Practice of Maker Education in Programming Courses of Higher Vocational Education
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Abstract. Because of the drawback existing in the computer professional talent cultivation in higher vocational colleges, this paper introduces the maker-style teaching in the programming curriculum built on the analysis of the maker education research theory. Teaching reform is carried out from the maker team construction, maker project design, teaching activity design and teaching evaluation design. This model breaks the maker project of the single curriculum boundary design curriculum group, adopts the project-based teaching method and multi-dimensional evaluation methods to cultivate students' innovative literacy and innovation ability. The practice has proved the most students recognize maker-style teaching and make a useful role in promoting innovative teaching reform in higher vocational colleges.

Introduction
The technological transformation represented by cloud computing, 5G technology, big data, and other information technologies has become the decisive force for leading industry change, and technological innovation has become the strategic height of economic development. In May 2016, China issued "The National Innovation Drives Development Strategy Outline", which clarifies that scientific and technological innovation ability is the core support for the country's sustainable development. In June 2016, the Ministry of Education issued the "Thirteenth Five-Year Plan of Education Informatization", the next focus of education reform work is to improve students' information literacy, innovative consciousness, and innovation ability. Faced with the rapid iteration of technological change, an important issue in higher vocational education connotation construction is to cultivate innovative talents with sustainable development abilities. The core value of maker education "innovation, practice, and sharing" is closely consistent with the innovative education of higher vocational colleges.

Research on maker education in China started late, especially the research on maker education integration course teaching is still in the exploratory stage. Higher vocational colleges should focus on the cultivation of innovation ability. The core idea of maker education has practical significance in higher vocational education. Therefore, this paper takes programming curriculum as an example, integrates maker education into curriculum design, adopts the implementation strategy of project-based teaching to form a teaching mode to cultivate students' innovation ability, and promotes the innovative consciousness, innovative thinking and innovation ability of higher vocational students.

Problems in Talents Training
The computer industry is a skill-intensive industry, which is commonly used in all walks of life. Only with strong practical innovation ability to adapt to industry development. It is necessary not only to cultivate the professional skills of higher vocational students, but also to draw attention to the cultivation of learning ability and innovation ability. With the deepening reform of talent cultivation, curriculum systems and curriculum teaching, the teaching quality of higher vocational colleges has been greatly improved, but the depth and intensity of the reform are not enough, and there are still many problems.

Students lack motivation to learn. With the expansion of higher vocational colleges, the quality of students shows a downward trend. Students lack the motivation to learn; with the popularity of mobile internet and smart phones, students' learning concentration has been greatly weakened. At the same
time, the learning curve of the computer courses is relatively steep, and the coding must not appear any grammatical and logical errors, which is easy to cause frustration, let alone expand the learning in other professional fields, making the possibility of carrying out innovative practice is very small.

**Teaching design is not scientific.** Computer course is abstract and boring with strong logicality and practicality. The teaching quality has been improved by carrying out the "integration of theory and practice" teaching reform. The teaching design has not broken through the subject limit, and is still arranged according to the knowledge and skill points of the subject. On the other hand, the design of learning tasks has not fully considered the cultivation of innovative thinking, and the cultivation of practical ability, problem-solving ability, and innovation ability is difficult to be implemented. It is not only difficult to complete the cultivation of professional skills, but also unfavorable to encourage students to explore and innovate.

**The teaching method is single.** At present, most of the computer course in higher vocational schools is teacher-centered teaching, students follow learning mechanically, and cannot mobilize the enthusiasm of self-learning. On the other hand, the coding practice in the classroom is usually the practice of each chapter knowledge point, lacking coherence and systematics. Due to the lack of understanding of the whole framework of the project, students cannot internalize knowledge and build knowledge systems, slow improvement of students' problem-solving ability, knowledge transferability and innovation ability, thus limiting students' development in the future.

**Theory of Integrating Maker Education in Curriculum**

**From Maker to Maker Education.** In "Maker: New Industrial Revolution", American writer Chris Anderson defines "Maker" as technology-loving, practical, willing to share, and strive to turn ideas into reality [1]. The popularity of open-source hardware represented by Arduino, 3D printers and information technology has lowered the threshold for creative design and implementation of the public and stimulated the upsurge of maker practice.

