Research on Gamification Teaching of "Network Security Technology" Under Improved Flipping Classroom

Zhi-yong Luo[✉], Jing-yuan Wang, Guang-lu Sun, and Yi-dong Chen

Computer Science and Technology College, Harbin University of Science and Technology, Harbin 150080, Heilongjiang, China
luozhiyongemail@sina.com

Abstract. Network security technology is a professional course that must be offered by network engineering majors in colleges and universities. Then understanding the relevant principles and concepts that are difficult to understand is a fundamental reason that affects students' true mastery of network attack and defense technology. Based on the previous research, this paper designs an improved "flip classroom" gamification teaching model. The model optimizes the traditional "flip classroom" teaching process into four stages: preclass, in-class, after-school and holiday review, which further deepens students' understanding of important knowledge points. At the same time, the new model also introduces the concept of gamification teaching, which further stimulates students' interest in learning. Practice has shown that the improved teaching model has certain advantages in improving the ability to solve practical problems, learning achievements and long-term grasp of relevant principles and concepts. In addition, the new model also provides a reference for the teaching methods of engineering courses in other colleges.

Keywords: Flipping classroom · Autonomous learning · Network security technology · Gamification teaching

1 Foreword

With the continuous emergence of new technologies such as "cloud computing" and "Internet +", education informatization has become more and more important to the attention of educators. The scientific application of emerging network technologies to current teaching activities not only enriches existing teaching methods to promote teaching reform, but also promotes the integration of China's teaching model with the world and towards a more favorable direction for students' learning. According to the spirit of the document "Development of Education Informationization Decade (2011–2020)" [1], domestic universities and colleges have applied modern information technology to their respective teaching activities, and basically established students to "self-study". The teaching system structure of the main and teacher-assisted, through the application of "micro-video", "flip classroom" and other new teaching models to achieve the purpose of improving teaching quality.

"Network Security Technology" is a theoretical and practical, professional-oriented course for engineering, and its practice links are more operational and engineering features [2]. Therefore, the teaching of this course not only allows students to verify the boring theoretical knowledge, but also allows students to design creative network security solutions, which seems to be incapable of achieving the ideal teaching objectives in the traditional teaching methods. Applying the improved "flip classroom" teaching mode to the teaching process of this course, not only can improve the existing teaching methods, but more importantly, it can also improve students' self-learning ability, and then introduce "gamification" teaching. Means can stimulate students' interest in learning, participate in the exchanges between teachers, students and students, improve their organizational ability and teamwork ability, so as to seamlessly realize the goal of training colleges and universities to train talents in the network security direction.

2 Improved Flip Classroom

2.1 The Connotation of Flipping Classroom and Its Research Status

The Flipped Classroom was first proposed in 2007 by American teachers Jonathan Bergmann and Aaron Sams, it is an emerging teaching mode, which divides the whole teaching process into three parts, namely, before, during and after class. The pre-school teaching mainly allows students to achieve self-study by watching micro-videos carefully prepared by teachers. The teaching in the class is mainly student-oriented, the teacher answers questions and explains the knowledge points; the after-school teaching is used for summarization, giving a scientific evaluation of the students' self-learning ability. Intel Global Education Director Brian Gonzalez [3] once pointed out: "Flip the classroom can give scholars more freedom of study, and put the teaching process in the spare time, so that scholars can accept knowledge points in the way that suits them best; The internalization of knowledge in the class is more convenient for teachers and students and students to communicate, and it is easier to master the knowledge". American education expert Stacey Roshan [4] used the flipping classroom in the teaching practice of the university pre-requisite course to further verify the effectiveness of the flip classroom.

