Research on OBE-Oriented Teaching for Digital Signal Processing Course under the Background of New Engineering Disciplines

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Abstract. Engineering education certification is an important guarantee to improve the quality of engineering and technical talent training. "Digital Signal Processing" is a compulsory basic course for students majoring in communication engineering. It has strong theory and wide application, and it focuses on the cultivation of students' ability to solve practical problems with basic knowledge. Guided by engineering certification education standards under the background of new engineering, based on OBE teaching mode, student-centered and results-oriented, a teaching outline, evaluation methods, achievement evaluation, and improvement measures were constructed for course teaching evaluation and analysis. Corresponding improvement measures were proposed based on the evaluation results.

Keywords: Engineering education certification; "Digital Signal Processing" course; Achievement degree evaluation; questionnaire

1. Introduction

With the concept of "new engineering" put forward, cultivating new engineering talents with innovative consciousness and digital thinking has become the goal of engineering talents cultivating in universities. The Ministry of Education has taken multiple measures and directions to promote the construction of new engineering, and the concept of student-centered education and teaching in higher education has been proposed.

Outcome-Based Education (OBE) is an educational model that aims to design, organize and implement teaching based on students' achievements and the basic abilities that students should master in their major. The model is "student-centered", "competency-based", "personality evaluation as the driving force" and "continuous improvement as the focus". Therefore, teaching reform guided by OBE is of great significance to promote new engineering construction.

Digital Signal Processing is not only the core curriculum in electronic information major, but also the foundation of subsequent courses in communication engineering major. It is the link between engineering practice and relevant theoretical knowledge of communication discipline. This course can effectively cultivate students' logical analysis ability and practical innovation ability. The main teaching method of this course has always been the application of blackboard writing or multimedia, and the course content is mainly based on mathematical analysis and abstract concepts, which is difficult for students to learn. In addition, the course is highly practical, but students cannot apply theoretical knowledge well to practice.

Now taking "Digital Signal Processing" as an example, according to the characteristics of this course, OBE oriented practical teaching reform is carried out to promote the new engineering construction from a small point of view. Based on new engineering and the education and training mode of OBE system, this paper studies the introduction of virtual simulation into the teaching of digital signal processing courses guided by OBE. Through such reform, the aim is to strengthen students' understanding and mastery of the content of digital signal processing courses, while improving their practical application ability, and further improve their innovative thinking and ability.

2. Research Status at Home and Abroad

In 2018, the "Education Informatization 2.0 Action " was proposed by the Ministry of Education, which emphasized that "education informatization has the unique advantages of breaking through the

restrictions of time and space, rapid replication and dissemination, and rich means of presentation. It will certainly become an effective means to promote education equity and improve education quality; It will become a strong support for building a ubiquitous learning environment and realizing lifelong learning for all. It will greatly improve the ability of scientific decision-making and comprehensive management in education" is pointed out Teaching is the central work in the field of education, and its core content is teaching informatization, including the modernization of teaching methods, education communication informatization, teaching means of science and technology, and the integration of big data, artificial intelligence, multimedia, and other advanced information technology in the teaching process.

In October 2019, the Ministry of Education proposed a first-class curriculum construction plan, calling on all teachers to participate in curriculum content innovation and model innovation. Nowadays, applying more information technology to teaching and improve students' learning effect is an important task for colleges and teachers. Information-based teaching shines brightly under the COVID-19 epidemic in 2020, making "teaching without stopping classes and stopping classes without stopping schools" a reality. The teaching system of colleges and universities has experienced the transformation from offline to online and then to the combination of both.

The arrival of the Fourth Industrial Revolution prompted a comprehensive transformation of engineering education. The Ministry of Education has actively promoted the construction of new engineering course, and issued the Notice on Carrying out New Engineering Course Research and Practice and the Notice on Promoting New Engineering Course Research and Practice Projects, which has comprehensively formed the Chinese model and experience of leading global engineering education and helped the construction of a powerful country in higher education. New engineering is a continuous deepening of engineering education reform, while putting forward new requirements for higher engineering education, pay more attention to the cultivation of students' innovative thinking, engineering practice and other abilities, and pay more attention to the interdisciplinary, comprehensive, and practical construction of its specialty.

In this context, based on the "Internet +" network teaching model has been proposed, such as Chinese university MOOC, rain classroom, super star learning, etc., it is difficult for teachers and students to achieve effective interaction in face-to-face teaching. However, the above teaching platform can only satisfy the remote theoretical knowledge teaching, and cannot carry out the teaching relying on hardware experimental equipment.

