

# The "4Rs" Teaching Method in Underwater Acoustic Communication Systems Course

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**Abstract.** According to the training goal of underwater acoustic engineering in Information Engineering University, we find the characteristics of underwater acoustic communication systems, summarize the experience during the years of teaching students practice, and then propose the teaching method of "underwater acoustic communication system" course, which is summarized as "4Rs". This paper firstly describes the meanings of "4Rs", which is suitable for our students. Then, we show the teaching contents and what the students can learn. And finally, we tell the implementation ideas of 4Rs teaching method, and through the consecutive practical teaching training, we can have many favorable teaching results.

**Keywords:** "4Rs" teaching method; underwater acoustic engineering; underwater acoustic communication system; teaching contents; implementation ideas.

## 1. Introduction

"Underwater acoustic communication system" is a compulsory course for undergraduate underwater acoustic engineering majors. President Xi requested to strengthen the construction on sea [1], and the effective and reliable underwater acoustic communication system is the one of important foundations and necessary platform. Therefore, as a training unit in underwater acoustic field, the course "underwater acoustic communication system" is opened to meet the actual training demand. At the same time, domestic and foreign course researching on underwater acoustics, sonar and other courses is very mature, but the underwater acoustic communication system has not formed a standardized, systematic course. Therefore, in order to cultivate a new generation of underwater acoustic engineering students, it is of great value and pioneering significance to design the course "underwater acoustic communication system".

The "4Rs", which are reuniting knowledge and practice, refresher, resource assistance, and rethink of ideology and politics, are the direction of student cultivation, the basis of the course teaching ideas, and the execution of education. First of all, the curriculum should reunite knowledge and practice. In order to realize the unity of knowledge and action, many domestic courses have paid attention to the unfolding of the practical content. Practical content can use personal computer software simulation, can be based on hardware physical operation, and even develop online simulation laboratory [2], these all aiming to realize the knowledge applied in practice.

Then, the teachers should review the known knowledge and introduce new things. BOPPPS model (including bridge, objective, pre-assessment, participation, post-assessment, and summary) is a popular teaching model [3][4], which has been borrowed, improved and promoted in many courses. The bridge and pre-test are the important expressions of refresher. However, the application of the existing courses on learning from the past lies more in reviewing the content of the previous lessons, but involves less in reviewing the knowledge from other courses.

Next, resources should be assisted for students after the lesson. Build a resource library about the course, which serves for both students and teachers. In China, the main approach of building the course resource is to build online resources, like MOOC[5]. In addition, online simulation laboratory are also the unique resources.

Finally, teaching should consider ideology and politics. Under the guidance of the "Guideline for the Construction of Civics and Politics in Higher Education Courses" [6], rethink of ideology and politics has been an indispensable part of any course, and is also a key issue in engineering teaching.

In [7], domestic engineering curriculum construction mainly focuses on, firstly, the cultivation of teachers to improve their ability; secondly, finding the elements of ideology and politics in courses, refining the key points, and designing the teaching plans carefully; thirdly, innovating the approaches, and using the elements of the professional celebrities, experts, profession history, and development status; fourthly, incorporating the assessment mechanism, and taking ideology and politics as an important processing evaluation index in course evaluation and teaching competition; fifthly, playing the results-oriented, ultimately to achieve a good teaching atmosphere of ideology and politics, and to enhance the confidence of the teachers.

To sum up, in order to design the "underwater acoustic communication system" course, we absorb the highlights of domestic curriculum construction and consider the characteristics of underwater acoustic engineering, then propose the "4Rs" teaching method and corresponding implementation ideas in this paper, finally aim to realize the comprehensive enhancement of knowledge, ability and quality.

## **2. Teaching Objectives, Teaching Content and Innovation**

### **2.1 Teaching Objectives**

The purpose of this paper is to design a teaching method on "underwater acoustic communication system" course about "4Rs". By analyzing the current learning situation and finding the teaching problems, we do research on the teaching content and teaching methods, which can not only promote the cultivation of underwater acoustic engineering students and lay the foundation for strengthening the ability of underwater talents, but also in the process of the research, exercise the teachers' teaching thinking and teaching ability, and establish a tough teaching team.

### **2.2 Teaching Content**

This section focuses on the curriculum design using "4Rs" teaching method. According to the different objectives, the teaching content is described as four parts: reuniting knowledge and practice to enhance capacity, refresher for consolidating the foundation, resource assistance to broaden the horizons, and rethink of ideology and politics to cultivate the sentiments.