China's research on flipping classrooms began in 2012 [5], and it is still a new thing. The most representative application is the flip classroom teaching experiment of Chongqing Jukui Middle School. In the following years, the domestic research on flipping classrooms has grown rapidly, and related research literature has gradually increased. Especially in 2014, the first national colleges and universities "flip classroom" micro-video teaching contest successfully held in 2014 will be "flip classroom". The teaching concept has been pushed to the top, which has greatly attracted the attention of domestic universities. According to the relevant statistics of the current statistics, the teaching mode of "flip classroom" is mainly applied in the basic education stage. The application of specialized courses in colleges and universities, especially engineering colleges, is mainly concentrated in the operating system [6], e-government [7], Chemistry [8] and modern educational technology [9–11] and other

courses. With the construction of the shared curriculum platform in Shanghai universities, the MOOCs courses of multiple universities and colleges have been launched one after another, which provides convenience for the students of each college to select the excellent courses of the universities in the region, thus breaking the boundaries of learning between universities [12]. Through research, the implementation of flipping classroom teaching in the practical and practical professional course teaching can effectively stimulate students' interest in learning and improve their self-learning ability, organizational ability and practical ability Through research, the implementation of flipping classroom teaching in the practical and practical professional course teaching can effectively stimulate students' interest in learning and improve their self-learning ability, organizational ability and practical ability [13].

2.2 Traditional Flipping Classroom Problems

China's research literature on "flip classroom" began in 2012. The existing research found that the implementation of the traditional "flip classroom" has the following problems [14]:

1. Flipping the classroom requires a lot of spare time for the students, so the number of flipped classrooms opened in each school year is not too much. If there is no reasonable mechanism to stimulate students' interest in learning, it will be difficult to guarantee the preparation effect before class.
2. Flipping the classroom requires the use of a computer network teaching platform, which increases the workload of familiar software for students with low computer operation level, which affects their enthusiasm.
3. Flipping the classroom puts higher demands on the teaching ability of teachers and changes the organizational model of traditional teaching in the past. This is a new challenge for some old teachers or new teachers with insufficient experience.
4. Flipping the classroom requires a new teaching reform and evaluation mechanism, and the existing evaluation mechanism cannot meet the requirements in this regard. The reform of the evaluation mechanism includes two aspects, one is to evaluate the reform of teachers' teaching ability and rewards, and the other is to evaluate the reform of students' learning ability. The former will affect the ability and enthusiasm of teachers to control the classroom, and the latter will affect the enthusiasm of students to participate in teaching. If the evaluation mechanism of these two aspects is not perfect, it will directly affect the implementation effect of the flip classroom.

3 The Status Quo of Network Security Technology Teaching

3.1 Teaching Problems

The Network Security Technology course is one of the important means to train students to work on Internet of Things and Web security. However, through visits,

research and years of teaching research, it is found that at present the teaching of this course has at least the following problems [2]:

(1) The teaching method is single and lacks the mechanism to stimulate students' interest in learning. At present, the network security technology of most colleges still adopts the traditional and single case demonstration teaching mode. The teacher gives the whole operation process of the case, the students only need to reproduce the case according to the process, and complete the knowledge point task assigned by the teacher. Therefore, this method can not stimulate the interest of students to learn independently, and students still complete the process of passive learning under the pressure of scores.

(2) Insufficient hours of study and complete case teaching. At present, more and more colleges have increased their investment in school hours. In our school, for example, the number of hours in the network security technology course has increased from 54 h to 64 h. However, due to the characteristics of this course, in order to complete the successful application of a network security case, students must complete security requirements analysis, program design, program code development or protection tool selection, debugging and installation and deployment, obviously 64 h Insufficient, and ultimately led to a serious decline in teaching effectiveness, making the case teaching model a "formal" project.

(3) The formulation of teaching content is too rigid and lacks the innovation of students' self-developed practice. At present, most of the cybersecurity technology courses are fixed, and students are not allowed to make their own questions. Students must also follow the teaching steps to achieve case recurrence. This limits the students' thinking, is not conducive to students' independent innovation, and designs content that is more suitable for their creativity.

(4) The teaching mode is old and lacks the teacher-student interaction mechanism. Due to the limitations of teaching conditions, a teacher often faces the teaching phenomenon of at least 30 students. This has made it difficult for teachers to fully guide each student, and the lack of mutual cooperation between the students has led to a lack of communication between the students. Therefore, when students are doing the case, the good students are busy reappearing, and the poor students simply do not, which ultimately affects the teaching effect.

(5) The assessment method is single and cannot reflect the true ability of students. Currently, most classroom computers have a recovery card installed. This has led to the students in the process of completing the case, the resulting works are difficult to save, and thus inconvenient for teachers to check. Over time, the student's grades are mainly based on their attendance, which does not reflect the true ability of the students.