At present, the teaching reform of "Digital Signal Processing" course has made some achievements. Li Yanfeng curriculum team put forward the teaching concept of "knowledge and having knowledge, learning and good use" to optimize the curriculum teaching system and teaching content. Wu Ling and other people combined Superstar learning and Matlab graphical user interface to design hybrid experimental teaching. Zhang Lili and other people elaborated the teaching mode of digital signal processing courses based on the OBE concept, and proposed the innovation and reform of teaching courses and the reform of teaching means and methods. Combined with the requirements of new engineering education, Shen Difan and other people conducted research and practice on the online multi-platform assisted mixed teaching mode. Liu Hong and other people elaborated the concrete implementation process of case teaching method. Under the background of "new engineering" and "Internet +" technology, Zhu Jun and other people explored the new teaching mode of "digital signal processing" and the teaching method focusing on "Bisexual degree".

Digital Signal Processing is a highly theoretical and practical professional course. After many years of teaching practice, I deeply feel that the theory of digital signal processing is relatively abstract, there is a lot of mathematical knowledge, and the derivation process is complicated, and students generally reflect that it is difficult to learn. The teaching materials used now pay attention to the explanation of theoretical knowledge and the integrity of the curriculum system, while the practical application links are relatively few because of the professional Settings. These situations will lead to students' fear of the course, and the teaching effect is very unsatisfactory. In order to improve the teaching effect of this course and students' learning interest, the teaching reform of digital signal processing course should be actively sought. In the teaching of this course, the core task

of teaching course should be closely centered on OBE, the student-centered concept should be strengthened, and the teaching mode should be improved.

3. Content of Reform

The fundamental task of colleges and universities is to cultivate and bring up outstanding talents who adapt to the development of The Times. Curriculum teaching is an important link in talent cultivation, and the teaching concepts have a profound impact on the teaching process and results. Digital signal processing is an important course of electronic information related majors, which contains both theoretical knowledge and technical content. The concept of the course content is abstract, and the traditional teaching methods cannot adapt to students' desire and demand for knowledge in the new era, hindering the realization of teaching objectives, and even less conducive to the achievement of professional ability cultivation. The Communication Engineering major of the School of Electronic and Information Engineering of Liaoning Technology University has set up a teaching team composed of 7 teachers for the digital signal processing course. According to the characteristics of the digital signal processing course, OBE oriented engineering concepts are integrated into the theoretical and practical teaching to promote the teaching reform and teaching practice, to optimize and improve the talent training system for the communication engineering major.

3.1 Section Headings. The syllabus is the programmatic document for curriculum teaching. The traditional syllabus overly emphasizes the standardization of knowledge, which stipulates that the teaching method is mainly taught by teachers, and students passively accept the knowledge "imparted" by teachers. The entire teaching process did not focus on student’s learning outcomes, resulting in a lack of continuous improvement measures. This is no longer suitable for the current requirements of the teaching reform. The important function of the curriculum outline is to standardize the teaching management and transform the training objectives and teaching requirements into measurable quality projects. Pursuing the principle of reverse design, the teaching syllabus takes the teaching objective as the core, and the course objective is the learning outcome orientation of students. The logical relationship of each module is shown in Figure 1. The designed theoretical and experimental teaching contents must be able to clearly point to the curriculum objectives. The teaching method implemented is based on the premise of helping students to improve their learning effect, which is conducive to improving students' grades. The assessment method should be set around the teaching objectives of the course. Through the evaluation of the degree of achievement of teaching objectives, we can put forward targeted continuous improvement measures.

Based on the OBE concept, the teaching objectives and teaching plans are formulated in combination with the characteristics and training programs of the major. Taking students as the center, the focus of teaching should be shifted from "teaching" to "learning". The educational goal should revolve around the cultivation of students, and the design of teaching content should focus on the cultivation of students' abilities.

Appropriate weakening of mathematical formula derivation. The mathematical analysis and abstract concepts involved in Digital Signal Processing contain many derivation processes, which are difficult to understand. Therefore, in the teaching design, the derivation of many complex formulas can be appropriately weakened, and the application of basic concepts, key conclusions, physical meanings, and theoretical knowledge in solving complex engineering problems can be emphasized to enhance the purpose of course learning.

