



The Course Design of Network Attack and Prevention Under the BOPPPS

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Abstract. First of all, based on the school's orientation, student situation, and professional talent training requirements, describe in detail the level of knowledge and ability that should be achieved after learning this course. Secondly, the key problems to be solved in the teaching reform of this course, blended teaching design, the construction and application of course content and resources, the organization and implementation of teaching activities, the method of course performance evaluation, the course evaluation and the reform effect, etc. Finally, use data or materials to illustrate the effect of blended teaching, describe the novel and unique aspects of curriculum design and its value for reference and promotion.

Keywords: BOPPPS · Online and Offline Hybrid · Network Attack and Prevention

1 Introduction

In recent years, with the proposal of building China's "Golden Course" [1], various teaching methods and concepts have appeared in the classroom, among which the BOPPPS teaching model is quite representative. Combined with the network engineering specialty course "Network Attack and Prevention", this paper introduces the use of BOPPPS teaching model to improve the effectiveness and teaching quality of the classroom [2–5].

With the continuous improvement of the goal of building a strong cybersecurity country at the national strategic level, the improvement of cybersecurity capabilities has become a key task during my country's "14th Five-Year Plan" period. The improvement of cybersecurity capabilities will be an important capability support for the country to rapidly realize the transformation of the digital economy.

According to CCIA statistics, in the first half of 2021, a total of 4525 companies in China carried out cybersecurity business, an increase of 27% over the previous year. It is worth noting that although the scale of my country's network security market will achieve a rapid growth of more than 20% in 2021, the supply of network security talents has not maintained a synchronous growth. Official data shows that in 2021, the shortage of cybersecurity talents will reach 1.4 million, and it is expected that the gap will further expand to 3 million in 2027. Network security talents are very scarce, and there are only more than 20,000 college graduates in network security-related majors each year. It can be seen that the supply of network security talents in my country is "green and yellow", and the growth and training speed of talents is significantly behind that of technology and society. The overall speed of change. In recent years, with the vigorous promotion of the construction of a national cybersecurity powerhouse, local governments and enterprises in various industries have also begun to attach importance to the training of cybersecurity talents.

2 Learning Situation Analysis and Course Objectives

"Network Attack and Prevention" is a network security course required for the applied undergraduate network engineering major in our school. The course is usually taught in the second semester of the junior year. There are 761 students in total, and 226 students in the recent one. The pre-course courses include "Computer Network", "Cryptography and Network Security" and "Web Security Technology". Practice" and "Graduation Internship" have important influence. Most of the students have mastered the basic principles and practices of computer networks, the basic methods and procedures of penetration testing, and the principles and basic practices of common vulnerabilities in Web Security Technology, but they do not know much about intranet attack and defense/Task method, but still need to strengthen training; have a certain ideological and political awareness, but still need to continue to strengthen learning. Therefore, it is hoped that through the projects/tasks of each stage of intranet attack and defense, the cultivation of penetration testing ability will be strengthened, so that students can discover, analyze and solve problems in the practice process.

This course is aimed at students who are interested in network security and who are interested in working in penetration testing. This course adopts an online and offline hybrid teaching model based on BOPPPS elements. The important idea of network power", adhering to the educating concept of our school's TOPCARES [7] education methodology, the teaching objectives of this course include:

- (1) Knowledge goals: Master the information collection, hidden tunnels, privilege escalation, lateral movement, domain control security, cross-domain attacks, privilege maintenance and related attack and defense techniques in each stage of intranet attack and defense.
- (2) Ability goals: to understand the relevant national laws such as the Cyber Security Law and the rules and regulations that must be followed for penetration testing; master the ideas and methods of common penetration testing; master the preparation method of a complete penetration testing report.

- (3) Quality goals: have good oral and written expression skills; have a good ability to overcome difficulties; have a sense of self-learning and lifelong learning, and have the ability to continuously learn new knowledge and new technologies, and to continuously improve oneself and adapt to development; Willing and good at cooperating with others, learning together and sharing results.

