Research and Practice on the Construction of Smart Courses in Optimization Methods

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Abstract: *In response to the requirements of educational digital transformation and artificial intelligence-enabled education, this paper takes the Optimization Methods course for the major of Information and Computing Science as the research object to explore the practical path of smart course construction. The paper elaborates on the characteristics of the Optimization Methods course and the limitations of the traditional teaching mode, proposes to take visual knowledge graph as the starting point, integrate teaching resources with the help of Chaoxing Learning Platform, and construct an online-offline integrated teaching mode of "pre-class preview - in-class teaching - after-class discussion"; at the same time, it organically integrates the education on forging a strong sense of community for the Chinese nation into the methods, content and resources of course teaching, so as to realize the unity of knowledge impartment and value guidance.*

Keywords: *Optimization Methods; Smart Courses; Knowledge Graph*

1. Introduction

The Report to the 20th National Congress of the Communist Party of China clearly proposes to "promote educational digitalization"[1]. Accelerating the digital transformation of education is an inevitable choice for China's education to achieve a leap from basic balance to high-quality balance, and from a large education country to a strong education country. On March 28, 2024, the Ministry of Education launched the Artificial Intelligence-Enabled Education Initiative[2], aiming to promote the integrated application of teaching and learning with artificial intelligence. As an important part of artificial intelligence empowering higher education, smart courses are one of the key approaches to realize educational modernization. With the core goal of cultivating new-type talents with innovative thinking, compound thinking and technical thinking, smart courses generate and structurally present teaching content through digital and intelligent technologies.

Optimization Methods is an elective course offered to junior students majoring in Information and Computing Science at the author's university. While systematically explaining the basic ideas and theoretical principles of various optimization methods, the course focuses more on cultivating students' abilities in algorithm application and practical operation, and is equipped with computer experiment teaching links. On the premise of solidifying the basic optimization theory, students can carry out systematic training through computer experiments, comprehensively use the mastered basic mathematical knowledge to analyze, abstract and refine practical problems, and construct corresponding optimization models; on this basis, select appropriate optimization algorithms, write computer programs to solve problems, and analyze and summarize the calculation results. The offering of this course plays an important supporting role in improving students' mathematical literacy, strengthening mathematical thinking and comprehensive application ability[3].

For a long time, most teachers of this course have carried out the teaching of Optimization Methods mainly in the form of traditional offline classroom teaching. In this mode, teachers mainly rely on face-to-face classroom interaction to grasp students' understanding of knowledge in real time, dynamically adjust the teaching progress, and guide students to achieve learning goals and master relevant methods and skills. However, restricted by the total class hours limited by the teaching syllabus and teaching plan, it is difficult to fully balance the time allocation between teachers' lectures and teacher-student interaction, which makes it impossible for offline classes to fully carry out the expansion and extension of relevant knowledge points and in-depth analysis of difficult problems, and students' understanding and absorption of the key and difficult contents of the course are often insufficient[4].

In contrast, smart courses can effectively improve the quality of classroom teaching in multiple dimensions. They can not only break the time and space limitations of traditional teaching, but also further enrich and expand teaching content, better practice the "student-centered" educational philosophy, and build a ubiquitous learning environment for students where "learning is possible everywhere and at any time". For the difficult and extended contents that cannot be fully explained in offline classes due to limited class hours, they can be systematically presented through online platforms, and students can watch and learn repeatedly according to their own learning needs to gradually master the key and difficult points. At the same time, students can also timely interact and communicate with teachers through online channels to discuss and answer questions encountered in learning.

At present, the teaching practice of smart courses in China is still in the stage of exploration and improvement. This new teaching mode not only puts forward new tests for students' awareness of independent learning and self-management ability, but also sets higher standards for teachers' professional ability and information-based teaching literacy. Therefore, how to base on the requirements of smart course construction, innovate the existing teaching mode of Optimization Methods, optimize teaching design and teaching philosophy, enrich teaching carriers and classroom forms, and then effectively stimulate students' learning interest, improve learning efficiency and classroom teaching quality, has become an important topic that needs in-depth research and practice by relevant course teachers.

