Reform and Practice of Programming Courses' Construction

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Abstract. The design of course group is an important part of major construction. The construction of course group should be closely focused on the professional talent training objectives. The cultivation of talents for artificial intelligence teachers specialty not only needs to develop students' ability to solve practical problems by applying the core technology in the field of artificial intelligence, but also needs to cultivate their theoretical knowledge, teaching practice and teaching ability of carrying out intelligent education. This paper analyzes how the programming course group plays its important supporting role in the process of talent training. The design method of the programming course group for AI teacher training is proposed. Besides we introduce the teaching practice and reform plan of the programming course group for AI teacher training in Capital Normal University.

Keywords: artificial intelligence teacher training program · programming course group · educational reform · teaching practice

1 Introduction

In recent years, the universities have actively dovetailed with national strategies on Artificial Intelligence (AI) development. Thoroughly implement the State Council's "New Generation of Artificial Intelligence Development Plan" [1] and "Action Plan for Artificial Intelligence Innovation in University" [2] published by the ministry of education. Data from the "2020 Artificial Intelligence Talent Training Research Report" show that there are 367 universities offering AI-oriented majors. The report of the 19th National Congress clearly proposed that artificial intelligence education should start from children, and the State Council's development plan for a new generation of AI also proposed to set up AI-related courses at the primary and secondary school and gradually promote programming education. The artificial Intelligence Normal Major cultivates senior scientific and technological talents and teachers with AI professional quality and cross-innovation ability. In the teaching of AI normal major, AI programming related courses require to be dynamic integrated and arranged as a whole. We should clarify the level of knowledge considering coherence and make the content rich and uncluttered. The aim of the reform is to improve students' comprehension and understanding. Our final goal is gradually improving students' problem solving skills, thus fostering innovative and application-oriented talents.

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2 Design of Course Group

Course group refers to the collection of courses with certain relevance in teaching content. Such relevance can be a series of bridging courses within the same major, similar courses offered in different majors with different requirements, and the same courses offered by different teachers, institutions or majors. A relatively common course group refers to a coherent set of courses that belong to the same major and have sequential relationship. Course group is not only the natural unit of resource aggregation, but also the important foundation to maintain curriculum learning community. The construction of community helps to make tacit knowledge system explicit and organize individual knowledge together, which is not only important for the ecological evolution of teaching resources, but also for the improvement of talent cultivation quality. Under the framework of professional curriculum system, we can explore the articulation relationship between courses, equip reasonable teachers for course cluster construction, avoiding duplication or disconnection of course contents, making knowledge coherent and progressive, and thus improve teaching quality. Course group plays an important role in aggregating teaching resources and high quality sharing. It is one of the most important elements in sustaining the ecological dynamics of the teaching system. In the past year, Capital Normal University has carried out the construction of course group in the direction of artificial intelligence teacher training, and has achieved good results. This paper discusses and summarizes the exploration and practice of the construction of programming course group.

2.1 The Basic Goal of Course Group Construction

The construction of course group is a part of the specialty construction, and the construction of course group should be carried out closely focused on professional talent training objectives [3]. The AI normal major cultivates a new generation of innovative talents in the field of artificial intelligence. Graduates should master the basic theories, methods and technologies in the field of artificial intelligence, as well as the ability to apply core technologies in the field of artificial intelligence to solve practical problems, having lifelong learning ability and sustainable development capability. At the same time, normal university students have educational theoretical knowledge, teaching practice and the ability to carry out intelligent education. Besides, high-level scientific research and teaching ability is the most important ability for the students and these capabilities will ultimately provide support for the construction of China's education, science and technology, and intelligent society. The construction of course group should serve the goal of talent training, and should focus on the knowledge reorganization and knowledge integration of courses, which requires the redesign of teaching contents such as syllabus and experimental syllabus of individual courses. In terms of teaching objectives, the programming course group teaching is to make students proficient in a programming language, familiar with relevant development methods and tools, understanding object-oriented thinking and familiar with object-oriented programming techniques.

