Spatio-Temporal Data Analysis Course Teaching Mode Reform under the New Liberal Arts Background

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Keywords: Problem-based learning, Flipped classroom, Spatio-temporal data analysis course, Teaching mode reform

Abstract: Under the education concept that the construction of new liberal arts promotes interdisciplinary integration and cultivates students' interdisciplinary ability, more and more departments of the Academy of Management Sciences have begun to offer courses related to big data analysis. Based on the teaching practice over the years, the course teaching team integrates the subject needs, practical applications and students' abilities, formulates feasible teaching objectives, and optimizes the course content and class time allocation. On this basis, the course team also explored and adopted the teaching mode of "Problem-based learning+ Flipped classroom", guiding students to independent deep learning, improving teaching efficiency and improving teaching effect through four stages of teaching: raising questions, flipping class learning, solving problems, evaluating and consolidating. Practice shows that the teaching organization mode of "problem-based learning+ flipped classroom" can help increase students' learning input, fully stimulate students' motivation for independent learning, promote exchanges and cooperation among students and between teachers and students, enhance students' comprehensive use and understanding of various technologies and research methods, and improve students' comprehensive ability. This approach conforms to the new requirements of breaking through professional barriers and disciplinary boundaries advocated by the new liberal arts, changing the talent training mode, and creating a student-centered personalized teaching mode.

1. Introduction

The development of emerging technologies such as big data and artificial intelligence is gradually affecting or changing the social structure and social operation mode, and also provides new perspectives and tools for the research of related disciplines [1]. In 2017, The State Council issued the "Action Outline for Promoting the Development of Big Data" specifically pointed out that universities are encouraged to carry out interdisciplinary big data comprehensive personnel training, and vigorously cultivate cross-border composite talents with multidisciplinary knowledge such as statistical analysis, computer technology, and economic management. In 2019, 13 departments including the Ministry of Education jointly held the launch conference of the "Six Excellence and one top-notch" Plan 2.0 to develop new engineering, new liberal arts, new medical, and new agricultural sciences, and promote a "quality revolution" in colleges and universities across the country [2]. Accordingly, liberal arts education is also advancing with The Times, combining the new needs of social development, the new trend of interdisciplinary integration, and the new achievements of scientific research, actively responding to and seeking change. In this context, in order to promote interdisciplinary integration, cultivate students' interdisciplinary ability, and respond to the new requirements of public management entering the "data facts" era, since 2017, the School of Management Science of Chengdu University of Technology has integrated existing disciplinary resources and relied on the Laboratory of big data and Resource and Environment Laboratory. Courses on Spatio-Temporal Data Analysis methods such as Big Data and Environmental Resources are offered to undergraduates and postgraduates to improve students'

  DOI: 10.25236/iemetc.2023.004

ability to analyze massive data and adapt to the needs of future disciplines and social development [3].

Combing through relevant research literature in recent years, it is found that, on the one hand, there are abundant research results on big data course teaching, but most of them regard big data as the background of The Times or technical means, and explore the opportunities and challenges brought by big data to teaching management, teaching evaluation, teaching philosophy, teaching and learning mode, teaching techniques, etc. However, the teaching and research results of big data analysis courses themselves are relatively few. On the other hand, as an important basic course, program design has similar teaching objectives and knowledge and skills that students need to master to big data analysis courses. Therefore, the teaching reform and exploration results of existing program design courses can provide a good reference for our big data analysis course teaching. In general, the teaching and research of programming courses covers all major mainstream programming languages, covers all types and levels of institutions, and involves all stages of the teaching process. The development of programming courses shows the following characteristics: (1) The transformation from focusing on improving students' programming skills to cultivating computational thinking and problem-solving abilities; (2) The transition from discussing more specific teaching problems and countermeasures to exploring teaching concepts and models [4-5]; (3) The shift from focusing on single teaching mode to exploring mixed teaching mode [6-8]. These changes not only conform to the rapid development of information technology to the new requirements of higher education, but also reflect the continuous popularization of student-centered personalized teaching concept and model. However, the existing teaching research literature is mainly for science and technology majors and students, and there is a lack of teaching research for the characteristics of humanities and social science majors. Occasionally, although it is mentioned that programming courses should be taught according to the major, the reference is still not beyond the scope of science and technology majors. In recent years, the construction of new liberal arts has been in the ascendant in our country, and more and more colleges and universities have begun to create projects and courses in interdisciplinary fields such as computational social sciences, big data and artificial intelligence. Under this situation, it is of certain theoretical and practical significance to study the teaching mode of big data analysis courses under the background of new liberal arts [9].

