welfare and people's livelihood, and is of significance in protecting national security. So the major of information security, as a primary channel of training information security personnel, is important for the safety of our country and the people.

Strong Practicality: the major of information security requests not only abilities of system analyzing, designing and programming, as the computer major, but also to master security mechanism and insurance means of database systems, routers, servers and all key systems and equipments. Besides, information security personnel should also master safety technologies of information transmission and storage, and practical technologies involving communication and electronic. Therefore, information security is a specialty with very strong practicality.

2.2 INFORMATION SECURITY PERSONNEL TRAINING IN CHINA

In China, the training of information security personnel was performed by few military academies and research institutions, which mainly focused on training talents specialized in digital communication and coding. In 2001, Wuhan University started to enroll new students in information security major as an undergraduate major, and begun to train undergraduate talents of information security since then. Until Jun 2013, information security major was opened in 78 universities. According to the latest major catalogue issued by the Ministry of Education in 2012, information security was attached to computer subject as one of computer majors [5].

'The Guidance of Professional Norms for Information Security Major' in China has provided two sets of proposals for information security personnel training, which are research-based and application-based, and each was assigned corresponding knowledge system and practicing ability system. To identify the meanings and connotations of research-based and application-based talents, we have to start from discussing the types of talents in modern society. From the perspective of social promoting, the first step is the understanding of the world, followed by the transformation of the world [6]. The so called understanding of the world is to know the essential attribute and the objective law of the world, which are to be refined into scientific principles and come into being knowledge, this is the process of understanding the world. And the transformation of the world is to conduct social practice according to objective laws and transfer those laws into social productive forces, thereby improve labor productivity, and then create more wealth for the society. This process is the transformation of the world, people who are engaged in this line of work are considered to be application-based talents.

Research-based talents, also known as academic talents, refer to those who discover and research objective laws, their primary mission is to explore objective laws of unknown fields, and engage in academic work with objective laws as their research target. Such researches are not directly and closely connect to concrete social practices, but their research outcomes are to be valuable at some certain point in the future.

Application-based talents are also called technical talents; they directly apply scientific principles to practical work. The major task they are to accomplish is the direct application of scientific principles and recently discovered knowledge into social practicing and daily lives. There are two circumstances in applying scientific principles (or objective laws) in social practice: one is to transfer scientific principles (objective laws) into engineering design (or work plan, business decision), another one is to transfer engineering design into projects, products or other material forms. The two transformations can barely be separated in actual operations, so we proposed the aims of training information security undergraduate student to be engineering application talents. Due to the differentiation of positions of information security graduates, engineering application talents can be further subdivided into software development engineer, software testing engineer and technical support engineer.

The education plan of China undergraduate talents contains three parts: the first one is the training objectives, namely the orientation of the training; another one is the basic requirement, which means basic demands of quality and ability, graduates are supposed to have basic quality, professional quality and comprehensive quality, as well as basic skills and professional skills; the last one is the curriculum system, which consists of theoretical knowledge curriculum and experiment/practice curriculum. Undergraduate colleges are generally emphasized on the use and application of knowledge, while actual practical ability should be considered more seriously [7].

In terms of training objectives of applied talents in

information security engineering, engineering application talents are specialized mostly in engineering design and application. In terms of information security specialty, such talents mainly include three categories: （1） Talents of research and development, who are capable of designing, developing and testing information security products, and able to transform principles and technologies of information security into information security products, master basic abilities of analyzing demands of software and hardware, designing systems, designing and testing systems. (2) Talents of technology application who are basically capable of designing projects, selecting products, implementing projects and maintaining safety for computer network information system. (3) Talents of management and service. Common characteristics of engineering application talents are being able to transform theoretical achievements of academic talents into information security products, maintain the safely operating of information system, and secure data of information system. The target position we proposed for engineering application talents is based on its differences from technology application talents, the former is the training target of information security majors, but the later tends to technology application, which focus mainly on application ability of information security technologies.

