



Analysis and Research on Gamification Teaching Strategy Used in C Language Programming Course

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Abstract. C programming language is an important bridge to realize software and hardware development and other engineering applications. In order to enhance students' interest in professional learning and cultivate their practical ability and innovation consciousness, we integrate the gamification teaching strategy into the content of course. This paper analyzes and evaluates the necessity and feasibility of this method, sorts out the elements of gamification teaching, and makes a comparative analysis of the teaching effect. Finally, it can be proved that the students' interest in programming and professional learning has been greatly improved, and the purpose of research has been achieved.

Keywords: C programming language · Gamification teaching · Learning situation analysis

1 Introduction

In recent years of teaching practice, we have found that due to the continuity of professional learning, students' mastery of specialized courses in the junior stage often determines their professional learning level in the whole undergraduate stage. In the questionnaire survey of 60 freshmen majoring in electronic information science and technology, when answer the question: Do you know anything about your future job? 81.4% of the students answered that they did not know much about it. In response to the question: Which way do you think will best increase your professional knowledge? 81.3% of the students answered that the best way is through study of specialized courses. The pie data analysis is shown in Fig. 1.

Through the analysis of the survey results, most freshmen have a sense of "cognition confusion" of their major. The specialized courses they will learn become the main way to establish professional cognition and cultivate their interest in specialized learning. However, if the initial learning of specialized courses makes the junior students feel boring, or difficult to master and other negative emotions, it will directly affect their subsequent professional learning, which is also the main reason for the low professional identity of most senior students [1]. Therefore, in order to increase college students' professional cognition and interest in professional learning, it is necessary to pay attention to the cultivation of junior students' interest in professional basic courses.

Which way do you think will best increase your professional knowledge?

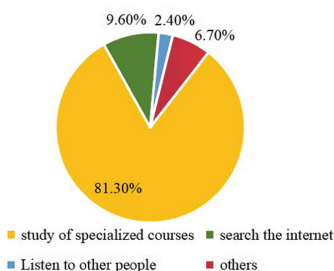


Fig. 1. Pie chart of a question in questionnaire

C Language Programming Course is offered in the first year of college, which is the most required programming course for the students majoring in electronic information science and technology students. It is a significant software-tool for subsequent professional learning, which can lay a solid programming foundation for students to participate in intelligent manufacturing innovation research and development in the future.

2 Gamification Teaching Strategy

Most practice has shown that a direct interest in learning is the most advantageous factors to improve the quality of learning [2]. The gamification teaching strategy is to enrich the learning process with appropriate teaching means and evaluation methods according to the characteristics of learners, to promote learners' direct interest, further stimulate students' interest in professional learning [3]. We refer to the famous futurist Jane McGonigal in her book *Games Change the World*, in which she describes the four elements of game design: The ultimate goal to be achieved, clear rules to be followed, a feedback system for distance from the goal, and incentives for voluntary participation [4]. Based on this concept, we integrated the gamification concept into the whole teaching process of C programming language course, formulated the game scenario of entering the C programming kingdom adventure to organize teaching, and detailed the implementation plan for practical teaching. The specific scheme shows in Fig. 2.

3 Application and Practice of Gamification Teaching Strategy

3.1 Create Game Goals

According to the cultivation objects, formulate the high-level course objective of C programming, which is connected with the subsequent professional curriculum system and focuses on the cultivation of professional interest. The ultimate goal is using C programming language to write program for intelligent traffic light control system.

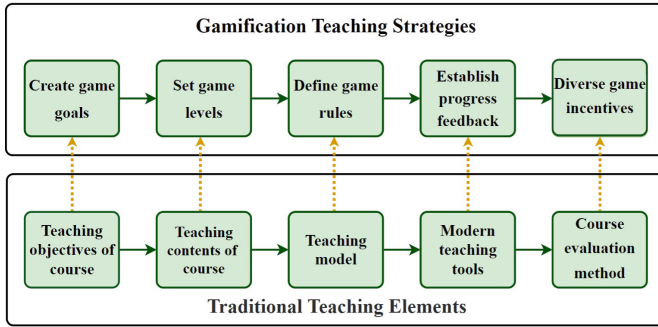


Fig. 2. Implementation plan of gamification teaching strategy

3.2 Set Game Levels

Break the restrictions of textbook chapters, reorganize the teaching contents based on the knowledge points, and establish a game connection checkpoint between the knowledge points. The game level is designed to achieve the final goal and each one is set up as a professional practice project closely related to professional application and with certain challenges, to cultivate students' systematic specialty thinking and innovation ability. In addition, professional ethics, professional frontier technology and other qualities that technical engineers of electronic information science and technology must possess are added to the practical projects, all six game levels are shown in Table 1.