In recent years' teaching practice, the teaching team of "Spatial-temporal data mining analysis" course in the School of Management Science of Chengdu University of Technology, based on the aforementioned teaching research results and experience, continuously listens to the students' feedback on the teaching situation, and constantly improves the teaching plan and teaching mode by combining the characteristics of the subject and the ability level of the students. A series of explorations and practices have been carried out in the teaching mode and techniques of big data analysis courses for humanities and social science students, and the teaching mode of "problem-based learning+ flipped classroom" has been explored. In the new situation where interdisciplinary disciplines are increasingly becoming the main way to cultivate top innovative talents, this model echoes the construction goal of the new liberal arts to adhere to the problem-orientation and carry out interdisciplinary research, and can provide useful reference for the teaching of computer, information, big data, artificial intelligence and other courses for management sciences related majors.

2. Overview of Problem-based Learning and Flipped Classroom Teaching Mode

Problem-based learning (PBL) is a teaching method based on the modern constructivist teaching theory, which originated from the medical education practice carried out by Barrows and Tamblyn of McMaster University in the 1960s [10]. Subsequently, it has been promoted to North America and even the world, becoming a useful supplement to traditional teaching methods [11]. Constructivism teaching theory emphasizes that the subject of the teaching process is students themselves, and students' learning activities must be combined with specific problems to explore problems to stimulate and maintain learners' learning interest and motivation, and learn new content and acquire new knowledge through the "known-unknown-new known" cycle and gradual mode.

Different from traditional teaching methods, problem-based learning method takes students as the main body of teaching situation, and the role of teachers is the designer, organizer and guide. In the teaching process, problem-based learning method advocates taking problems as the starting point of learning, planning learning content with problems as the core, and guiding students to discover, analyze and solve problems. Through this continuous teaching activity, it can stimulate the motivation of students' independent learning and improve their professional quality, so as to achieve the goal of talent training. The many characteristics of problem-based learning method make it especially suitable for the cross-disciplinary or curriculum teaching where the knowledge is updated quickly, the network learning resources are rich, and the practical application orientation is clear.

On the other hand, thanks to the rapid development of information technology and the Internet, the flipped classroom teaching mode has made substantial progress in the early 21st century and has become popular all over the world, helping teachers to accomplish teaching goals more efficiently [12]. Flipped classroom refers to a new teaching mode in which teachers provide learning resources mainly in the form of teaching videos, students watch and learn the learning resources before class, and teachers and students complete homework question-answering, collaborative exploration and interactive communication activities together in class [13]. Of course, flipped classroom does not simply mean making micro videos for students to watch in advance, but its fundamental purpose is to promote students' autonomous deep learning. The development of flipped classroom, a teaching model, subverts the traditional teaching process of "teacher teaching + student homework", strengthens the student-centered position and reshapes the role positioning of teachers and students in the teaching process. From the perspective of its implementation effect, flipped classroom is conducive to stimulating students' learning passion, cultivating students' research and innovation ability as well as cooperation and expression ability.

In general, the common core of problem-based learning method and flipped classroom is to advocate student-oriented teaching, and the essence is to return to the logical starting point of teaching activity -- student learning. Whether it is guiding students to discover, analyze and solve problems, or providing students with rich flipped classroom resources, it is always necessary to focus on students, fully consider students' knowledge background and understanding ability, and respect students' differences and subjectivity.

3. New Requirements and Realistic Challenges of the New Liberal Arts Curriculum

The essence of the new liberal arts is to restructure the traditional liberal arts, break through professional barriers and disciplinary boundaries, integrate emerging technologies such as big data and artificial intelligence into professional learning and training, and change the mode of personnel training. In terms of teaching philosophy, the new liberal arts emphasizes the combination of tradition and modernity, innovates teaching content, teaching mode and teaching means, and empowers traditional disciplines with new technologies and new methods. As an interdisciplinary course, Spatio-Temporal Data Analysis mainly includes collecting, mining, analyzing and displaying data in the field of public management and public policy by using big data, natural language processing, machine learning and other methods, so as to deepen the understanding of the subject, structure and process in the policy process. As data collection, mining, analysis and presentation require certain programming ability, compared with other courses, this course has slightly different requirements for teachers and students. Especially for students majoring in humanities and social sciences, it faces some unique challenges in the teaching process, which are mainly reflected in the following aspects:

