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The Reform of GIS Practice Curriculum for Geography Science (Normal) Major Integrating Geographic Big Data and Multi-track Teaching Mode

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Abstract

Using geographic big data to reveal the development of the real geographic world and its rules is a new trend in the development of geography teaching. How to effectively integrate the technical methods related to geographical big data, so as to improve the GIS (Geographic information system) practical ability of students majoring in geography science (normal), is one of the momentous issues facing geography teaching at present. To this end, relying on the existing research projects, the new geographic big data-related technology methods are introduced into the GIS course, and the "LBL+PBL+RBL" multi-track teaching mode is constructed. The teaching practice shows that the multi-track teaching mode should be carried out in a certain sequence, with the LBL mode as the main rode in the early stage and PBL mode in the later stage. While integrating RBL into the process of LBL and PBL, the principal part of obtaining resources has changed from teachers to students, so as to solve the problems existing in practical teaching. The integration of geographic big data into the "LBL+PBL+RBL" multi-track teaching mode has improved the teaching content and teaching format, and enhanced the GIS practical ability of Geography normal students. Students have a high degree of recognition and learning interest in this reform method.

Keywords

Geographic Big Data, Gis, Geography Science (Normal) Major, Practical Ability, Multi-Track Teaching Mode

1. Introduction

The Geography Curriculum Standards of Ordinary Senior High School (2017 Edition) puts forward: "Make full use of geography information technology to create an intuitive, real-time and vivid geography teaching environment." In the new curriculum reform, more and more attention is paid to the interrelation among geography science, life reality and modern information technology, thereby exerting influence on students' knowledge system and ability shaping. Under modern condition, geography information technology has gradually covered the whole process of high school geography teaching (Ning & Fang, 2021). With the support of modern information technology, geographic big data can perce-

ive geographical phenomena and elements in a wide range with high resolution (Liu, 2022), and it plays an important role in the research fields of urban internal spatial structure, urban planning, epidemic prevention and control, and population mobility. Geographic big data has the characteristics of massiveness, multi-source, high sample coverage, fast update, fine granularity and high density, which endows it with important teaching functions: providing more real-time, intuitive, realistic and scientific data information teaching resources, introducing cutting-edge knowledge in a targeted manner and enriching teaching content; Being able to explore the knowledge of the pattern of geographical elements and human behavior modes (Pei, Liu, Guo, Shu, Du, Ma, et al., 2019), it is of great significance for understanding and solving the man-earth relationship issue and implementing the cultivation of the core literacy of geography. The use of geographic big data to reveal the development of the real geographic world and its laws is a new trend in the future development of geography teaching (Dou & Huang, 2020). GIS (Geographic information system) technology is the basic means for the in-depth development, analysis and application of geographic big data, and the integration of both with geography science can effectively promote the change of senior high school geography teaching.

The rapid development of information technology and geography has put forward new requirements for teachers' ability to master geography information technology and apply it to teaching practice. At present, more teaching is restricted to displaying intuitive images by using network GIS (Google Earth, Tian Di Map of China, etc.) and 3D GIS, and only a few use GIS technology to analyze big data such as house price and POI (Point of Interest), and then assist the teaching of location selection, spatial change of population, urban internal spatial structure, etc. (Wang & Zhang, 2021; Wang & Hu, 2020; Li & Wang, 2021). A scholar has studied the application of GIS in front-line teachers' teaching in a certain place. The survey shows that most front-line teachers think that GIS is helpful to teaching and are willing to use GIS for teaching (Yan, 2020). However, it will be restricted by the deficiency of knowledge of GIS technology and the lack of software and hardware facilities. Therefore, in addition to strengthening the training of front-line teachers, more attention should be paid to the cultivation of GIS practical skills for students majoring in geography science (normal), so as to solve the problem of "mismatch between supply and demand" between the demand for secondary school geography teaching and the lack of solid GIS practice ability of geography (normal) students (Sun, 2020).

