Research and Analysis on OBE Teaching Model of Software Engineering Specialty Under the Dual Background of "Emerging Engineering Education + Engineering Certification"

Chunmei Li, Yun Yu(✉), Shuying Liu, and Yiwen Zhang

College of Big Data and Artificial Intelligence, Anhui Xinhua University, Hefei, China
448240431@qq.com

Abstract. Under the dual background of "new engineering + engineering certification", the OBE mode is adopted to determine the new target of software engineering professional training and build a new system of professional courses. Optimize the course structure, adopt the "top-down" method to decompose the training standards layer by layer and implement them in each course. Establish a sound evaluation and assessment mechanism, deepen the integration of production and education and discipline competition, and promote the training of new engineering talents. Analyze and evaluate on the overall teaching data of the recent graduates, students. Able to meet the expected graduation requirements.

Keywords: Emerging Engineering Education · Engineering Certification · Software Engineering · OBE teaching model

1 Introduction

The development level of higher education is an important symbol of a country's development level and development potential, engineering education is an important part of China's higher education, In the higher education system, there is "one of three in the world" [1]. In June 2016, China officially became a member of the Washington Agreement [2], which means that the degrees of engineering graduates who have passed the engineering certification in China are mutually recognized within the members of the Washington Agreement, and the international influence of China's engineering education has been improved.

Engineering education and industrial development are closely linked and mutually supported. In order to promote the reform and innovation of engineering education, in 2017, the Ministry of education promoted the construction of emerging engineering education, and successively formed the consensus and guiding opinions of "Fudan consensus" [3], "Tianda action" [4] and "Beijing Guide" [5], requiring engineering colleges and universities to play a leading role in Engineering Science and technology innovation and industrial innovation, and cultivate a number of talents with excellent engineering

X. Yuan et al. (Eds.): ICEKIM 2023, AHCS 13, pp. 92–105, 2023.
https://doi.org/10.2991/978-94-6463-172-2_12

practice, sharp thinking, strong innovation ability and international vision compound high-quality "emerging engineering education" talents.

As a Local Application-oriented University, it should seize the opportunity of the times, integrate into the upsurge of engineering education certification and emerging engineering education construction, actively construct the training mode of engineering professionals, improve the quality of talent training, and meet the development needs of the region and industry [6]. The software engineering major of our college is also actively exploring the talent training mode under the dual background of "Emerging Engineering Education + Engineering Certification". Among them, the construction of curriculum system is the core content of the whole talent training mode. This paper expounds the construction of the curriculum system of this major from the aspects of guidelines, system construction, goal achievement and evaluation.

2 Guidelines for Teaching Model Construction

Under the guidance of the engineering education certification standard, according to the industry market demand and combined with the relevant professional characteristics of similar colleges and universities, explore the professional characteristics of their own colleges and universities, improve the overall quality of graduates, and thus improve the employment rate of graduates.

OBE (output based education) is an educational mode that follows the result oriented and reversely designs the teaching system. Emphasize "student centered", "achievement oriented" and "continuous quality improvement" [7]. This requires that the teaching model should first integrate the new direction and new technology of the industry, clarify the objectives of teaching and learning, strengthen the practical teaching links, strengthen the cultivation of multi-disciplinary integration ability, and establish a perfect evaluation and assessment mechanism.

3 Construction of Teaching Model

3.1 Cultivation Formulation of Objectives

For the construction of software engineering specialty, the logical thinking of reverse design is adopted to determine the occupation and level of graduates, that is, to clarify the training objectives of the specialty, that is, what kind of talents can be trained through four years of study, whether they can meet the future needs of economic and social development, and whether they have special skills or abilities in some fields compared with other similar colleges, So that they can gain advantages in the employment process, or even be superior to others.

Therefore, our school mainly sets the training objectives of software engineering talents from the perspective of industry demand, school positioning, professional positioning, professional certification and evaluation standards at home and abroad, and the school running idea of "integration of production and education, dislocation and competition, and characteristic development". The objectives are: the training of this major has socialist core values, is suitable for the development needs of economic society and

software engineering field, has a solid theoretical and engineering foundation, Technical personnel who can use advanced engineering methods and technologies to solve practical problems of software engineering in enterprises and institutions, have good scientific literacy and critical analysis, comprehensive and innovative thinking ability, high social responsibility and professional ethics, strong professional communication ability, cooperative role ability, physical and mental health, and are competent for scientific research, design and technical personnel for project management in professional fields.

