

# Combining Engineering and Medical Knowledge for Construction of Inquiry Teaching Method on Digital Signal Processing Curriculum

Xiaou Li, Boyu Si, Baodan Bai, Jiayong Yan  
College of Medical Instruments  
Shanghai University of Medicine & Health Sciences  
Shanghai, China  
bradyli@163.com

**Abstract**—Based on the combination of engineering with medicine knowledge, the inquiry teaching method based on the curriculum reform of digital signal processing is studied. Through strengthening the practice and problem based learning, a teaching mode of taking the students as the main body is established. In order to cultivate the basic knowledge of medical science and engineering knowledge, this paper provides a practical method for the cultivation of medical instrument compound talents.

**Keywords**—*biomedical engineering; digital signal processing; problem based learning; inquiry teaching*

## I. INTRODUCTION

“Digital Signal Processing” is an important major curriculum for biomedical engineering, which introduces the signal analysis methods and processing techniques. The traditional teaching method is mainly based on theoretical teaching, which contains more mathematical concepts and formula derivation. For the engineering students, these contents are boring with learning by rote, rather understanding them. Therefore, it is very important to study the teaching method of this curriculum and associate the theory contents with medical application for performing the teaching reform of biomedical engineering [1].

The traditional teaching method mainly involves the style of knowledge installation, which can no longer meet the needs of students and make the students loss the interest of learning. In order to mobilize the students’ enthusiasm and creativity, the inquiry teaching method based on problem based learning (PBL) is studied in this paper. It breaks through the bottleneck of traditional signal processing, and makes the students understand the basic theory from the medical application point of the electrophysiological signal processing. In the meantime, the basic concept and the calculation principle are understood through the virtual graphical operation result [2].

## II. CURRICULUM DESIGN BASED ON PBL

### A. Multi-mode practice teaching for medical instrument engineer

The medical practice platform is built through the joint function of enterprise, university and hospital. A model of multi-win integration develops the innovation platform and practical teaching method for the students.

The teaching team including engineer, teacher and physician can carry out the real teaching guidance of internal and external experiments. The combination of production and medical study improves the design of the innovation project. The teaching team is regularly organized for the teaching discussion on the medical instrument development. The practical ability of the student is improved by extracurricular activities and classroom instructions [3].

### B. The application of PBL Mode in digital signal processing curriculum

A learning team is built, and each student member votes a leader with organizational skill and strong responsibility. The leader is responsible for the organization of the team and the coordination and division of learning activity.

According to the teaching syllabus and practice teaching content, the teachers set up a number of experimental issues with engineering background and certain complexity on the subject. For example, a detection system of ECG data is designed for implementing the acquisition and filtering of ECG signals. The students would be guide to understand sampling theorem and filtering in practice. The main problems offered in this stage include the main frequency range of the active signal, the frequency range of the main interference source and the influence of the linear and nonlinear phase filtering. The students can perform the filter design such as IIR and FIR.

The relevant issues raised in the practice project are released, and the learning teams would study the teaching subject, read the teaching materials and review literatures. They are encouraged to conduct the preliminary analysis by the discussion. The practice items for this curriculum are shown in TABLE I. These experiments are simulated based on the Matlab function.

TABLE I. THE LIST OF PRACTICE ITEMS

Item	Purpose	Content	Attribute
Signal sampling and recovery	Understanding sampling theorem	The sampling of ECG and SPO2	Validation
Spectrum analysis with FFT	Understanding the spectrum and FFT algorithm	The spectral information of ECG and SPO2	Validation
IIR filter design FIR filter design	Understanding digital filters	The filtering of ECG and SPO2	Integration

The teachers organize the students to perform the discussion for understanding the problems and tasks. Each learning team finally completes the corresponding experimental project [4].

### C. The achievement evaluation

The final grade assessment is not only determined by the experimental assessment, but also by the process performance. The self-learning performance accounts for 30%, the experimental process and report accounts for 35%, and the experiment test accounts for 35%.

