

Reform and Practice of Teaching Methods in Postgraduate Professional Foundation Courses

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Abstract—Postgraduate professional foundation courses are an important part of postgraduate teaching and the foundation for learning professional courses well. Aiming at the common problems in the teaching of professional foundation courses, this paper combines the information theory of postgraduate professional foundation courses in communication related majors to carry out research on teaching methods, in order to improve the teaching methods of professional foundation courses and guide students to use their learned knowledge flexibly to solve practical problems in scientific research, which not only enriches the content of lectures, but also facilitates the students to master the content of the courses, so as to achieve a multiplier effect.

Keywords—professional foundation courses, engineering practice, teaching reform, physical meaning, new engineering

I. INTRODUCTION

The professional foundation courses are the connection between the public foundation courses and the professional courses, which are the combination of basic education and professional education and play a role of connecting. Under the current teaching mode of “thick foundation, wide caliber, strong ability, and heavy practice”, the teaching of the basic courses and professional courses has been strengthened, and the research on basic and professional teaching methods has received extensive attention [1]. How to carry out the teaching reform of the professional foundation courses and play the role of the professional foundation courses is particularly important. This article is the research result of the graduate teaching reform project.

Teaching research needs to be carried out according to the characteristics of specific courses. On the basis of familiarity with the content of the course, it is necessary to analyze the characteristics of the course deeply, summarize and condense the direction of reform, and apply them to the course teaching. In the teaching of the basic courses of postgraduate majors in communication, we found that because of the unclear understanding of the basic concepts,

students are not stable in the study of professional courses and the ability to solve practical problems with basic knowledge is not strong; because the “use” of the concept is not clear, the actual problems cannot be correctly modeled and the professional foundation courses and professional courses are separated; due to the basic characteristics of professional foundation courses, many teachers do not pay attention to the combination of new technology when teaching professional foundation courses and cannot play the driving role of basic theories on the frontiers of science and technology; the combination of professional foundation courses and innovation is insufficient. With the rapid development of science and technology, people's yearning for a better life is more and more urgent, leading to many new problems are needed to be solved. The new engineering is the new direction of multidisciplinary collaboration in this situation. How to play the basic role of professional foundation courses in the construction of new engineering is also a new problem we are currently facing.

Information theory is a summary of human research on the essence of communication for many years, and it is also a gradually formed theory [2]. The “Information Theory” course is the theoretical basis of communication technology. As a professional foundation course, “Information Theory” course has been established in many universities, including undergraduate, postgraduate and doctoral degrees, especially in the fields of communications, electronics and information. Practice shows that “Information Theory” course, as a foundation theory course of information major, can lay a foundation for the follow-up of professional courses, and can further improve the knowledge structure of students, broaden students' horizons and enhance their ability to solve practical problems [3].

II. TEACHING REFORM METHODS FOR PROFESSIONAL FOUNDATION COURSES

A. Combine physical meanings to teach basic concepts

The “Information Theory” course is a theoretically strong and conceptually abstract course, and its course content involves a large amount of mathematical knowledge, including a large number of thinking methods and technical means scientific research. The results obtained from mathematical solutions are often abstract, so in order to achieve our original understanding of the objective world, we need to give our mathematical results or mathematical

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models a suitable physical interpretation, the so-called "physical meaning".

In the teaching process, we need to consider how to dilute the mathematical derivation process, clear the conclusion, and emphasize the physical meaning [4], which can deepen the understanding of the course content.

Some courses have begun to explore these aspects [5-6], emphasizing the physical meaning of the basic concepts.

The fundamental understanding of physics in the world can be attributed to concise concepts and images. When you forget all the mathematical formulas, your remaining understanding of the laws of the world is the so-called physical meaning. "Entropy" and "Entropy Rate" are very important concepts in information theory, so in order to enable students to master concepts well, we try to explain them in combination with physical meaning.