3.2 Characteristics of Student Learning

The network security technology course is a professional direction course. The general colleges are usually opened in the fourth semester, so the subjects are often taught by lower grade students. Through years of practical teaching, low-level students have the following characteristics when conducting cybersecurity technology courses [2]:

(1) The level of network security operation technology is uneven. The junior students have just experienced public class learning, and most of their energy has not yet been put in the direction of cybersecurity, so students generally have huge differences in skill levels.

(2) The difference in learning interest is obvious. Due to the huge differences in students' awareness, employment direction, and personal preferences, students' interest in learning this course is different.

4   Improved Flipping Classroom Gamification Teaching Model

4.1   Improved Flipping Classroom Teaching Model Design

Traditional flipping classrooms use the teaching model shown in Fig. 1 [15]. Since the model has the problem described in 1.2 during the implementation, it has been improved in this paper.
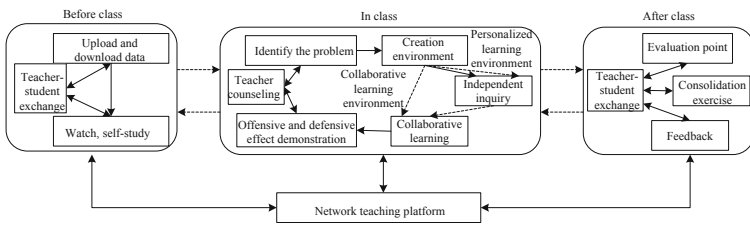

Fig. 1. Traditional flipping classroom teaching model

The new model will increase the game settings and student self-assessment and mutual evaluation modules to further stimulate learning interest; the model also increases the teacher evaluation and reward module, which inspires the enthusiasm of teaching. The improved model can effectively solve some of the problems described in 1.2. Other problems can only be solved through policy reform. For example, the total score of the course should be automatically generated by the system during the middle of the holiday, and the teacher only gives 90% of the total score at the end of the period. The remaining 10% should be automatically given by the system after the students return to important knowledge points twice and make reasonable suggestions at the end of the holiday. The improved flip-up gamification teaching model is shown in Fig. 2. The "Network Security Technology" course will use this model for teaching reform.
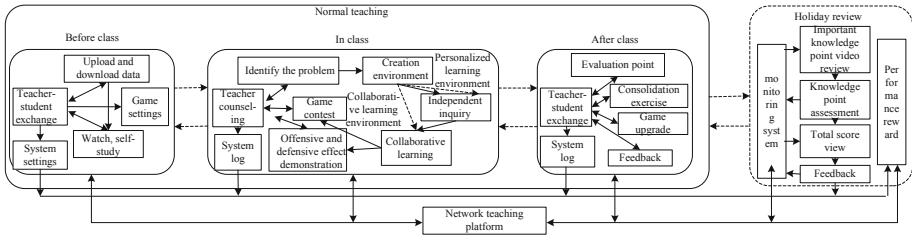
Fig. 2. Improved flipping classroom gamification teaching model

Figure 2 divides the entire teaching activity into two phases: normal teaching and holiday review. The normal teaching stage consists of three parts: before class, during class and after class. The improved new teaching model should be completed in addition to the pre-class, in-class and after-class tasks of the model in Fig. 1 (see the author's previous research results, the literature [15]), and should also provide the function of completing the new task. For example: before class, teachers and students can design game activities according to the characteristics of this data, give game rules and reward descriptions and update the game module; in the class, teachers and students can choose real-time confrontation of game competitions and record the whole process, giving the results of the game; After class, teachers and students can watch the game video in time, comment on the highlights to give mutual evaluation results, excellent game cases should be upgraded into a game library for future teaching use. During the holiday review period, the teacher sets the time period, the system automatically prompts the students to log in, and the students watch the video of the important knowledge of the course to review, and after the review, a simple test of the knowledge points is required. After the student submits the test results, the system automatically calculates the total score of the course for the students to view and ask for reasonable advice. At the same time, the system will also calculate the reward level of the teacher according to the log files of the course and the reasonable suggestions of the students, and give reward reference, pay attention to only reward without penalty.

