

Quantitative Analysis and Evaluation for Achievement of Training Objectives in Graduation Requirements of Pharmaceutical Engineering

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Abstract—This paper aimed to access the scientific and comprehensive evaluation for achievement of graduation requirements of pharmaceutical engineering through quantitative data. Four-year course objects and graduation requirement should be systematic programmed and supported by a series of index points, and their achievement degree can be quantified by the assessment scores obtained with various ways. The quantitative results provided detailed and reliable statistical data, which can reflect the achievement of individual index point and total training objectives as expected. Compared with traditional one-sided total score analysis, this method is proved to be effective and useful for responsible administrators together with teachers, which can help them master teaching effect and promote continuous improvement.

Keywords—achievement evaluation, quantitative assessment, pharmaceutical engineering

I. INTRODUCTION

Among the branches of chemical engineering, pharmaceutical engineering is an important interdisciplinary major formed by the combination of chemistry, biology, pharmacy and engineering knowledge. It aims to cultivate personnel engaged in the research & development of new drugs, new technologies, new equipments, new processes and their design together with magnification [1,2]. Its name officially appeared in the undergraduate catalogue of China's Ministry of education in 1998. As a relatively new major, more research on teaching reform is needed to promote the perfection and maturity of its educational system. Ever, the research of engineering education in our country has ever been very active; but in recent years, the number of researchers is being gradually reduced and the atmosphere of research is not strong like before. New methods and ideas about engineering education are urgently to be expected. This requires current engineering educators to continuously implement and deepen

three major goals including "student-centered", "output-oriented" and "continuous improvement"[3], and constantly improve the evaluation of the achievement of train objective, the adaptability of social needs, the support of the teachers and conditions, the effectiveness of the teaching quality assurance, and the satisfaction of the students and employers, etc [4,5]. The scientific assessment for the achievements of courses and graduation requirements is an important way to measure the quality of higher engineering education, which is an important work for every teacher to think and complete carefully.

Based on above background, current high education of pharmaceutical engineering is expecting scientific and comprehensive evaluation method for achievement of training objectives in graduation requirements. In this paper, the actual examples of graduation requirement for related major in Sichuan University (SCU) are provided, and then corresponding concrete objects and assessment ways will be introduced. Based on that, the quantitative method was developed for administrators and teachers to analyze statistical data of achievement degree, which is expected to replace the traditional single evaluation method and guide related people to master teaching effect and promote continuous improvement.

II. METHODS

In order to ensure that the students can meet the training objectives when they graduate and have the ability of social adaptation and employment competitiveness after graduation, this major adopts various ways to track and evaluate the students' performance in the whole learning process. The college has set up a responsible organization, namely, the educational administration office and the student working group, which are respectively subordinated to the teaching staff of the college. The vice president for undergraduate education and his office with full-time staff are in charge, who are responsible for the overall follow-up of the work. The

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educational administration office is responsible for the follow-up and evaluation of students' academic performance, and the vice dean of teaching is responsible for it. The main responsibilities are to arrange professional leaders and professional teachers to monitor and track the quality of the whole teaching process and all teaching links, to organize department teaching and instruction commissions and professional teachers to assess the achievement of students' graduation requirements, to organize participation in scientific research and innovation activities, subject competitions, teaching inspection, student seminars and examination papers quality. The details are shown in Table I.

On the basis of the achievement evaluation of each course related with certain graduation requirement, the achievement evaluation results of each index point supporting graduation requirements can be calculated according to Equation (1).

$$P_{ij} = \sum_{k=1}^m P_{ijk} \quad (1)$$

where P_{ij} represents the evaluation value of the index point j under the graduation requirement i , and P_{ijk} indicates the evaluation value of the course k supporting the index point j (calculated by Equation (1)), and m is the number of courses corresponding to this index point. Therefore, the achievement evaluation value of certain index point can be obtained through adding P_{ijk} values of all the courses supporting the index point.

On the basis of the evaluation results of the graduation requirements of each index point, the achievement degree of various graduation requirements can be calculated by Equation (2).

$$P_i = \min[P_{ij}] \quad (2)$$

where P_i indicates the achievement degree of graduation requirement i , and P_{ij} represents the achievement evaluation value of index point j under the graduation requirement i (calculated by Equation (1)). Therefore, the minimum value of the achievement degree (P_{ij}) under the graduation requirement i is selected as the final achievement evaluation result of this graduation requirement.

The evaluation organization will reach a conclusion of graduation requirements, and related results will form the evaluation report on the achievement degree of course goals. It is necessary to make clear whether each graduation goal is "reached" and analyze the actual achievement of every index according to those data just like shown in Appendix A. The achievement degree (P_i) of graduation requirement (i) will be determined with the minimum value of the graduation requirement (P_{ij}) of corresponding index. The qualification threshold value for graduation requirements is set to 0.70. Based on the results of the evaluation report, it can be tracked and evaluated about the graduation requirements of graduates. Moreover, all the students will submit their evaluation results through survey shown in Appendix B. All functional departments use evaluation results to guide continuous improvement of related teaching activities.

