Enhance the Efficiency of Technicians' Training Based on the Cognitive Law

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Abstract. In the upgrade-training of technicians, we improve the teaching method from the Bloom cognitive model and Ebbinghaus forgetting theory. First, the knowledge points are classified, and different teaching methods are adopted for the knowledge points at different cognitive levels. Second, the online teaching software platform is used to guide students to preview, pre-class test and after-class test, and timely make statistics to find students' knowledge loopholes, so as to make the classroom teaching more targeted. Third, we pay attention to the cross-cycle between the theory and equipment operation teaching. Statistics show that by using the improved teaching method, the excellent rate of students increased by 4.16% in the final examination.

Keywords: Bloom cognitive model, Ebbinghaus forgetting curve, technicians training

1 Introduction

The upgrade-training is an indispensable part as the technicians want to be promoted. In our 2024 communication technician upgrade-training, these technicians have these characteristics as following.

They like equipment operation, but are afraid of theory learning. In our survey, 78.8% of the technicians said that they were most interested in the equipment operation, and 83.5% of them expressed that the biggest difficulty was theoretical learning in the upcoming study.

At present, the communication technicians' upgrade-training time is only one month. In this month, technicians need to learn at least 3 courses which is about 120 class hour. It is a difficult problem how to teach and help these technicians to reach the upgrade-training purpose in short time.

In order to solve this problem, the teachers explore some new teaching methods. One of them is the flipped-classroom-teaching [1]. The other one is the software testing teaching method[2]. And some of them are the mixed teaching [3-5].

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In this paper, we improve the teaching methods based on the basic human cognition laws. First, the teaching content is classified according to cognitive levels. And different teaching methods are adopted for different types of content. Second, the internet learning platform is used in the pre-class preview, pre-class test, after-class test. Therefore we can timely find these technicians' knowledge defects, and give them targeted explanation and practice. Third, the equipment operation and theoretical teaching are crossed and cycled. In this cross-cycle these technicians gradually make progress.

2 Improvement of the Teaching Methods

2.1 The Basis for Improvement

In order to improve teaching, we designed the teaching method from Bloom's cognitive theory and Ebbinghaus forgetting theory.

Bloom's Cognitive Theory. The process of human learning is actually the process of cognition. American educational psychologist Benjamin Bloom divided the cognitive goal into six levels. From low to high these six levels are: memory, understanding, application, analysis, evaluation and innovation[6, 7].

Ebbinghaus Forgetting Law. Ebbinghaus is the famous German psychologist. He discovered the human forgetting law, which corresponds to the Ebbinghaus forgetting curve. The Ebbinghaus' study tells us of the following conclusions[8].

The Relationship between Forgetting and Time. This relationship shows that the forgetting is faster at the beginning than that at the following. The knowledge learned in a day later, if not to review, only 33% of the original is left. Over time, the rate of forgetting slows, about 21% is left after a month.

Relationship between the Forgetting and Material memorized. Different memory materials corresponds different forgetting curves. Compared with catchy poetry and meaningless syllables, the forgetting curve of poetry drops much more gently. This shows that if people understand and are interested in the material memorized, the material is not easy to be forgotten.

2.2 The Teaching Methods Improved

Based on the Bloom cognitive theory and Ebbinghaus forgetting curve, we improve the teaching method in this course "Optical Transmission Equipment Theory and Operation". This course is a required course in the communication technicians' upgrade-training. The teaching goal of this course is to consolidate the technicians' basic theoretical knowledge of optical transmission equipment, instruct technicians about the instrument operation and testing methods, and help the technicians to master the equipment troubleshooting methods.

From above goals, the teaching is divided into two parts, one part is theoretical teaching, and the other one is equipment operation teaching.

Theoretical Teaching. As shown in Figure 1, theoretical teaching starts with the pre-class preview. The day before class, we arrange technicians to preview the content

which will be explained in the upcoming class. In this module, the corresponding mathematics knowledge is emphasized.