At present, there are many problems in GIS courses of normal universities, such as unreasonable curriculum structure, limited teaching content, single teaching mode and assessment mode, and emphasis on theory rather than practice. For this reason, a great deal of scholars have made teaching reform exploration for this course. Wu and Zhang (2019) introduced modular learning and case-based teaching methods into GIS practice courses, modified the assessment system and practice evaluation indicators, and cultivated students' ability to solve practical problems by "promoting learning through competition". Chen et al. (2021) integrated the PBL (Project-based Learning) method into the GIS curriculum. According to the learning process, teachers set up basic tool learning, simple projects, complex projects, and group design projects to guide students to gradually improve their practical application ability. Wu et al. (2020) integrated the OBE (Outcomes-based Education) concept and PBL mode into the course, adjusted the teaching content, model and evaluation, and carried out project-based teaching from three aspects: ability self-assessment, project practice and project evaluation. Sun (2020) pointed out the prominent problem that the current instructional objectives of undergraduate GIS course "can't conform to the teaching demand of middle schools" based on the application needs of middle schools, and put forward the curriculum reform path of relying on the teaching of scientific research achievements in universities and implementing innovative teaching modes such as task-driven.

Under present conditions, the mainstream teaching modes are mainly divided into teacher-centered (including Lecture-Based Learning and Case-Based Learning) and student-centered (Project-Based Learning and Resources-Based Learning) (Zhang, 2011). These teaching modes have their own advantages and disadvantages. More and more scholars try to break the limitation of single teaching mode and build dual-track or multi-track teaching mode by integrating the advantages of each teaching mode according to the subject characteristics and teaching contents. At present, multi-track teaching mode is more often applied in management (Zhang, 2011) and medicine (Yang, Li, Zhang, Wang, Lin, Yu, et al., 2018) Teaching.

Aiming at the shortcomings of GIS practice course in Lingnan Normal University and the rapid development demand of geographic big data at present and in the future. This paper draws lessons from the successful experience of other universities, introduces the multi-track teaching mode of "LBL+PBL+RBL" into the GIS practice teaching reform, integrates geographic big data, and optimizes the teaching content and teaching form. This provides a reference for cultivating normal universities which are in line with the digital information age and have a solid foundation of GIS theory and practice.

2. Questionnaire Survey of GIS Practice Teaching

In order to further understand the current teaching situation of GIS practice courses for teachers' majors and provide

targeted teaching reform directions, this paper selects 98 students majoring in geography science (normal) of 2019 in Lingnan Normal University as the survey objects, and the survey was conducted in three aspects: “learning situation of GIS course”, “tendency of choosing course reform method” and “interest in learning geographic big data”. Some of the survey results are shown in the chart as follows:

Table 1. The Learning Situation of GIS Course and the Choice Tendency of Reform Mode

Survey Content	The Main Factors Influencing The Learning Effect of GIS Courses		The Way to Improve GIS Practical Application Ability	
Options and Corresponding Proportions	Self-learning ability and attitude.	48%	Strengthen the connection between theory and practice.	72%
	Short practice time.	45%	Increase practical teaching time.	47%
	Single teaching form.	55%	Enrich teaching forms, combine case exercises and extracurricular knowledge expansion.	63%
	Scattered knowledge points, and the connection is weak in practical application.	50%	Enrich data types and integrate new big data.	60%
	Excessive difficulty and incomprehensible knowledge.	60%	Obtain data and resources from other online learning platforms.	45%
	Monotonous teaching content and difficult access to scientific frontier.	40%	Enrich course content and integrate cutting-edge scientific research results to assist learning.	50%
	Cases of textbook are classic but little useful for scientific research and future teaching.	25%	Adopt project-based learning (solve problems in groups and complete experiments).	45%
	Connection between the course content and the normal major is not obvious.	40%	Integrated training in ‘acquiring data - processing - analyzing - mapping’ process.	52%
	Low learning motivation and weak innovative thinking ability.	35%	Other	0%