2.2 Course Group Framework

Artificial intelligence has now become one of the new focal of international competition, and it has become an inevitable trend for the future development of education to offer AI-related courses in primary and secondary schools. The gradual promotion of programming education and the promotion of AI teacher training has become an inevitable trend in the future educational development. Cultivation and improvement of programming ability is the key to the quality of AI teacher training majors. Programming courses have highly practical features [4]. Students are expected to master concepts as well as practical programming. From the point of view of teaching content, programming course teaching has the problem of complex content and disconnection between courses, and some students are easy to gradually lose confidence and interest in the process of learning. The existing teaching models of this kind of courses rarely reflect and summarize the differences between the results of previous course assessment. Few analysis and the achievement of students' learning objectives are clarified, so lacking of optimize of the subsequent teaching design and few efforts is to enhance the teaching effect through continuous improvement. Therefore, the related courses must be integrated and arranged, and the hierarchical relationship between knowledge and skills must be clarified, so that the knowledge points are coherent and progressive in teaching procedure. In the gradual improvement of students practical problem solving ability and improvement of students' understanding, and then we can train the future teachers with strong professional skills. In the teaching process, what is the most important is the technical training and ability training, including the training of students' practical ability, analysis and problem solving ability, writing and expression ability, cooperation ability and so on. We should emphasize the importance of practical teaching and formulate appropriate systematic teaching plans and training objectives for students. The construction of course group is conducive to the sharing of teaching resources and the improvement of teaching quality. Course group is not only the natural unit of resource aggregation, but also an important basis to maintain the curriculum learning community. Teaching resources can be shared among courses to avoid repeated construction. The teaching accumulation established by different courses from their own perspective can be used as reference and expansion of others. The contribution of teachers and students from different courses can create and refine some excellent works and improve the quality of teaching. The most important thing is that the construction of course group can establish a systematic training process. The training mode from shallow to deep and step by step is conducive to students' building of professional identity and the mode can solve the problem of difficult for entry and slow improvement during the learning process.

Combined with the relevant requirements of the national standard for undergraduate teaching quality, the core competencies of artificial intelligence teacher training are summarized and sorted out, integrated into the course group, and the overall framework of the program course group is designed, as shown in Fig. 1.

The teaching of the programming course group of normal major in artificial intelligence should be carried out to serve the realization of talent training objectives as well as the programming ability and teacher training skills. The required abilities need to achieve internal integration and equip the teaching process with the cultivation of ability by creating a practical platform for students. The programming course group created by the

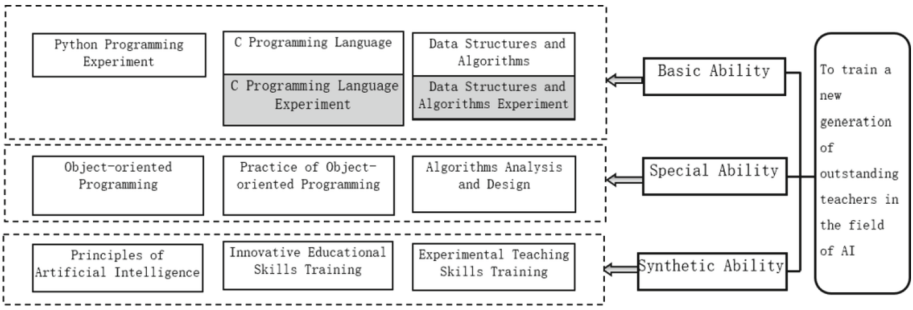

Fig. 1. Programming course group framework

Artificial Intelligence Teacher Training Program of Capital Normal University contains 11 courses, namely "Python Programming Experiment", "C Programming Language", "C Programming Experiment", "Data Structure and Algorithm", "Data Structure and Algorithm Experiment", "Object Oriented Programming", "Comprehensive Practice of Object Oriented Programming", "Algorithm Analysis and Design", "Principles of Artificial Intelligence", "Innovative Education Skills Training", and "Experimental Teaching Skills Training". These courses are all sequential in content with varying degrees of interconnection, and the major-related courses involve eight instructors. Graduates can work in the field of basic education in the teaching of technical courses, teaching management, teaching support, or pursue a master's degree in a related discipline. Figure 1 shows the framework of the programming course group for the AI teacher training program.

3 Course Group Construction and Practice

As the source of high-quality teacher training, the core characteristics of teacher training should be highlighted in the training of normal students under the background of artificial intelligence. In normal education, artificial intelligence-related knowledge and skills courses need to be introduced into the training of normal university students, and the ability of teachers to implement intelligent education needs to be cultivated.