4.2   Normal Teaching Case Design

Since the normal teaching stage of the "Network Security Technology" course uses the teaching model shown in Fig. 2, its teaching process design is divided into four aspects: pre-class design, in-class design, after-school design and game module design.

4.2.1   Pre-class Design

Pre-class design requires teachers to summarize the knowledge points of this course in advance, provide necessary courseware, previous students to learn the wonderful video, network security attack and defense tools and team division instructions, students download these materials through the network teaching platform Team analysis, preliminary understanding of these materials, design of competition cases or game content and rules, feedback from the group leader to teachers. After the teachers and students communicate, further design the game plan or the game case to upload to the system, so that the game can be compared in the class.

4.2.2 Class Design

The design of the class is the key to flipping the classroom. In the implementation process, we must actively implement the "student-led" thinking. Therefore, the design of this stage is divided into four parts. This article assumes that each course is 180 min or 4 h.

(1) The first 20 min of the course is the teacher's explanation part, focusing on the teaching tasks, important concept theorems, competition or game rules and reward methods of this course.
(2) The student prepares and starts the discussion according to the teacher's explanation. Teachers are required to participate in each group's discussion and task division activities, correcting the unreasonable part, which is expected to take 50 min. For example, taking the ARP attack defense in network security as an example, the natural class of 30 people is divided into 6 groups, among which 3 groups simulate network intrusion, 3 groups simulate network defense, each group independently designs its own attack and defense program, and each group of teachers tutors Go to the difficult issues and specify the offensive and defensive tools they can choose.
(3) Students are expected to take 90 min to showcase their work or play games. If the course selection program works, the students will complete the group work with the group to explain the wonderful ideas and the specific division of labor and tasks for each team member, other groups and teachers to ask questions; if you choose the game contest, then each The two groups are for a team to conduct offensive and defensive game competitions within a limited time, and the entire process requires recording screen records for easy post-evaluation.
(4) The teacher sums up this course and is expected to take 20 min. The teacher gives further explanations on the key and difficult issues of the course, gives comments on the performance of the students and the wonderful game works under the class and plans the contents of the next course.

4.2.3 After Class Design

After-school design is divided into four aspects: feedback, evaluation, consolidation exercises and game upgrades.

1. Feedback. The teacher collects the improvement suggestions in the course of the course through the online teaching platform, and completes the optimization of the course.
2. Evaluation points. The teacher gives the advantages and disadvantages of each student through the online teaching platform, and the students view their comments through the platform.
3. Consolidation exercises. According to the overall performance of the students, the teachers determine the problems of the students, and make relevant exercises for students to download exercises to further consolidate the knowledge points of this course.

4. Game upgrade. The game competitions used in this course are summarized, further optimized and saved as classic games, and the game library is updated for future reuse.

4.2.4 Game Module Design

Because the professional curriculum is different from the ordinary online game, the design of the module only uses the relevant title in the online game to complete the mapping with the teaching objectives of the network security technology course, as shown in Table 1.

Table 1. Game title and network security technology goal mapping relationship

Game appellation	Curriculum teaching goal	Game appellation	Curriculum teaching goal
An intruder	Network intruder	Guard the gate, BOSS	Network defender
Reporter	Classroom teacher	Game announcement	Classroom discipline norms
Novice's Guide	Introduction to case Operation Rule	Stage property	Network attack and defense tool
Empirical value	Score of the attack and defense task	Upgrade	Team Role
Clearance	End of case	Carbon	Team work
Game forum	Peer assessment	Hero list	Individual score ranking

Some of the game title functions in Table 1 are introduced as follows:

(1) Game announcements. It mainly introduces the classroom discipline of this lesson and the general content of the next lesson.
(2) Beginner's Guide. It mainly introduces the competition rules and evaluation criteria of this offensive and defensive game, and gives the precautions and knowledge points in the competition.
(3) Props. It mainly introduces the offensive and defensive tools that may be used in this course, and can exchange them with experience values.
(4) Empirical value. According to the performance of the player's offense and defense process, the score is given and the cumulative score is calculated. The high scorer will determine the role to play in the future competition tasks.
(5) Upgrade. When the experience value accumulates to a certain extent, the system automatically completes the role upgrade, and the high-level role plays a more important role in the subsequent tasks, and will give higher scores in the final results.
(6) Customs clearance. At the end of the game, if the player successfully defeats the BOSS, the network intruder team wins; if the player does not defeat the BOSS, the network defender team wins. No matter who wins, you will get the experience value, but the experience value is different.

