Research on the Reform of C++Language Programming Experimental Teaching Based on Segment Upgrade Mode

Biao Zhang[1*], Yusen Li[2], Xiaoguang Liu[3], Haiwei Zhang[4]

{zhangbiao@nankai.edu.cn[1*], liyusen@nbjl.nankai.edu.cn[2], liuxiaoguang@nankai.edu.cn[3], zhhaiwei@nankai.edu.cn[4]}

School of Computer Science, Nankai University, Tianjin, China

Abstract: In response to the universality education issues in the traditional C++language programming experimental teaching process, modern teaching methods (such as Rain Classroom, MOOC, Flipped Classroom) are applied to experimental teaching based on the different cognitive levels and understanding abilities of different students. A reform plan for experimental teaching based on the rank upgrade mode is proposed, and the effective results of this method in experimental teaching are introduced.

Keywords: C++language, experimental teaching, rank upgrading, teaching reform

1 Background

C++language programming, as a fundamental course for first-year computer majors[1], is the foundation for subsequent professional courses and plays a crucial role in first-year students' initial understanding of programming language and mastery of programming skills[2]. The practice of C++language programming experimental courses on the computer can help students consolidate and digest the theoretical knowledge learned in the classroom, provide opportunities for independent field programming[3], and more importantly, through experimental courses, stimulate students' interest in their major, identify shortcomings in the experiment, and improve programming skills.

The traditional experimental teaching mainly focuses on universal teaching, where teachers explain concise examples in experimental classes, and students conduct experiments based on the teacher's explanations. After a relatively thorough understanding, they then conduct experiments on slightly complex topics. This "big pot rice" experimental teaching model ignores the differences in the abilities of different students, which is not conducive to the progress of experimental teaching and the improvement of students' abilities.

To this end, students are divided into four levels. Based on the abilities of students in different levels, differentiated course requirements are proposed for teaching according to the "level". After passing the assessment, students can be promoted to the next level of level. This level upgrading mode is combined with modern teaching methods such as the Rain Classroom[4], the internally built Online Judge system (OJ system)[5][6], the MOOC platform[7][8], and flipped

ICMEIM 2023, September 08-10, Wuhan, People's Republic of China

DOI 10.4108/eai.8-9-2023.2339991

classroom[9] to stimulate students' learning enthusiasm, Maximize the improvement of students' practical abilities.

2 Analysis of the Current Situation of 2 C++Language Experimental Teaching

In the traditional C++language experimental teaching process, there are several problems:

2.1 The knowledge points are complex, the cognitive load is high[10][11], and the theory and practice are disconnected.

When experimental teachers teach, in order to combine the knowledge points of theoretical courses, they usually strive for concise examples, and most of them are confirmatory experiments. However, experimental courses aim to improve students' ability to connect theory with practice, focusing on improving their hands-on ability and solving complex engineering problems. Therefore, teachers will assign slightly complex experimental questions on the existing OJ system, which are incompatible with simple theories, This makes it easy for students to understand and practice in class.

2.2 The experimental teaching mode is too single[12][13].

In the teaching process of C++advanced language programming experimental courses, the teacher's teaching is usually the center, and a model of teacher speaking and student following practice is adopted. There is little communication between students, and there is no horizontal comparison, no goal, unclear level of oneself, and lack of initiative in learning.

2.3 There are significant differences in understanding and hands-on abilities among students at different levels[14].

Freshman students come from different regions, and there are significant differences in their educational level, educational methods, practical skills, or computer skills. In the process of experimental teaching, it is often found that students with good comprehension and strong hands-on ability often have insufficient problem-solving skills. After a period of learning, these students' programming abilities have exceeded the scope of experimental training, which is not conducive to their own development and improvement; However, students with weak hands-on skills or a lack of computer knowledge struggle to complete experimental content, gradually losing interest in their major[15].

Therefore, there is an urgent need to reform the experimental teaching of C++language programming to solve this problem.