3.1 Course Group Design

Teachers of artificial intelligence courses in primary and secondary schools should keep active in learning. For example, we should keep abreast of national and regional artificial intelligence development policies and take the initiative to use network resources to carry out autonomous learning of artificial intelligence knowledge [5]. In terms of attitude, it should be recognized that AI courses are an essential information technology foundation for future education to prepare for future changes. In terms of professional knowledge, in addition to learning disciplinary professional knowledge, modern teaching methods should be enriched. The most important thing is to improve practical knowledge through systematic process as "theoretical learning - practice application - reflection - practice again". In terms of professional ability, in addition to constantly improving their own

Table 1. The supporting matrix of course group for training requirements

Training Requirements Courses	Practice teacher's ethics			Learn to teach		Learn to nurture		Learn to develop	
	Ethics norms	Educational sentiment	Academic literacy	teaching ability	Class guidance	Comprehensive education	Learn to reflect	Communication and collaboration	International vision
Python Programming Experiment	3	3	5	3	3	2	4	3	4
C Programming Language	3	3	5	4	3	2	5	4	3
Data Structure and Algorithm	3	3	5	4	4	3	4	4	3
Object Oriented Programming	3	3	5	5	4	3	4	4	3
Algorithm Analysis and Design	4	4	5	4	3	4	4	3	3
Principles of Artificial Intelligence	5	4	5	5	4	3	3	3	5
Innovative Education Skills Training	5	5	4	4	5	5	5	5	4
Experimental Teaching Skills Training	4	4	3	5	5	4	5	4	4

teaching ability, more important is to improve teaching research ability and practice. The teaching objectives for normal university students should be implemented through appropriate curriculum setting and educational approaches, so all courses and teaching activities should be carefully designed and rationally arranged to form a unified education and teaching system to ensure the realization of all teaching objectives. The construction of course group should be carried out around the training goal of artificial intelligence teachers. AI normal students in capital normal university should meet the teachers' professional graduation requirements. The four aspects should be covered as Practicing teacher ethics, learning to teach, learning to nurture, learning to develop. The training objectives are broken down into 8 requirements including teacher ethics, educational sentiment, subject knowledge, teaching ability, class guidance, comprehensive education, learning to reflect, communication and cooperation, etc., The objectives is decomposed into 23 graduation requirement index points. The different courses in the curriculum group have their own responsibilities and focus on the corresponding competencies, but they are closely focused on core professional skills and the development of teacher excellence ability. We regard the training requirements as a one-dimensional space, and the courses in the curriculum group as a one-dimensional space. This two-dimensional space can constitute the design space of the programming class course group, which make the correlation between the training objectives and the curriculum responsibilities. The support degree of the curriculum is described for the graduation requirements with 5 levels of intensity. A support matrix of course group for graduation requirements is formed, as shown in Table 1.

Programming courses aim to cultivate students' ability to "abstract" and "design" programming. Students accumulate rich programming experience and familiar with relevant programming languages, tools and platforms. Solid basic skills and strong practical ability can be learned to solve problems proactively and to be good at using the knowledge they have learned. In course design, we respect the learning rules, proceed from the simple to the deep, pay attention to practice, and link each other closely. The specific settings are shown in Table 2. The maturity of digital teaching resource platform provides a powerful guarantee for resource sharing. Compared with the large and complete resource library, the teaching resource platform which is related to the major, has the moderate scale, and has the curriculum internal correlation which is beneficial to promote the teaching development. In practical teaching application, course group with certain relevance should become an important carrier of digital teaching resource construction for courses sharing and optimization. In addition, in the construction of the application platform of digital teaching resources, attention should be paid to the continuous construction process of resource optimization and dynamic evolution, so as to fully mobilize the enthusiasm of teachers and students and promote the virtuous cycle development of shared teaching resources.

3.2 Practical Teaching Methods and Means

The cultivation of artificial intelligence normal university students needs to give consideration to the cultivation of innovation ability and normal university students' skills. Programming courses are very important for the development of students' professionalism, and they must be unique in teaching methods and means boldly strengthen on

Table 2. The curriculum of the programming course group

Course Name	Credits	Total Hours	The Bilingual State
Python Programming Experiment	3	5	3
C Programming Language	3	5	4
Data Structure and Algorithm	3	5	4
Object Oriented Programming	3	5	5
Algorithm Analysis and Design	4	5	4
Principles of Artificial Intelligence	4	5	5
Innovative Education Skills Training	5	4	4
Experimental Teaching Skills Training	4	3	5