In combination with the actual situation of our students and the school running of software engineering, the specific expected objectives of our software engineering graduates are as follows:

Objective 1: have a solid foundation, systematic thinking, deep professional cross integration and comprehensive analysis ability of technical problems, have an international vision, and pay attention to the cutting-edge development of the computer field;

Objective 2: be able to comprehensively apply multidisciplinary knowledge to provide reasonable solutions to professional technical problems faced by software engineering posts;

Objective 3: have the comprehensive ability of software system research, analysis, design, development and project team management;

Objective 4: have the awareness of engineering ethics and moral responsibility and respect for social values, physical and mental health, and initially form the consciousness of engineering system view, engineering society view, engineering ethics view, engineering safety view, engineering law view and engineering value view;

Objective 5: have the ability of critical reflection, innovative learning, leadership and command and other modern engineers.

3.2 Formulation of Graduation Requirements

According to the concept of engineering education certification, around the training objectives, the majors opened by the school must have clear, open, supportive and measurable graduation requirements. The ability and accomplishment described in the graduation requirements and the training objectives support each other. The training objective of software engineering in our college is directly supported by 12 graduation requirements: Training Objective 1 (graduation requirements 1, 2, 3, 5, 10); Training objective 2 (graduation requirements 1, 2, 3, 5, 9, 10, 11); Training objective 3 (graduation requirements 3, 4, 5, 6, 9, 10, 11); Training objective 4 (graduation requirements 6, 7, 8, 9, 10, 12); Training objective 5 (graduation requirements 4, 5, 10, 12).

3.3 Construction of Teaching Model

According to the connotation and characteristics of 12 graduation requirements on students' ability, graduation requirements 1–5 reflect professional knowledge and skills; 6,8Morality and value orientation; 7. External constraints such as society, environment and culture; 9, 10, 12 modern ability; 11. Economic and social benefits. It can be determined that the curriculum system consists of natural science, engineering foundation,

professional skills, practice and Humanities and social sciences. Through research and analysis, indicators 1–8 of the 12 indicators are mainly reflected by the course teaching method; the remaining indicators 9, 10 and 12 are mainly reflected through training, internship and practice.

1) Overall design of teaching model.

The interdisciplinary integration of emerging engineering education majors should focus on the connection and integration between general education and professional education. The courses offered by general education are interdisciplinary and professional [8]. General education pays attention to the comprehensiveness of basic knowledge, ability and quality, and plays a leading role in professional education, especially in the aspects of professional knowledge learning, professional ability training and comprehensive humanistic quality.

In combination with the dual background of emerging engineering education + engineering certification, the construction of the teaching model of this major is oriented by the ability training and aims at innovative and excellent engineering and technological personnel. The whole curriculum system mainly lays a solid foundation, strengthens the core professional quality and creates a characteristic curriculum benchmark. Vertically, the "project-based + project-centered curriculum model" is adopted to spiral through the curriculum content, and horizontally, the curriculum cross integration is adopted to break the curriculum boundaries. Let students spend more time to complete the high-level learning and challenging project practice of the integrated curriculum,

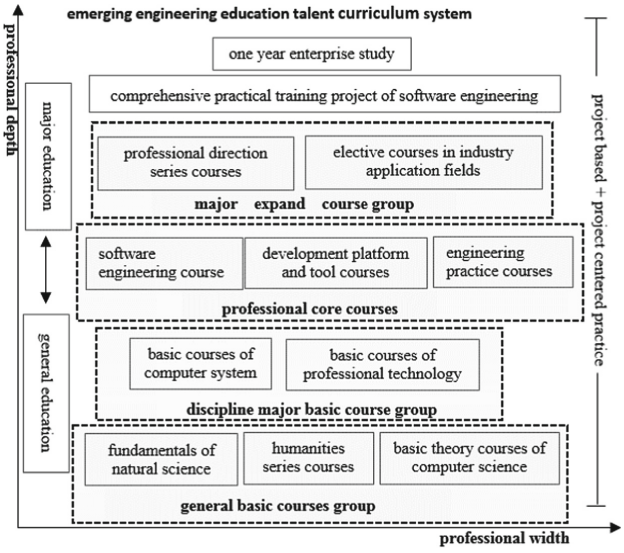

Fig. 1. Overall design of teaching model for software engineering

and transform knowledge into ability and accomplishment [9]. The overall design of software engineering teaching model is shown in Fig. 1.