3 Design of Reform Plan for C++Language Programming Experimental

In the process of teaching C++language experiments, it was found that students can be roughly divided into the following 5 situations，see **Figure 1**.

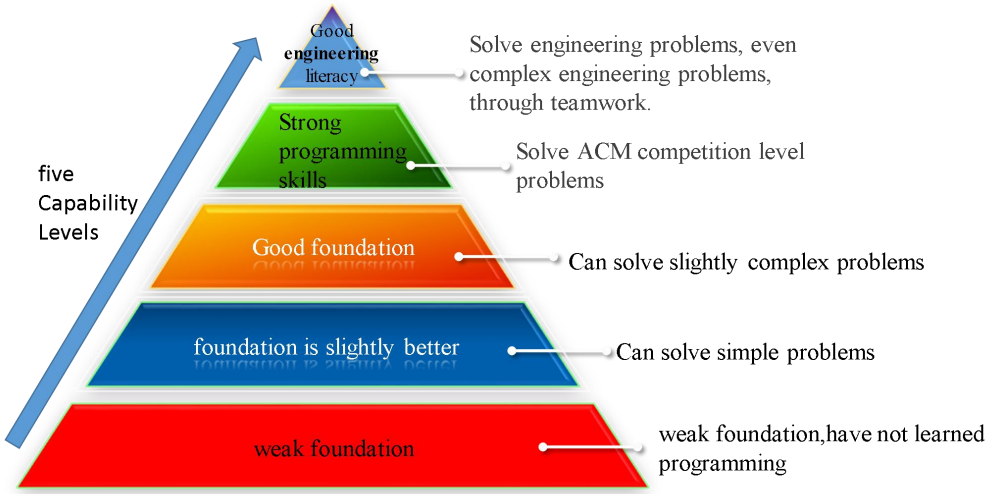

Fig. 1. Five situation

1th:insufficient mastery of theoretical knowledge, frequent errors in completing basic validation experiments, chaotic code writing, and inability to debug.

2nd:Master basic theories and be able to complete basic confirmatory experiments, but cannot independently complete slightly complex experimental questions. If problems arise, they cannot be quickly located.

3rd:Capable of independently completing slightly complex experimental questions, able to quickly locate problems based on compiler prompts, but unable to solve problems similar to ACM competition level.

4th :Strong programming ability, able to solve ACM competition level problems, but lacking the ability or experience to solve engineering problems, especially complex engineering problems.

5th Possess good engineering literacy and be able to solve engineering problems, even complex engineering problems, through teamwork.

Based on the five situations of students mentioned above, after three weeks of experimental classes, students will be divided into four levels according to their abilities. Different experimental content will be designed for each level of students, and differentiated teaching methods will be adopted. The specific reform plan for C++language programming experimental teaching based on segment upgrade mode is shown in **Figure 2.**

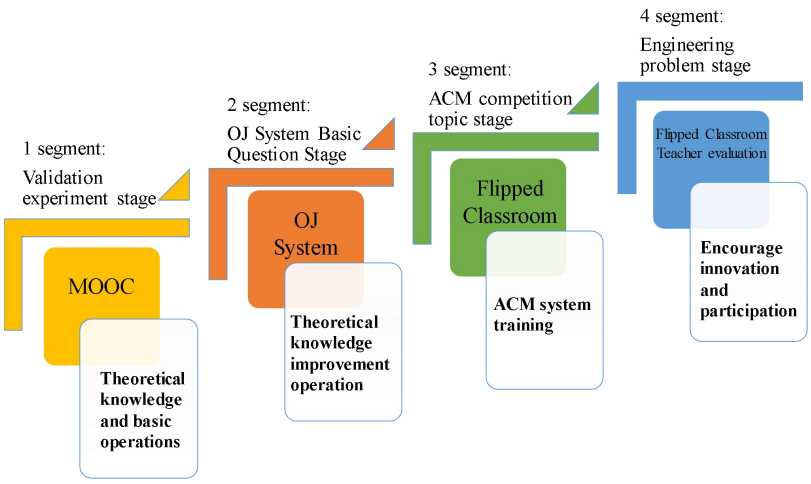

Fig. 2. C++language programming experimental teaching based on segment upgrade mode

