The Application of Heuristic Teaching Method in Explaining the Asterisk Triangles Pattern in C Language

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Abstract. The C language is a programming language which has both the characteristics of the low-level and high-level. The C language program design course has been set up in every major of the College of Mechanical Engineering at the Inner Mongolia University of Nationalities. However, as a non computer major student, when studying the knowledge of loop structure, the complexity and abstraction of the knowledge point and the various multiple loop structures are difficult to learn. But as the most common and basic knowledge point, it must be mastered skillfully. In this paper, the pattern of a isosceles right triangle composed of asterisks was used as an example. By using the loop structure to output the pattern, the students were inspired and learned how to find ways to solve the similar problems. The actual teaching practice achieved good results which proved the effectiveness of the teaching case.

Keywords: Program design · Triangle · Graphical method · Heuristic teaching

1 Introduction

The C language is an important basic lesson of general knowledge. The basic goal of this course is to make the students master the skills of using a computer programming language to write the algorithms to solve problems as well as to develop the ability to analyze problems. After the lesson, the students can effectively use the computer to solve the problems in the professional field, and to lay a good foundation for the follow-up study and work. As an object oriented general programming language with the characteristics of high execution efficiency, function reconfigurability and the portability, the C language program design course has been set up in every major of the College of Mechanical Engineering at the Inner Mongolia University of Nationalities.

The loop structure is a very important basic knowledge point in the C language, and almost used in every program. So to learn the loop structure well is very important in the C language course. According to the 8 years of teaching experience of C language, most of the students were not good at the knowledge of the loop structure. The way of reciting the programs was not effective to learn the knowledge. When the loop program was slightly modified during the examination, the students would give an irrelevant answer.

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The theoretical teaching time is 16 h and the practical time is 32 h of the C language program design course in the mechanical manufacturing and automation major. According to the previous teaching experience, the teaching result was relatively general by explaining the examples according to the textbook directly when learning the loop structure knowledge point in C language.

Most of the students responded that they could not understand well in this way. So the teaching method should be improved when explaining the loop structure knowledge point. In this paper, the patterns of the triangles composed of asterisks were used as examples. By using the loop structure to output the pattern, the teaching method of progressive catechesis to inspire the students gradually was proposed.

Before explaining the loop structure knowledge point, the students were asked to output the pattern in Fig. 1 through programming by themselves. Because they have just learned the "print()" function, the first reaction in everyone print mind was to use the "print()" function to solve the problem. And the program is as follows:

```
Int main()
{
printf("    *     ");
printf("   ***    ");
printf("  *****   ");
printf(" ******* ");
printf("*********");
}
```

Fig. 1. A asterisk pattern of 5 lines and 5 columns

If the question was slightly modified as to output an asterisk pattern of 200 lines and 10 columns, most of the students would think of using the "print()" function 200 times continuously to solve this problem. Was there a simpler method to solve it? And then the loop structure knowledge point was introduced and the program is as follows. Obviously, the using of the loop structure made the program much concise and can achieve the same function as the sequential statement in 200 lines.

```
int main()
{
Int i=1;
While(i<=200)
{
printf("**********");
i++;
}
}
```

Fig. 2. The right triangle pattern

In the hybrid teaching platform to modify homework, some of the typical problems that exist in students to organize, check each student's progress and learning status.

Through this example, the concept of loop statement was introduced and left a deep impression in the students' mind after the careful thinking. To output the asterisk pattern of 5 lines and 5 columns was the simplest and most basic loop structure question. Based on this question, a new question was raised to output a right triangle pattern composed by the asterisks of 5 lines and 5 columns as shown in Fig. 2. For beginners who just learned the loop structure, they may feel very difficult since they could find the breakthrough to solve the problem. The textbook gives the answer directly without the solving process in details which is helpless to the students. For this kind of questions, the routine teaching method of teaching examples directly should be changed by the progressive catechesis to inspire the students gradually.