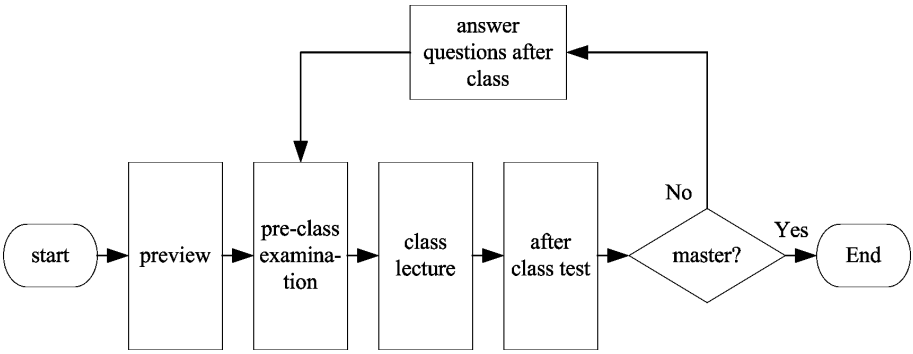

Fig. 1. The theory course teaching flow chat

One of the main reasons why technicians are difficult to make progress is that their math knowledge is deficient, even those knowledge points already were taught in the junior high school. Therefore, these technicians hardly understand some content in the upgrade-training class. However, our class time is limited. It is impossible to spend much time to make up for their math shortcomings in the class. Therefore, it is necessary to remedy these contents by preview before class.

Illustrated in Figure 1, after the pre-class preview, we design the pre-class examination block in order to check up the preview effect. In this block, we carry out the test on the Internet learning platform.

These test questions come from either memory or understanding knowledge points. And the type of questions are mainly single choices and multiple choices. In this way, these technicians needn't spend too much time on it. And they are willing to do it. When the pre-class examination questions are issued on the internet learning platform, the answers are also set by the teacher at the same time. And the test papers are checked by the learning platform automatically. The platform can give not only the students' scores, but also the statistical information. This statistical information includes the number and names of the participator and no participants in the pre-class examination, the proportion of students in different grades and the accuracy of each question. By consulting the statistical information, teachers can easily find out the specific location of the students' knowledge loopholes, so as to facilitate the targeted explanation in class.

In Figure 1 the third block is the class-lecture. In this module we firstly review the relevant mathematics knowledge and help technicians make up their knowledge loopholes. Subsequently we start the lecture about the textbook content. These contents are classified into three levels involving memory, understanding and application according to Bloom's cognitive model.

According to the Ebbinghaus forgetting law, by the repetition with the short time intervals the simple memory content can be remembered for a long time. Therefore, for the contents in the memory level are repeated in the pre-class preview, the class explanation, after-class test.

According to the same law, the forgetting curve of the understood knowledge declines much more slowly over time. Hence, for the content needed to understand, the class-lecture focuses on explaining the internal principles, so that students can understand the basic rules.

In the classroom, we explain not only the theory knowledge point itself, but also the application, especially the corresponding equipment operation. It is not only to establish a preliminary connection between theory and operation in students' minds in advance, but also to make preliminary preparation for students to enter the Bloom's application and analysis level. This is the first time linking theory to equipment operation.

After the class lecture it is the after-class test. In this block, the test questions are also released through the internet learning platform. The test questions mainly include two parts, one is that students generally make mistakes in preview block, the other one is corresponding to the knowledge points taught in class. Through the after-class tests, teachers can know whether the students master the content taught in class.

For these knowledge points not mastered by students we explain them at the "answer the question after class" block. And we arrange the similar questions into the pre-class examination block of the next class for helping students to overcome these difficulties.

Equipment Operation Teaching. Figure 2 is the flow chart of the equipment operation teaching. In Figure 2, the first module is the preview and test before class. In this part, the preview content is issued through the internet learning platform, and the pre-class test also are completed. The preview and test contents are the theoretical knowledge points related to the equipment operation taught in this class.