Carry out "problem-driven" case teaching. Application cases supporting relevant theoretical knowledge of the course are constructed, and "problem-driven" case teaching is carried out through the introduction, analysis, and solution of problems to improve students' learning enthusiasm and initiative. By using DSP-CAI, Matlab platform and elabradio and other virtual simulation software, the theoretical analysis and specific application are combined to demonstrate the process of theoretical derivation and specific application and the results presented, so that the theoretical teaching process is as dynamic and visual as possible, and the diversity and flexibility of online and offline classroom teaching methods are increased. Further deepen students' understanding and mastery of knowledge and improve the classroom teaching effect.

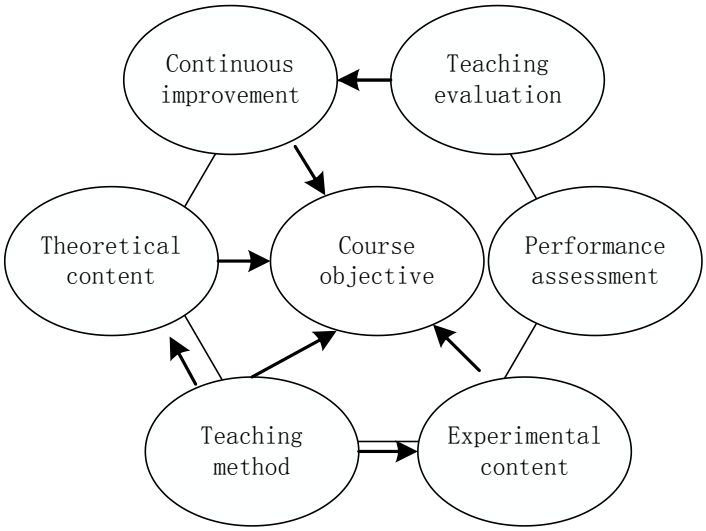

Figure 1. The logical diagram of the implementation module of the syllabus

3.2 Results-oriented, reform personnel training model. Establish a student-centered training mode of "large class + small practice class", and change from the traditional single mode of "teacher teaching" to the initiative "learning mode" of students, and improve students' classroom participation and enthusiasm for independent learning through this training mode. Students are encouraged to apply for and participate in subject competitions, such as China "Internet +" College Student Innovation and Entrepreneurship Competition, National College Student Electronic Design Competition, Blue Bridge Cup Competition, college Student Innovation and entrepreneurship training program, etc. Students are encouraged to carry out extracurricular scientific research activities, choose a scientific research direction related to the course according to individual or group interests to conduct in-depth research, and cultivate scientific research ability and academic paper writing ability. From point to area, from old to new, and gradually realize that most students can have the ability to solve complex engineering problems in digital signal processing.

3.3 Multi-level experiment system of virtual simulation is established based on the ability. The course 'Digital Signal Processing' has the characteristic of strong practicality, in order to cultivate students' exploratory spirit and the ability to apply knowledge to solve engineering problems, a multi-level and multi type experimental content system is constructed according to the principle of gradual progress and gradual deepening. Firstly, the problem-oriented basic knowledge understanding and application layer are adopted to improve students' operational ability. Secondly, the task-driven comprehensive practical ability enhancement layer aims to cultivate students' comprehensive practical ability; Thirdly, the engineering practice innovation layer based on small projects aims to cultivate students' scientific and technological innovation ability. Among them, verification experiment, professional basic experiment, comprehensive experiment, and design experiment are the carriers to form a multi-level, all-round and progressive practical teaching system. a multi-level, comprehensive, and progressive practical teaching system is formed using validation experiments, professional basic experiments, comprehensive experiments, and design experiments as carriers.

3.4 Taking personality assessment as the driving force to optimize the curriculum evaluation system. The assessment changes from "score" to "ability". Exam results do not fully reflect the actual level of students. Therefore, the assessment of learning effect should attach importance to the cultivation of students' ability, and the assessment form should implement a multi-stage, diversified and multi-category assessment system, such as increasing the assessment of learning process and applied knowledge ability, strengthening students' extracurricular learning and independent learning,

and increasing the proportion of comprehensive training, small papers, homework and discussion in the performance assessment. To test professional basic ability and comprehensive quality.