But how to use the progressive catechesis to solve this kind of problems? By observing the Fig. 2, it could be find that there was a law on the number of the asterisks in each line. Then the question was transformed into finding the law of the asterisks' number in each line with the line number. The question could be answered easily once the law was figured out. By observing the Fig. 2, it could be found that the number of the asterisks in each line was similar to the line number. In other words, there was an asterisk in the first line and two asterisks in the second line and so on. The relationship between the asterisks' number in each line with the line number is shown in Table 1.

Table 1. The relationship between the asterisks' number and the line number

The line number	The asterisks' number in each line
i	j
1	1
2	2
3	3
4	4
5	5
The relation ship	I=j

The program was written quickly after the relationship was figured out. The program is as follows:

```
Int main()
{
Int i=1,j=1;
for(i=1;i<=5;i++)
for(j=1;j<=i;j++)
printf("*");
}
******
*****
****
**
*
```

After answering the two questions above, the students have developed a deep understanding about the loop structure. In order to enable the students to master the knowledge point skillfully, a new question was proposed to output the pattern in Fig. 3 based on the previous questions. The new question was quite similar to the last one and after the relationship between the asterisks' number and the line number was found out, the question could be settled by the loop structure easily. The relationship between the asterisks' number in each line with the line number is shown in Table 2.

Table 2. The relationship between the asterisks' number and the line number

The line number	The asterisks' number in each line
i	j
1	5
2	4
3	3
4	2
5	1
The relation ship	J=5;j>=I;j−−

The program was very simple once the relationship was figured out. The program is as follows:

```
Int main()
    {
  Int i=1,j=1;
for(i=1;i<=5;i++)
 for(j=5;j>=I;j--)
   printf("*");
    }
```

The question was complicated again to use the loop structure to output the pattern in Fig. 1. It was still a loop structure of 7 lines and 7 columns but contained the extra loop sentences to output the spaces. The letters i, j and k were used to indicate the times of the three loop structures. The sign i denotes the line loop; the sign j denotes the space output loop; the k denotes the asterisks' loop numbers. The question could be settled by inspiring the students to find out the internal relationships between these three variables. By decomposing this question, it could be found that the line loop was very simple and its loop number was directly related to the output line number. The internal loop were the space output loop and the asterisk output loop which were directly related to the line loop, too (Table 3).

Table 3. The relationship between the asterisks' number and the line number

The line number	The space number in each line	The asterisks' number in each line
i	J	k
1	6	1
2	5	3
3	4	5
4	3	7
5	2	9
6	1	11
7	0	13
The relation ship		J=7;j>=I;j−−

2 Course Evaluation

The traditional teaching model evaluates students' learning only in the final exams. As a result, many students do not usually study at the end of the exams. They take a comprehensive assault before the final exams, and their participation in learning is not high enough to deal with the exams. In a blended teaching model, evaluating a student's learning can actually achieve procedural evaluation. In the evaluation of the dimension is not limited to the final grade in the class and the final exam scores, but also the completion of each knowledge point in the teaching task, the completion of each experiment, the whole dimension of the students' learning evaluation. Evaluation of quantitative methods shown in Table 1, the assessment criteria shown in Table 2.

3 End

For this question, once the relationship between the space number and the line number and the relationship between the asterisks' number and the line number were clear, it could be settled by nesting the space loop and the asterisk loop into the line loop. The relationship between the line loop and the space loop was (j=7;j>=0;j-i;) and the relationship between the line loop and the asterisk loop was (k=2*i-1;k<=13;j++). Through the decomposement process of the question, the students could study the loop structure knowledge point from shadow to deep and could leave a deep impression about the loop structure. The same question could be settled easily by the students and proved that the progressive catechesis teaching method was much better than just explaining the example according to the textbook.

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References

1. Jin, L.F.: Some experiences in the teaching of C language. Sci. Technol. Inf. **5**(8), 53–54 (2012)
2. Tan, H.H.: The Programming of C Language. Tsinghua University Press, Beijing (2010)
3. Yang, C.X.: C Language Program Design Experiment Guidance and Answers. China Railway Press, Beijing (2005)
4. Tang, G.M.: The Programming of C Language. Tsinghua University Press, Beijing (2009)
5. Zou, X.C.: C Language Program Design Training Course. Southwestern Normal University Press