## III. INQUIRY TEACHING METHOD

In this paper, the cooperative inquiry learning model is combined with independent inquiry learning. This study is based on the guidance of teachers and taking students as the main role. The curriculum knowledge and clinical practice are combined to conduct the special study. This kind of cooperative learning model can fully stimulate the student' learning interest and provide the practice opportunity. It can also reflect student-centered, teacher-oriented education ideas. The construction of this learning mode makes the learning style change from acceptance learning to research learning, from indoctrination type to inquiry type [5-6].

This curriculum sets up electrophysiological signal (such as ECG, SPO2) processing projects by the school-enterprise cooperation. Combined with the work of the construction of medical electronic instrument testing and theoretical analysis, the comprehensive ability is cultivated to integrate knowledge. Through the combination of engineering and medical knowledge, we have realized the combination of teaching, learning and doing.

The essence of this course is the use of digital signal processing system. The teaching contents are closely developed around two theorems, three transformations and two systems, such as time domain sampling, frequency domain sampling, Z transform, discrete Fourier transform, fast discrete Fourier transform, infinite impulse response filter and finite impulse response filter. The knowledge structure of this course is clear, and the connection of knowledge points is tight. It creates the conditions for the students to use the knowledge to explore and discover new knowledge. The digital signal processing is widely used in medical monitoring and health checks, and it is closely related with daily life. The practical tasks are designed according to the interest fields of students. This lays a foundation through teamwork and exploring knowledge. We construct a cooperative inquiry learning model. It involves five aspects, that is, the allocation of learning team, the design of learning tasks, the design of heuristic problems, the expansion of communication and the discussion of communication.

## IV. SUMMARY

Through the teaching methods from acceptance learning to research learning, from indoctrination type to inquiry type, we make the students actively participate in the knowledge discovery and acquisition process and develop the spirit of innovation. The cooperative inquiry learning mode is studied in this paper, which adheres to the educational concept of the students as the main role. Combined with the characteristics of the digital signal processing curriculum, we optimize the classroom teaching mode. The change from passive learning to cooperative learning is helpful to cultivate the consciousness and ability of active learning.

## ACKNOWLEDGMENT

This research was financially supported by Natural Science Foundation of Shanghai (Grant no. 14ZR1440100), Research Project in Medical Education (Grant no. 2016B-KC008), and 2017 Special Educational Reform Project (Grant no. JG(17)04-A5-01, Grant no. SYHZW201719).

## REFERENCES

- [1] Q. H. Dong, J. Ma, X. H. Yin, C. P. Xu, Development and realization of experimental system based on hierarchy ladder model for digital signal processing, *Experimental Technology and Management*. vol. 33, 2016, pp. 202-205.

- [2] H. X. Liu, H. B. Li, J. Li, The teaching reform research of digital signal processing based on the comprehensive mode, *Journal of EEE*. vol.37, 2015, pp. 38-39.
- [3] Q. H. Dong, X. J. Huang, J. Li, Q. Yang, Research on the integration of experiment and theory teaching based on digital signal processing course, *Course Education Research*. vol.6, 2015, pp. 253-254.
- [4] R. Zhao, Teaching reform of digital signal processing for “Outstanding Engineers”, *Science and Technology Innovation Herald*. vol. 19, 2015, pp. 159-160.
- [5] Y. M. Shen, L. J. Qiu, S. J. Tang, W. Tan, Design of experimental system for biomedical signal measurement, *Experimental Technology and Management*. vol. 32, 2015, pp. 75-80.
- [6] V. J. M. Wijnen, H. J. Eilander, B. de Gelder, G. J. M. van Boxtel, Visual processing during recovery from vegetative state to consciousness: Comparing behavioral indices to brain responses, *Clinical Neurophysiology*. vol. 44, 2014, pp. 457-469.