Advanced placement courses were opened in many colleges domestic and foreign, these courses include: 'Introduction of Information Security', 'the Computer Network Security', 'Elements of Information Theory'. etc. The positions of these courses were adjusted by different colleges based on their own characteristics. Regular colleges offer the course of information security to all students as a public elective course, to improve overall safety concept, technology and consciousness. College of science and engineering sets information security to be a required course for majors of science and computer science, and teach students professional technology and technique of safety protection. One characteristic of information security courses is valuing both practice and theory, more practice than theory. Current features of China information security education are stated as followed:

As priorities of information security were differentiated, and conditions of laboratory were limited, many colleges only put theoretical teaching in the first place. However, complex algorithm and structure of this course result in uninteresting contents, monotonous teaching mode, and destitute experimental simulation and verification, which can hardly produce students intuitive feelings on security strategy and pattern, and unable to arouse students' interest in learning.

Information security courses have high requirements in foundations of mathematics. In many colleges of science and engineering, advanced placement courses of information security, such as 'Elements of Information Theory' and 'Teaching Elements of Cryptography' are

not set up completely, which leads to students' difficulties in grasping difficult points and key points, and causes laborious studding in required course for students majored in computer. And information security courses in regular colleges, which are open to all students, can only take simple information securities cases as the main content, and leave the core uninvolved, which is far from the purpose of teaching in this course.

The core of information security course is to develop practical ability of students, on the basis of mastering speculative knowledge. Students are required to use specialized hardware and software to actualize security strategy according to principles of algorithm. For instance, to accomplish simulation experiments with C++, JAVA. Students' practical abilities are unable to be improved due to the expense of hardware equipments and the limited conditions in many colleges. Practical courses such as security software designing are lack. In addition to use security tool to run system security tests, students in information security major have to be masters in defending and resolving system security vulnerabilities. Besides, certain students want to be engaged in security software engineering. Colleges are supposed to open courses on security software design and development, to assist students in mastering necessary knowledge and skill on related fields.

Computer is developing rapidly, intrusion and defense technologies are also booming in confrontations, but current teaching materials are far behind actual operation. Theory-focused teaching cannot keep pace with the development of the subject and technology, new frontiers can hardly be brought to students, and their innovation consciousness cannot develop properly.

Information security requires logical knowledge structure of teachers, and solid foundation of mathematics and computer. Some colleges have narrow range of selectable proper teachers, and the lack of practical teaching experiences leads to poor interaction and communication barriers between teacher and student, therefore students' enthusiasm of learning cannot be mobilized.

2.3 THE OVERSEAS CULTIVATION OF INFORMATION SECURITY ENGINEERING APPLICATION TALENTS

In the field of information security, the US is undoubtedly the leading power, who is in the leading position in nearly all fields from basic TCP/IP protocol architecture, chip design, development and promotion of operating system family to design and development of information security products. In order to strengthen the education of cyberspace security, the US had issued a national special plan in Apr 2010-American national cyberspace safety education plan. The plan was aimed at carrying out education for all and enhancing the consciousness of information security protection and

prevention by adding information security education and technology contents in kindergarten, primary school, junior middle school, high school and university educations. Educations for talents of information in the US are emphasized on mathematics, physics, chemistry and basic principles of engineering, to lay a solid foundation. Teaching materials for information talents are updated more frequently in the US, courses selection are market-oriented, and each college has their own unique features. Flexible modules which alternate working and learning are adopted to train inter-disciplinary talents with technology and business knowledge.

The aim of Japan is to train talents to understand management and technology. Concerns about the width of education and comprehensive contents of education are required. Japanese education is distinctive, latest achievements of global information technology can be reflected in educations from primary school to college, teaching materials are renewed in a high frequency. Working and studding are combined to form the major education mode. Enterprises consider training as a long-term investment on the labor, schools also take workers in to study and assist lecturers in directing them.

Germany education centres on possible professional activities which students may choose. Students make full use of enterprises to learn functional operation skills, and have dual roles as learner in school and apprentice in enterprises. This dual system, which emphasizes on practice training, is tally with the practical characteristic of information talents training.