experiment and innovativeness. In recent years, we take the opportunity of strengthening the practice reform of programming course group, and form the teaching method of combining experiment driven teaching with comprehensive practice. The traditional practical teaching of programming is generally uniform in its requirements, the content, the procedure etc., which restricts creative thinking of students with different foundation. We change the previous way, fully use the information platform in the students' experimental stage, and create an experimental teaching mode supported by a variety of media teaching resources and interactive learning. On the premise of giving full control to students' autonomy and aided by teacher-led learning, a multi-level independent experimental teaching mode is formed, which fully mobilizes students' enthusiasm for programming learning. Firstly, the teachers of each course re-divided the knowledge points of course and skills mastery, established a system of knowledge points based on "fragmentation". Then combined with the actual situation of our students, teachers recorded these "fragmented" knowledge points into practical micro-lesson videos with emphasis on the progressive relationship between knowledge points for students to watch and learn repeatedly. We realize online learning across time and space, and at the same time to prepare for the regularization of the epidemic [6]. In addition, on the basis of self-made practical micro-lesson videos, high-quality MOOC videos are also introduced to provide comprehensive online teaching resources to meet the learning needs of students at different levels. In the teaching process, case-based teaching are used throughout. Heuristic and research-based teaching methods are adopted to pay attention to cultivating students' programming innovation ability of independent learning and independent experiment. Students will improve their ability to organize seminars and develop good presentation skills through document preparation and comprehensive experiment defense. In terms of teaching methods, we aim to cultivate innovative and application-oriented teacher-training talents. By breaking the past practice of setting experiments by courses only, we establish a hierarchical experimental and practical teaching system. By means of "basic skills - comprehensive case –expanded practice" according to the new requirements of professional training, we comprehensively considerate the requirements of the programming course group for personnel training goals.

We build a practical teaching platform for students from the unified cases throughout each class and achieve the ability cultivation goals, as shown in Fig. 2.

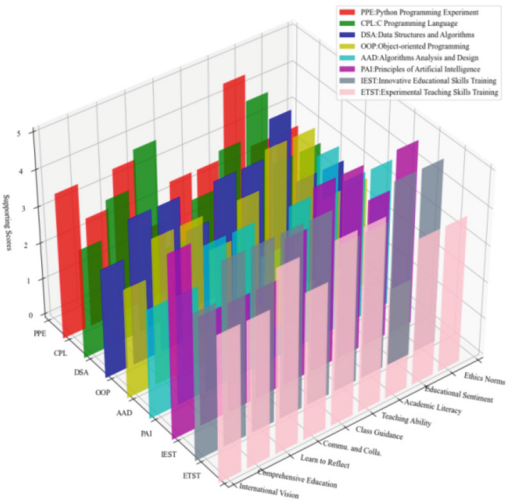

Fig. 2. Course competency development objectives

Firstly, basic skills are primary target [7]. This level covers basic programming knowledge, debugging techniques, syntax, algorithms, and verification experiments. The main purpose is to strengthen students' basic experimental skills and theoretical training, and gradually form the ability to connect with reality, analyze and solve problems, and lay a foundation for cultivating students' innovation ability. Secondly, comprehensive cases are taken as the main clue, and the case backgrounds of all courses are consistent, so as to reduce repeated understanding of application needs. Students are required to face simple engineering problems in the form of large assignments, and to complete the design, development, debugging and testing by themselves. Thirdly, to improve practice, mainly through the comprehensive practice in extra semester we achieve the teaching goal. Students are required to provide a practical process of integrated design, simulated products or scientific research. The extended practical connection places more emphasis on students' independent learning by research projects, extracurricular science and technology innovation activities, and subject competitions, etc. Students choose their own topics, build their own experimental platforms, design the implementation process, complete the tests, and finally pass the expert group defense assessment.

3.3 Hierarchical Practice Teaching

Learners use their existing knowledge and cognitive ability to learn new knowledge and use the new knowledge to build their own system of knowledge and ability. Because students have different levels of prior knowledge and cognitive abilities, it is impossible to meet the self-constructed needs of all students if all learners are confronted with no

differences. 17% of our AI normal students come from Xinjiang or Tibet, and although in recent years minority students have completed their matriculation in language and basic subjects at the high school level in the high school class, there is still a big difference between their learning base and that of students from other places of origin.

The essence of multi-level teaching is to meet the differentiated needs of different students, which is the concrete embodiment of taking students as the learning main body. And that is the basic strategy to achieve effective teaching and efficient learning. Among them, basic experiments are required to do experiments, focusing on the training of students' basic skills. Comprehensive experiment is a part of selective experiment, pay attention to cultivate students' ability of comprehensive use of knowledge and problem solving capability. The extended experiment focuses on cultivating students' ability of application innovation and exploration spirit. Basic experiments and comprehensive experiments are mainly carried out in class exercises. The extended experiment was carried out in a group way of project team cooperation.