3.5 Curriculum ideological and political reform. Promote curriculum ideological and political construction, using the new era socialism with Chinese characteristics by Xi Jinping to Build the soul and educate us. In the process of knowledge transfer and ability training, help students to shape the correct world outlook, life outlook, values. The ideological and political content is integrated into multiple knowledge points, and the curriculum ideological and political ideas are embodied from three levels: knowledge goal, ability goal and education goal. While teaching, we focus on introducing the scientific and technological achievements in the field of digital signal processing in China, emphasizing the importance of localization of digital signal processing chips, and cultivating students' scientific spirit and patriotism. Students are required to combine theory with practice, be able to design simulation experiments, and work together to complete experimental projects. Students are encouraged to challenge projects with certain difficulties, and cultivate students' spirit of adhering to the truth, assiduous study, and independent innovation. Through the study of courses, students are guided to care about the development of technology in related fields, cultivate students' rigorous and realistic academic attitude and meticulous work style, and establish the value of serving national construction.

4. Implementation Plan

OBE oriented virtual simulation is integrated into the whole teaching process of digital signal processing courses to provide guarantee for the teaching needs of different online and offline teaching environments. With the new engineering teaching concept as the guide, the reform of engineering certification curriculum system as the core, and the training of innovative talents as the goal. Introducing virtual simulation and project-driven teaching to closely integrate theoretical teaching with practical teaching.

The implementation plan follows the "12345" principle to run virtual simulation teaching through all aspects of teaching. One education concept - follow the OBE education concept; Two implementation main lines -- theory teaching main line and practical ability main line; Three ideological and political levels - knowledge goal, ability goal and education goal; Four practice directions - signal time-frequency analysis, IIR/FIR filter design, music/speech signal spectrum analysis and denoising, ECG signal denoising system design; Five learning methods - experience-based learning, problem-based learning, case-based learning, project-based learning and doing-based learning.

Design the teaching mode of "big class + small practice class". "Big class" is divided into three levels: 1) "overall grasp", through the introduction of "overview" and "prospect" in the first and last two classes, reflecting the overall grasp of the course content setting; 2) "Basic Preparation", Lessons 2-8, namely "Discrete-time Signals and Systems" and "Z-transform and discrete-time Fourier Transform", supplement the basic content of the prerequisite course; 3)"Specific decomposition", the other 15 lessons reflect the main content, around "DFT, FFT spectrum analysis of signals", "IIR, FIR filter design" from the perspective of "problem solving or task completion" to introduce specific lesson content Settings. With the help of the virtual simulation platform DSP-CAI, Matlab and elabradio, the "problem-driven" case teaching is adopted. Through the requirements and objectives of cases, students are asked to ask questions, guide students to analyze problems, give methods to solve problems, and demonstrate the process and results, so that students have a deeper and more intuitive understanding of theoretical knowledge.

Adopt the principle of gradual progress and gradual deepening. The teaching program is divided into three levels: first, problem-oriented basic knowledge understanding and application level, aiming at improving operational ability; Second, the task-driven comprehensive practical ability enhancement layer aims at cultivating comprehensive practical ability; Third, the engineering practice innovation layer with the background of small projects aims to cultivate the ability of scientific and technological innovation. These three levels of practical projects from easy to difficult, layer by layer, and verification experiment, professional basic experiment, innovation experiment, course design,

graduation design, engineering project practice, innovation training projects and scientific and technological innovation competition as the carrier, forming a multi-level, all-round, progressive practical teaching system. The first level is the basic experiment, including: time domain analysis of discrete system, spectrum analysis of signal by fast discrete Fourier transform, FIR filter design by window method, IIR filter design by bilinear transform method, and so on. The second level of comprehensive experiments is aimed at solving practical problems, closely combining with real life, including music signal processing, image signal extraction and interpolation, speech and music signal sampling and filtering, dual tone multi-frequency (DTMF) signal synthesis and recognition and so on. The third level takes small projects as the background, and cooperates with enterprises, and hires enterprise engineers and teachers to guide students and solve practical engineering problems. Currently, the projects that have been carried out include voice recognition smart home system, video advertising system, intelligent lamp control system, music synthesis system and so on. This practical teaching system is built based on deep integration of the classroom, combining the actual situation of students, making use of the favorable conditions of schools and enterprises, using high-quality network resources, and effectively combining theory and practice, so that students can continuously improve their engineering practice and innovation ability in the process of imperceptibly and gradually. Students have significantly improved their scores in various professional competitions, and this approach has greatly improved the teaching effect

In this teaching mode, "small practice class" can simultaneously discuss the teaching content of "large class ", and has corresponding specific teaching content, practice topics, and special teaching platform and system. In a multi-level and multi-type virtual simulation experiment project system, virtual experiment environment is used. Students can choose specific projects from multi-level verification experiments, professional basic experiments, comprehensive experiments, and design experiments. According to the methods suitable for collaborative learning and discussion learning, students can freely form teams and gradually complete the projects through independent learning and group collaborative learning. Table 1 illustrates the teaching arrangements for Chapter 6 of "Digital Signal Processing".