3 Course Teaching Design Ideas

3.1 The Key Problems of Teaching Reform

The prominent problems encountered in the teaching of this course are:

- (1) How to choose teaching content among many offensive and defensive content?
 Network attacks and prevention involve a wide range, not limited to the network itself, operating systems, application systems, middleware, Web vulnerabilities, device vulnerabilities, and social engineering.
 First, how to choose reasonable teaching content is a difficult problem?
 Second, how can the selected content be linked with the previous and subsequent courses?
 Third, how to properly cut into the curriculum ideology and politics?
 Fourth, is the choice of content conducive to student employment?
- (2) How to drive student participatory learning?
 Intranet attack and defense include environment construction, information collection, hidden tunnels, privilege escalation, lateral movement, domain control security, cross-domain attacks, privilege maintenance, and related attack and defense technologies at various stages, which are extremely difficult and challenging.

First, how to choose representative projects and tasks so that students can get started quickly? Second, for some students with weak foundation or poor hands-on ability, how to improve their learning interest and learning effect? Third, for some students with strong ability, how to drive them to learn more advanced and challenging methods and content? Fourth, how to improve the quality of their reports? Fifth, how to solve some students who cannot participate in offline learning during the epidemic.

3.2 Blended Instructional Design

The traditional teaching mode cannot effectively solve the above problems. For this reason, this course proposes and implements an online and offline hybrid teaching mode based on BOPPPS elements. The main design is as follows.

- (1) BOPPPS requirements, taking into account ideological and political, teacher-led, and improving teaching efficiency
 The classroom teaching of this course is based on BOPPPS + ideological and political approach, through the following 7 aspects:
 Introduction: Main task: introduce teaching content, attract students' attention, and stimulate students' interest in learning.

Goals: Main tasks: To clarify the teaching goals, let students understand what the knowledge can do.

Pre-assessment: Main tasks: test students, understand the knowledge base of students, and lay the groundwork for subsequent teaching.

Participatory learning: The main task: the thematic link of classroom teaching, allowing students to participate in classroom activities and learn actively.

Post-evaluation: The main task: to experience whether the teaching objectives of this course are achieved, and to give feedback on the learning effect.

Summary: Main tasks: course summary, reflect on what you have learned, and lead to the next course content.

Ideological and political entry: can cut into the above 6 aspects, the main tasks: the new era of family and country values, the socialist core values, the scientific development concept, the fine traditional culture concept, the modern legal concept, the professional cultivation concept, new methods, new technologies, encourage students To output papers, soft works, patents, certificates, and competitions.

- (2) Based on the work process project/task student-centered, improve the quality of learning [8]

Teachers: Teachers post online or offline tasks/projects/problems and guide students to consult, decide, plan, implement, evaluate, summarize, and improve using a work process-based approach.

Students: Students understand tasks and consult, decide, plan, implement, evaluate, summarize, improve through individual or group based work process methods.

Teachers: Teachers monitor the whole process, appropriately raise students' mistakes, and make summaries and improvements.

- (3) Combination of online and offline resources, unlimited repetition of learning and consolidation of knowledge anytime, anywhere

The purpose of adopting blended teaching in the course is to effectively promote students' personalized self-learning and in-depth learning, and improve teaching effect through sufficient online learning, in-depth interactive face-to-face teaching, timely evaluation feedback and accurate support in the process. Blended teaching strives from the following three aspects:

Online teaching: Students can make full use of various network platform resources such as SPOC, supporting assignments and tests, FAQs, reading materials, etc. to complete learning tasks, learning exchanges, and learning reflections. Most students can walk into the classroom with a good learning foundation. Thereby ensuring the quality of classroom teaching.

Offline teaching: Teachers carefully arrange teaching content and teaching activities around the key points, difficulties and common problems of students' self-learning; organize students to consolidate and flexibly apply what they have learned, effectively improving the depth of learning for most students.

