A Course Construction Mode of “One Body-Two Wings” for Software Engineering Major under Background of New Engineering

Jiujiu Yu*, Jishan Zhang, Yun Chen, Ning Wu, Yingying Mei, Deqing Zhang, Canglu Zhu and Lili Zhu
School of Computer Engineering, Anhui Sanlian University, Hefei, Anhui, 230601, China
*Corresponding author’s e-mail: jsjgc@slu.edu.cn; yjjyjL@163.com

Abstract. The research is based on the background of new engineering, taking the software engineering major of Anhui Sanlian University as an example, this study is devoted to exploring and implementing on a feasible mode of “one body-two wings” for course construction of software engineering major. Talents cultivation based on integration of industry and education is “one body”, curriculum design and case resource construction are “two wings” of the mode. Furthermore, further work is put forward to optimize for this mode from three aspects.

1. Introduction
New engineering is the new reform direction of the current engineering education [1]. The construction of new engineering should update the curriculum system and teaching content according to the development of engineering technology, and introduce new engineering technology achievements into the teaching process in time. Combining quality education with professional education is the new engineering education concept [2]. Such approaches of inheritance and innovation, crossover and integration should be taken for construction of new engineering major, and high-quality engineering talents with knowledge, practice, innovation, entrepreneurship, etc., are trained in universities [3].

Software engineering is also a core area of the information technology industry. Under the guidance of new engineering, facing the upgrading of industrial transformation and the development of local economy, universities should play a crucial role and connect with the local industrial chain and innovation chain actively, so as to adapt to the background of new business and new technology development positively [4]. How to strengthen the training of local application-oriented software talents in accordance with the requirement of the construction of new engineering courses is a major challenge, especially for software engineering education and even information technology education in domestic local universities. Software engineering major has the characteristics of "intersection of knowledge and technology, knowledge in the multi-fields, wide employment of graduates, and a great social demand for talents", talent training for wide-calibre and general education are the talent training mode of software engineering major [5]. Talents cultivation in software engineering require general education and professional education, pouring more attention to students' practical engineering ability, and work closely with local software enterprises to construct and improve the curriculum system.
Many similar research studies have been carried out on this topic. As an example, Table 1 demonstrates a teaching mode of “one goal-two pillars” from the perspective of case study for software engineering course in [6]. Table 2 demonstrates another practice teaching mode of “one body-two wings” in [7].

Table 1. A teaching mode of “one goal-two pillars”.

| Software engineering course | One goal-two pillars |
|----------------------------|----------------------|
| Content                    | Learning outcomes for software engineering in National Standards | Teaching platform | Design of teaching cases |

Table 2. A practice teaching mode of “one body-two wings”.

| Practice teaching | One body-two wings |
|-------------------|---------------------|
| Content           | Major practice | Innovation practice | Social practice |

Moreover, there are quite a few researches in depth for new engineering construction or talents cultivation recently. “One entity-two wings-four drive” mode for improvement of university students’ computer skills [8], “one goal two pillars four drive” mode of new engineering construction in Beijing Jiaotong University [9], etc. But, at the time of this writing, there is still no standard way of research on “one body-two wings” mode.

This paper devotes to exploring and practicing on a feasible mode of “one body-two wings” for course construction of software engineering major under background of new engineering. The structure of the paper is organized as the following: Section 2 describes the connotation and content of the “one body-two wings” mode. A study case of “one body-two wings” mode for software engineering major of Anhui Sanlian University is given in Section 3. Section 4 concludes the paper and puts forward the further work.

2. Course construction mode of “one body-two wings” for software engineering major

In response to the construction of new engineering, the Ministry of Education clearly stated in 2017 that universities should “cooperation deeply, school-enterprise cooperation, and collaborative education to promote the transformation and upgrading of traditional engineering majors.” Universities have advantages on theoretical courses teaching, while advantages of enterprises have advantages on advanced technologies, project development and management, social demand docking, especially for some new engineering majors, such as software engineering major [10]. Facing the upgrading of industrial transformation and the development of local economy, colleges and universities should play a crucial role and actively connect with the local industrial chain and innovation chain, so as to adapt to the training of applied talents under the background of new technology development effectively [11].

In this section, a feasible mode of “one body-two wings” for course construction of software engineering major under background of new engineering is put forward. Table 3 demonstrates the components of this mode of “one body-two wings”.

Table 3. A mode of “one body-two wings”.

| Software engineering major | One body-two wings |
|---------------------------|--------------------|
| Content                   | Talents cultivation based on integration of industry and education | Curriculum design | Case resource construction |
2.1. Talents cultivation based on integration of industry and education
According to the requirement of enterprises for talents, a connection between universities and local software enterprises are established, target of talents cultivation should be revised for “courses docking with occupation, majors docking with industries”.