Maker education in China started late, theoretical and practical research is still in the exploration stage, and the connotation of maker education has not yet been unified. Zhiting Zhu believes that maker education is an innovative educational practice field integrating information technology and an educational mode oriented by cultivating the maker quality of learners [2]. Xianmin Yang believes that maker education integrates information technology, upholds the "open innovation, exploratory experience" educational idea, advocating "learning by making" and cultivating innovative talents with the goal of ability-oriented education [3].

In summary, most researchers agree that maker education is a new pattern educational idea that uses information technology and digital tools to carry out innovative thinking and creativity education, pays attention to the comprehensive application of knowledge, promotes problem awareness and critical thinking, and is a maker-style education to train innovative talents [4].

**Theory of Maker Education.** *Learning by doing.* The theoretical basis of maker education is "learning by doing" by educator John Dewey. "Learning by doing" abandons the traditional "teacher-centered" teaching model and puts forward new "student-centered" model, which proposes gaining knowledge and experience through active exploration and problem-solving.

**Innovative education.** Innovation is the core value of maker education. Innovation is a complex process, creative ideas need to break the thinking pattern and carry out an effective practice such as "demand survey, user experience, demand analysis, and creativity formation" to cultivate students' innovative consciousness, innovative thinking, and innovation ability.

**Project learning.** Project-based learning is not only the practical carrier of the theory of "learning by doing" in maker education but also the practical platform for cultivating innovation ability. Students complete the process of information collection, scheme design, project realization and project evaluation in the form of team collaboration, based on professional learning objectives and outcome need, starting from project demand or practical problems. This process is student-centered and guided by teachers. Students improve their high-level abilities such as self-study ability, innovation ability, and collaboration ability through project practice.
Teaching Practice of Integrating Maker Education in Curriculum

Integrating maker education into the curriculum teaching of computer major in higher vocational colleges, focusing on the educational idea of "learning by doing", designing maker projects according to the situation of students, forming a maker teacher team, combining job objectives to create a programming curriculum group, adopting a "student-centered" teaching method, paying attention to process evaluation, sharing customer creation results, and implementing maker-style teaching.

Teaching Design Ideas. The maker project is the carrier to improve students' innovation ability. Although maker education advocates "learning by creation", but project content and implementation path based on students' wishes may lead to uncontrollable project development. Because of this, it is necessary to design a maker project that matches professional skills and is related to the needs. At the same time, it lists some optional expanding need to provide direction for students' divergent thinking.

A team of teachers with maker spirit is essential to the success of maker project. Maker education puts forward higher demands of teachers, not only to change the traditional teaching idea, but also to have complete professional knowledge, rich practical experience and good teaching ability to guide students. Professional teachers often lack job experience and extra-professional knowledge. When setting up a team of teachers, it is necessary to break professional boundaries and integrate external resources such as enterprise engineers, interdisciplinary teachers, and entrepreneurial mentors.

Teaching Design Plan. Computer programming course has a distinct logic progressive relationship. Traditional teaching is based on the implementation of knowledge points of curriculum, students cannot clarify the application of the course in project development and its position in the professional system, which leads to great blindness in learning, and the interest in learning decreases with the increase of the difficulty of the course. Maker project design cannot be limited to a single course, it needs to revolve around the requirements of vocational post competence, reorganize core course, establish course groups, design systematic maker project, and improve students' interest in learning and the quality of ability training.

For the development direction of mobile App projects, maker-style teaching was deployed in the first semester of the second year of mobile application development major. Four courses including HTML web page design, JavaScript front-end technology, Web application development, and mobile application development technology, are selected to form a course group for project design. Professional teachers and enterprise engineers form a team of teachers and employ art and economics teachers as part-time instructors to fully discuss the teaching objectives such as job objectives, core competencies, project design, schedule, and teaching evaluation. Take the actual project of the enterprise as the carrier, the skill requirements corresponding to the core competence of the post are decomposed. According to the project development process, the knowledge points of the course group will be explained, and the internalization of professional knowledge and the cultivation of professional quality will be continually strengthened.

In the teaching arrangement, change the traditional teaching process and weaken the subject characteristics of the course. Using the interdisciplinary learning theory of cognitive science [5], the course sequence is arranged according to the real project development process. Taking the list display module of the development news app as an example, 24 teaching time is arranged, and the detailed teaching schedule is as shown in figure 1. Each module interleaves are learning in a nested manner, helping students to repeatedly apply knowledge in the development context, and strengthen teamwork and problem-solving skills.