Process evaluation feedback: Teachers can effectively monitor students' learning process with the help of online learning behavior data (number of visits, learning time, etc.), review reports, seminars, etc., and can provide timely and effective feedback on students' task completion and students' problems. Evaluation feedback and accurate support.

- (4) Utilize the advanced teaching tools of Xuexitong, VMware virtual simulation platform and QQ group

Xuexitong: The school has launched a strategic cooperation with the Xuexitong platform. Students can log in to each major course with one account, and log in to Xuexitong to learn, submit reports, attendance and other teaching activities across platforms; teachers can publish various course resources, attendance, and correction through Xuexitong Report.

VMware virtual simulation: Students can control the experimental environment independently, simulate topology, and perform various simulations.

QQ group: Through the real-name system, anonymous chat with teachers and students, students and students can communicate Q&A anytime and anywhere. Analysis of experimental results.

3.3 Construction and Application of Course Content and Resources

This course adopts composite three-dimensional teaching resources, including video, PPT, experimental instruction book, and experimental report.

- (1) SPOC resources

There are 159 videos with a duration of 2398 and 54 non-video resources. In 2020, it will be rated as “school-level offline first-class course”, in 2021, it will be identified as “industrial and information technology vocational skills improvement training project”, and in 2022, it will be identified as “Guangdong provincial-level online and offline hybrid first-class undergraduate course”.

- (2) Textbook resources

According to the actual situation, according to the employment needs, the average is updated once every 2 years, and the textbooks used successively are as follows:

“Network Attack and Defense Technology and Practice”, edited by Zhuge Jianwei, Beijing: Electronic Industry Press, ISBN 9787121138027, June 2011.

“Python Stunts--Using Python to Become a Top Hacker”, editor-in-chief of [US] TJ.O'Connor (Okoro), Beijing: Electronic Industry Press, ISBN 9787121277139, January 2016.

“Computer Security: Principles and Practice (Original Book 4th Edition)”, by William Stallings [US], Lawrie Brown [Australia], translated by Jia Chunfu, Gao Minfen (Nankai University), etc., Beijing: Machinery Industry Press, ISBN: 9787111617655, March 2019, classic textbook in the field of computer security.

“Network Attack and Defense Principles and Technologies 3rd Edition”, edited by Wu Lifa, Hong Zheng, and Li Huabo, Beijing: Machinery Industry Press, ISBN: 9787111680727, June 2021, “13th Five-Year” National Key Publication Publishing Planning Project.

“Intranet Security Attack and Defense: A Practical Guide to Penetration Testing”, edited by Xu Yan and Jia Xiaolu, Electronic Industry Press, ISBN: 9787121377938, January 2020.

- (3) Pre-class study guide

Teachers arrange students to learn relevant content before class through lesson plans and learning resources.

(4) PPT courseware

In order to meet the needs of students' ability training, teachers have compiled 4 sets of PPTs. The last 2 PPTs are as follows:

The first set is the content of the Python-based network attack and defense course, which involves prominent principles and practices, with pictures and texts;

The second set is based on the content of the intranet attack and defense course, which involves the process of intranet attack and defense, and is mainly based on actual combat practice.

(5) Experimental report

Adopt a project/task drive based on work process. Teachers use it to test students' learning effects after class. This course has arranged 8 experiments and 1 large homework in the last period of the course. The list of experiments and large assignments is as Table 1.

(6) Offensive and defensive laboratory equipment and systems 360 Net God information security training system V5.0, 360 Net God information security competition system V5.0, CTF competition module, red and blue confrontation module, offensive and defensive combat module.

3.4 The Organization and Implementation of Teaching Activities

After students study online or offline courses, in the 4A flexible laboratory provided by the school, everyone must independently complete all experiments and major assignments.

Students who have spare capacity, according to the actual situation, are recommended to join the school team and participate in authorized enterprise, municipal, provincial, national offensive and defensive drills and other related activities.

Students are encouraged to have course-related papers, soft works, patents, certificates, and competition outputs.