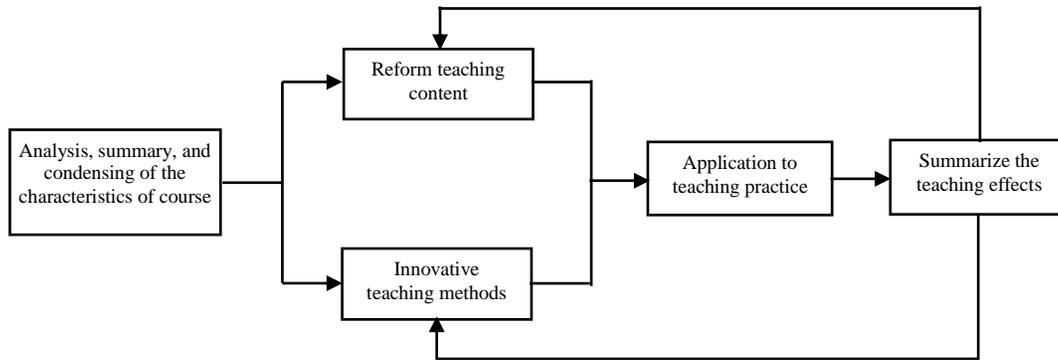


Fig. 1. Teaching reform scheme diagram

In information theory, the meaning of "Entropy" is the amount of information carried by the source on average to output one symbol, and also the minimum number of symbols required to represent the symbols of the source in binary. Of course, the source entropy also represents the average number of problems required to the output symbol of the determined source. For sources with the same number of states, the less entropy indicates the greater the redundancy and the greater the degree of compression required. The source entropy also represents the ability of the source to carry information. For an image, the image entropy can be calculated based on the distribution of the pixel gray value. The larger the entropy, the richer the image texture. As we know, the entropy of a continuous source is infinite, which is based on its infinite detail.

The "Entropy Rate" indicates that the amount of information carried by each symbol averaged by the source sequence when the source outputs an infinite number of symbols. It is also equal to the infinite order conditional entropy, and its size reflects the statistical dependence between symbols. In order to achieve efficient transmission, the redundancy of the source needs to be compressed. The effective amount of information carried by each symbol of the actual source is the "Entropy Rate", but in order to fully compress the redundancy, the infinitely long source output sequence needs to be considered. For example, when watching an NBA game, in order to fully compress the redundancy, we must wait until the game is completely over and then unify the coding compression, but this will not satisfy the people's urgent desire to watch the game live. Therefore, sometimes the source code and real-time performance should be balanced.

B. Combine engineering practice to design lecture content

As we know, the theory can guide practice to make people's practice more effective and more productive [7]. All the theories obtained from the reality will inevitably be "practical". The empty talks that are inconsistent with reality are opposed, and the theory obtained from the reality will certainly return to the reality [8]. In the process of information theory teaching, how to combine theory with practice to achieve a good teaching effect is a topic that teachers should focus on. The characteristics of information theory course are many abstract concepts, many theorems, and a certain distance from the actual application, and less links with other courses. Therefore most students feel that the content is boring and difficult during the learning process, and they are less connected with the future direction of career [9]. The teaching of "Information Theory" course has been the balance problem between theoretical analysis and engineering practice. If "Information Theory" course is taught as a purely theoretical course, it will violate the cognitive rules of students.

For college students, the lack of practice and interaction is not conducive to the in-depth understanding of the content of the course, the formation of study style in theoretical and practical, and the cultivation of problem-finding and problem-solving abilities, which affects the development of innovative thinking. In the teaching process, if the theory is overemphasized, students will feel that the content is boring and difficult to understand. On the other hand, if the engineering applicability is overemphasized, it is very unfavorable for cultivating innovative research talents.

Information theory is the theoretical basis of communication technology, which establishes unified physical and mathematical models of a communication system. A complete communication system includes a source, source coding, channel coding, a channel, channel decoding, source decoding, and a sink, etc. The source is a source of messages and message sequences, which can be human, biological, or machine, or something else. The encoder is responsible for signal transformation and processing. It can be divided into three types: source encoder, channel encoder and secret encoder. A channel is a medium (such as a cable, waveguide, fiber, radio wave, etc.) in which a communication system transmits a signal carrying message from a ground to a ground. Noise sources are artificial or natural interference and noise. The decoder performs inverse transformation on the received signal to recover the source message. The sink is the object of message transmission, including legal or illegal objects such as machines and people, etc.

The ultimate goal of communication is to transmit information to the receiver in a timely and reliable manner. The main concept of measuring communication capability is "mutual information". How to teach clearly the concept of "mutual information" to students in combination with communication practice is the focus of information theory teaching reform. For example, we can introduce the settings of transmitters in communication system by combining "mutual information", and consider the case of average joint mutual information between two transmitters and one receiver, which can be proved:

$$I(X_1 X_2; Y) \geq I(X_1; Y) \quad (1)$$

It shows that two transmitters are better than one transmitter. If X_1 and X_2 are independent, then:

$$I(X_1 X_2; Y) \geq I(X_1; Y) + I(X_2; Y) \quad (2)$$

It shows that it is better to use two transmitters at the same time than to use two transmitters separately.

C. *Combine the development direction of the discipline to reform the teaching contents*

Foundation research is the source of high and new technology, the upstream of scientific and technological innovation, and plays a leading role in the development of new technologies. Basic courses and professional foundation courses are not only the basis for students to conduct professional studies at school, but also the basis for future life development and future innovation.

The construction of professional foundation courses is a long-term work. It is necessary to constantly update the teaching contents so that it meets the requirements of the times. It is necessary to fully tap the potential of students, cultivate students' scientific literacy and inquiry ability. Master basic knowledge and build the foundation for the learning of other courses in the future by learning basic concepts, basic ideas, and basic methods. In the teaching process of information theory, we combined the

development direction of mobile communication systems to introduce students to new technologies of communication.

