Research on achievement assessment method for course objectives of bridge engineering based on OBE

Wei Jiang[1,a,*], Litong Sun[1,b] and Xiwen Zhang[1,c]

[1]School of Civil Engineering and Architecture, University of Jinan, Jinan, China

[a]cea_jiangw@ujn.edu.cn, [b]cea_sunlt@ujn.edu.cn, [c]cea_zhangxw@ujn.edu.cn

Abstract. Achievement assessment for graduation requirements is an important basis in the continuous quality improvement of majors. Consequently, the calculation for curriculum achievement becomes the first step. Based on the graduation requirements indices of civil engineering, instructional objectives for bridge engineering are conducted in this paper. The relationship matrix of course objectives and graduation requirements indices is established. Teaching contents and procedures are designed to support all the instructional objectives. Achievement assessment method for bridge engineering is presented. A numerical example based on the scores of an integral group class is adopted to verify the method. The evaluated results could reveal the evidence in the teaching process and provide the references for the further continuous quality improvements.

1. Introduction

Engineering Education Accreditation (EEA) is a type of quality assurance system being used internationally. EEA is also the basis to accomplish the mutual recognition in the field of engineering education and engineer qualification. In recent years, the feasibility of EEA for engineering majors in the undergraduate higher education has been verified by the practice. Three core ideas are involved in the EEA: the student centered (SC), the outcome based education (OBE), and the continuous quality improvement (CQI). The SC demands that: all the students should be concerned, the comprehensive development of the students should be concerned and the whole growth process of the students should be concerned. The OBE contains: the guidance of training objectives to graduation requirements, the supports of curriculums and teaching resources to graduation requirements and the verifications of assessment methodologies to graduation requirements achievement. The CQI requires that: the quality monitoring system for the teaching process should be established, the tracing and feedback system for the graduates should be formulated and the evaluated results should be applied in the continuous quality improvement [1, 2].

The concept of OBE primarily emerges in the basic education reform in America and Australia. The Washington Accord was originally signed in 1989 by many English-speaking countries such as the United States, Canada, the Great Kingdom, Ireland, Australia and New Zealand. Washington Accord recognizes that there is substantial equivalence of programs accredited by those signatories. Graduates of accredited programs in any of the signatory countries are recognized by the other signatory countries as having met the academic requirements for entry to the practice of engineering. Ending a three-year wait, China on the 2nd, June, 2016 became a permanent member of the Washington Accord [3, 4].

The assessment for the graduation requirements achievement demands the supplies of all courses and group classes. Therefore, all teachers should participate in this work. The comprehensive evaluated results could offer theoretical references for the further continuous quality improvements. Based on the OBE concept, the assessment method for curriculum achievement is researched in this paper. The bridge engineering course is utilized as an illustrated example to verify the method.

2. Instructional objectives for bridge engineering

The bridge engineering is a professional compulsory course of the civil engineering major (Road and bridge engineering direction). All the students are required to grasp the structural components, the design theories and the construction technologies in this course. The purpose of the course is for the students to acquire the ability to solve the practical engineering problems. According to the relationship between the curriculum and the graduation requirements, the instructional objectives are divided as follows:

(1) Grasp the knowledge of structural components, design theories and construction technologies for frequently used bridge types (objective 1).

(2) Acquire the ability to consider the influences of society, health, safety, law, culture, and environment in the design and construction (objective 2).

(3) Acquire the ability to evaluate the design and construction schemes (objective 3).

The relationships between the instructional objectives and the graduation requirements indices are listed in Table 1.

Table 1 Relationship between instructional objectives and graduation requirements indices.

Graduation requirements	Indices	Instructional objectives
2.Problem analysis	2.2 Acquire the ability to apply the mathmatics, the natural science and the professional knowledge in modeling of complicated engineering problems.	Objective 1
3.Design (schemes)	3.2 Acquire the ability to consider the influences of society, health, safety, law, culture, and environment in the design and construction.	Objective 2
6. Engineering and society	6.2 Acquire the ability to evaluate the design and construction schemes.	Objective 3

3. Design of teaching contents and procedures

The multimedia teaching skills are introduced into this course to illustrate the basic theories and methodologies. Meanwhile, the latest studies and construction technique are involved. Both basic principles and practical skills are emphasized in the teaching design of bridge engineering. Teaching contents include two parts, the teaching procedures and the training procedures. The relationships between the teaching contents and the instructional objectives are listed in Table 2.

Table 2 Relationship between teaching contents and instructional objectives.

Teaching contents	Instructional objectives		
	Teaching	Training	Objectives
Introduction	6 hours	Classwork 1	Objective 2 and 3
RC and PC pin-ended bridges	7.5 hours	Classwork 2	Objective 1
Cantilever and continuous girder bridges	6.5 hours	Classwork 3	Objective 1
Conrete arch bridges	8 hours	Classwork 4	Objective 1
Pier and abutment of bridges	4 hours	Classwork 5	Objective 1

Notes: RC means reinforced concrete and PC means prestressed concrete.