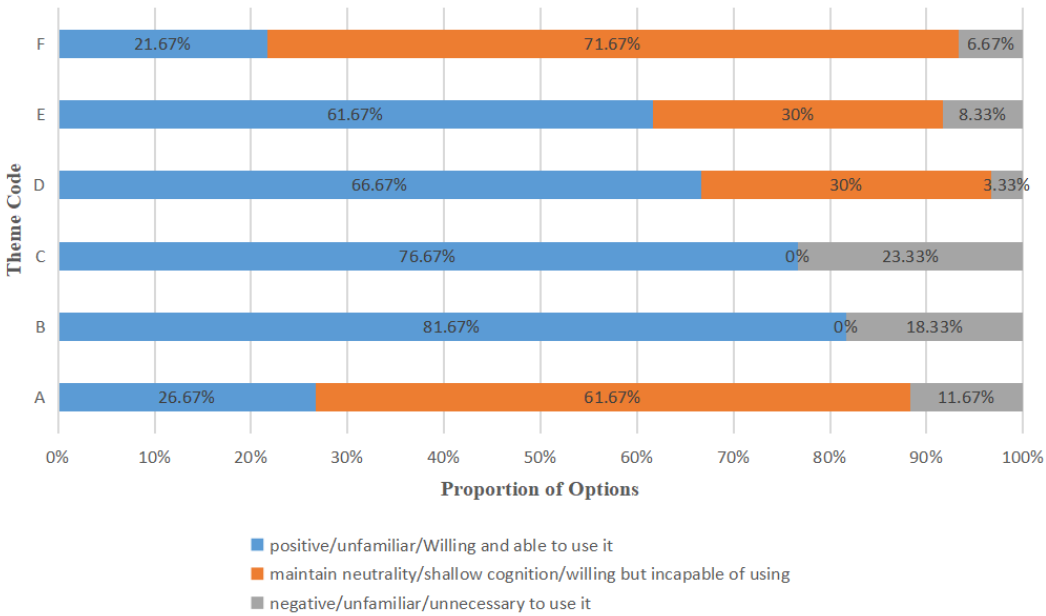

Figure 1. Investigation on the Understanding Degree and Learning Interest of Geographical Big Data.

Each code in Figure 1 indicates:

A: Do you know anything about geographic big data?

B: Are you interested in learning more about the acquisition mode, processing and application forms of geographic big data?

C: Are you interested in using GIS technology for spatial analysis of geographic big data?

D: Do you think the integration of big data practice projects in the current GIS practice teaching can stimulate learn-

ing interest?

E: Do you think setting up a practice project combining big data, GIS technology and middle school geography content will help to improve the teaching application ability in the future?

F: What is your attitude towards using GIS and big data in middle school teaching in the future?

Based on the comprehensive analysis of the survey contents, the following conclusions are drawn: normal students just have a vague understanding of the current application of GIS in middle school teaching. And some students still think that it is not necessary to improve their practical application ability of GIS, which shows that students' emphasis on GIS and their awareness of teaching application require to be strengthened. In the students' choice of factors that affect the learning effect of the course, it is found that there are many common problems, e.g., excessive difficulty knowledge, single teaching form, scattered knowledge points, and short practice time. The prominent problems are monotonous teaching content and the lack of obvious connection between the course content and normal majors. Accordingly, students tend to choose to strengthen the connection between theory and practice, enrich teaching forms and data types, adopt the integrated exercise of "acquire data-processing-analysis-mapping", enrich course content, obtain data resources through network platforms, and project-based Cooperation and other ways to improve the practical application ability of GIS. Apart from this, students' cognition of geographic big data mostly stays in superficial layer and less practical application. They have high recognition and learning interest for the integration of geographic big data with GIS courses and middle school geography teaching. Therefore, this paper focuses on solving the problems existing in the GIS practice course, and puts forward the GIS practice course reform scheme integrating geographic big data according to the students' choice and interest in the course reform.

3. Design Mentality of GIS Practical Teaching Methods in the Context of Big Data

3.1 Subject Application-oriented Practical Skills Cultivation Objectives

The geography science (normal) major in colleges and universities takes possess solid geography subject knowledge and outstanding geography practice as its cultivation aim, and provides high-quality talents for geography teaching positions. After graduation, students majoring in geography science (normal) are mainly engaged in middle school teaching and scientific research. Therefore, in the reform of the practical teaching method of GIS courses, this paper is guided by the application of subject technology, and is divided into two different levels to meet the learning demands of different students. In the first instance, oriented to the background of secondary school geography teaching reform and the teaching trend of integrating geographic information technology, it pays attention to cultivating students' awareness and ability of applying geographic information technology to geography teaching in middle schools at the undergraduate stage, while gradually developing and accumulating cases where geographic information technology, geographic big data and secondary school curriculum fit together to enrich the course resource base. In the next place, aiming at the great innovations in concepts and methods brought about by the era of informatization and big data, students are guided to actively explore and innovate under the new research paradigm of geography, and to assist geographic research with emerging technologies. Comprehensively meet the demands of middle school teaching and scientific research ability, and enhance the core competitiveness of students majoring in geography science (normal).