Guided by the general goal 'everyone uses computer, everyone knows computer', India has established the educational idea of elementary, professional and hierarchical, and taken professional education and mode of education combined with production and research. The ratio between practice course and theory course is roughly 68:100. With guidance of engineers, students can greatly improve their practical ability in practice. Above-

mentioned countries are each with its features in information security talent training, which can be elaborated from three aspects: (1) Clear objectives, distinct stages; (2) Targeted teaching mode; (3) Practice is the absolute principle.

3 System optimization of information security curriculum

Course learning is the most important way for students to master knowledge, so the rationality of course setting has direct influence on training effects of information security students [9]. In the early development stage of information security major, the discipline identity of the major was controversial. Position and characteristics of the major vary from college to college which leads to different course settings. Information security curriculum is a secondary discipline of computer science and technology in many colleges, it is also a secondary discipline of information and communication engineering or mathematics in some other colleges. So information security majors have their own distinguishing features in different colleges.

Course settings of information security should meet two requirements based on the target of training application talents. Firstly, mastering basic theories and skills should be emphasized, the theoretical depth of courses can be reduced and knowledge coverage can be expanded. For instance, the depth of the courses such as cryptography, intrusion detection system, principle of computer virus can be accordingly reduced, and courses such as database security, security software designing, network offense and defense, network security regulations can be added to extend the students' scope of knowledge. The hour of foundation courses which are less relevant to information security can be combined and reduced [10]. Students are supposed to have general understanding of these courses such as digital circuit,
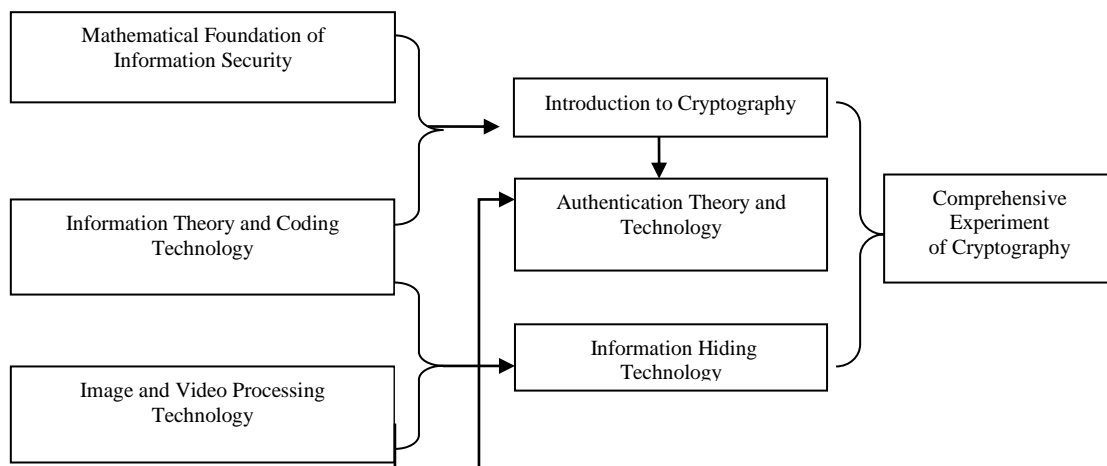
FIGURE 1 The structure of cryptography curriculum group

analog circuit, compilation principles, computer system architecture and database principles. Secondly, the course schedule should be optimized. For established course system, the course schedule should be arranged reasonably based on the basics and ability of students as well as teaching laws, to make sure that students can learn from easy to difficult in a certain degree of tightness. In addition, courses should be equally arranged in different semesters to avoid excessive curriculums in one term. The post graduate entrance examination, the civil service examination and job hunting could impact education for senior grade. Important courses should be opened as early as possible, only elective courses and internships can be leaved for the senior year. That would help students to master basic theories and skills.

