Construction of Curriculum System for Software Engineering Major under Background of New Engineering—A Case Study of Anhui Sanlian University

Jiujiu Yu, Jishan Zhang, Ning Wu, Yingying Mei, Canglu Zhu, Deqing Zhang, Gang Xiao, Lili Zhu

College of Computer Engineering, Anhui Sanlian University, Hefei, China

yjjyl@163.com, 695856623@qq.com, 18774803@qq.com, 745307042@qq.com, 874805055@qq.com, 82779881@qq.com, 444816686@qq.com, 181530981@qq.com

Abstract. The innovation of the curriculum system of software engineering major has become an important part under background of new engineering currently that cannot be ignored. As a case study of Anhui Sanlian University, from the three aspects of talent training, knowledge of vocation, curriculum setting to explore the construction of curriculum system for software engineering major under background of new engineering. Finally, further work is expected in the future. Firstly, sustainable agile teaching system for competitiveness should be developed. Secondly, a local platform for innovative practice on "Five Classes" based on Outcomes-Based Education (OBE) should be established.

1. Introduction

New engineering is the new reform direction of the current engineering education. The construction of new engineering is based on the new economy and new industry, which needs to establish innovative, comprehensive, full cycle engineering education and new concepts to combine with new engineering majors and traditional engineering majors, and explore new mode of the talent training for engineering education implementation [1]. In the book of China Manufacturing 2025 Bluebook, the application of the technologies of Cloud Computing, Big Data, Internet of Things (IOT), which promote the continuous change of information industry model and framework of the business system. Engineering education has become an important source of national competitiveness, and traditional engineering education needs to be reformed to adapt the requirements of new industries for new talents [2]. Information technology is the entry point of the construction of new engineering, and software technology is the soul of information technology, the transformation and innovation of software talent education plays an important role in the formation and development of new engineering [3].

Anhui Sanlian University is a local application-oriented university, which is located in the city of Hefei in China. The orientation of the university is to cultivate application-oriented talents with social responsibility, innovative entrepreneurship and practical ability, it is devoted to serving technology of engineering and management positions on all kinds of medium-sized, small and micro enterprises. The software engineering Major was first set up in year of 2017 to cultivate application-oriented talents for the profession of mobile terminal engineer who are engaged in requirement analysis, designing, coding, testing, maintenance, and management of web software application systems which are based on current mobile terminal platform.
In this paper, as a case study of Anhui Sanlian University, from the aspects of talent training, knowledge of vocation and curriculum setting to explore the construction of curriculum system for software engineering major under background of new engineering. Finally, we think about the new challenges deeply which is fully based on the actual situation of local teaching and prospect for the future.

2. Idea on Talent Training under Background of New Engineering for Software Engineering Major

The construction of new engineering major should take the approach of inheritance and innovation, crossover and integration, coordination and sharing, and cultivate high-quality engineering talents who comprehensively take into account knowledge, practice, innovation and entrepreneurship [4]. Therefore, in the development of talent of engineering software major in Anhui Sanlian University under background of new engineering, it is necessary to reflect the new trends of the development of the software industry that combines information, network, and artificial intelligence (AI) in the period of AI 2.0 currently, and highlights new concepts on talent training and higher education.

The structure of talent training for software engineering major in Anhui Sanlian University is shown as Table 1. General education and professional education have been integrated in terms of knowledge structure and ability structure. In the period of the new engineering, abilities of computational thinking and Internet thinking should be trained and developed for students in order to achieve a new literacy that are integrated with the new concept of education.