#### **2.2.1 Reuniting knowledge and practice to enhance capacity**

We have found that students pay much attention on the examination. Firstly, formative grades are set, but it only account for 30% of the total grade and has a limited impact. At the same time, how to set practice content in formative grades needs to be in-depth discussed, in order to enhance the attractiveness to do practice; secondly, because of the teaching management regulations on the written test results of the one-vote veto, which tells that less than 60 points in written test will be judged as a failing grade. As a result, students are prone to form a learning attitude that emphasizes the examination over the process. Therefore, we consider that in the course design, classroom lectures should be the main focus, supplemented by the necessary practical training. The form of practical content can be divided into in and out class according to the time period, can be divided into simulation experiments and field experiments according to the field. Thus, we set up the relevant practical tasks, after the end of one day's or staged teaching content, which can deepen the understanding of knowledge, cultivate hands-on ability, and reunite knowledge and practice.

#### **2.2.2 Refresher to consolidate the foundation**

The course "underwater acoustic communication system" is positioned as a compulsory course, which combines the knowledge from the basic courses of communication, like "Principles of Communication" and "Digital Signal Processing", and the basic courses of underwater acoustics, like "Principles of Underwater Acoustics" and "Sonar Technology". It can help explore the knowledge of underwater communication by underwater acoustics on the one hand, and understanding the underwater acoustic environment by using the communication theory on the other

hand. Therefore, in the process of teaching, it is necessary to sort out the teaching content of the course, determine the learned knowledge associated with the new knowledge, and set the relationship between the learned knowledge and the new knowledge, then reasonably arrange the entry point to review the learned knowledge to make this process smooth. As a result, the students can build a solid professional foundation.

### 2.2.3 Resource assistance to broaden the horizons

Currently, students grow up in the era of rapid Internet development, are used to using computers, telephones and other electronic products, and are good at using the Internet to collect resources and carry out self-study learning activities in MOOC, Bilibili and other platforms. As a result, they have more initiative in encountering difficult problems, and more channels for solving problems. In order to give full play to students' learning enthusiasm, create rich learning resources conditions and expand students' professional vision, for the existing resources, one is to organize paper or electronic publications, literature, journals and other book resources, and the other is to list MOOC, micro-course, vocational education and other video resources. What's more important is to establish database and program library. The database and program library can display the teaching content more prominently, which is easy for students to understand. At the same time, it can also provide materials for the practical content and guarantee that students get adequate exercise.

### 2.2.4 Rethink of ideology and politics to cultivate the sentiments

Rethink of ideology and politics is a necessary part of the course teaching, which has a big difference with the engineering teaching ideas, which request to avoid hard but smooth, and poses a big challenge to teaching ability. At the same time, in the current teaching process, individual ability is prominent, but teamwork ability is trivialized, which further reflects the importance of ideology and politics in course design. This paper firstly clarifies the viewpoints of ideology and politics, including: correct outlook on life, values, sense of mission and sense of honor, etc.; then discover the elements of ideology and politics, making clear in which knowledge point teaching process to start this education, how to do a good job of articulation, what views are conveyed, and what goals are achieved; finally form a set of systematic and complete library of cases of ideology and politics.

## 2.3 Innovations

The advantages of "4Rs" teaching method can be summarized as follows:

(1) The course design of "underwater acoustic communication system" has originality. "Underwater acoustic communication system" is a new course established according to the development characteristics of underwater acoustic field for the cultivation of underwater acoustic engineering students. This paper carries out the research on the course design of "underwater acoustic communication system" to continuously improve the teaching quality of the course, enhance the students' underwater acoustic knowledge and ability, and meet the needs of scientific research talents in underwater acoustic communication signal analysis.

(2) The course design of "underwater acoustic communication system" puts forward the systematic "4Rs" teaching method. Although we can find the elements of four parts of "4Rs" in many domestic curriculum design, they are relatively independent. This paper takes "underwater acoustic communication system" course as an example, combines the basic learning situation of students, considers the basic needs of development, integrates the characteristics of underwater acoustic specialty, and researches on the realization method of the four objectives, which can efficiently complete the training of talents, strengthen the teacher team, and provide important ideas for the future design of underwater acoustic courses.