The construction of course groups can be helpful in dividing the curriculum, clarifying the correlation between courses, systematicness and intersectionality of curriculum system, and expanding comprehensive experiment at the same time. Besides, on the basis of educational goal, systematically investigating knowledge system of information security, tracking the latest developments of information security and ensuring the integrity and advancement of curriculum system would finally solve various problems existing in information security curriculum. For undergraduate majors, the information security specialty can be divided into three course groups including cryptography, network security and information security.

Figure 1 indicates the structure of cryptography course group. Mathematical foundation of information security, information theory and coding are fundamentals of
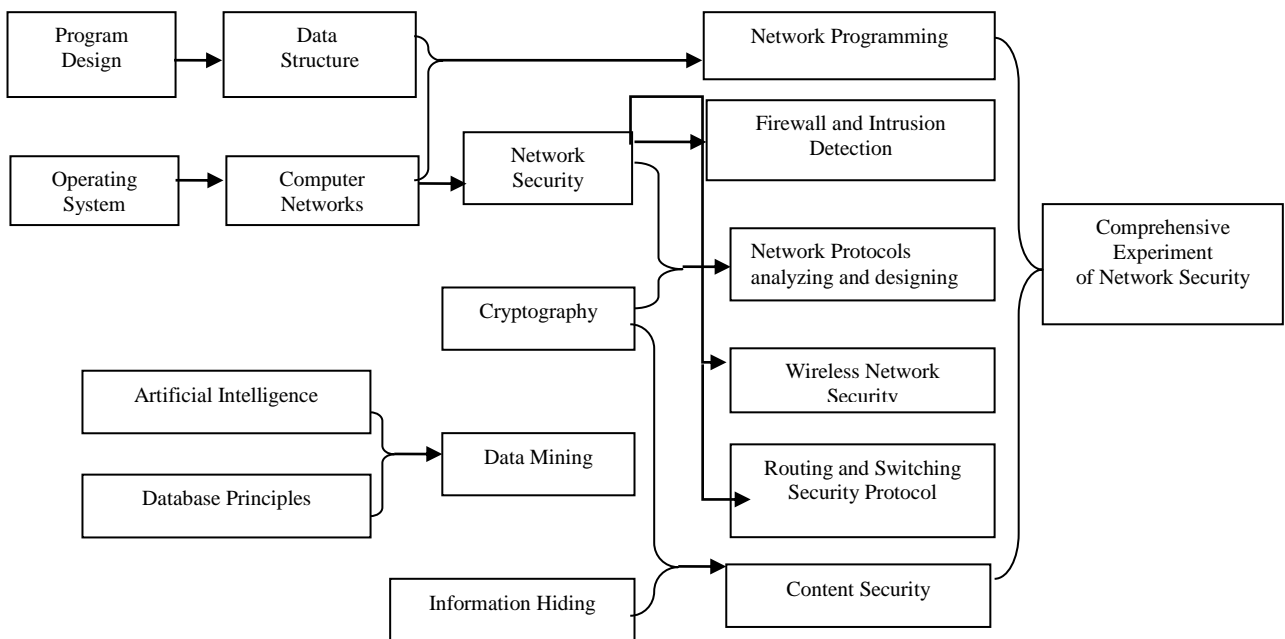
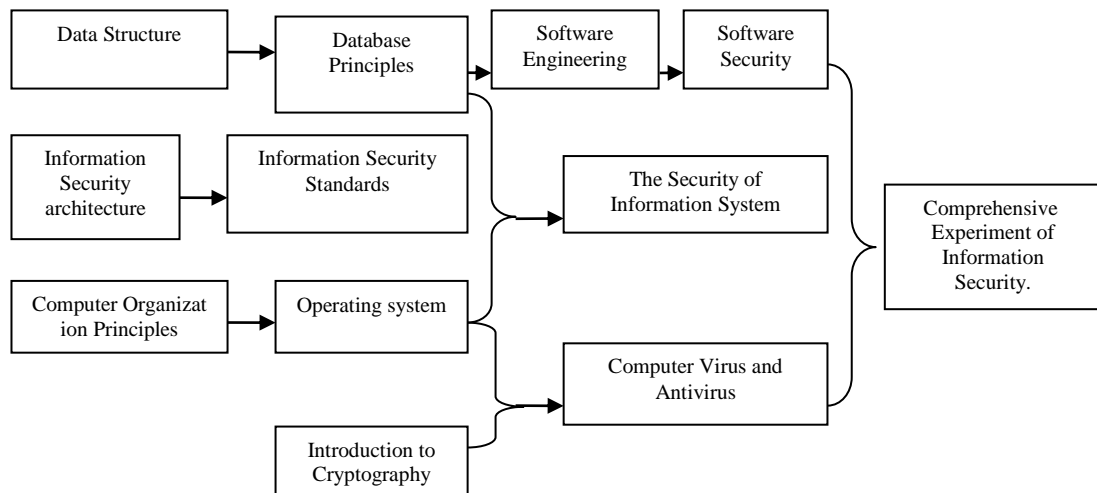FIGURE 2 The structure of network security curriculum group