TABLE I. ASSESSMENT OF STUDENT'S LEARNING PERFORMANCE

Assessment items	Assessment methods	Assessment Person in charge
Classroom study	Attendance rate, classroom questioning, homework, research report, usual test, final examination, comprehensive performance evaluation	Teachers in classrooms
Experiment study	Experimental preparation, experimental design, experimental operation standardization, co-operation, desktop cleaning, experimental report: preview, raw data recording, data analysis and processing, experience, question answering	Teachers in labs
Course design	Design Performance, Intergroup Evaluation, Design Report, Drawing Quality, Respond, Comprehensive Performance Evaluation	Instructor of course design
Cognitive practice	According to the performance in the process of internship, internship report and other factors, comprehensive performance evaluation is carried out.	Supervisor of cognitive practice
Production practice	According to the performance in the process of internship, internship report and other factors, comprehensive performance evaluation is carried out.	Supervisor of production practice
Students' graduation design (thesis)	Thesis proposal, mid-term examinations, thesis reviews and graduation design (thesis) replies are organized by colleges and specialties; instructors conduct periodic examinations in accordance with the process; graduation design (thesis) scores are based on instructors' scores, experts' rating, and defense team ratings, while taking into account. The rationality of professional achievement distribution should be evaluated comprehensively.	Instructor of graduation design/thesis, reviewing experts, oral defense groups
Scientific research and creation	Including various lectures, scientific and technological competitions, campus cultural activities, social practice activities and other innovative practical activities, including the Challenge Cup, the innovative experimental program for college students, the innovative entrepreneurship training program for college students, the National University Pharmaceutical Garden Forum, the National University Pharmaceutical Engineering Design Competition, and the National Student Pharmaceutical Engineering Research. According to the specific situation, the Academic Affairs Office of the College will evaluate and assess the students' performance.	Educational administration of college

III. RESULTS AND DISCUSSION

After the achievement degree of individual course and its objects are known, the evaluation on achievement degree of graduation requirements can be completed on the basis of these obtained results. Table II shows the evaluation result on achievement degree of graduation requirement I, which is helpful for responsible educators to make their conclusions for the performance of both sides during the four-year teaching and studying cycle.

TABLE II. EVALUATION RESULT ON ACHIEVEMENT DEGREE OF GRADUATION REQUIREMENTS

Index points of graduation requirement i	Supporting courses	Original calculated values of achievement degree	x_{ijk}	P_{ijk}	P_{ij}
i-1: Be able to recognize the necessity of continuous exploration and learning, and have the consciousness of autonomic and lifelong learning.	(1) Freshmen Seminar	0.870	0.35	0.30	0.83
	(2) Introduction to Pharmaceutical Engineering	0.775	0.35	0.27	
	(3) Preparation of Chiral Drugs	0.882	0.30	0.26	
i-2: Have the quality and ability of self-directed learning and adaptive development.	(1) Situation & Policy	0.853	0.25	0.21	0.84
	(2) Mental Health of Undergraduates	0.850	0.25	0.21	
	(3) Introduction to Bioengineering	0.832	0.30	0.25	
	(4) Guidance for Employment	0.867	0.20	0.17	
i-3: Understand the current professional situation and development trend	(1) Drug development & research	0.903	0.50	0.45	0.90
	(2) Freshmen Seminar	0.870	0.20	0.17	
	(3) Frontier of Pharmaceutical & Bioengineering	0.917	0.30	0.28	
Achievement degree of graduation requirement i (P_i)					0.83
Achievement evaluation of graduation requirement i					Achieved

In the second step, the evaluation on achievement result of graduation requirements is carried out. For example, the graduation requirement i is decomposed into three index points, the index point of i-1 is to train students to recognize the necessity of continuous exploration and learning, and make them have the consciousness of autonomic and lifelong learning. Its achievement degree is calculated by assessment scores of related courses including “Freshmen Seminar”, “Introduction to Pharmaceutical Engineering”, “Preparation of

Chiral Drugs” and so on, which is 0.83 and higher than the preset threshold of 0.7. Then the index point of i-2 is to train students to have the quality and ability of self-directed learning and adaptive development. Its achievement degree is calculated by assessment scores of related courses including “Situation & Policy”, “Mental Health of Undergraduates”, “Introduction to Bioengineering” and “Guidance for Employment”, which is 0.83 and also higher than the preset threshold of 0.7. Finally, the index point of i-3 is to make students understand the current professional situation and development trend. Its achievement degree is calculated by assessment scores of related courses including “Drug development & research”, “Freshmen Seminar”, and “Frontier of Pharmaceutical & Bioengineering”, which is 0.90 and still higher than the preset threshold of 0.7. Above obtained achievement degree can indicate all of three index points have been reached satisfactorily. Moreover, the results of the following courses need to be specially fed back to the responsible teachers: achievement degree of "Drug Development & Research", "Frontier of Pharmaceutical & Bioengineering" and other courses is too high (> 0.9) for certain index point. Besides the stress on the reaching graduation requirement, it should be paid attention for the setting of the evaluation criteria and the examination difficulty at the same time. To sum up, among three index points decomposed from the graduation requirement i, the minimum is 0.83, and the highest reaches 0.90; both of them are higher than the preset threshold of 0.7, and the achievement degree of related courses are also higher than 0.75, so the achievement is ideal and graduation requirement i is reached.