Table 1. Sample teaching arraangement

Chapter	Chapter 6 The design of IIR digital filter
Main content	(1) Design method of digital filter (2) Design of analog filter (3) IIR filter design (4) Frequency conversion of digital filter
Key and difficult points	Impulse response invariant method, bilinear transformation method
Class assignment	8 class hours (6 class hours lecture +2 class hours experiment)
Learning basis	Transfer function, frequency characteristic
Basic requirement	(1) Understand various forms of analog filter design methods (2) Use impulse response invariant method and bilinear transformation method to design various digital filters (3) The conversion of low-pass digital filters to other digital filters is realized through frequency conversion

Students will apply the knowledge they have learned to the project by constructing the knowledge. After completing the project, they will display and evaluate the project results by submitting the project report, online/offline project report, project defense, or recording the project report video, etc. The submitted results will be evaluated and recorded in the evaluation system as part of the course score.

5. Evaluation system

Engineering education certification emphasizes results-oriented, and the assessment method should make specific provisions for the assessment of learning results. The assessment methods should be

diversified and adapted to the content of the assessment, so that the learning results can be truly tested and the correct evaluation can be made.

An important part of OBE model to optimize curriculum evaluation system is to evaluate the learning effect, so the assessment changes from "score" to "ability". The digital signal processing course has many abstract concepts, mathematical formulas, and exercises. If the assessment only focuses on exam results, it will inevitably cause students to take the exam for the purpose of ignoring the cultivation of ability, and the exam results cannot fully reflect the actual level of students. Therefore, the form of assessment should be multi-stage, diversified and multi-category assessment system, increase the assessment of learning process, increase the assessment of applied knowledge ability, increase the assessment of knowledge ability system, strengthen students' extracurricular learning and independent learning, and increase the proportion of project practical training, essay, homework, discussion and reference reading in the performance assessment to test professional basic ability and comprehensive quality. The evaluation system not only focuses on the depth and breadth of students' knowledge and ability, but also evaluates their emotional attitude and values, communication and coordination ability and teamwork spirit. The score table for the achievement degree evaluation of "Digital Signal Processing" is shown in Table 2. The evaluation data provided for students' specific course examination data are shown in Table 3.

Table 2. The "DSP" achievement eveluation score sheet

Target points	**Method**	**Evaluation basis**	**Score**
Engineering knowledge 1.3	Exam	Q1-14; Q23-25	60
Engineering knowledge 1.4	Exam	Q15-22	40
Problem analysis 2.1	Training	Training report	100
Research 4.3	Experiment	Experimental report	100
Use of modern tools 5.2	Research	Course research report	100

Table 3. The "DSP" achievement eveluation data table

Course number	H062230204048			**Title**	Digital Signal Processing	
Teaching term	2019-2020-02			**Class**	CES 2017	
Student number	**Name**	Graduation requirements indicator points				
		1.3	1.4	2.1	4.3	5.2
…	…	…	…	…	…	…
Average score	81	45	32	86	75	72
Achievement degree	0.81	0.75	0.80	0.86	0.75	0.72

As can be seen from the data in Table 3, the evaluation results of the second semester of the 2019-2020 academic year show that students have not yet established their autonomous learning habits, their ability to raise questions is not enough, the classroom discussion atmosphere is not active, and their ability to solve practical problems with knowledge is weakly.

Therefore, in the teaching in 2021, the assessment of classroom discussion has been strengthened, comprehensive exercises have been added, and students' ability to independently solve problems has been consciously trained. The effectiveness of these measures has been reflected in the 2021 assessment, and the pass rate has increased. Especially, students can independently complete comprehensive experiments, which reflects a certain degree of application ability. In this evaluation, the degree of achievement of graduation requirement 5.3 in the course is not very high, indicating that students' ability to solve complex engineering problems still needs to be improved. In the future, it is necessary to increase the allocation of class hours and training projects in this area. In the indirect evaluation, a questionnaire was used to investigate the subjective self-evaluation of students' achievement of curriculum goals in 2018. A total of 123 questionnaires were sent out, and 121 were recovered, with a recovery rate of 98.37%. The sample questionnaire and results (converted into scores) are shown in Table 4 and Table 5.