2) Course credit setting.

The whole teaching model is divided into general education basic curriculum group, discipline professional basic curriculum group, professional core curriculum group and professional development curriculum group according to the depth of knowledge. In order to meet the requirements of engineering education certification standard (2017 Edition) and in combination with the characteristics of software engineering, the course credit distribution proportion is divided as follows: engineering foundation, professional foundation and professional 40%; Engineering practice and graduation design 23%; General education in Humanities and Social Sciences 17%; Mathematics and natural science courses shall be at least 20%, with 174 credits in total.

3) Course group setting.

The basic courses of general education include the basic courses of natural science, the series of humanities courses, and the basic theoretical courses of computer science. Focus on cultivating the core quality of emerging engineering education talents of students, the ability to solve complex engineering problems by using natural science knowledge, strengthen the national feelings, global vision and legal awareness of engineering students, and improve innovation and entrepreneurship, cross disciplinary integration, independent lifelong learning, communication and leadership.

The basic courses of the discipline are mainly the most basic theoretical basis of software engineering. These courses cover the contents of the software engineering discipline, such as mathematical logic, algorithm analysis, formal representation of language, etc. It cultivates the students' ability of abstract and logical thinking, enables them to understand the working principle of computer system, familiarize themselves with the underlying environment of system development, and provide a broad discipline foundation and professional foundation for emerging engineering education professionals.

The professional core curriculum group mainly includes software engineering courses, software development platforms and tools courses, and software engineering practice courses. In the form of project driven, students are trained to use software development platforms and tools for system analysis, design, coding, testing, debugging and optimization, so as to cultivate the ability to solve complex engineering problems, such as analysis, design, research and development, innovation, etc.

The professional development course group mainly consists of professional direction series courses or industrial application field courses and software engineering comprehensive practical training projects. According to the characteristics and advantages of the major in the field of information, four characteristic modules of web application development, desktop application development, mobile application development and data analysis and processing have been built, and four benchmark courses have been created accordingly: Java EE framework technology,.Net program design, UI design and python program design.

At the same time, according to the needs of the industry and the interests of students, a series of cutting-edge elective courses, such as software laws and regulations and

intellectual property, information security, it new technology and other courses, are added to provide a broad platform for the career and personality development of emerging engineering education students.

4) Build the "Three Three Systems" and "3 + 1" Talent Practice Education Mode.

The training of software engineering major in our university is based on the educational concept of emerging engineering education talent training, and the "three three systems" and "3 + 1" talent training modes are constructed. The "three three systems" means that in the process of talent training, we insist on strengthening the training of engineering practice ability as the main line, and give full play to the role of the school, Research Institute and enterprise in educating people; Strengthen the training of engineering innovation consciousness, application design and R & D ability and engineering practice ability."3 + 1" requires students to study in school for 3 years and work and study in enterprises for at least 1 year. The whole process takes professional cognitive ability, basic skills, comprehensive application ability and innovative thinking ability as the main line, and carries out practical teaching from four levels: public basic practice, professional basic practice, professional practice and comprehensive practice. Adhere to the combination of experiment, internship, training, practice and innovation, and gradually and orderly integrate the practice into the talent training cycle.

Based on the curriculum system, we will open up the training both inside and outside the school, and invite the enterprise engineers outside the school to participate in the formulation of the ladder comprehensive practical training project. Finally, we will complete a complete advanced challenging project practice, reasonably arrange the course schedule, and ensure that the ladder comprehensive practical training project can fully implement the whole four-year learning process. All basic and professional courses will be integrated on the basis of the ladder comprehensive practical training project. The comprehensive practical training project is taken as a course project for challenging practice. It is oriented by solving practical problems to cultivate students' engineering ability and stimulate students' interest and thirst for knowledge. The comprehensive practical training project was started from the second academic year. Around the courses such as database principles, data structure and Java program design, the first stage comprehensive practical project was designed as the course practice content.