FIGURE 3 The structure of information security curriculum group

cryptography, and cryptography support authentication theory and technology courses. Regarding cryptogram as information encryption, information hiding is information secreting, progenitor courses of information hiding technology are information theory and coding, image and video processing technology; Cryptography, authentication theory and technology, information hiding can be synthesized to comprehensive experiment of cryptography. Comprehensive experiment should be cross-course, for instance, integrate cryptography and information hiding technology to set up information secreting experiment which hides encrypted information.

Figure 2 indicates the structure of network security course group. Network security is a core course, its progenitor course is computer networks, and its successor courses are firewall and intrusion detection, network protocols analyzing and designing, wireless network security, routing and switching technique security protocol. Artificial intelligence and database principles are basics of data mining. And data mining, cryptography and information hiding provide theoretical and technical support for content security, content security is a new course based on the latest development of information security and practical work, its main contents are security filtering, detection and response of various network medium. Firework and intrusion detection, network protocols analyzing and designing, and content security can synthesize comprehensive experiment of network security to provide an innovating practice ability platform for students to solve network security problems with all kinds of network security technologies [11].

Figure 3 indicates the structure of information security course group. Among which, software security is a new trend of information security, which is on the basis of information security architecture and information security standards. The two core courses are the security of information system and computer virus and antivirus. Technologies as software security engineering, trustworthy software, web security are combined in the course of software security. The security of information system mainly introduces operating system, database, computer access control and other related contents. Software security should be learned after understanding basic principles of software engineering. The security of information system, software security and computer virus and antivirus can be combined to establish comprehensive experiment of information security.

4 Professional Teacher Training for Information Security

The development of china information security lags behind that in overseas, current education system is unhealthy for training innovative information security talents. Teacher of information security major are mostly specialized in computer, signal communication, mathematics and other relevant professions, some of them do not have comprehensive and in-depth understand of information security, therefore, appropriate trainings for existing teachers are necessary [12]. There are several ways for teacher training such as controlling over teaching skills training strictly, improving schoolteaching level for teachers, strengthening communications and widening the view of teachers. Research ability and theoretical level of teachers can be cultivated through research projects. Teachers would be encouraged to participate in scientific researches on information security to improve their own qualities. At the same time, taking the introduction of talents into consideration is also one way to improve the teaching level. Not only high quality teacher team but also strong professional academic echelon would be built by perfecting research directions of the subject and enforcing the schooling capability. Moreover, hiring information security experts of enterprises to be adjunct professor is also an effect measure.