3.3 Define Game Rules

When students complete different learning items, they receive C-kingdom adventure points, game rules are designed to encourage students to explore and learn independently [5]. For example, extra points will award for pre-class preview and after-class expansion. Table 2 shows the pre-class preview questions and its extra points.

3.4 Establish Progress Feedback

In combination with information teaching tools, we establish a timely process feedback mechanism from two aspects: one is timely feedback of course learning progress shown in Fig. 3. The second is to display the personal learning score ranking after every classes [6], so that students have a clear understanding of current course progress and their current learning achievements.

3.5 Diverse Game Incentives

In exploration and learning of the whole C language kingdom, continuous process incentives are given to strengthen students' desire to further explore specialized knowledge and their self-efficacy in learning. The evaluation of course performance consists of three parts, shows in Eq. (1).

$$\text{Course performance} = \text{Score ranking of the game (20\%)}$$

Table 1. Six game levels of C programming language course

Level	Practice project	Simulation circuit diagram
1	Using C language to light one LED.	
2	Using C language to light three LEDs (Red, Yellow and Green).	
3	Using C language to make the three LEDs flash in turn (Simulate the running effect of signal lights).	
4	Using C language to realize the running effect of two direction signals.	
5	Using C language to add the countdown function for signal lights in one direction.	
6	Using C language to simulate the signal lights running in four directions with countdown function.	

+ Five real time programming practice exams (50%)

+ Team work project (30%)

(1)

The first part is obtained according to the game score ranking of the whole course. The second part is in the form of real time programming practice exam after each module, which must be completed by students within the specified time, and the teacher scores each student in according to their ability of practice. The last part is an intelligent control project completed by the team, which covers important knowledge points and reflects comprehensive programming ability, and reflects the basic programming norms, good ability and professional quality required by engineers.

Table 2. Example of pre-class preview questions and its extra points

Extra points	Questions	Answers
3 points	Calculate the runtime of the following code: for(i=1000;i>0;i--) for(j=110;j>0;j--);	About 1 second
2 points	How many times does the following code run: for(i=1000;i>0;i--) for(j=110;j>0;j--);	11000 times
1 points	Run the following code and analyze the results: for(i=3;i>0;i--){ for(j=10;j>0;j--) printf("*"); printf("\n");}	<pre>***** ***** *****</pre>

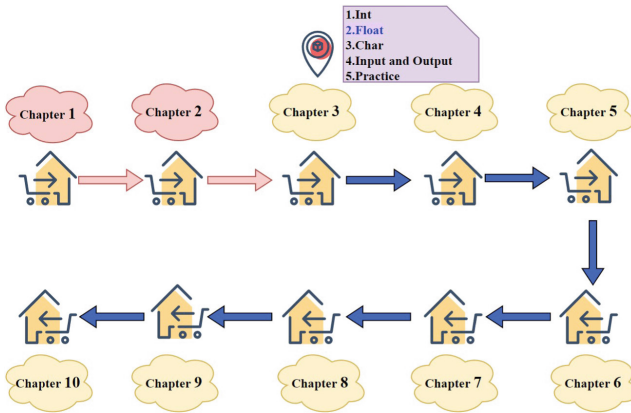


Fig. 3. Feedback of course learning progress

4 Feedback and Effect of Gamification Practice Teaching

We have implemented two rounds of teaching reform for grade 2020 and 2021 students of electronic information science and technology majors of our school. Analyze the feedback and results obtained from the perspective of students, teachers of subsequent specialized courses and teaching supervisors.

4.1 Perspective of Students

In order to obtain the implementation effect and existing problems of gamification teaching strategy in C programming language course, after the end of grade 2021, we conducted paper test and questionnaires among the students.

1) Paper test.

The Grade 2021 was tested with the same C language final paper as the grade 2020. It was found that the mean score of the grade 2021 was 14.6 points higher than that of the grade 2020, and the median score was 18 points higher than that of the grade 2020. The overall programming ability of the class students was effectively improved. The score distribution of the two grades is shown in Fig. 4.

2) Questionnaire.