2. Visual Knowledge Graph Empowering the Construction of Smart Courses in Optimization Methods

Knowledge graph is an important starting point for smart course construction. With its unique advantages, it brings a new perspective and possibility for "smart course construction". It presents knowledge semantics and semantic relationships in a graphical form, emphasizes the presentation of teaching methods and course content from the three dimensions of "quality - knowledge - ability" under the guidance of course teaching objectives, and uses intelligent and digital means to organize the embedding of various types of teaching resources to form a three-dimensional and visual semantic network and resource library. Knowledge graph provides strong support for the reorganization and innovation of course content, and plays a pivotal role in teaching methods, evaluation systems and other aspects. Therefore, knowledge graph has begun to be applied in various aspects such as diversified teaching innovation, personalized learning paths, precise course teaching, comprehensive learning management, and intelligent resource push, empowering smart course construction and teaching innovation.

Based on the training objectives of the major of Information and Computing Science, a four-dimensional curriculum system knowledge graph of curriculum objectives, graduation requirements, knowledge and ability, and talent training is constructed. It includes teaching design elements such as training objectives, teacher ability, teaching mode, educational content, learning environment and evaluation methods. A multi-dimensional personalized teaching activity of "teacher - student - machine" and a three-dimensional and all-round course evaluation system of "teaching - learning - evaluation" are constructed.

Taking the graduation requirements of the talent training program of the major of Information and Computing Science and the course objectives of the Optimization Methods syllabus as the standards, the theoretical knowledge of Optimization Methods and the target abilities of student training are linked to reconstruct the progressive logic of knowledge, ability and literacy, and an Optimization Methods curriculum system graph centered on students, oriented to employment and based on the cultivation of new-type talents is constructed.

The main teachers of this course have recorded 42 learning videos on the Chaoxing Learning Platform, among which 11 videos are set as task points, and there are 38 additional learning videos for materials. The total duration of teaching videos is 449 minutes, with 49 non-video resources, 42 exercises, 25 questions, 80 test questions, and 209 questions in the question bank.

To improve the effect of classroom teaching and students' learning efficiency, the author has explored the teaching mode of smart courses in Optimization Methods. Taking "Optimization Methods (3rd Edition)" published by Higher Education Press as the teaching textbook[5], the main content taught includes basic theories such as convex programming and optimality conditions, linear programming, linear search and trust region methods, unconstrained optimization methods, quadratic programming, and theories and methods of constrained optimization. In view of the characteristics of the

Optimization Methods course, such as dense knowledge points, abstract mathematical theoretical knowledge and wide application, the author has designed a trilogy of "pre-class preview - in-class teaching - after-class discussion", combining smart courses with offline teaching[4].

a. Pre-class preview: Let students review the relevant basic mathematical theoretical knowledge, preview the basic framework of classic algorithms to be explained in class, build confidence and stimulate learning enthusiasm. The author will push the explanation videos to students in advance through the Chaoxing Learning Platform.

b. In-class teaching: Implement a face-to-face teaching mode in the classroom, focusing on explaining key and difficult contents. To urge students to preview in a timely manner, the author takes 5 minutes in each classroom teaching to randomly invite students to explain a knowledge point on the spot. In view of this, online teaching objectively serves as an extension of offline teaching, relieves the pressure of tight class hours, allows students to effectively study short teaching videos independently in their spare time, and reduces students' learning costs. In addition, randomly inviting students to display a knowledge point previewed before class in classroom teaching not only enriches the classroom teaching methods, improves students' expression and organization ability, but also activates the classroom atmosphere.

c. After-class discussion: According to the results of students' homework and classroom tests, the knowledge gaps of each student will be found by using the knowledge graph. The author will send the relevant learning videos on the Chaoxing Learning Platform to students, or conduct online communication and discussion with students through the Chaoxing Learning Platform and Tencent Meeting Platform, so as to address the problems in a targeted manner.