The second and third phases of the comprehensive practice project are planned from the aspects of design and development around the courses of demand analysis and modeling, software design and architecture, project management, etc. offered in the third academic year. The fourth phase of the comprehensive practice project is designed around the contents of UI, algorithm design, engineering economics, etc. offered in the Fourth academic year, mainly from the aspects of availability, efficiency and economy. Finally, the whole comprehensive training project will be brought into the enterprise for achievement verification, and the experts will conduct evaluation, evaluation and guidance to complete the last stage of the whole comprehensive training project. The comprehensive training project system is shown in Fig. 2:

In addition, make full use of the holidays to carry out practical training outside the school. During the two-week corporate cognitive practice in the summer vacation of freshman year, students will understand the cutting-edge trends of the industry. During the three-week corporate practical training in the summer vacation of sophomore

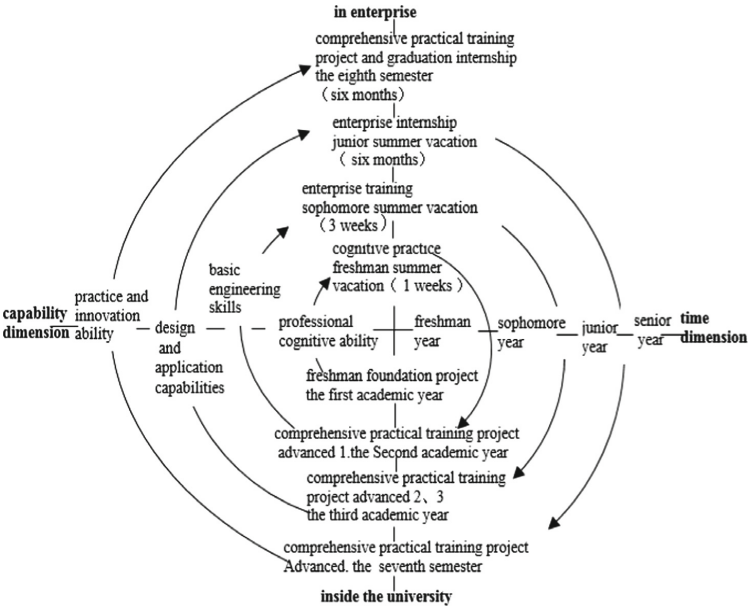

Fig. 2. Comprehensive training project system

year, students will deepen their understanding of theoretical knowledge by applying the knowledge they have learned in practice. After practice, they will return to the classroom with relevant problems to further promote the integration of theory and practice and strengthen basic knowledge and practical skills. In the sixth semester, I participated in enterprise project development in combination with seven months of enterprise internship in the summer vacation.

In the eighth semester, the comprehensive practical training project in the school will be evaluated and tested by the enterprise, and the improvement plan will be put forward. Finally, the practical training project will be completed, the graduation practice will be conducted, and the graduation thesis will be completed. Form a community of talent training between schools and enterprises, it highlights the Active docking of local universities to meet the needs of local economic and social development and the requirements of enterprise technological innovation, and deepens the connotation of the education mode of integration of production and education, learning output and collaborative education.

At the same time, relying on the discipline competition to cultivate innovative talents in emerging engineering education. By encouraging and guiding students to participate in science competitions, the interactive mode of "classroom teaching - Student Competition - scientific and technological innovation" is constructed and practiced, so that students can reasonably, effectively and systematically master professional basic knowledge and cultivate students' ability to solve practical problems and innovation. The entries involve information technology, network technology, big data skills, robot program design and other competitions, which fully reflect the characteristics of "emerging engineering education" with interdisciplinary integration.

4 Evaluation and Analysis Model of Graduation Requirement Achievement

4.1 Determination of Evaluation Indicators

In order to make it clear that the training objectives can be measured and achievable, and at the same time, the connotation and characteristics of the students' ability requirements are more in line with the teaching rules of the curriculum links, further refine the index points, and select teaching activities (including theoretical courses, experiments, internships, etc.) that can cover all the index points of the graduation requirements as the core support to ensure that each graduation requirement index point is supported by appropriate teaching activities [10].

Decompose the index points item by item, and decompose each index point into 3–5 small index points. At the same time, list 3–5 courses supporting each index point, and assign support weight to each course supporting this index point according to the support strength. The purpose of index point decomposition is to decompose the output content, so as to connect with the teaching content of the course unit, course module and course unit, and convert it into ability or learning output. According to the supporting relationship among the training objectives, graduation requirements and courses, a first-class matrix is formed by the docking of the curriculum and graduation requirements.