| Idea on talent training | Structure organization | Description |
|------------------------|------------------------|-------------|
| Structuring of knowledge | Basic knowledge of humanities and social sciences | Master the basic principles of Marxism and the basic knowledge of Chinese law, as well as sociology and psychological knowledge, with the traditional moral concepts and excellent moral qualities of the Chinese nation. |
| | Basic knowledge of natural sciences | Master basic knowledge of natural sciences, such as advanced mathematics and university physics. |
| | Basic knowledge of Instrumentality | Ability of reading, speaking, writing and listening in foreign languages. |
| Structuring of ability | Knowledge acquisition | Master the basic methods for literature retrieving, information querying and using of modern information technology to obtain relevant information. |
| | Knowledge application | The basic knowledge and organizational process of modern software engineering can be fully applied to the entire process of developing web software systems which are based on mainstream mobile platforms. |
| | Team cooperation | Have abilities of certain organization and management, teamwork spirit, strong expression ability and interpersonal skills. |
| Computational thinking | Innovation and entrepreneurship | Have a certain sense of innovation and entrepreneurship. |
| | Mathematical thinking | Have mathematical thinking for problem solving. |
| Internet thinking | Technologies of Big Data, Cloudy Computing and | Acquaintance with technologies of Internet, big data, cloudy computing and Artificial Intelligence (AI) fully in the period of “Internet+”. |
| Idea on talent training | Structure organization | Description |
|-------------------------|------------------------|-------------|
| Artificial Intelligence | Thinking from the mobile Internet perspective | Have the ability to think about the software service industry chain from the perspective of the mobile Internet. With the ability to re-examine the business ecology of the market, users, products, and value from the perspective of the mobile Internet [3]. |

3. Knowledge of Vocation under Background of New Engineering for Software Engineering Major
Under background of new engineering, in addition to cultivating traditional engineering thinking for students in terms of vocation on software application and service, abilities to analyze problems through the Internet thinking and solve problems through computational thinking are also developed. The knowledge of vocation for software engineering major in Anhui Sanlian University is shown as Table II.

| Vocation Education | Knowledge of Vocation |
|--------------------|-----------------------|
| Problem Solving    | Preliminary programming skills, data structure and algorithm, graph theory |
| System Cognition   | Preliminary system for software/hardware/network, operation system(OS), medium-sized and small web application systems |
| Method of Software Engineering | Method of software engineering for requirement analysis, designing, coding, testing, maintenance and management |
| Professionalism    | Professionalism of software development and service, teamwork cooperation, engineering economics |
| Application        | Comprehensive software applications based on mobile terminal platform in the field of "Internet+" |

4. Curriculum Setting under Background of New Engineering for Software Engineering Major
At present, there is no uniform standard for the curriculum system of software engineering major under background of new engineering. Different universities can combine their orientation and market requirement of the local IT industry to design the curriculum structure. Cooperate with some famous software companies to set up professional direction curriculum in the way of school-enterprise cooperation and train application-oriented software talents in one field of software engineering is one of the curriculum setting modes.

The aim of curriculum setting for software engineering major in Anhui Sanlian University, two curriculum modules of professional core and professional direction are reflected that combined with the actual situation of teaching, which is shown as Table III, and several categories are included in each module.

| Module | Category | Key Curriculum | Semester |
|--------|----------|----------------|----------|
| Professional Core Curriculum | Basic Curriculum | Basic Programing for C Language/Introduction to Computer System/Discrete Mathematics/ Introduction to Database/Data Structure and Algorithm/Operation System/ Introduction to Network | 2-4 |
| Module                        | Category                              | Key Curriculum                                                                 | Semester |
|-------------------------------|---------------------------------------|--------------------------------------------------------------------------------|----------|
| Curriculum for Computational Thinking | Object-oriented Programming (C++/Java/C#) /Introduction to Software Engineering/Software Design and Architecture/System Analysis and Modelling/ Technology of Software Testing/ Software Project Management | 5-6      |
| Curriculum for Internet Thinking | J2SE Lightweight Framework/Software Requirements Analysis/ Intelligent System Application/ Networks and Calculation/Big Data and Cloudy Computing/Software Engineering Method of Human-Computer Interaction | 6-7      |
| Professional Direction Curriculum | Software Development on Mobile Platform | Programming for Android/Programming for IOS/ PHP/Python/Linux kernel Programming and Driver Development/ Artificial Intelligence/ Photoshop | 7-8      |
| Professional Direction Curriculum | Software Testing | Software Performance Testing/Technology of Software Automated Testing/Software Quality Assurance/Software Testing Management | 7-8      |

(Note: ①Professional direction curriculum of software testing will be set up in year of 2020 based on the mode of school-enterprise cooperation.)