5 The Construction of Practice System of Information Security Engineering

5.1 PRACTICAL TEACHING SYSTEM

The strong features of application and practice in information security technology major lead to the high requirements for training. Students can master applicable knowledge and professional technology only by participating in actual experiment environment. Therefore, practicing is crucial for engineering application talents training. It is necessary to investigate thoroughly to optimize practical teaching system, reform practice teaching in-depth, and evolve new system of course series for information security [13]. To form a new practical teaching system for series of courses of information security Specialty gradually, it is necessary to create practical teaching systems through the following four main points: conducting basic experiments, focusing on ability training, developing innovative open experiments and encouraging competition and authentication. Basic experiments mainly include verification experiments of information security principles, perceptual knowledge of students can be rapidly increased in basic experiments, and students are to know the essences and the principles of knowledge. Ability trainings mainly include experimental operations on information security products, students' practical abilities can be enhanced in practical trainings, and they are trained to comprehensively use multiple information security skills, enhance their practical ability and innovation ability, and then prepare themselves for graduation design, internship and jobs. To achieve the training demands of engineering application personnel, innovative experiments have to be designed in the practice link, students must master system designing, security software developing .etc. Innovative experiments

follow the practical teaching idea of 'linking to enterprise projects, managing strictly on enterprise standards, combining information security theories with projects, gradually improving from the shallower to the deeper'. Students are encouraged to participate in all kinds of information security competitions, project applications and information technology security certification, such as the national college information security competition and the 360 national undergraduate information security contest.

5.2 PRACTICAL TEACHING PLATFORMS of INFORMATION SECURITY

Information security practices request platforms, which include basic experimental platform, integrated training platform and open research platform. Basic experimental platform is functioned to train students' basic ability, help students to understand, and master basic principles and methods learned in class. Basic experimental platform should include commonly used cryptographic machine, firewall, NetGap and network monitoring and scanning system. Teachers and students would get to participate in real security projects through basic experimental platform. By observing equipments such as smart card reader and fingerprint device, students can intuitively understand their working principles.

Integrated training platform is functioned to improve the ability to use comprehensive applied knowledge, it also enables students to synthesize knowledge of one or more courses for design. Thereby the ability of comprehensive design and their abilities to solve practical problems in their engineering designs would be improved [14]. Integrated training platform includes network security experimental training platform and information security integrated training platform. These two platforms contain most typical experiments and most common tools of network security and information security, such as information security audit tool 'BackTrack'. Through the study and practice in these two platforms, students can comprehensively apply their learning and improve the ability of practice.

Open research platform is functioned to cultivate innovative abilities. Based on their own scientific research tasks, teachers design some sub projects for students to participate in to train their teamwork ability. At the same time, students can also apply for projects of their own, and then ask teachers for assistance and guidance. By these means, the enthusiasms of students for learning can be mobilized and the innovation abilities can be improved. Apart from information security practice platforms established by school, students can also cooperate with information security companies outside school. Their fully understanding of all project development processes, and the accumulation of experience could lay the foundation for obtain employment.

6 Innovations in Practical Teaching Mode

Information security is highly practical, which requires tight combination of theoretical knowledge and practice, and integration of educating, learning, and practicing. This is a main mean of training application talents, and an important way to improve the quality and efficiency of teaching.

Class discussion teaching methodology is to be applied in classroom theory teaching. Students' interests in learning should be stimulated by giving introductory first lecture, this type of lecture would mainly focus on education target and method of the course, and then be supplemented with vocational education according to the characteristics that teaching targets are high grade students. It should be got through to students the importance of network security courses in the respects of scientific theory and engineering practice by using vivid and interactive methods. Impel students to combine the learning of this course into their career plans and thus fully arouse their innovation consciousness. The course should be divided into different modular. Contents of each modular will be arranged by tests and assignments after lectures, to intensify consolidation and application of theoretical knowledge. Tests are focused on reviewing engineering science basic knowledge of network theories, cryptography etc. Assignments are focused on the combination of theory and practice, which are mainly in the form of investigation report. Students would be requested to research current hot topics evolving contents of the modular and all fields of information security in such report. Students have to be adapt in opening symposiums related to the course by using question-centered studding modular, and writing discussion reports such as developments and potential vulnerabilities of online banking authentication technology and digital signature technology, technical, social and law issues of information security caused by scandals, cloud security techniques initiated by cloud computing, PRISM door, news events and cases of Bimawen virus, Flame virus and Trojans.