### **3. Teaching Implementation Ideas**

#### **3.1 Reuniting knowledge and practice with a plan**

In order to achieve reuniting knowledge and practice in the course design, firstly we control the time, where we divide the time into in-class and out-of-class. The classroom practice session is an integral part of the course, with formal content and concentrated time. Currently, the course is arranged with 4 class hours of practical teaching content, divided into 2 times of teaching, when the third chapter and the fourth chapter of the lecture is completed. Test the students' mastery of the contents in time and systematically apply what they have learned to the understanding of signal processing and equipment. The post-class practice session is mainly in the form of post-class assignments, which is an important reference for formative grades. Its content is varied and flexible to deepen understanding of the day's points in a timely manner.

Secondly, we divided the content of practice into two parts, which are simulation experiment and field experiment. The simulation experiment is based on the software platform, simulating the underwater communication system or processing the actual reception data, to achieve the goal of consolidating basic knowledge and enhancing the application ability. The simulation experiment is the main content of the post-class practice session and the form of the first course practice content. The field experiment is based on the actual equipment and facilities in the laboratory, and in the artificial lake, we carry out the pool test and lake test experiment, which is the form of the second course practice content. By continuously adding underwater equipment and improving the experimental subjects, students can better understand the actual underwater communication, and also uncover problems to motivate subsequent learning. At the same time, an underwater mindset is fostered based on actual equipment operation.

#### **3.2 Refresher with rich content**

We first emphasize the learned knowledge. Currently, the course "underwater acoustic communication system" is opened when "Digital Signal Processing" and "Principles of Underwater acoustics", have been completed, but "Principles of Communication" and "Sonar Technology" is not. Thus, the students have a deeper understanding of the completed courses, and we mainly concern that how to apply the knowledge to the current teaching content. As for uncompleted courses, students do not have a deep enough understanding of the knowledge, and we need to review the main points of the knowledge, with a focus on the underwater communication.

Secondly, it is also necessary to know the differences and similarities between the learned and the new. "Underwater acoustic communication system" is a course on the systematic integration of communication and underwater acoustic knowledge. In addition to review the learned knowledge, students also need to be guided to distinguish the difference. Thus, the comparison of the learned wireless communication system and the current learning underwater acoustic communication system throughout the teaching. Not only understand the basic concepts, basic principles, and basic technologies of underwater acoustic communication system, but compare and contrast the similarities and differences of wireless communication systems, and do the same in analogies to push the boundaries.

#### **3.3 Resource assistance with its own characteristic**

In order to establish a strongly targeted, high-value degree of the characteristics of the resource base, we first clarify the content of the resource base. Resource library mainly includes one is book resources, meetings and literature, mainly in the day after the class to provide relevant reference materials, especially meetings and literature is required to be targeted; the second is including micro-courses, MOOC, vocational education courses (can provide the URL) and other resources, which is for the afterschool cramming, review and viewpoint enhancement as a support; the third is organizing database and the program library, where database stores the radiated noise signals and underwater acoustic communication signals collected from the actual equipment operation, which is

closer to the actual environment, while the program library is mainly for the simulation program and processing software program, which not only serves the teaching, but also accumulates materials for the future scientific research.

Secondly, we should manage the resource. First, classify the resources to ensure the best use, and not repeat the work or lost sources in the accumulation process. The second is to collect, with the continuous deepening of teaching, resources update in time. The third is to reasonably allocate resources according to the teaching content to select the resources.

### 3.4 Profound rethink of ideology and politics

We carry out the rethink of ideology and politics, according to the thought that what to do, where to teach, and how to push. First of all, what to do, is said to sort out the main points of the ideology and politics and what is the key issues, including the outlook on life, values, sense of mission and honor of the post, the principles of Marxism, history and so on. We need to choose the deeply meaning elements of the ideology and politics. Then, where to do, is said to determine in which part we can correlate teaching content with ideology and politics, which is really worth teaching and really meaningful. Finally, how to do, is said to ensure that the content connection is smooth, and can quickly return to the main topic.

## 4. Conclusion

In this paper, we propose the "4Rs" teaching method for "Underwater Acoustic Communication Systems" course. We first describe the meanings of "4Rs", and then talk about the main content and the implementation ideas. In the future teaching process, we will collect student feedback, continuously summarize the advantages and disadvantages, then improve teaching methods, and finally form a mature teaching method, and enrich the connotation of "4Rs".

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