(7) A copy. Sharing the solutions developed by the team facilitates teamwork, and the team can also collaborate in real time to complete the offensive and defensive tasks.

(8) Game forum. The exchange platform between students is convenient for recording the opinions or opinions of the team in the game in time for further discussion and analysis.

(9) Heroes list. Show the total experience value of each classmate who participates in the game competition. At the end of the period, the usual score will be given according to the hero list.

4.3   Holiday Review Design

The new teaching model will break the scoring standard of traditional teaching in the past, and arrange about 10% of the total score of this course in the winter and summer vacations, and be automatically calculated and generated by the network teaching platform. Since the holidays are the rest time of teachers and students, the design of this part should not be too cumbersome. Upload the video of the classic game competition and important knowledge points in the normal teaching activities to the system, and stipulate that the students can watch online before the start of the school, and answer some questions after watching. The system will give results based on the viewing and question answering, and automatically calculate the total score in conjunction with the final grade.

5   Implementation Effect Analysis

5.1   Experiment Procedure

The experiment compared the traditional and improved "flip classroom" students to learn, the target is a network engineering major sophomore, the number of students per class is 30. Questionnaires were surveyed before the lectures, and the results of the survey are shown in Table 2.

Table 2. Student network operation level statistics

Teaching object	Number of people	Male to female ratio	Computer-owned ratio	Net-to-net ratio	Programming experience ratio	Network security experience ratio
Traditional class	30	21:9	93.33%	93.3%	86.67%	16.67%
Improved class	30	20:10	96.67%	96.7%	83.33%	16.67%

The contents of Table 2 show that students in the traditional and improved flip-class classrooms are basically the same in terms of the relevant theories and skill levels of cybersecurity technology, and almost all have just come into contact with cyber-security. During the six months of normal teaching and holiday review, the author used the "flip classroom" teaching model shown in Fig. 1 for the traditional teaching class; the improved "flip classroom" shown in Fig. 2 for the improved teaching class. "The model is taught".

5.2 Comparative Analysis of Student Achievement

The total scores of the students in the traditional and improved classes are compared as shown in Fig. 3. After calculation, the average total score of the traditional class is 75.07, and the average total score of the improved class is 81.37. The average total score of the improved class is 6.3 points higher than the average total score of the traditional class.
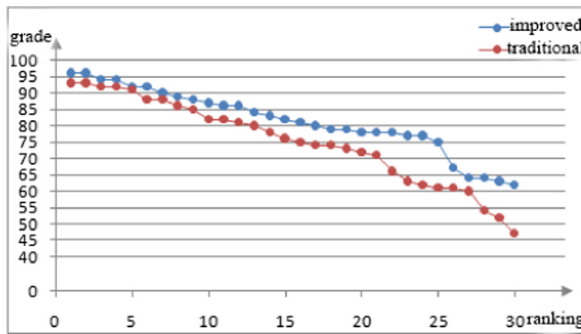

Fig. 3. Comparison of traditional teaching classes and improved teaching classes

If the final grades of the two classes are compared by the number of people in the score segment, the comparison is shown in Fig. 4. It can be seen from Fig. 4 that the ratio of the number of people in the traditional class is 16.66%, 26.67%, 26.67%, 20%, 10%; the ratio of the different segments of the improved class is 23.33%, 33.33%, 26.67%, 16.67%, 0%. The improvement rate of the improved class is higher than the traditional class of 6.67%, the good rate is higher than the traditional class of 6.66%, the medium rate is almost the same, and the pass rate is reduced by 3.33%. The overall performance of the improved class is obviously better than the traditional type. Classes are taught.
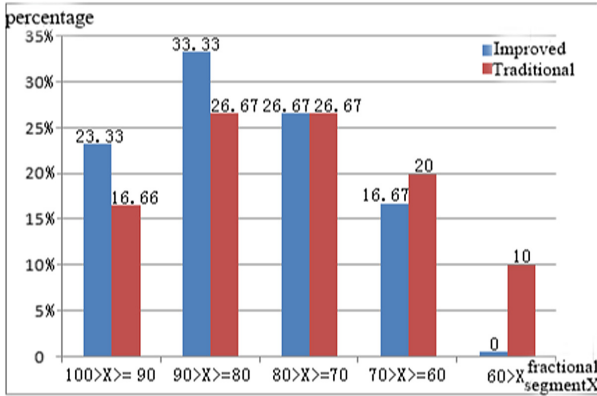
Fig. 4. Comparison of the number of people with different scores