For practice teachings, information security teaching mode can be innovated on the basis of international CDIO engineering education mode [5]. CDIO is the abbreviation of Conceive, Design, Implement and Operate, it is the concentrated generalization and abstract expression of 'leaning while practicing' and 'educating and learning base on projects', it takes the life cycle of engineering projects as carrier. It leads students to learn engineering in an active, practice, organic connected way, and cultivates occupation qualities for modern engineering technology. Composing and designing are two particular links which play an important role in the training of the initiatives to accomplish tasks. After the theory teaching, comprehensive training and innovative open experiments are to be carried out. Comprehensive training has no provisions of the experiment contents,

which requests students to integrate technology of symmetric encryption, hash function, asymmetric encryption technology, identity authentication, VPN and digital signature into application developments such as website development, online communication application, mobile phone application development image encryption. They also have to have proficiency in the use of information security tool, such as information encryption in LAN chat system, designing and using of Hadoop sub nodes authentication and key agreement protocol, identity authentication system based on mobile phone dynamic password, Backtrack and Metasploit tools for detection of network vulnerability, etc. Innovative open experiments take project-driven as advancing method, and these projects include three types: innovation experiment projects explored by students independently; engineering development projects of enterprise supervisors; and engineering research projects of school teachers. Innovation experiment projects explored by students independently are mainly focus on training the ability of problem seeking and problem solving, students would be requested to select topic and determine project objectives based on information security demands around. For example, some students have designed and accomplished flow control technology based on ACL according to the Internet speed of the dormitory; some students have selected attack/defense and crack test of WEP, WPA and WPA2 for security access of wireless LAN, and demonstrated the way to break weak passwords. Students' abilities of active learning and practice would be enhanced through independent projects, and the abilities of problem finding, analyzing and solving would be trained. The purpose is to cultivate comprehensive abilities of using multiple information security skills, improve their practical and innovation abilities, and lay a groundwork of their graduation design and employment. Engineering projects of enterprise mentors are focus on technology development, topics are mostly from industrial circles, such as SSL based bank remote secure access system design, IPSec based VPN system design, etc. Students are required to master all programming techniques and MIRACL password function library, and further accumulate information security engineering practice skills. Academic mentors are school lecturers or professors, they can introduce scientific research tasks arranged or participated by themselves to students, and get students involved. Mentors' engineering scientific research projects are mostly pre-research, which mostly are from their longitudinal research projects, such as foundation of cryptography theory, design of security protocols, and formal verification, those projects can lay firm foundations for students in their master and doctor studding. Innovation experiments based on project-driven have another main effect, which is to cultivate the abilities of teambuilding and project operating. It is also a main connotation of CDIO mode.

Thirst of knowledge can be aroused by the way of competing with practicing, students are encouraged to participate in all levels of college students' innovative projects and high levels of information security competitions. By this way, the ability to learn by themselves can be trained and the required scientific knowledge can be accumulated. On the other hand, students' innovative thinking can be perfected [16]. For example, the national undergraduate innovative experiment project, the competition of the National College of information security, and the 360 national information security technology contest for college students, those are with the form of the project and competition primarily. At the same time, those would be to mobilize initiatives, enthusiasm and creativity of students, arouse innovative thinking and consciousness, grasp the method of problem thinking and solving, and then improve abilities of innovation and practice. Some outstanding works were emerged in these events, such as the development of the document encryption system based on gesture recognition, Android based Dynamic one-time password production development, and Android based short message privacy protection software development. All kinds of national, provincial and civic innovational competitions have aroused students' innovative thinking, team cooperation consciousness, Project management and software design developing capabilities. The practice shows that students who are involved in science and technology innovation contest have better scores and project practicing ability than average, and their innovation ability and engineering practicing ability are recognized by teachers, students, and training enterprise, most of them would be submitted to the graduate and hired by excellent enterprises.