3.1 The Course Content and Teaching Arrangements do not Fully Take into Account the Characteristics of Interdisciplinary

According to the current training program, the course "Spatial-temporal data mining analysis" has a total of 32 class hours. In this short period of 32 class hours, students should not only understand the theoretical basis related to big data, but also be familiar with the basic operation of

Python programming language in a relatively short period of time and be able to use it for data capture and analysis processing. At the end of the class, they often need to combine specific cases to write debugging programs, carry out data analysis and complete the final report. Time is tight and the task is heavy, which presents a big challenge for most students who master a new programming language from scratch and use it for data analysis. As one student said in a teaching review, "It would be better if we could extend the class hours and more fully study the knowledge and its application in research." When the course was first offered, the teaching team failed to fully consider the characteristics of interdisciplinary courses. The course content and teaching arrangement still followed the usual "routine", and each chapter was carried out in the structure of theoretical explanation and case analysis, which easily led to the "fragmentation" of knowledge points and the disconnection between course design and practical application, which affected the realization of teaching objectives.

3.2 Students' Cross-Disciplinary Basic Ability is Relatively Weak

For students majoring in humanities and social Sciences, although they have completed the study of basic computer or computational thinking courses during their undergraduate years, some students may also take quantitative analysis courses such as Stata as elective courses in their senior undergraduate years. They have certain experience in using command line or code for data processing, but due to a long time gap, they rarely use it in daily life. As a result, most students are unfamiliar with the operation principle and programming of computers. In the actual teaching process, some students even successfully installed the integrated development environment after several weeks of the course, which brought great obstacles to the course teaching. Common demands from students include: "I hope the teacher can speak more easily and gradually, and don't make a 'great leap forward' before we understand it, because we don't have the relevant foundation."

Another negative effect of students' weak foundation is that it is difficult to maintain learning motivation for a long time. The practice found that the students' learning enthusiasm was generally high in the early stage of the course, and they had a longing and expectation for learning a new programming language and using it to solve various problems. However, with the continuous advancement of the course, the knowledge points and learning difficulties increased, and the students' frustration gradually emerged. In the middle and later stages of the course, the differentiation of abilities among students has accelerated significantly, and it is difficult for students who do not have a solid grasp of basic Python knowledge in the early stage to fully keep up with the teaching rhythm, which affects the teaching effect.

3.3 The Traditional Teaching Mode is Difficult to Adapt to the Requirements of the New Liberal Arts Era

At the beginning of the course, the teaching team divided the course into two parts: theoretical explanation and experimental teaching according to the usual practice. In the theoretical lecture, teachers mainly introduced the relevant theories of big data, various concepts and syntax of Python, and various application scenarios and operation processes of big data analysis methods. The experimental teaching part revolves around a certain knowledge point or method, and the students complete the writing, debugging and running of the program code under the guidance of the teacher. The shortcomings of this conventional teaching mode mainly include: the content reflected by students in the theoretical explanation part is rather boring, and it is not easy to form an intuitive impression on the use of related concepts and grammar. In the part of experimental teaching, if the number of students is large, it is difficult for teachers to take into account each student and check their experimental progress, and it is inconvenient to know the true grasp of a certain knowledge point by students. Under this traditional teaching mode, if the basic programming students in the early stage can barely keep up with it, when it comes to the advanced application and analysis practice in the later stage of the course, more and more students begin to actively or passively "fall behind". Typical teaching comments include: "In the second half of the course, people find it difficult to understand the content and complete the homework."

3.4 Insufficient Incentive for Students' Independent and Personalized Learning

As a practice-oriented course, the realization of the teaching objective of Spatio-Temporal Data Analysis depends largely on students applying the theoretical knowledge and methods to solve practical problems. In the early teaching practice, for each knowledge point and data analysis method, the teaching team will choose appropriate case data to explain, promote the teaching plan in the processing and analysis of actual data, and try to combine theory with practice. According to the teaching feedback, although this practice is helpful to understand the basic operation of Python and big data analysis methods in practice, the questions and data in the exercise homework are selected by the teacher rather than the research questions that students are interested in. Moreover, the questions selected at various knowledge points lack continuity, resulting in students' weak sense of participation in the course. It affects their initiative of independent inquiry learning. In the evaluation of the teaching, the students said, "The examples used by the teacher in class are very interesting and practical," but they also hoped to "appropriately increase the learning of current social issues and improve the ability to solve problems."