5.3   Questionnaire Analysis

After the normal teaching activities, the author distributed 30 questionnaires to the traditional teaching class and the improved teaching class. The purpose is to understand the students' satisfaction with different teaching methods. According to the feedback from the questionnaire, the improved "flip classroom" teaching mode is very popular among students, which not only achieves the purpose of learning but also achieves interesting effects. In addition, the new teaching mode has also changed the short-comings of the past winter and summer vacations, so that students can not forget to review during the break, and achieve the purpose of consolidating the important knowledge points of network security technology for a long time without increasing the extra workload of teachers.

6   Conclusion

The "Network Security Technology" course can avoid the problems in the traditional "flip classroom" teaching while improving the "flip classroom" gamification teaching mode, and further increase the students' interest in learning, so that the students' learning activities run through the whole Semester and winter and summer vacations, to achieve work and relaxation to consolidate the purpose of learning. The reform of the gamification teaching method of "Network Security Technology" under the improved flipping classroom has changed the traditional concept of education and learning in the network engineering profession, and has raised new problems and challenges for teachers and students. At the same time, this learning model also provides a certain reference for the majority of educators.

References

1. Ministry of Education. Ten Years of Education Informationization Development Plan (2011–2020) [EB/OI.] [2012-05-06]. http://www.edu.cn/zong_he_870/20120330/t20120330_7606-03_3.Shtml
2. Zhiyong, L., Zhaowei, Q., Yidong, C.: Research on teaching methods of network security courses in engineering universities. Sci. Technol. Manag. **11**, 143–146 (2011)
3. Future classroom: upside down room. <http://www.jyb.cn/ad/news/201110/t20111010_456993.html>
4. Roshan, S.: Changing the Class Experience. <http://www.thedailyriff.com/articles/the-flipped-class-good-stuff-happens-715.php>
5. Yi, L.: An empirical study of "flip classroom" applied to information literacy education courses. J. Acad. Libr. **6**, 96–102 (2014)
6. Qiliang, Z., Yongsheng, C.: Application research of flip classroom in experimental teaching of operating system. Lab. Technol. Manag. **12**, 173–176 (2014)
7. Jianqiang, Z., Xiaozheng, W.: Research on the flipping classroom teaching mode and gamification experimental system. Comput. Educ. **12**, 43–47 (2014)
8. Wei, X., Shaochun, Z., Xiangchun, Ma.: Research on the teaching model and support system of chemistry experiment based on flipping classroom. J. Distance Educ. **5**, 107–112 (2013)
9. Jiumin, Y., Mingjie, S., Lei, H.: Application of flip classroom based on micro video resources in experimental teaching. Modern Educ. Technol. **10**, 36–40 (2013)
10. Qingsong, L.: Design of the "modern educational technology" experimental course based on flipping classroom. Lab. Res. Explor. **1**, 194–198 (2014)
11. Wei, H., Ling, J., Lei, H.: Application of flipping classroom in the experimental teaching of "Modern Educational Technology". China Electro-Educ. Educ. **4**, 110–115 (2014)
12. Shanghai University Curriculum Center, 18 July 2014. http://www.ucc.sh.edu.cn
13. Hailong, L., Minjie, D., Cunliang, L.: Design and application of task-based flip classroom teaching mode. Modern Educ. Technol. **9**, 46–51 (2013)
14. Baozhen, Q.: Application design of flipping classroom teaching mode in experimental teaching of colleges and universities. China Educ. Technol. Equipment **6**, 114–115 (2014)
15. Zhiyong, L., Yuanxin, T., Weicheng, Z., Hongzhuo, Q.: Research on the teaching model of network database system based on flipping classroom. Teach. Learn. **1**, 73–75 (2016)