4. Assessment methods and standards

Assessment methods and standards have significant influences on the learning effects and the achievement of instructional objectives. The assessment of teaching processes and learning effects are also determined by the examination systems. Assessment methods include two parts in this course, the examination and the daily performance. In the final grades evaluation the examination accounts for 80 percent and the daily performance accounts for 20 percent. Rigorous paper requirements and evaluation standards are introduced in the examination. For the daily performance, two parts are considered, the homework and the class behavior. The evaluation standards of homework and class behavior are shown in Table 3 and Table 4.

Table 3. Evaluation standards of homework.

Observation points	A (100%)	B (80%)	C (60%)	D (<60%)
Attitude	Serious	Less serious	Not serious	Do not do the homework or plagiarize others homework
Progress	Finish on time	Basicly finish on time	Not finish on time	
knowledge	Grasp	Basicly grasp	Not grasp	
conclusion	Reasonable	Basicly reasonable	Not reasonable	

Table 4. Evaluation standards of class behavior.

Observation points	A (100%)	B (80%)	C (60%)	D (<60%)
Attendance	No absence	Absence less than twice	Absence less than four times	Always absence
Class performance	Active	Basicly active	Not active	

The relationships between the assessment methods and the graduation requirements indices are listed in Table 5.

Table 5. Relationships between the assessment methods and the graduation requirements indices.

Graduation requirements	Indices	Instructional objectives	Achievement approach		
			Class behavior	Homework	Examination
2.Problem analysis	2.2	Objective 1	√	√	√
3.Design (schemes)	3.2	Objective 2	√		√
6. Engineering and society	6.2	Objective 3	√		√

5. Achievement assessment method for course objectives

The achievement assessment for course objectives is the basis of the achievement assessment for graduation requirements. To test the learning outcomes of bridge engineering, the achievement index could be calculated. As mentioned before, the achievement assessment for course objectives contains two parts, the examination and the daily performance. The hundred percentage point system is applied in both of the two parts. Therefore, the target grades for all the procedures could be listed in Table 6.

Table 6. Target grades for different procedures.

Total grades	Proportion	Assessment procedures	Target grades	Objectives
Daily performance (100)	20%	Homework	50	Objective 1
		Class behaviour	50	Objective 1, 2, 3
Examination (100)	80%	Examination	70~80	Objective 1
			10~15	Objective 2
			10~15	Objective 3

The achievement assessment for the instructional objectives contains two parts, the partial achievement assessment and the total achievement assessment. The indices for partial achievement assessment can be expressed as

$$D_{\mathrm{p}} = S_{\mathrm{pm}} / S_{\mathrm{pt}} \tag{1}$$

where, D_{p} is the total achievement index, S_{pm} is the mean grades for different objectives, S_{pt} is the total grades for different objectives

The achievement assessment for different instructional objectives of bridge engineering could be eventually formulated as

$$D_{p1} = \frac{\alpha_1(P_1 + P_2) + \alpha_2 Q_1}{\alpha_1(20 + 50) + \alpha_2(70 \sim 80)} \tag{2}$$

$$D_{p2} = \frac{\alpha_1 P_3 + \alpha_3 Q_2}{\alpha_1 15 + \alpha_2(10 \sim 15)} \tag{3}$$

$$D_{p3} = \frac{\alpha_1 P_4 + \alpha_2 Q_3}{\alpha_1(20 + 50) + \alpha_2(15 \sim 30)} \tag{4}$$

$$D_p = \frac{\alpha_1 P + \alpha_2 Q}{100} \times 100\% \tag{5}$$

where, D_{p1} is the achievement index of objective 1, D_{p2} is the achievement index of objective 2, D_{p3} is is the achievement index of objective 3, P is the grades of daily performance, Q is the grades of examination, $\alpha_1 = 20\%$, $\alpha_2 = 80\%$.

6. An illustrated example

For an integral group class, the achievement assessment method is utilized to calculate the achievement indices. The results are listed in Table 7.

Table 7. Target grades for different procedures.

Indices	Instructional objectives	Assessment procedures	Target grades	Mean grades	Achievement indices
2.2	Objective 1	Class behaviour	70	34.66	0.67
		Examination	80	13.95	
3.2	Objective 2	Homework	31.67	29.80	0.64
		Examination	33.33	13.95	
6.2	Objective 3	Homework	31.67	29.80	0.64
		Examination	33.33	13.95	
	Total achievement indices		100	65.27	0.65

7. Summary

To assess the achievement for the graduation requirements of civil engineering, course achievement assessment for bridge engineering is conducted in this paper. The comprehensive evaluated results could offer theoretical references for the further continuous quality improvements.

Acknowledgement

References

[1] P. H. Gu, W. L. Hu and P. Lin, OBE engineering education model in Shantou university, *Research in Higher Education of Engineering,* vol.1, pp. 27-37, 2014.

[2] Z. Su, J. Ai and Y. M. Shen, A study on the completion degree of graduation requirement in higher-education via outcome-based education, *Journal of University of Shanghai for Science and Technology*, vol.40, pp. 184-189, 2018.

[3] Y. Q. Chen and B. Zhao, Preliminary study on the course reform of "embedded operating system" based on the achievement evaluation, *Jiangsu Science & Technology Information*, vol.27, pp. 75-77, 2018.

[4] Y. Z. Zeng and S. H. You, The evaluation on teaching quality of electrodynamics using target reached degrees, *Physics Bulletin*, vol. 4, pp. 36-42, 2017.