After the curriculum matrix is formed, the curriculum is designed, and the content and process are designed according to the requirements of knowledge and skills. All lesson points are defined by two-level matrix decomposition. Lesson points are composed of knowledge points, skill points and attitude points. They are individually or combined into the smallest information unit through the number, quality and order of interconnected relations. Each course is divided into all course points, and the overlapping course points are deleted. The overlapping course points are deleted, and the class hours are reduced. These remaining time can be used for project practice to ensure that practical courses account for a sufficient proportion of the total credits. Take C++ object-oriented programming as an example, as shown in Fig. 3:

Secondary matrix *C++ object-oriented programming* course teaching objectives.

4.2 Evaluation Process

According to the examination results of students, evaluate the curriculum achievement degree of the corresponding graduation requirement index points, and synthesize the evaluation results of the curriculum achievement degree of each index point to evaluate the graduation requirement achievement degree. The evaluation process and steps are as follows:

1) Evaluation of course goal achievement.

CSIa (Course Small Indicator achievement) course small indicator point achievement evaluation is conducted from various aspects such as process assessment and final assessment in the teaching process. ***Sm*** (Standard marks) teaching goal standard score and ***Am*** (Actual marks) teaching goal actual score are set. The specific calculation

GR / T / C	Graduation requirements 3-1：Basic methods of program design, algorithm analysis and design, with the ability to analyze and design efficient and reliable software systems	
	Teaching objective 2：Have the ability of algorithm analysis and design	**Teaching objective 3**：Master the process design, code writing and testing of project development
…	…	…
Chapter III Classes and objects	…★**Class point 21** constructor, copy constructor	…★**Class point 23** static member, pointer to class member
…	…	…

Teaching objective 2	Learning method	Teaching method	Learning output measurement
★**Kn**：constructor definition ★**Km**：copy onstructor definition ★**Sn**：deep copy	Teachers assign learning tasks, and students preview and discuss according to the tasks before class	project driven	**K:** Be able to write out the default constructor and copy constructor, Qualified.**S:** Be able to customize the copy constructor according to the problem, qualified .**A**：Able to complete tasks independently and seriously , qualified.

CR: Graduation requirements;T: Target; C: Chapter; A：**Attitude; K:Knowledge;S:Skill**

Fig. 3. Specific contents of secondary matrix and course points

method is shown in formula (1):

$$CSIa = \sum_{i=1}^{n} \left(\frac{Am_i}{Sm_i} * Tw_i \right), n \geq 1, Am_i \leq Sm_i \tag{1}$$

where ***Tw*** (Target weights) is the support weight of the corresponding curriculum objective supported by the teaching objective, and multiple teaching objectives support the same curriculum objective

2) Evaluation on the achievement of graduation requirements.

By summing up all the small index points within the index points supported by the course, the course indicator achievement (***CIa***) of the course can be obtained. The specific calculation method is shown in formula (2):

$$\mathrm{CIa} = \sum_{\mathrm{i}=0}^{\mathrm{n}} (\mathrm{CSIa_i} * \mathrm{CSIw_i}), \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{CTw_i} = 1, \mathrm{n} \geq 1 \tag{2}$$

where ***CSIw*** (Course Small Indicator weights) is the weight of the corresponding graduation requirement indicator point supported by the course target point. Multiple course targets of the same course support the same indicator point, and the sum of the support weights is 1. A course may support multiple different indicator points, and the achievement degree of each indicator point needs to be calculated separately.

3) Evaluation on achievement of small index points of graduation requirements.

Summing all the courses supporting the graduation requirement index point according to formula (3) can obtain the evaluation value ***Ia*** (Indicator achievement) of the achievement of the graduation requirement index point.

$$Ia = \sum_{i=0}^{n} (CIa_i * CIw_i), \sum_{i=1}^{n} CIw_i = 1, n \geq 1 \tag{3}$$

where ***CIw*** (Course Indicator weights) is the weight of the corresponding graduation requirement indicator point of the course support. Multiple courses support the same indicator point, and the sum of the support weights is 1.

4) Evaluation on achievement of graduation requirement index points.

Take the minimum value of achievement evaluation of all graduation requirements index points as the final graduation requirements achievement evaluation (***GRa***), as shown in formula (4):

$$GRa = \min_{1 \le i \le n} \{Ia_i\} \tag{4}$$

According to the actual situation of the school, the school has made it clear that the standard value of graduation requirements evaluation achievement is not less than 0.68.