From the evaluation of the achievement of the goals of the 2018 "Digital Signal Processing" course in the Communication major, it can be seen that, through the implementation of the above

continuous improvement program, the achievement of the curriculum objective 1 has improved, but the curriculum objective 3 has decreased, which indicates that the 2018 students have certain engineering computing ability through the course teaching, but their reasoning ability and analysis ability are relatively weak. Compared with 2017's students, the distribution of the 2018's students' course objectives achievement was more concentrated. It shows that the teaching methods adopted in the teaching process are suitable for most students, but the very low achievement of some students should be paid attention to, and teachers should strengthen the individual guidance to the students who are weak in learning.

Table 4. Questionnaire on the achievement of the objectives of the "DSP" course

Objective	**SN**	**Content**	**Rating**
1.3	A	Master Z transformation	
1.3	B	Master the time-domain and frequency analysis methods of discrete time signals	
1.3	C	Understand the time-domain and Z-domain identification methods	
1.3	D	Understand the effect of zero-pole distribution of system function	
2.2	E	Master the representation and properties of DFS	
2.2	F	Master the representation of discrete Fourier transform DFT	
2.2	G	Master the operation of circular convolution and the convolution and linear convolution	
2.2	H	Master the same address operation	
2.2	I	Understand the principle and implementation of DIT base 2-FFT	
2.2	J	Understand the principle and implementation of DIF base 2-FFT	
2.3	K	Master the structure of IIR filter	
2.3	L	Master the method of impulse response invariant method	
2.3	M	Master the method of bilinear transformation method	
2.3	N	Master the design method of digital IIR filter	
2.3	O	Master the window function design method of FIR filter design	
2.3	P	Quantization errors and finite word length effects in operations	

Note: Fill in "Rating" to indicate "very good", "good", "average", "poor" and "very poor". Profession: CES: 2020-2021 Second term of the 2018

Table 5. Questionnaire resulte (except)

Questionnaire Score												Score	Object -1	Object -2	Object-3
1.3				2.2				2.3							
A	B	C	D	E	F	G	H	I	J	K	L				
4	3	3	4	2	2	2	3	4	4	4	4	39	10	18	11
4	5	3	3	3	4	2	3	4	3	4	4	42	11	21	10
4	3	4	4	2	2	2	4	5	5	2	4	41	11	18	12
3	3	3	2	4	2	2	3	4	3	3	2	34	11	17	7

6. Improvement Measure

The next round of teaching should address more complex engineering problems and non-technical factors; therefore, the following specific improvement measures are proposed. Network or video resource sharing platform should be built to avoid the problems of large classroom capacity and indigestible teaching content in multimedia teaching. After class, let the students log in the online course, through the online question and answer, discussion, and incentive system, stimulate the enthusiasm and initiative of the students. Optimize experimental teaching content, reform experimental teaching means, strengthen the integration of teaching content and engineering application. Adhere to the practice and application as the teaching purpose, design experiments hierarchically, optimize the content of experiments, appropriate to reduce confirmatory experiments, strengthen the comprehensive, design, innovative experimental teaching. The test paper proposition is more in line with the requirements of engineering certification education. In the examination paper design, the distribution proportion of each knowledge point should be consistent with that of the engineering education certification version of the syllabus, to achieve standardization and standardization.

Taking the new engineering teaching concept as the guide, keeping the reform of the curriculum system of engineering professional certification as the core, aiming at the cultivation of innovative talents, under the background of new engineering, the teaching research of digital signal processing course oriented by OBE is carried out. The course evaluation system throughout the whole learning process was established, which can comprehensively cultivate students' thinking, research, decision, and innovation ability.

7. Conclusion

Through the analysis of the characteristics and current teaching situation of the "Digital Signal Processing" course, based on the OBE teaching mode in the context of the new engineering discipline, reforms have been made in the curriculum system, experimental system, and ideological and political aspects. And implemented in accordance with the "12345" principle, which integrating virtual simulation teaching into all aspects of teaching. The evaluation system has been optimized, through teaching evaluation and analysis of the courses of 2017 and 2018 students, corresponding improvement measures have been proposed.

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