7 Professional Teaching Evaluation System Standards

Effects of teaching evaluation are as followed: 1, testing teaching effect; 2, diagnosing teaching problems; 3, offering feedback information; 4, guiding teaching direction; 5, control teaching process. Information security courses emphasize on practicality and participation, which requires teaching assessment to be considered more than simple test for basic knowledge and simple operation skills. Different possess evaluation ways can be combined to thorough evaluate the cultivating process of student' information literacy. Learning achievements and research results can be seen in each stage of the development through possess evaluation ways, and then teachers and researchers can effectively improve teaching methods. Therefore, process evaluation is an effective feedback mechanism to lead processes and designs of teaching to go along the predetermined target, improper targets can be corrected timely. Learning and feedback of courses under the CDIO model are the important parts of interactive teaching model, and run through the whole process of educating. Three types of

summaries after each modular, which include experiments, tests and assignments, all request self assessment, peer assessment and teacher review as learning evaluation methods. The evaluation results should be feed back to academic and experience teachers to adjust following teaching contents and methods.

8 Conclusions

Information security is a global concern nowadays according to the new requirements for network management and network security techniques to meet new network applications and network structures. Several measures have been proposed in the paper, such as optimizing curriculum system, improving teacher qualities, strengthening practice abilities of students, and standardizing course evaluation system. It has been emphasized that mastering the latest trends of network development and network security technologies, bringing CDIO model into practical education, focusing on cultivating interests and schoolwork planning, encouraging students to participate in science and technology innovation contests and projects to train abilities of engineering practice and innovation.

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References

[1] Duan X H 2013 Study on process-based evaluation reform under innovative talent training mode: taking evaluation reform of mathematical base for information safety as an example *Value Engineering* (34) 239–41

[2] Feng Y, Cai Z Y 2014 Optimization and practice of information security talents training in teaching-research universities *Computer Era* (1) 61-63

[3] Xiong B, Jiang G 2013 Research on curriculum system of network security and management *Computer Era* (10) 62-64

[4] Zhou Y W, Lin M F 2014 Research on the reform of college information security curriculum system and teaching content of optimization *Network Security Technology & Application* (7) 235-8

[5] Liu P, Deng Y M 2014 Network security teaching reform based on CIDO Engineering education model *Journal of southwest china normal university (Natural Science Edition)* **39**(1) 161-4

[6] Feng Y, Wang Y H 2012 Preliminary investigation on CDIO incorporated educational reform of the course of network security *IERI Procedia* (2) 346–9

[7] Liu Y, Hu Z G 2009 Discussion and practice of CDIO oriented 'operation system' educational reform *IT Education* (14) 24–6

[8] Wang Z Q, Cai P 2009 Based CDIO educational reform of basic courses of media applications *IT Education* (12) 137–43

[9] Chen H, Tan Z H 2012 Discussion on "outstanding engineers" training program for information security major in china *IERI Procedia* (2) 868–72

[10] Jonathan R 2011 Online education as a toll good: an examination of the south carolina virtual school program *Computers and Education* **57**(2) 1583-94.

[11] Sun C Y 2012 Research on training mode of high-Level innovative talents in computer science in colleges *Procedia Engineering* (29) 2749-53

[12] Ross A M, Matthew E 2014 Gam-based learning for systems engineering concepts *Procedia Computer Science* (28) 430-40

[13] National Training Standard For Information Systems Security (2012) http://www.cnss.gov/Assets/pdf/nstissi_4011.pdf

[14] National Cyber Security Division 2012 *Information Technology Security Essential Body of Knowledge* http://ww.us-cert.gov /ITSecurityEBK/EBK2008.pdf

[15] Teaching Guidance Committee for information security in Higher Educational Institutions 2012 *Guidance professional norms in the type of information security (third draft)* http://ci.hfut.edu.cn/index/tit /cid/50

[16] Theoharidou M, Gritzalis D 2007 Common body of knowledge for information security *IEEE Security & Privacy* **5**(2) 64-7

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