5 Data Statistics and Analysis of Graduation Requirements and Achievement of Course Objectives

5.1 Analysis on the Achievement of Course Objectives

Take the 2018 software engineering major as an example, randomly select the scores of one class of students in Java program design a to analyze and explain the evaluation process of goal reach, As shown in Table 1. The assessment of this course is mainly composed of examination paper assessment and process assessment, accounting for 70% and 30% of the total score respectively. Including 100 points for process assessment (including 20 points for attendance). According to Formula 1, the evaluation result of course goal reach is obtained, the student's evaluation on goal reach of graduation requirements is shown in Figs. 4 and 5:

The difficulty of graduation requirements index points 2.3and 3.3 is gradually increasing, and the reach degree of students shows a decreasing trend, which indicates that with the increase of difficulty and complexity, the achievement degree of students' ability is gradually decreasing; Graduation requirement 2.3 is to assess students' mastery of basic knowledge, and the achievement degree is 0.83, indicating that students' mastery of basic knowledge is good; Graduation requirement 2.3 is to assess the students' mastery of the basic methods of program design, algorithm analysis and design, the achievement degree of 0.8 indicates that the students have relevant abilities, but there is still room for improvement. Graduation requirement 3.3 Train students' ability to select and use the platform to program design and complete software system development. The degree of achievement is 0.70, indicating that some students have not met the requirements and need to be further improved.

5.2 Analysis on the Degree of Course Achievement of the Major Graduation Requirements

Summarize the achievement of all courses of 2018 software engineering major on the index points. Take the data structure of index point 2.1 supporting graduation requirements as an example, the degree of achievement of the course objective 1 supporting

Table 1. Evaluation of Course Objectives of JAVA Program

Learning outcomes	Course design assessment link and observation points			Course-Reach degree evaluate-information		
Course Objectives	Index points	Link of assess	Observation points	Target score	Average score	Evaluation results
Course objectives 1, 2, 3	2.3	performance	Classroom performance	20	18.66	0.83
		Process assessment	The 1st and 3rd process assessment	30	25.82	
		final examinations	fill in the blank and iudgement questions	13	9.35	
Course objectives 2, 3	3.3	Process assessment	The 5th process assessment	18	15.71	0.70
		final examinations	Programming questions 1,2	30	19.67	

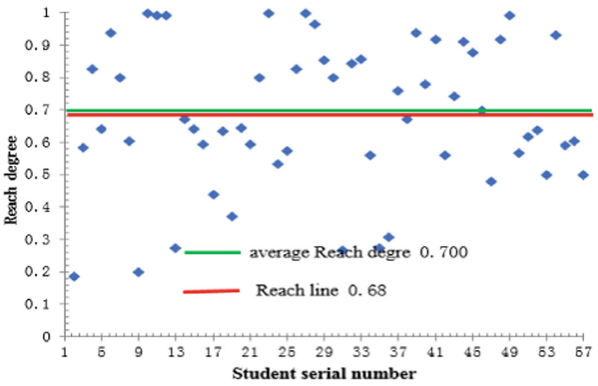

Fig. 4. Individual Evaluation of Graduation Requirements 2–3

the index point is 0.78, and the course weight of the course supporting index point 2.1 is 0.17. According to Formula 2, the achievement evaluation value of the corresponding index point 2.1 of the course is 0.13. The evaluation summary of other courses according to this process is shown in Fig. 6, The achievement evaluation value of graduation requirement 2 is 0.80, which is similar to other graduation requirements, and is higher than 0.68.

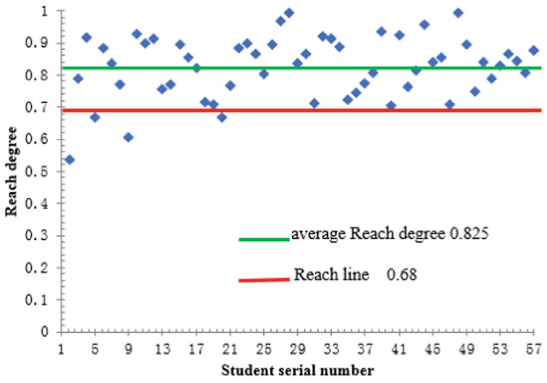

Fig. 5. Individual evaluation of graduation Requirements 3–3

Table 2. The degree of achievement of course index points

Index Point	Supporting Curriculum	Course Weight	Course Reach Degree	Achievement Degree
2–1	Data structure	0.17	0.13	0.85
	Database principle	0.15	0.14	
	Advanced software engineering	0.15	0.15	
	Software design	0.13	0.12	
	Graduation Design/paper	0.4	0.3	
2–2	Algorithm analysis and design	0.16	0.13	0.80
	.NET Programming	0.32	0.25	
	Advanced software	0.28	0.23	
	Software design	0.24	0.19	
2–3	Physics Experiment	0.10	0.08	0.81
	Microcomputer principle	0.17	0.14	
	Database principle	0.15	0.14	
	Java programming	0.17	0.14	
	Graduation Design	0.41	0.31	