**Teaching Activities.** Maker-style teaching is taught from one-way knowledge-based teaching, and the multi-directional information exchange is mainly based on the interaction between teachers and students and between students and students. This is the mixed learning initiated by the teaching reform [6]. The traditional teaching relationship between teachers and students is also transformed into an equally cooperative relationship. Learn from Allen, who summed up four stages including the maker culture teaching project preparation, experimental design, prototype implementation and integration feedback [7]. Programming course of maker culture teaching shown in Figure 2 below.

![Diagram](image)

**Figure 1. Project module development sequence**

At the beginning of the teaching activities, students set up a team of makers, invite students from other colleges to set up a multi-disciplinary team, and students from other colleges can provide help outside the class after class. Professional teachers, enterprise engineers, and art colleges and faculty members set up a multi-disciplinary team of Maker instructors. The team of maker tutors discusses the framework of the maker project, and professional teachers and enterprise engineers complete the decomposition of the course knowledge points involved in the project.

After the team formed, the maker team members discuss the project demand by data collection, case studies, question raising, and group discussion. The maker team develops an implementation plan based on the feasibility of professional knowledge. Teachers join in team discussions and tap into the innovation potential of team members. Through repeated modification, the most suitable project plan is finally optimized, and the demand analysis report is written elaborately on the project demand, technical demand and implementation progress. This stage mainly cultivates students’ digital literacy, expressive ability and teamwork ability to use the network to collect information.

The project implementation adopts a hybrid learning model combining in-class and after-class activities. The project management software is utilized to manage and monitor the entire project cycle.
In class, team members work out the functions of the modules and solve problems by looking for information on the internet, self-learning, discussing with each other or seeking help from teachers. At this stage, maker teachers explain knowledge, provide high-quality teaching resources, track team progress, observe team members' performance, participate in team discussions, and help students solve difficult problems. Teachers of the art college help the team optimize the UI interface through lecturing. Teachers of economics college guide students to write a product strategy plan, and commercialize the project. Compared with traditional teaching methods, teachers do not explain knowledge points in detail. Students need to learn, iterate and internalize knowledge in the process of realizing system functions.

After the Maker project completed, the team sends the project's final materials, show the project completion and achievements to other teams in PPT, and sees the advantages and disadvantages of each team through sharing. Stimulates new ideas through communication, continues to improve projects over the course ends, take part in various innovations and entrepreneurship projects and competitions, or apply for software copyright, and further improve the students' innovation ability.

Teaching Evaluation. The traditional evaluation method mainly judges whether the students complete the predetermined teaching objectives. The advantage is that it evaluates the students' mastery of knowledge and skills, and cannot evaluate the innovation ability and teamwork. Maker-style teaching should be evaluated from multi-dimensions including knowledge and skills, innovation ability, practical ability, and teamwork. A scientific evaluation should be constructed by result evaluation and process evaluation. The process evaluation quantifies students' class performance, teamwork, and communication skills through observations, interviews, and evaluation scales. The result evaluation quantifies students' problem-solving ability, practical ability and innovation ability through project management software data, project completion degree, innovation point, and project reply. The weight of the result evaluation and the process evaluation is 40 percent and 60 percent.

Teaching Reform Effect and Analysis. After the programming course is organized into a curriculum group for make-style teaching, the students' participation in learning is improved, and a good teaching effect has been achieved. The task implementation stage, team members give full play to their subjective initiative and find resources to solve problems, which not only stimulate the students' innovative motivation but also improve their self-confidence in learning. At the end of the course, the students reflected that they spend much time on project development after class, and maker education has helped for their professional study.

On the other hand, the maker-style teaching not only improves students' innovation ability and knowledge internalization ability, but also increases learning intensity and self-study difficult. It is easy for students with a weak foundation to give up learning because they cannot keep up with the learning progress of the class. This situation puts forward a higher requirement for teachers, who need to carefully design maker projects with suitable difficulty, also spend much time and energy to give students timely guidance and encouragement after class, patiently coach students with a poor foundation, and encourage students with a good foundation to strive to achieve their own creativity.

Summary

The integration of maker education and professional courses is not only in line with the needs of the construction of higher vocational colleges, but also meets the needs of innovative talents cultivation in higher vocational colleges. It is a useful attempt to reform the higher vocational curriculum. Because of the current teaching situation of computer professional talent cultivation in higher vocational colleges, this paper analyzes the theoretical basis of maker education with mobile application development course as the carrier. This paper has carried out a maker-style teaching practice from the aspects of the overall idea of teaching design, design scheme, activity implementation, teaching evaluation and so on.

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