“Interaction of industry and university, process of reform and cultivation” in [11] is fully referenced for the content of “one body” in the research of this paper. In the design of the curriculum system, each course needs to penetrate the requirement of the application of capabilities for enterprise. For teaching target of each course, teaching activities can be organized around projects of real enterprise, and students are required to use feasible technologies to complete the specified tasks of the project. In the process of the construction of the curriculum system, the concepts of engineering education and innovative practice are reflected, focusing on cultivating students' ability of analysis and innovative awareness of practical engineering problems [11].

2.2. Curriculum design
Activities on curriculum design process must be based on employment and the application ability of students should be improved. For some key courses with strong practicality, the feasibility of the implementation process of the curriculum design is crucial. The curriculum design can be implemented by teamwork, the requirement and content of the curriculum design should be combined with the application scenarios of the enterprises closely. Students have both intuitive knowledge and interest in curriculum design. Moreover, the goals of curriculum design are hierarchical and the difficulty should be moderate. The results of curriculum design of each course are diverse and process evaluation standards are established.

2.3. Case resource construction
Teachers and engineers from software enterprises carefully design case resources and case library for each course is developed. During the course of teaching, teachers can integrate cases into the teaching and assignment of homework, students can directly or indirectly participate in the study of various software engineering cases in different ways when completing the homework [6]. Teachers should discover and summarize new teaching cases continuously, and modify enterprise-level cases to form teaching cases appropriately, which are consistent with cognitive abilities of students.

3. Implementation
Anhui Sanlian University is a local application-oriented university in the city of Hefei in China. Software engineering major was set up in year of 2017, which cultivates application-oriented talents for development and management of web application systems [2].

3.1. Construction of talents cultivation for “one body”
The curriculum system is a crucial part as the “one body” for talents cultivation. The curriculum system is revised according to the talents cultivation program of the integration of industry and education for software engineering major of Anhui Sanlian University. The curriculum system is student-centered and based on the concept of OBE (Outcome Based Education), which solves the actual problems of local medium and small-scale software enterprises as background. Ability of innovation for students' engineering practice is emphasized and a professional committee for the participation of enterprise engineers is established. Teachers in university and enterprise engineers participate in the revision process of the software engineering curriculum system. Figure 1 demonstrates the revision process of curriculum system. Universities explore on the employment requirement of local software enterprises, and combine the future development of IT talents to cultivate the sustainable competitiveness of students for the development of new engineering [12]. Table 4 demonstrates the curriculum system for IT talents requirement of local software enterprises.
Table 4. Curriculum system for IT talents requirement.

| One body | Knowledge, ability and literacy for IT vocation |
|----------|-----------------------------------------------|
| **Talents requirement for IT enterprises** | Computer foundation/Programming foundation/Software engineering/Software design/Software testing/Software project management/Mobile development/UI design/Scientific and technical writing |
| **Course module** | General education courses/Professional foundation courses/Professional core courses/Professional orientation courses/Professional practice courses/Innovation and entrepreneurship courses |

3.2. Curriculum design for “one wing”

Curriculum design plays a crucial role in cultivating students' engineering thinking and using their knowledge to solve practical engineering problems [13]. The content of curriculum design for a course of software engineering must be operable, appropriate and comprehensive. Project as the main line, students form teams, according to the enterprise process standard, use new technologies, new tools, and new thinking to actually complete the training of a project practice process. Figure 2 demonstrates implementation mode of curriculum design [12]. Table 5 demonstrates the topic of curriculum design for some courses of software engineering major.

Table 5. Topic of curriculum design.

| Course | Topic of curriculum design | Type |
|--------|---------------------------|------|
| Basic programming for C language | Design of an application program of GUI | Designable |
| Data structure and algorithm | Comparison of sorting/search methods | Comprehensive |
| Object-oriented programming | Design of a simple Java web system. | Designable |
| Database | Design of a database management system. | Designable |
| Software engineering | Development of a comprehensive web system based on PC. | Designable |
| Programming for Android | Development of an App based on Android. | Designable |
| Software testing | Analysis and implement on an Agile test process. | Comprehensive |
| Software design and architecture | Analysis and design of a Service-Oriented Architecture (SOA) for a web system. | Comprehensive |
| Software project management | Analysis and implement on an IT management process by tool of Microsoft Project. | Comprehensive |

3.3. Construction of case resource for “another wing”

Local software enterprises are participated in iterative developing teaching cases in actual IT environment. The content of the cases covers real IT tasks which are interested by students as possible. Taking an example of software engineering major, Table 6 demonstrates the list of case resource for some courses. What needs to be explained is that the case resource of each course should be applicable from the perspective of enterprise engineering, and new project case resource can be summarized continuously in teaching process.

4. Conclusions and further work

A course construction mode of “one body-two wings” under background of new engineering is put forward and applied for software engineering major of Anhui Sanlian University in this paper. For better optimization for the mode of “one body-two wings”, from my own perspective, further work will be done in the future. Firstly, development and construction of a visual platform for resource cases of software engineering major. For each course, resource cases can be demonstrated, storage and updated conveniently. Secondly, development of instructions or guide books for curriculum designs by
cooperation between universities and local enterprises. Thirdly, the ability of mobile micro-learning for students should be improved on talents cultivation based on integration of industry and education.