5.3 Overall Evaluation of Graduation Requirements Achievement

It can be seen from Table 2 that the achievement degrees of the three index points 2.1, 2.2 and 2.3 are 0.85, 0.80 and 0.81. According to formula (4), the achievement degree of graduation requirement 2 is 0.80. Evaluate other graduation requirements

of software engineering major according to the above curriculum based evaluation. The comprehensive evaluation value of each graduation requirement is equal to or higher than the expected value of 0.68, that is, the comprehensive evaluation result of graduation requirements of this major is "achieved". It shows that graduates of this major have the ability to solve complex problems in the field of software engineering after training.

6 Conclusion

This paper mainly introduces that under the double background, according to the new requirements of the teaching mode and talent training of software engineering, the training objectives of software engineering are determined, the training standards are broken down layer by layer in a "top-down" manner, the course structure is optimized, and the course positioning, design, implementation and evaluation are carried out. We will deepen the integration of industry and education and discipline competition, and establish a sound evaluation and assessment mechanism. Through the analysis of teaching results in recent years, the scientificity and effectiveness of the OBE teaching model are fully reflected, and the demand for talents in the industry is well met.

Acknowledgements. This work was financially supported by the following funds: Anhui provincial key teaching and research project: curriculum system reform of software engineering under the background of "emerging engineering education discipline+ engineering education certification" (No. 2021jyxm0606).

Anhui Provincial Quality Engineering offline course project: C++ Object Oriented Programming (No. 2021xxkc076). Provincial "six excellence, one top" excellent talent training innovation project: software engineering excellent engineer training innovation project (No: 2020zyrc075), Anhui Teaching Demonstration Course: Data Structure (No. 2020SJJXSFK1291).

References

1. Tian Lihui. "Several important aspects of the globalization development of China's higher education." [J]. China's higher education, No. 8, pp. 33–34, 2018.
2. Fu Hua, Ren Shuxia, Yu Gang. Construction of new engineering professional curriculum system under the concept of engineering education certification[J]. Education and Teaching Forum, No. 16, pp. 275–276, 2020.
3. Department of higher education, Ministry of education. Fudan consensus on "new engineering" construction [J]. Higher engineering education research, No. 1, pp. 10–11, 2017.
4. Department of higher education, Ministry of education. Action route of "new engineering" construction ("Tianda action") [J]. Higher engineering education research, No. 2, pp. 24–25, 2017.
5. Department of higher education, Ministry of education. Guidelines for new engineering construction ("Beijing guidelines") [J]. Higher engineering education research, No. 4, pp. 20–21, 2017.

6. Zhang Qiwen, Zhang Qiyu, Gu Qun Research on the training mode of software engineering application-oriented talents for new engineering [J]. Western Quality Education, No. 15, pp. 159–160, 2018.
7. Zhang Yongxin, Wu Linli, Zhao Xiuying Research on the "reverse" talent training program of software engineering specialty from the perspective of OBE engineering certification – take the software engineering specialty of Luoyang Normal University in 2020 as an example [J]. Journal of Luoyang Normal University, No. 11, pp. 18–20+57, 2021.
8. Xu Mingze and Zhang Ting shrug Analysis of college physics teaching reform under the new engineering background and interdisciplinary talent training mode [J]. University: Teaching and Education, No. 2, pp. 129–132, 2022.
9. Liao Yong, Zhou Shijie, Tang Yu, et al Construction of core curriculum system of software engineering specialty for emerging engineering education [J]. Research on higher engineering education, No. 4, pp. 10–18, 2022.
10. Wu Huixin, Wang Qingjiang Research on the achievement evaluation of the curriculum objectives and graduation requirements of engineering certification specialty [J]. Educational Science Development, No. 2, pp. 33–36, 2021.