We designed an online questionnaire to investigate 72 students and recovered 72 valid questionnaires with an effective rate of 100%. The contents of the questionnaire are divided into three aspects: learning results of C language programming, specialized learning interests, and other suggestions for improvement. Bar charts of three main questions are shown in Fig. 5. When answer the question: After learning this course, do you think programming is an interesting job? 90.28% of the students answered: Yes, I think so. In response to the question: Do you think the teaching method of this course can help you expand your professional thinking? 91.67% of the students answered: Yes, I think so. When answer the question: Do you think this course have increased your interest in major learning? 84.73% of the students answered: Yes, I think so.

The questionnaire shows that the application of gamification teaching strategy in C programming language course has been recognized by the vast majority of students, and has achieved the goals of stimulating learning motivation and cultivating students' interest in professional learning.

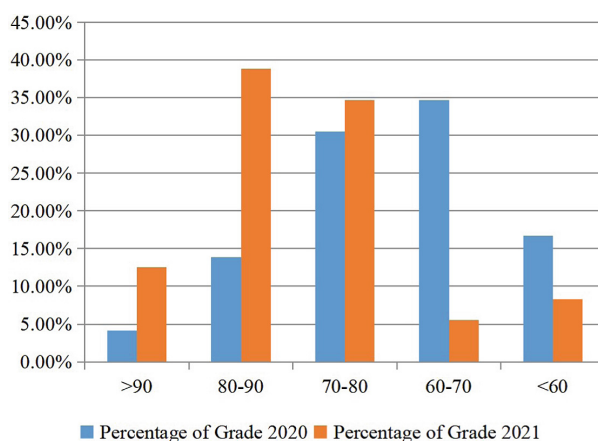


Fig. 4. The score distribution of the two grades

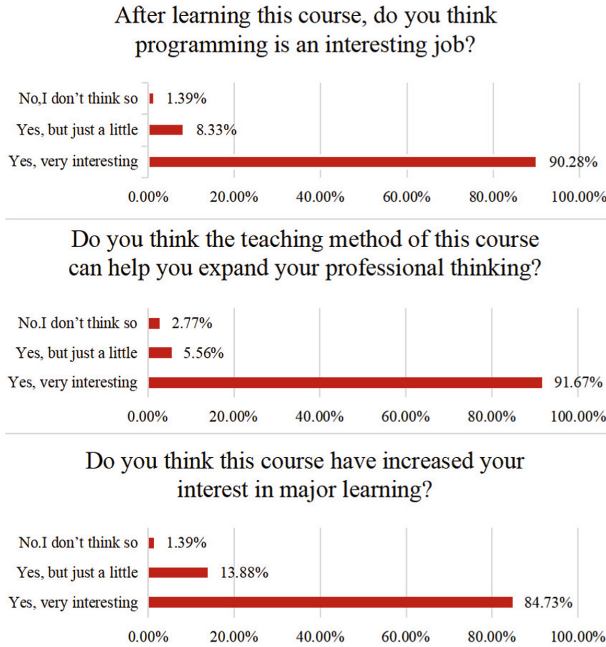


Fig. 5. Bar chart of three main questions in questionnaire

4.2 Perspective of Peer Assessment from Subsequent Specialized Courses

Teachers of follow-up specialized courses (Principles and applications of single chip computers, embedded systems and DSP) are invited to hold teaching seminars. The teachers agree that the learning enthusiasm of students in grade 2021 have been significantly improved compared with previous years, and the number of students with outstanding programming skills had increased significantly, especially in the course of principles and applications of single chip computers. Nearly half of the students would study the course content in advance, and can complete the practical work of single chip microcomputer higher than the requirements.

4.3 Perspective of Teaching Supervisors

Since the implementation of gamification strategy, the research group has been affirmed and praised by the teaching director of the department for many times. They all agree that the gamification teaching strategy used in C programming language course establish an effective connection for students' subsequent professional learning. The Supervisors also suggest that the course unit can apply for open courses on campus to promote innovative teaching exchanges in other majors.

5 Conclusions

C programming language course is an essential basic skill for students majoring in electronic information engineering, and it is also an important foundation in their professional development. In order to stimulate students' interest in programming learning and cultivate students' love for the major in lower grades, we integrate the concept of gamification into all aspects of teaching. Through teaching practice, it has been proved that gamification teaching strategy can achieve student-centered, game-goal-oriented, immersive learning experience for students to master skills in practice and cultivate professional cognition, and is committed to helping students become excellent industry engineers in the future.

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1. The research results of the "14th Five-Year plan" project of education science in Inner Mongolia Autonomous Region "Reform and Research on gamification teaching of C Language Programming Course based on professional interest cultivation" (Project No: NGJGH2021506).
2. 2020 teaching reform project of Ordos Institute of Technology (Project No: 20210201).

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