4. Effectiveness of the PBL and Flipped Classroom Teaching Mode

In recent years, the teaching team has made reference to the advanced teaching research results at home and abroad, constantly sorted out and summarized the challenges faced in teaching practice, and continuously listened to the feedback of students on the teaching situation. On this basis, combined with the characteristics of humanities and social science majors, we constantly adjust the teaching objectives of the course, optimize the experimental teaching design, explore and form the teaching mode of "problem-based learning + flipped classroom", and achieve good teaching results.

4.1 Adjust and Optimize Teaching Objectives and Course Content

At the beginning, the team teachers referred to and integrated the content of Python programming language, Python data processing, natural language processing, machine learning and other relevant courses, and determined the experimental teaching objectives of the initial version, requiring students to be proficient in Python programming language, independently write debugging programs and carry out data processing. After the first teaching task, the teaching team felt that the teaching goal deviated from the subject needs and students' ability level to a certain extent, which affected the teaching effect. Considering the rich sample codes related to big data analysis projects on the Internet, students do not need to "build wheels" from scratch, the teaching team adjusted the teaching objectives to: familiar with Python syntax and basic operations, able to read and modify and debug sample codes according to project requirements, and able to carry out big data analysis in the field of public policy with the help of third-party resources and tools. Compared with the original version, the revised teaching goal is more "down-to-earth", echoing the "utilitarian" learning purpose of humanities and social science majors "do not seek understanding, but seek use", reducing students' learning pressure and improving their learning enthusiasm.

In addition, in terms of the design of the teaching syllabus, considering the relatively weak computer thinking and programming foundation of students majoring in humanities and social sciences, the content of basic knowledge of computer hardware and software and overview of programming language (1) is added to the course content, and the class hours of the basic operation module of Python are slightly increased. At the same time, since humanities and social science majors often need to deal with massive text data, the learning content of regular expressions has been increased. On this basis, according to the application status and development trend of big data in the field of this discipline, several core integrated application knowledge modules are screened, and students are reasonably planned and gradually promoted according to their ability level, so as to guide students to solve practical problems with the programming skills they have mastered. In the teaching process, the teaching of the knowledge points of each module is based on the example code explanation, and pays attention to the students' understanding of the program and the exercise of debugging ability.

Based on the teaching practice of the new syllabus, it is found that students can quickly run the program and complete various data processing and analysis tasks after modifying and debugging the sample code according to specific needs, effectively avoiding the psychological resistance of programming from scratch. On this basis, some students also make use of network resources to continue in-depth exploration under the guidance of teachers. At the end of the course, they can write and debug relevant program code proficiently.

4.2 Adopt the "Problem-Based Learning + Flipped Classroom" Teaching Mode to Guide Students to Learn Independently

Under the "problem-based learning + flipped classroom" teaching model, students are motivated by strong problem motivation and take the initiative to learn learning resources before and after class under the guidance of teachers. On this basis, they explore and interact independently to achieve predetermined learning goals. Thanks to the abundant learning resources related to Python and big data analysis on the Internet, in the teaching process, teachers can accurately "push" learning resources and reference materials according to the progress and mastery of knowledge points of each learning group. In the concrete implementation, it mainly includes four stages: question raising, flipped classroom learning, problem solving, evaluation and consolidation.

4.2.1 Ask a Question

As the first stage of this teaching mode, the primary task is to establish course rules and systems, promote teachers and students to reach a consensus on the teaching objectives, teaching modes and specific requirements of this course, and facilitate the smooth development of subsequent teaching activities. On this basis, students are divided into several study groups, and each group proposes research questions according to their research interests, cutting-edge issues of the subject or the topics they participate in. The solution steps of the problems should include the four core knowledge modules of the course and be determined after consultation with the teachers. At this stage, the central task of teachers is to guide students to change their learning concepts, mobilize students' desire for knowledge and exploration, and recommend or guide students to choose reasonable and feasible research questions throughout the course learning.