The above contents are some experiences of the author in the practical exploration of the smart course teaching mode, which truly realizes the organic unity of pre-class preview, in-class teaching and after-class discussion. After one round of teaching, with 6 tests and 18 assignments, the author personally feels that the teaching effect has been improved. From the feedback of students, they can face up to the application of Optimization Methods in practical problems, and their learning enthusiasm is relatively high.

3. Integration of Education on Solidifying the Community Sense of the Chinese Nation into the Construction of Smart Courses in Optimization Methods

Professional courses are important carriers for the construction of ideological and political education in courses. In the construction of smart courses in Optimization Methods, we adhere to the unity of knowledge impartment and value guidance, organically integrate the education on forging a strong sense of community for the Chinese nation, dig deep into the combination points between the mathematical characteristics of the course and the elements of forging a strong sense of community, and achieve the educational effect of subtle influence. By interpreting the internal connection between the global optimal solution of optimization problems and the feasible solution set, students are inspired to understand the historical inevitability of all ethnic groups' coordinated development and common prosperity under the framework of the Chinese nation community; combined with the teaching of core algorithms such as the steepest descent method, Newton's method and conjugate gradient method, students are guided to deepen their in-depth identification with the Chinese nation community, and the spirit of the Chinese nation is implanted in the explanation of theoretical knowledge such as algorithm convergence and convergence speed, so as to cultivate era new people with solid professional ability and profound family and country feelings[6].

At the level of teaching methods, heuristic and metaphorical teaching are adopted to realize the in-depth integration of solidifying elements and professional content. When explaining local optimal solutions and global optimal solutions, students are guided to dialectically understand the relationship between local and global, individual and whole, metaphorically taking all ethnic groups as local individuals and the Chinese nation community as the global whole, so that students can deeply realize that the Chinese nation community is a complex optimization system, and all ethnic groups are interdependent and share weal and woe. To achieve the "global optimal solution" of national rejuvenation, all ethnic groups need to closely cooperate, complement each other's advantages, and jointly overcome the "local extremum" difficulties in development.

At the level of teaching content, we elevate from algorithm principles to the education of community awareness. When explaining the KKT conditions of constrained optimization problems, the

constraint conditions are compared to hard boundaries such as national policies, laws and regulations, and cultural norms, the Lagrange multipliers correspond to the degree of attention to core elements such as ethnic unity and national interests, and the complementary slackness reflects the unity of principle and flexibility, that is, there is no slack in core interests and national unity in principle, but flexibility is allowed in specific implementation aspects such as local cultural protection, helping students establish a correct view of the country and nation while understanding professional theories.

At the level of teaching resources, exclusive cases of forging a strong sense of community are integrated into the digital course platform of Chaoxing Learning. Taking the teaching of Newton's method as an example, relying on the mathematical nature of the algorithm iteration formula and the acceleration of convergence by the second derivative, the 5,000-year-old Chinese civilization is compared to the deep spiritual motivation supporting national rejuvenation. By comparing the two algorithm solution scenarios of ignoring cultural roots and deepening cultural resources, the core value of cultural confidence is highlighted, which naturally transitions to the educational theme of forging a strong sense of community for the Chinese nation, making ideological and political education more professional, persuasive and appealing.

4. Conclusion

Taking the course Optimization Methods as an example, this paper discusses the necessity of smart course construction and the approaches to integrating smart courses into teaching. Meanwhile, it incorporates education on solidifying the community sense of the Chinese nation into the development of the smart course for Optimization Methods. Teachers should stimulate students' learning enthusiasm and improve their learning efficiency in the teaching process, so as to achieve favorable classroom teaching effects and lay a solid foundation for students' subsequent development.

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