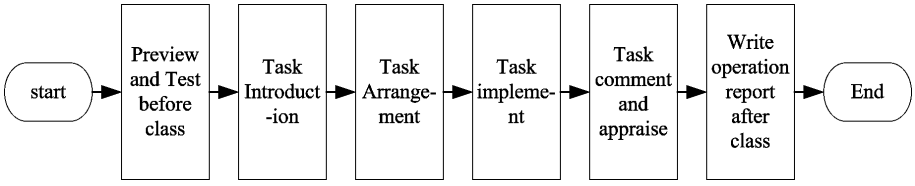

Fig. 2. The equipment operation teaching flow chat

Second module is the "Task Introduction". From this module we enter into the classroom teaching. In this module, the teacher first reviews the theoretical knowledge points appearing in the preview and test module, and then introduce the equipment operation. In this introduction, we pay attention to the connection between the theoretical knowledge points and the equipment operation. Here the equipment operation and the corresponding theory are correlated for the second time.

The third module is the "Task arrangement". In this part, the demonstration teaching is adopted. The teacher demonstrates the equipment operation while explaining the essentials.

The fourth module is the "Task implementation". In this part, students conduct equipment operation exercises in groups. And teachers judge and correct the problems in time.

The fifth module is the "Task comment". In this one, teachers give comments on the common problems in operation exercise. In this evaluation, teacher needs explain the

equipment operation problems from the theory. This is the third time that the theory is linked to the operation.

The sixth module is the “Write operation report after class”. It is the fourth time to establish the connection between theory and equipment operation.

From the process of the above theoretical and practical teaching, we can see that the whole teaching process is from the memory, understanding to the application, and then from the application to the memory and understanding. In this cycle process, the students' cognitive level has been improved.

In the initial memory and understanding stage, when explaining the theory, teacher need to give the examples of operation, for stimulating the technicians’ enthusiasm for learning. In the equipment operation demonstration, the relevant theories are reviewed, so that students not only know how to operate, but also know why. After the above teaching cycle, students often have a sense of enlightenment, especially for those technicians who have some practical experience.

Using this cycle of practical and theoretical teaching we get good results especially in the teaching of equipment troubleshooting. In the troubleshooting process, the students do not know where the fault is in advance. Therefore, they must think and reason from the theoretical knowledge i. e. using theory to guide practice. At this time, students are no longer simply to imitate, but to make analysis and judgment. In this way, under the "urging" of the fault, the students' cognitive level gradually rises to the analysis level. In this process, the teachers play a guiding role. In this role teachers help the students to review the theory, and guide them to analyze and reason from the theory, so as to lead the students' analytical ability to be improved.

3 Analysis of the Learning Results

In the actual teaching process, we designed a comparative teaching experiment. First, choose a knowledge point as the content of experiment. Here we chose the calculation of the main light power and the monitoring light power in the optical power regulation as this experiment content. And the students were divided into two classes, Class A and Class B. Before learning in class, we gave them an initial test in which the questions are only related to this experiment content. After teacher marked the papers, the students' score were recorded. Here, we used the level 5 scoring method. These 5 levels were excellent, good, medium, pass and fail respectively.

In teaching process, we used the above teaching method in Class B. In Class A, the traditional teaching method was used. In the traditional teaching method, there were only the class lecture and homework. Finally we gave a final exam to these students about this experiment content.

After the examination papers being checked, we separately compared the final test scores with the initial examination results of Class A and B. And these two classes were compared in their scores increment.

Shown in Figure 3 (a), it was the Class A score distribution in the initial test. It can be seen that 9.09% of the technicians in this knowledge point were excellent in the test,

indicating that these students had mastered the knowledge point. However, the proportion of students who passed and failed was 15.91% and 18.18%, respectively.