5. Application and Further Work
The curriculum system for software engineering was implemented since year of 2018 and teaching feedback is good. Application of teaching on curriculum system is focused on students actually, and innovation of the business model of the software industry is valued. Diversification on modern teaching methods is fully used to complete self-construction and fragmented learning. Teaching methods that used in some of the key curriculums is shown in Table IV. From the perspective of exploring new approaches to the construction of new engineering, and focusing on the perspective of cultivating future-oriented sustainable competitive talents, further work will be done in the future.

5.1 Development of Sustainable Agile Teaching System
Agile teaching is a feature that responds to the diversification of teaching goal and the personalized requirement of talents in the new era of new engineering. Focusing on student development, through the cross-parallel and rapid reconstruction of theoretical, technical, and practical teaching, and the efficient collaboration of cross-university and cross-field on education resources that realizing multiple rounds of iteration of knowledge learning and capacity improvement, with high flexibility and dynamic adaptability, is a new form of future on university education development [5].

As the case on software engineering major of Anhui Sanlian University, a flexible course selection system should be established to build and optimize the basic learning units of each curriculum with the ability of software engineering application as the guide, and establish or use various high-quality online learning resources such as MOOCs to support individual learning of students. In addition, channels for diversified contacts and cooperation will be established fully with similar major of other local universities for co-construction and co-sharing. An opening software engineering major education ecosystem for agile teaching with sustainable competitiveness will be established in the next three years.

5.2 Establishment of a Platform for Innovative Practice on "Five Classes" Based on OBE
New engineering talents with the abilities of good engineering practice, innovation and international competitiveness for the training of software engineering major is of great urgency under background of
new engineering. Innovative practice system for "Five Classes" based on Outcomes-Based Education (OBE) was put forward in [6]. Future work will be on the basis of reference [6] and combining with the actual teaching environment of Anhui Sanlian University, collaborative training mode of "Five Classes" based on OBE for software engineering major is designed to establish a platform for innovative practice. The innovation and practice ability training system for local software engineering talent is formed that conforms to the actual condition of the engineering industry, which has the characteristics of engineering education under new engineering background and prepares for the future national engineering education professional certification [6].

Table 4. Teaching Methods

| Curriculum                                      | Teaching Method                        |
|-------------------------------------------------|----------------------------------------|
| Basic Programing for C Language                 | MOOC                                   |
| Discrete Mathematics                            | MOOC                                   |
| Data Structure and Algorithm                    | MOOC + Flipped Classroom               |
| Operation System                                | Blended Learning for Online and Offline|
| Object-oriented Programming                     | SPOC                                   |
| Introduction to Software Engineering            | MOOC + Case Study                      |
| Software Design and Architecture                | Case Study + Flipped Classroom         |
| Programming for Android                          | Virtual Simulation Experiment+ Case Study|
| Intelligent System Application                  | MOOC + Flipped Classroom               |
| Technology of Software Testing                   | MOOC + Case Study                      |
| Software Project Management                     | Case Study + Flipped Classroom         |

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References

[1] Ministry of Education of the People's Republic of China. Fudan Consensus on the Construction of "New Engineering". http://www.moe.gov.cn/s78/A08/moe_745/201702/t20170223_297122.html. 2017.

[2] P.G. Li, “What's New for New Engineering Education,” Researches in Higher Education of Engineering, issue. 4, Apr. 2017, pp. 1-4.

[3] B. Luo, J. Liu, and Q. Liu, “Construction of Teaching on Software Engineering Major for New Engineering,” China University Teaching, issue. 3, Mar. 2018, pp. 20-24.

[4] D.H. Zhong, “Connotations and Actions for Establishing the Emerging Engineering Education,” Researches in Higher Education of Engineering, issue. 3, Mar. 2017, pp. 1-6.

[5] X.F. Xu, L. Li, D.C. Zhan, etc., “New Perspectives on New Engineering: Agile Teaching System for Sustainable Competitiveness,” China University Teaching, issue. 10, Oct. 2018, pp. 44-49.

[6] F. Lin, X.J. Gong, and H. Ma, “Construction of Innovative Practice System for Software Engineering Major under Background of New Engineering,” Experimental Technology and Management, vol. 36, May. 2019, pp. 181-183.