3.1 segment 1

Characteristics: The main characteristics of students at this stage are weak theoretical foundation, weak hands-on ability, and confusion in thinking. Therefore, the teacher recorded the experimental teaching MOOCs in advance, covering key theoretical and practical operations, including the writing of simple programs, code specifications, program debugging, common error types, and other content. Students can repeatedly watch important knowledge points and operational notes based on the MOOCs recorded by the teacher. At this stage, the experimental teacher mainly assigned confirmatory experimental questions, allowing students to understand the knowledge points from simple questions, gradually, Find an interest in learning.

Rank promotion assessment method: Teachers assign a limited time theoretical foundation test questionnaire in the "Rain Classroom", and assign simple online exam questions for key content. Students who pass the exam can be promoted to the previous rank.

3.2 segment 2

Characteristics: The main characteristics of students in this stage are that their theoretical foundation is relatively solid, or their hands-on and comprehension abilities are slightly stronger than those of students in the first stage. They are able to find solutions to problems based on error prompts in programming, have a certain ability to analyze problems, and do not need to conduct further confirmatory experiments. In this section, the experimental teacher fully utilizes the convenience of the internal OJ system and assigns some design experimental questions to students, allowing them to gradually master programming ideas and learn how to convert their thoughts into programming languages. The usage and operation rules of the OJ system are basically consistent with the ACM online evaluation system, laying the foundation for students to advance to the next section.

Rank promotion assessment method: Teachers assign complex programming questions on the OJ system, but do not involve complex data structures and algorithms, such as array sorting,

function recursion problems, linked list operations, etc., to examine whether students can flexibly apply theoretical knowledge points to solve slightly complex problems. If the AC (Accepted) number meets the requirements on the OJ system, students can be promoted to the previous rank.

3.3 segment 3

Characteristics: The main characteristics of students in this stage are that they have reached a certain level of theoretical and practical abilities, can quickly solve problems that arise in programming, and have more flexible application of knowledge. They have a certain level of competitive ability, and the questions assigned by the teacher on the OJ system can no longer meet the needs of students in this stage. At this time, the experimental teacher should make students focus on the ACM system of the school or other universities to broaden their horizons. At the same time, use the "flipped classroom" mode to allow students to explain and discuss a certain data structure, algorithm, or problem-solving solution. Conduct competitions similar to ACM within the group, and provide appropriate rewards to the outstanding groups in the competition. Encourage students to participate in the ACM selection competition on campus, and even participate in domestic and international competitions to promote learning through competitions and competitions.

Rank promotion assessment method: Due to the excellent programming ability of students in this rank, if they are interested in engineering or projects, they can voluntarily be promoted to the previous rank.

3.4 segment 4

Characteristics: The main characteristics of students in this stage are that their programming skills have been greatly improved, and they have good engineering thinking and team collaboration abilities. At this stage, teachers should be more bold in implementing the "flipped classroom" teaching method, dividing students into several project groups. The project group only provides reasonable suggestions on the topic selection and feasibility of the project, and during the implementation process of the project, members of the group should evaluate each other, Conduct assessment through mutual evaluation between groups. Encourage students to divergent thinking, promote innovative thinking, and participate in various school or domestic project competitions.

4 Effectiveness of Curriculum Reform

4.1 Course effectiveness

This teaching reform selected students enrolled in the 2022 major category as the sample, with a sample size of 160 people. A comparison was made with previous students in 2020 and 2021 which had about 150 students per session and it was found that the teaching reform method based on the rank upgrade model can better reflect the advantages of individualized teaching, pay attention to the differences in individual knowledge levels, make "fast" students eat, and "slow" students have confidence to catch up, significantly improving students' learning interest, The comparison of survey results before and after the curriculum reform is shown in Table 1,Table 2 and Table 3.