For example, the next generation of mobile communication technology is built around the fifth generation (5G) mobile communication. The core goal of 5G is to increase the communication rate and increase the system capacity, so that the system can accommodate more users. How to achieve this goal? According to the knowledge of information theory, the system capacity can be expressed as follows:

$$C_{sum} \propto \sum_{cells} \sum_{channels} B_i \log\left(1 + \frac{P_i}{I_i + N_i}\right) \quad (3)$$

Where B_i , P_i , I_i and N_i represent the channel bandwidth, signal power, interference power and noise power, respectively. The first summation is the summation of the cells, and the second summation is the summation of the channels. Therefore for a new generation of communication systems, the signal-to-noise ratio (SNR), channel bandwidth, number of channels, and cell size all affect system capacity. Power control technology and interference cancellation technology can increase the signal-to-noise ratio $P_i / (I_i + N_i)$; to increase the channel bandwidth, in the case of limited frequency bands, it is necessary to develop new frequency bands, such as visible light communication, millimeter wave communication; multiple input multiple output (MIMO) large-scale antenna technology can increase the number of channels; to increase the number of cells, by reducing the cell area, the ultra-dense heterogeneous networking may be formed using the cell splitting of the micro-zone and the pico-cell coverage. In addition, orthogonal frequency division modulation (OFDM) technology, dynamic spectrum allocation technology, and software radio technology can improve spectrum utilization and signal-to-noise ratio; the application of full-duplex technology and the new transmission waveform technology are the research directions of future communication technologies. Through such explanations, students have learned both the basic concepts and the development direction of communication technology.

D. *Combine scientific research to test teaching results*

The undergraduate stage is a period of laying a professional foundation. Undergraduate education attaches great importance to the combination of general education and professional education, and attaches more importance to professional universal education and comprehensive teaching. Different from the undergraduate stage, the postgraduate stage pays more attention to turning theory into practice, and more focuses on cultivating students' ability to find and solve problems. The teaching of professional foundation courses should be combined with scientific research practice, which not only can inspire students to think about professional issues, but also use the knowledge they have learned to solve practical problems.

In the teaching of information theory course, the small problems encountered in the subject are usually left to

students to think. For example, we have encountered statistics on the number of microorganisms in the culture dish. Due to the angle of shooting and the overlap of microorganisms, the size of the microorganisms after imaging is different. The conventional statistical methods are time-consuming and laborious. The students are guided to use the concept of information theory from information. Firstly, the average information amount of a microorganism is estimated, and then the information amount of the whole image is counted, and the number of microorganisms is quickly and effectively counted. The research result "Method of Estimating the Number of Microorganisms Based on Image Processing" has been published. For example, how to use the track to distinguish between surface vessels and underwater vehicles is a problem that has been plagued for a long time. The graduate students were guided by the infrared image of the wake of the vehicle, and the concept of entropy was used flexibly to calculate the difference between the entropy of the underwater target and the infrared image wake of the underwater target, and an effective identification method was invented. At the same time, the result has been patented for invention.



Fig. 2. a photo of an underwater acoustic communication modem

Combined with our cross-media communication project for joint detection of seabed information, the knowledge of signal coding and processing is taught to the students. At the same time, the students are encouraged to participate in these projects to increase students' interest in learning. Figure 2 shows the underwater acoustic communication modem that graduate students are involved in and this modem is applied to the sea-sky cross-media communication experiment.

The new teaching mode that combines the actual communication subject with the content of the information theory lecture is not only conducive to students' understanding of the teaching content, but also promotes students to solve practical communication problems, and can open up students' innovative consciousness and develop innovative thinking.

III. CONCLUSION

As a pre-course of professional courses, the teaching effect of professional foundation courses plays a vital role in the study of professional courses for graduate students. Especially in recent years, with the reform of the credit system, the teaching hours for most courses in the teaching plan are compressed. In a limited teaching time, how to refine the teaching content and optimize the teaching method is particularly important. The postgraduate professional basic courses should not only ensure that the students lay a solid foundation and cultivate basic scientific qualities, but also introduce the latest scientific and technological achievements to the students in combination with the professional characteristics and lead students to grasp the frontier dynamics. In the paper, aiming at the common problems in the teaching process of the basic courses of engineering majors, the teaching methods are studied through combining the postgraduate information theory course. Through the exploration and reform in teaching practice, good teaching results are obtained, which not only promote the students' mastery of the basic concepts, but also guide students to solve practical communication problems with what they have learned. The unity of theoretical teaching and practical teaching has been realized. The reform of the professional foundation course teaching has a long way to go. Reform and optimization of teaching content should be continued to promote the cultivation of research-oriented and innovative talents.

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