4.2.2 Flipped Classroom Learning

The central task of flipped classroom learning stage is to solve the problem as the orientation, students independently learn the course resources provided by the teacher, the teacher evaluates the students' learning situation and adopts the method of combining concentrated explanation and individual guidance to find out the shortcomings and fill in the gaps. In this phase, the teacher's focus is to help the teams work out a technical roadmap to solve the problem, then work backwards on the required programming skills, and relate the skills to the knowledge points in the course resources. Thus, the operation steps, required programming skills and knowledge points of course resources involved in problem solving can be sorted out clearly, and students can self-study efficiently before class. After the self-study before class, each group summarized the difficult knowledge points and puzzles encountered respectively, carried out discussions in class, and the teacher gave concentrated explanation or individual guidance according to the situation. The introduction of flipped classroom teaching mode "liberated" teachers from the usual teaching work in the order of knowledge points, and replaced it with the answer to the important difficult points and key issues that students really care about. This approach effectively solves the problem of fewer class hours and heavy learning tasks, turns classroom time into a "golden time" for teachers to check and supervise the learning progress, and teachers and students to communicate and cooperate, and improves students' ability to independently apply what they have learned to solve practical problems.

4.2.3 Solve the Problem

After "breaking down" the basic programming skills and knowledge required to solve the problem, the student begins to focus on solving the problem presented in the first stage. This stage

is not only the "touchstone" to test the effect of previous teaching, but also the "arena" to train students to apply the knowledge to solve practical problems. Objectively speaking, it is indeed a big challenge for students to correctly use the new knowledge and methods they are learning to solve complex problems. However, on the one hand, students have mastered relatively solid basic skills in early learning; on the other hand, abundant online learning resources and tools, as well as guidance and help provided by teachers, can provide solid support for students to solve problems. More importantly, the process of problem solving is actually a process of constantly encountering and solving new questions, which will encourage students to actively seek new learning resources, learn new knowledge and improve comprehensive ability.

4.2.4 Evaluation and Consolidation

When the course progresses to the integrated application module, in the last two class hours of each module, the teacher will randomly select two or more groups to report on the problem solving process, share the difficulties and blocked points encountered in the problem solving process, summarize the innovation points and shortcomings of the solution used by the group, and respond to the questions and doubts of other groups. Then, the teacher comments on the presentations of each group in combination with the thematic content, and briefly introduces the skills, methods, tools and processes needed to solve such problems in general. Through this "training" type of centralized reporting and communication, it can better stimulate students' sense of joy and achievement after solving problems, consolidate learning results, and cultivate students' teamwork and communication skills.

5. Conclusion

The rapid development of emerging technologies such as artificial intelligence and big data and their wide application in different scenarios have provided new research tools and methods for the development of different disciplines, which have caused profound changes in the research methods of the entire liberal arts. The cross-development and integration of big data and artificial intelligence in various disciplines also put forward higher requirements for the big data analysis skills of humanities and social science researchers and students. In this context of The Times, based on the teaching practice of the big data analysis course for students majoring in humanities and social sciences, this paper summarizes the new requirements of the new liberal arts for the course and several challenges faced by the big data analysis course for students majoring in humanities and social sciences, and proposes to combine the needs of disciplines, practical applications and students' abilities. Make practical teaching objectives, optimize the teaching syllabus and suggestions for the allocation of class hours; On the other hand, it shared the practice and exploration of improving classroom efficiency, guiding students to independent deep learning, and improving teaching effect through the teaching mode of "problem-based learning+ flipped classroom".

The practice of teaching reform shows that the teaching organization form of "problem-based learning+ flipped classroom" is a student-centered personalized teaching mode, which helps to increase students' learning input and fully stimulate students' independent learning motivation. This effect is consistent with the empirical research results of "new liberal arts" top talent training quality carried out by Zhang Tianshu. More importantly, independent learning and discussion under the guidance of teachers can also promote communication and cooperation among students and between teachers and students, enhance students' comprehensive problem-solving ability, improve self-expression and team cooperation ability. This exploration, in response to the new situation of the construction of the new liberal arts to cultivate cross-border integration of talents in the main melody requirements, for the training of interdisciplinary professional background and cooperation ability of the new era of college students to provide a practical approach.

Indeed, management sciences includes many disciplines, each of which has different visions for the construction of the new liberal arts and different requirements for the cultivation of interdisciplinary talents. Moreover, students have different knowledge backgrounds and abilities.

How to explore and adopt more scientific and personalized teaching models in light of these different characteristics to achieve the goal of cultivating new liberal arts talents, which is worthy of further study and continuous exploration and optimization in teaching practice.

Acknowledgements

This paper is supported by the 2022 Ministry of Education Industry-University Cooperative Education Project, "Construction of the Practice Base of Spatio-temporal Data Analysis Couse Based on Big Data and Machine Learning", No. 221001141120634.

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