Table 1. Pre reform course satisfaction survey in 2020

Issue Names	Very satisfied	Satisfied	Fair	Poor
learning interest	20.3%	29.8.%	33.2%	15.7%
Classroom atmosphere	15.1%	18.2%	50.3%	15.3%
Ability development	14.6%	19.7%	38.5%	27.0%
Work volume	2.3%	26.4%	60.4%	10.4%
Classroom gains	18.4%	19.2%	58.3.4%	3.7%

Table 2. Pre reform course satisfaction survey in 2021

Issue Names	Very satisfied	Satisfied	Fair	Poor
learning interest	28.2%	19.3%	33.2%	19.3%
Classroom atmosphere	12.3%	11.5%	44.8%	31.4%
Ability development	10.9%	18.7%	40.6%	29.8%
Work volume	5.8%	17.3%	64.6%	12.3%
Classroom gains	20.1%	17.3%	61.4%	1.2%

Table 3. Survey of Curriculum Satisfaction after Reform in 2022

Issue Names	Very satisfied	Satisfied	Fair	Poor
learning interest	50.9%	43.6%	5.5%	0%
Classroom atmosphere	78.9%	20.3%	1.2%	1.2%
Ability development	76.7%	12.4%	1.6%	0.8%
Work volume	79.8%	9.3%	1.6%	0.8%
Classroom gains	78.3%	10.9%	1.6%	0.8%

4.2 Overall Ability Effectiveness of Students

Through modern teaching methods such as MOOC, students are encouraged to prepare well before class and review well after class, cultivating their ability to discover problems. The student-centered teaching method allows students to actively participate in classroom teaching, broaden their thinking, and cultivate their good problem-solving abilities. Students at the same level engage in group learning and learn from each other, enhancing their innovation and teamwork abilities. The average level of students' abilities in various aspects has been greatly improved compared to before the reform, with obvious advantages. The comparison of students' overall abilities before and after the curriculum reform is shown in **Figure 3.**

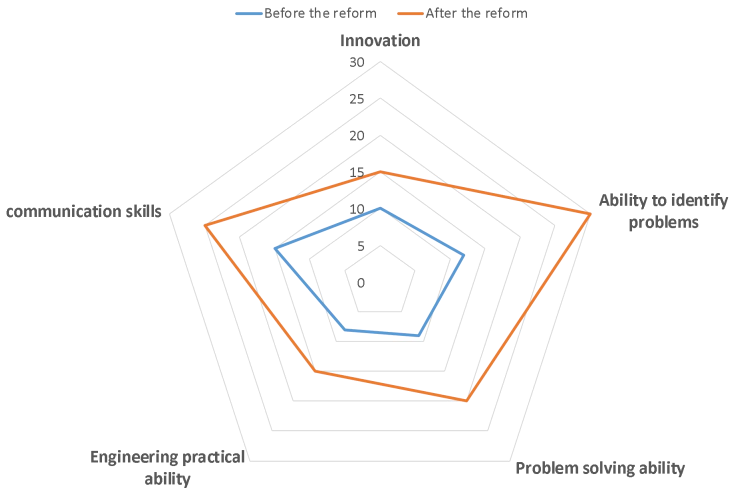

Fig. 3. Comparison of students' comprehensive abilities

5 Conclusion

This article aims to address the issue of universal education in the experimental teaching of C++language programming, and proposes a reform plan for experimental teaching based on segment upgrading mode using modern teaching methods. In practice, it has been found that students in lower grades, especially those in the first grade, have a significantly increased sense of urgency. When they see classmates in the same grade being promoted, they have a greater sense of crisis, resulting in a significant improvement in their enthusiasm and initiative in learning. Students in higher positions have enhanced their programming skills, proactive thinking awareness, and independent innovation awareness, and have fully played the role of a "locomotive". In addition, the number of freshmen entering the ACM team on campus has increased compared to before, and they have repeatedly achieved good results in the ACM International Programming Competition with good programming skills.