3.5 Evaluation Method of Course Grades

According to the school's regulations, the total grades of the course include the process assessment results and the final assessment results, as shown in the following Table 1.

3.6 Curriculum Evaluation and Reform Effect

This course was established in the spring of 2017, and since the implementation of the online-offline hybrid teaching reform in the spring of 2020, it has insisted on taking students as the center in the teaching process, guiding students to output, and continuously improving according to industry and enterprise research, combining theory with practice, tradition and innovation Combined, the teaching mode has been highly recognized by students. In summary, the following formulas are summarized.

4 Curriculum Teaching Reform Effect Achieved

Since the online-offline hybrid teaching reform was adopted in this course, the curriculum has been remarkably dynamic and the reform has achieved remarkable results, and teachers and students have benefited a lot from it.

(1) Teachers benefit as follows:

In the past 3 years, the teaching quality is A, and the scientific research and teaching performance is A. Received 3 letters of thanks at or above the municipal level; 5 horizontal and vertical projects above the municipal level, including 1 ministerial-level project; 1 first prize of the provincial teaching achievement award; 3 provincial commendations.

(2) Students benefit as follows:

In the competition, he guided students to win 1 runner-up for the strongest team in the 1st National College Student Network Security Ability Competition, 1 s prize for the 4th National University Mobile Internet Application Innovation Competition, and the sixth and seventh national "Meiya Cup" competitions. 7 third prizes in the China Electronic Data Forensics Competition, 1 Excellent Organization Award, 5 Third Prizes of the 3rd National Changan Cup Electronic Data Forensics Competition, 1 Excellent Organization Award, and 1st in the Guangdong Provincial Final of the National College Student Software Testing Competition 2 first prizes, 4 s prizes and 3 third prizes.

In terms of creativity, innovation and entrepreneurship, it has won 3 provincial-level "climbing plans" in Guangdong Province, 2 provincial-level college students' innovation and entrepreneurship projects, and 2 provincial-level natural science academic paper awards. Led and guided students to write and publish more than 10 papers, of which 7 were indexed by EI. Successfully incubated 3 companies and 2 teams.

In terms of employment, there are well-known enterprises such as Qi Anxin, NSFOCUS, Baidu, Ali, Tencent, JD.com, and Sangfor. The government institutions include Qingyuan Public Security Bureau, Guangdong Information Security Evaluation Center, China Saibao, San Zero Guard, etc.

In terms of further studies, some students have been admitted to famous universities such as Jinan University, Renmin Police University, Guangzhou University Fangban, etc.

5 Conclusions

Practice has shown that by comprehensively using BOPPPS teaching model and task-driven teaching method for teaching design in the teaching process, teachers can stand at a higher position more consciously, sort out the internal connection between knowledge, know how to penetrate the cultivation of subject thinking and methods, and improve teaching. Efficiency. In the process of participatory teaching, students gradually internalize offensive and defensive thinking, and complete the transformation from knowledge accumulation to ability and intelligence.

Table 1. Performance Evaluation Form

Assessment	Subdivision	Percentage of Total Grades (%)	explanation
Process assessment	Attendance	10	roll call
	Build an intranet penetration test environment	5	experimental report
	Intranet information collection	5	experimental report
	Building a hidden communication tunnel	5	experimental report
	Privilege Escalation	5	experimental report
	Lateral Movement	5	experimental report
	Domain Controller Security	5	experimental report
	Cross-domain attack	5	experimental report
	Backdoor	5	experimental report
Final assessment	Intranet actual combat	50	big job

Acknowledgments. In 2022, Guangdong provincial-level online and offline hybrid first-class undergraduate courses.

In 2020, “Guangdong Neusoft College--Red Hat Community Off-Campus Practice Teaching Base”, a construction project of teaching quality and teaching reform in Guangdong undergraduate colleges and universities.

In December 2020, “Research on the Cultivation Path of Outstanding Talents in Network Engineering” (key topic: 20GZD08), the “13th Five-Year Plan” of the Guangdong Higher Education Society, the 2020 Higher Education Research.

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