Finally, it can be found from the data in Table III that all of the achievement degrees of graduation requirements are higher than the threshold value of 0.7 (suggested by Teaching supervision system of SCU), so related graduation requirements of the graduates in this session are basically reached, and training quality and result meet the requirements. Meanwhile, the following problems should be paid attention to and further improved in the coming sessions and later grades: (1) the achievement of the basic and public courses in the lower grade is generally low, indicating the basic knowledge and skills related to pharmaceutical engineering are not satisfied enough. It should be strengthened on the communication and cooperation with the departments together with teachers in charge of basic public courses. With the assistance of class advisor and coach staff, the inadaptability of the freshmen/junior students to the University's study and life should be reduce or eliminate as soon as possible after their first entry into our campus, which is very crucial and beneficial to arouse their learning interest and consolidate their basic knowledge.

(2) In the high-grade professional core courses, more and more team learning or group discussion are carried out as main teaching and assessment ways. It has been found there are some lack of the consciousness and initiative of the minority students during related processes. They are too dependent on the role of the core members of the team. In the future, more individualized and meticulous means should be adopted to improve the teaching process and assessment methods, which will supervise and ensure that each group member participates

in team cooperation actively and effectively; (3) the lower achievement of a small number of professional core courses reflects there still is great space for continuous improvement for the comprehensive ability of some students to identify, analyze and solve practical pharmaceuticals problems. This may be that the learning and handholding of some basic knowledge are not ideal; on the other hand, it is also necessary to cultivate their skills to use these knowledge and methods. It brings

forward new requirements and challenges for teachers responsible for related core course, which is also a very good research subject for teaching reform. More case teaching application practice should be explored and encouraged. In this aspect, there are many specific instantiations in pharmaceutical enterprises, so case teaching can be well promoted through cooperation among teachers, engineers and industry experts.

TABLE III. ACHIEVEMENT RESULTS OF INDEX POINTS AND GRADUATION REQUIREMENTS FOR GRADUATES OF PREVIOUS SESSION

Graduation requirement	Index point	Achievement degree of index point	Achievement result of index point	Achievement degree of graduation requirement	Achievement result of graduation requirement
a	a-1	0.82	Reached	0.81	Reached
	a-2	0.81	Reached		
	a-3	0.84	Reached		
	a-4	0.75	Reached		
b	b-1	0.89	Reached	0.82	Reached
	b-2	0.82	Reached		
	b-3	0.85	Reached		
c	c-1	0.78	Reached	0.78	Reached
	c-2	0.84	Reached		
	c-3	0.83	Reached		
	c-4	0.82	Reached		
d	d-1	0.83	Reached	0.83	Reached
	d-2	0.84	Reached		
	d-3	0.90	Reached		
e	e-1	0.82	Reached	0.81	Reached
	e-2	0.74	Reached		
	e-3	0.79	Reached		
f	f-1	0.74	Reached	0.74	Reached
	f-2	0.83	Reached		
	f-3	0.89	Reached		
g	g-1	0.83	Reached	0.80	Reached
	g-2	0.80	Reached		
h	h-1	0.84	Reached	0.83	Reached
	h-2	0.83	Reached		
	h-3	0.83	Reached		
i	i-1	0.87	Reached	0.85	Reached
	i-2	0.86	Reached		
	i-3	0.87	Reached		
	i-4	0.85	Reached		
j	j-1	0.84	Reached	0.82	Reached
	j-2	0.82	Reached		
	j-3	0.83	Reached		
k	k-1	0.89	Reached	0.83	Reached
	k-2	0.83	Reached		
	k-3	0.87	Reached		
	k-4	0.85	Reached		
l	l-1	0.84	Reached	0.80	Reached
	l-2	0.81	Reached		
	l-3	0.80	Reached		

IV. CONCLUSIONS

In this paper, a quantitative method is successfully developed in order to access the scientific and comprehensive evaluation for achievement of graduation requirements of pharmaceutical engineering. At first, four-year course objects and graduation requirement need to be systematic programmed and supported by a series of index points, and their achievement degree can be quantified by the assessment scores obtained with various ways. The quantitative results can provide detailed and reliable statistical data, which reflect the achievement of individual index point and total training objectives as expected. Compared with traditional one-sided total score analysis, this

method is proved to be effective and useful for responsible administrators together with teachers, which can help them master teaching effect and promote continuous improvement.

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