The online judge system used in teaching reform does not support the evaluation of object-oriented programming, and we hope to improve it in subsequent teaching reforms. At present, the school is promoting the construction of "new engineering subjects", and the next step will continue to optimize teaching content and incorporate curriculum ideological and political construction to better meet the needs of cultivating "four new" talents.

Teaching reform project: 2023 Experimental Course Teaching Reform Project Of Nankai University (Project Number: 23NKSYSX08)

References

[1] Yang Mei, Wang Yang. Research on the Teaching of Fundamentals of Programming Based on Computational Thinking [J]. Computer Education, 2015, (16), 94-97

[2] Xu Hongzhi, Zhang Binlian, Zhong Jian Reform and Exploration of Experimental Teaching in the Course of C++Programming [J]. Modern Computer (Professional Edition), 2017 (15): 50-53
[3] Liao Xuehua, Li Lanjie. Research on the Teaching Reform of C Language Programming Experimental Course Based on Online Juge [J]. Computer Education, 2016, (06), 130-13
[4] Lan Li, Hu Xiaohui. Improving the Key Teaching Links of "C Language Programming" Course Based on "Rain Classroom" in the Background of Engineering Certification [J]. Computer Age, 2019, (01), 102-104
[5] Xu Chaohuan, Xu Xinhua, Yu Yeqing, et al. Research on the Application of Online Programming Platform in C++Practical Teaching [J]. Computer Education, 2023 (08): 145-149. DOI: 10.16512/j.cnki.jsjy.2023.08.029
[6] Zheng Y ,Sarem M ,Yang Q , et al. A Novel Improvement for International Online Judging System and its Applications to Experimental Reform of C++ Course[C]//Research Institute of Management Science and Industrial Engineering.Proceedings of 2017 2nd International Conference on Automation,Mechanical Control and Computational Engineering(AMCCE 2017).Atlantis Press,2017:4.
[7] Staubitz T,Meinel C. Collaboration and Teamwork on a MOOC Platform[P]. Learning @ Scale,2017.
[8] Zee D V T,Davis D,Saab N, et al. Evaluating retrieval practice in a MOOC[P]. Learning Analytics and Knowledge,2018.
[9] Herala A,Vanhala E,Knutas A, et al. Teaching programming with flipped classroom method[P]. Computing Education Research,2015.
[10] Sun Jie, Qin Jianyong. Exploration of Teaching Reform of C Language Programming Course for Engineering Majors [J]. Computer Education, 2016, (11), 73-75
[11] Hengyang L ,Ling L . A Reform Research in C++ Language Teaching——Some Thoughts of Combination MFC with C++ Language Teaching[C]//Intelligent Information Technology Application Association.Proceedings of 2011 International Conference on Advanced Materials and Information Technology Processing(CMS 2011 Part 1).TRANS TECH PUBLICATIONS,2011:4.
[12] Chen Yanjun, Wang Pengjiao Research on teaching reform of Advanced Language Programming based on O2O mode in the context of "Internet plus Education" [J]. Software Guide, 2017,16 (11), 233-234+237
[13] Ma Y ,Chen D .Reform of C++ Programming Course[J].Computer Education,2020(12):31-34.DOI:10.16512/j.cnki.jsjjy.2020.12.006.
[14] Kong Liying. Teaching Reform of C++Programming [J]. Software Engineering, 2017,20 (07): 57-59
[15] Jiang Y. Experimental Course Reform of Applied Chemistry Specialty under the Background of "Double First-class" Construction[J]. Frontiers in Educational Research,2023,6(5).