Figure 3 shows the practical teaching content system of program design course group at 3-level for artificial intelligence normal major. The experiment content of each level is longitudinally from shallow to deep, from simple to complex. To break through the boundary barriers of relevant courses horizontally, we aim to cultivate students' problem-solving ability and innovative spirit. By carrying out hierarchical teaching, students can have a solid grasp of basic theories and professional knowledge. At the same time, students with different foundations can have a sense of gain in the course practice, so as to stimulate students' interest in learning and improve their professional skills.

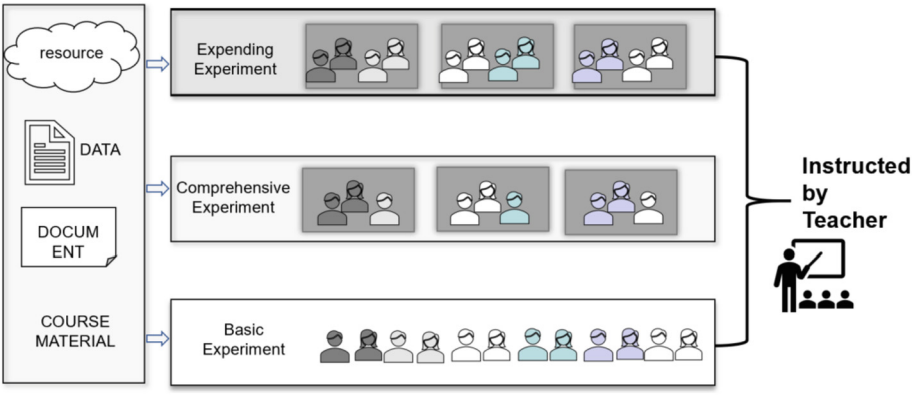

Fig. 3. Hierarchical teaching practice system

4 Teaching Reform of Programming Course Group

The course group construction is an iterative process, which needs to explore the improvement of teaching mode and method. Teachers are one of the core elements of teaching activities. A course cluster teacher group is formed by the course lead teachers, with

a reasonable mix in terms of education, title and age. Experienced teachers and young teachers need to form a supportive relationship. The teacher in charge of the course cluster, mainly responsible for the construction and planning of the whole course cluster, as well as the organization of regular teaching communication. We actively promote the reform of "MOOC + Flipped class" teaching mode. Firstly, teachers are guided by the training objectives and take the syllabus as a framework to cut and optimize the teaching content, dissolve the knowledge content in a number of tasks. Then teachers develop an implementable independent pre-study task list. Through the analysis of the platform data, teachers can timely adjust the teaching strategy and personalized counseling for students. Finally, we effectively improve the teaching effect [8, 9] by flipped classes. Programming language and data structure algorithm classes use online assessment system within the course group, which provides online compiling, linking, running and discriminating functions. It can provide instant feedback on students' programming results and make more scientific and effective evaluation of students' ability.

The extension of flipped class requires students to work in groups to prototype and develop a mini-management system. The creation of a mini-management system, which runs through the different courses but has its own focus of requirements, thus avoiding the disadvantage of repeatedly understanding and starting from scratch for possibilities of progressive development. We emphasis on process-oriented examinations and the use of multidimensional evaluation. We integrate online and offline process evaluation and final exam evaluation for multi-dimensional assessment thus for evaluation to continuously teaching design improvement. According to the training objectives, we continuously improve and optimize the teaching design, and improve the teaching objectives and assessment as well as evaluation methods. Continuous teaching reform in a closed-loop mode, thus making the teaching methods more efficient, the teaching contents more rich and practical, and the teaching schedule more reasonable, thus continuously improving the students' professional skills and teaching and research abilities, and prompting them to become excellent teachers with excellent professional abilities. Continuous teaching reform in a closed-loop mode, can make the teaching methods more efficient, the teaching contents more rich and practical, and the teaching schedule more reasonable. So as to continuously improve the students' professional skills as well as teaching and research abilities to help them to become excellent teachers with excellent professional abilities.

5 Conclusion

The undergraduate normal major of artificial intelligence is an important base for cultivating high-level teachers with professional qualities of artificial intelligence. The training process also aims to equip students with the innovative practical ability to use the core technology of artificial intelligence to solve practical problems. Programming courses directly determine the quality of professional talents training. This paper introduces how to realize the course group construction to serve the cultivation goal from three aspects: course group design, construction and teaching reform. In the following teaching research work, we will further improve the construction of the course group according to the current accumulated teaching data, strengthen the continuous reform on iterative updating, further expand the scope of practice, deepen the content of practice, and explore the laws of the construction of the course group.

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