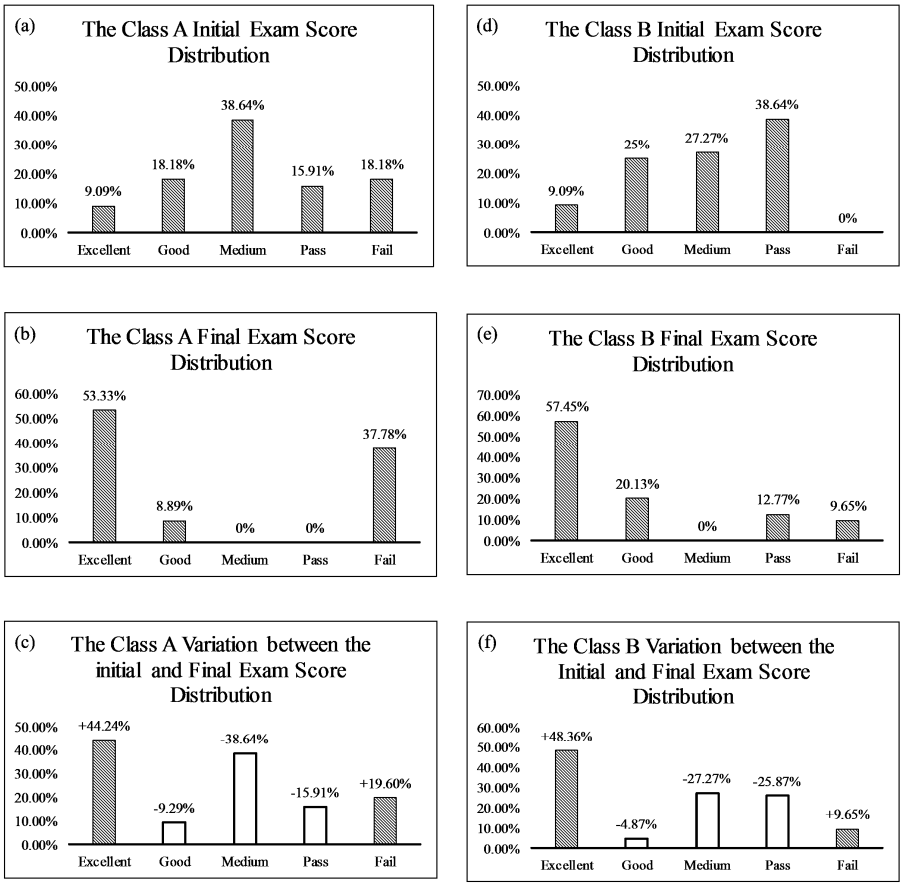

Fig. 3. The Class A and B score in the initial and final examination

Figure 3(b) showed the final test scores distribution of Class A. It can be seen that the scores showed bipolar distribution. The proportion of excellent and fail both increased, while the others decreased.

Figure 3(c) showed the ratio variation between the initial and final examination for Class A. The proportion of excellent and fail increased by 44.24% and 19.6% respectively, while the proportion of good, moderate, and passing students decreased by 9.29%, 38.64%, and 15.91% respectively.

The increment of excellent proportion was the results of teaching, which was easy to be understood. But the fail rate had also increased, the reasons were worth exploring. By confabulating with students, we learned that in the initial exam without teacher supervision, the exam questions were published through internet learning platforms, some students in Class A asked classmates or plagiarized their answers in the initial exam.

Therefore, the initial exam scores, shown in Figure 3(a), contained a lot of "moisture", which meant that some students should have failed, if they strictly followed the rule of exam. But due to "cheating", they passed the initial exam.

However, in the final exams, due to the teacher supervision, they were unable to "cheat". So their scores declined. Therefore, as shown in Figure 3(b) and (c), the number of failed people increased which was the result of “squeezing water”.

Figure 3(d), (e), and (f) were the scores distribution of Class B in the initial exam, the final exam and the scores variation between these two exams. Shown in Figure 3(d) and (e), in Class B there were no fail in the initial exam, but 9.65% failed in the final exam. It comes from the similar reason to Class A.

In order to merely reflect the results of different teaching methods, we calculated the scores proportion variation between the initial and final exams of two classes. This results were illustrated in Figure 3(c) and 3(f).

By comparing Figure 3(c) and (f), it can be seen that the excellent rate of Class A students who did not adopt the improved teaching method increased by 44.2%, while the excellent rate of Class B students who adopted the improved teaching method increased by 48.36%. From these data, it can be illustrated that the excellence rate increased 4.16% by improving the teaching method. It can be seen that the improved teaching methods can enhance the effectiveness of upgrade-training.

4 Conclusion

In the process of upgrade-training for technicians, we improve the teaching methods based on the Bloom cognitive model and Ebbinghaus forgetting theory. In the teaching process, different teaching methods are adopted for knowledge points at different cognitive levels, and it is emphasized to cross circulate between the theory teaching and equipment operation instruction. Experimental statistics show that after adopting the improved teaching method, the excellent rate increased by 4.16%.

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