![Diagram of curriculum system revision process](image1)

![Diagram of curriculum design implementation mode](image2)

**Table 6. List of case resource.**

| Course                                | Case resource                                                                 |
|---------------------------------------|-----------------------------------------------------------------------------|
| Basic programming for C language      | Various of file systems for information management                           |
| Database                              | Visual enterprise database management systems for functions of adding, delete, query, etc. |
| Software engineering                  | Various of documents, code components, software tools packages, e-books, etc. |
| Programming for Android               | Various of documents, e-books, code components, etc. for APPs development on Android platform. |
| Software testing                      | Various of testing documents, e-books, test scripts, testing tools packages, test suites, etc. for Agile testing. |
| Software design and architecture      | Various of code components for common interface and software architecture, etc. |
| Software project management           | Various of IT management tools packages, e-books, management cases, etc.      |

**Acknowledgments**

The work was supported by "Project of Natural Science of Anhui Province University" under Grant No. KJ2020A0809, "Project of Quality Engineering of Anhui Province University" under Grant No. 2019jxtd122, "Project of Quality Engineering of Anhui Province University" under Grant No. 2019jyxm0508, "Excellent Young Talent Support Project of Anhui Province University" under Grant No. gxyq2019138 and "Project of Quality Engineering of Anhui Province University" under Grant No. 2020kcszyjxm087.

As the corresponding author of this paper, I would like to express my heartfelt gratitude to my colleagues of Anhui Sanlian University and the whole authors of the references in this paper.

**References**

[1] Yu, J.J., Zhang, J.S., Wu, N., etc. (2020) Construction of Curriculum System for Software Engineering Major under Background of New Engineering—A Case Study of Anhui Sanlian University. In: 2020 4th International Workshop on Renewable Energy and Development. Sanya. pp. (062032)1-5.

[2] Yu, J.J., Mei, Y.Y., Zhang, J.S., etc. (2020) A Way of Students' Ability Cultivation of “Five-one” for Software Engineering Major under Background of New Engineering. In: 2020
International Conference on Big Data and Informatization Education. Zhangjiajie. pp. 178-181.

[3] Zhong, D.H. (2017) Connotations and Actions for Establishing the Emerging Engineering Education. Researches in Higher Education of Engineering, Issue 3: 1-6.

[4] Xia, J.G., Zhao, J. (2017) On the Reform and Development of Engineering Education in Local Universities and Colleges Based on Establishing Emerging Engineering Education. Researches in Higher Education of Engineering, Issue 3: 15-19.

[5] Huan, Z.L., Yu, P.Y., Zhu, X.C., etc. (2020) Exploration and Practice of Training Mode of Individualized Talents in Software Engineering under Background of New Engineering. Journal of Higher Education, Issue 25: 158-160.

[6] Yang, L., Li, T. (2020) Construction and Practice of the “One Goal Two Pillars” Model of Teaching in Software Engineering from the Perspective of Case Study Teaching Method. Research in Higher Education of Engineering, Issue 1: 177-181.

[7] Zhang, Y.Y., Guo, Yu. (2020) Construction of "One Body and Two Wings" Practice Teaching System in Applied Undergraduate Universities. Western China Quality Education, Issue 3: 190-191.

[8] Zhang, C. (2019) A Computer Skill Educational Mode Featuring “One Entity with Two Wings, Driven by Four Wheels”--with Bozhou University as an Example. Journal of Jilin Teachers Institute of Engineering and Technology, Issue 7: 11-14.

[9] Li, Q.Y., Zhang, X.R. (2019) “One Goal Two Pillars Four Drive” Mode of New Engineering Construction in Beijing Jiaotong University. Industry and Information Technology Education, Issue 3: 2.

[10] Yu, J.J., Zhang, J.S., Chen, Y., etc. (2020) A Teaching Mode of PBL for Software Engineering Course Based on Integration of Industry and Education. In: 2020 International Symposium on Electronic Information Technology and Communication Engineering. Jinan. pp. (012104)-1-5.

[11] Wu, L., Li, Q.Q., Wang, X.P., etc. (2020) Research on the Talent Training Mode of School-enterprise Cooperative Education under the Background of Emerging Engineering Education—Taking Software Engineering Specialty as an Example. University Education, Issue 8: 19-22.

[12] Wan, J.S, Chen, L., Dai, P., etc. (2019) New Paradigm of Applied Talent Cultivation by the Union of Enterprises and Schools Based on the Construction of New Engineering. Journal of Kunming University of Science and Technology (Social Sciences), Issue 2: 87-93.

[13] Ji, Y., Wang, X.R., Xiao, L.Y., etc. (2021) Construction and Exploration on Teaching System for Water Conservancy Engineering Specialty Course Design Based on OBE Concept. Journal of Higher Education, Issue 5: 103-106.