The application orientation of the discipline requires that students need to learn not only the technology, but also the application of the technology. Therefore, the following three levels of practical skills objectives are set in the GIS course of geography science (normal) major.

Level 1: Strengthen the basic application skills aiming at constructing knowledge system and simple practical operation.

Level 2: Emphasis on comprehensive application skills which take contact with reality as the goal and contact with the frontier as the direction.

Level 3: Practice the innovative development skills oriented by middle school teaching application.

3.2 Construction of "LBL+PBL+RBL" Multi-track Teaching Model Integrating Big Data

Under the new curriculum reform, the role of teachers has changed from the disseminator of knowledge to the guide and facilitator of students' learning, and students have become the main body of learning. GIS is a comprehensive discipline combining geography science, cartography, remote sensing and computer science. Using the traditional teacher-centered teaching method and computer operation teaching mode, many students express that it's difficult, the content and form are single and boring, which affects the learning effect of the course. According to the characteristics of difficult knowledge and outstanding practicality of GIS courses, this paper integrates the advantages of the following modes, introduces geographic big data into GIS curriculum, and establishes a"LBL+PBL+RBL" multi-track teaching

mode.

3.2.1 LBL teaching mode

LBL (Lecture-Based Learning) teaching mode is a teacher-centered knowledge-instilling teaching used in traditional classroom. This mode is suitable for teaching basic theoretical knowledge. Teachers help students to establish knowledge system through systematic and continuous explanation. However, students can only passively receive knowledge in this mode, and their learning initiative and innovation ability are not effectively cultivated (Zhang, 2011).

3.2.2 PBL teaching mode

PBL (Project-Based Learning) teaching mode aims to guide students to "learning by doing", which is different from the traditional classroom focusing on theoretical indoctrination. This teaching mode requires teachers to select appropriate projects for students as classroom practice content, infiltrate and consolidate knowledge around the projects, and help students establish a connection between theory and practice. Students discover, analyze and solve problems in cooperation and inquiry, and highlight the coherence and practicability of knowledge. Students as the main body promote the development of the project, are stimulated to learn autonomy, enhance their ability to solve practical problems and teamwork, and cultivate innovative thinking (Chen, Gao, Sun, Sun, & Zhao, 2021; Zhao, Liu, Huang, & Xie, 2019).

3.2.3 RBL teaching mode

RBL (Resources-Based Learning) mode means that students can independently acquire, process and analyze information resources, and connect with subject knowledge to solve practical problems, so as to improve students' thinking ability and creativity (Du, Zheng, & Zhang, 2013). At present, this mode requires teachers to select and provide fragmented extracurricular information and data for students, which are connected with the curriculum content. Students actively study and solve problems according to these resources. Geographic big data contains geographic information e.g., the distribution law of various geographic phenomena and the characteristics of temporal and spatial evolution. The rapidity of information revolution has led to an increasingly multi-source and massive amount of data. As a discipline that processes and analyzes spatial information, GIS needs to integrate new data with geographic mining significance in a timely manner. At the same time, it also puts forward requirements for the updating of teaching content and the ability of students to obtain and apply resources independently. Therefore, the RBL model runs through the whole process of teaching, which can not only supplement and update the teaching contents, but also gradually broaden students' horizon, accumulate cutting-edge scientific knowledge and broaden the breadth of course learning.

4. Practical Scheme Under Multi-track Teaching Mode

GIS is a course with close connection between theory and practice. Therefore, the teaching process is divided into two parts: the theoretical and basic operation part adopts "LBL+RBL" teaching mode; the practical application part adopts "PBL+RBL" teaching mode, and the specific plan is shown in Figure 2.

4.1 Theoretical Explanation and Basic Operation Stage Under the "LBL + RBL" Mode

According to the survey, even after studying the relevant theoretical prerequisite courses, up to 56.67% of students still think that their GIS theoretical knowledge and practical ability are weak. Therefore, before the actual operation, we need to adopt LBL teaching mode, with teachers as the main body to lecture key knowledge, to help students consolidate the theoretical foundation and to construct the relevant knowledge system of GIS course. Under RBL teaching mode, teachers should specify the learning objectives and difficult point to students according to the curriculum standards, and assign the task of autonomous learning. Teachers assume the roles of resource providers and learning guides, provide basic learning courseware, and select high-quality online learning resources on platforms e.g., MOOC and Bill-bill in China. For example, the density, interpolation, clustering and spatial auto-correlation analysis methods are studied by using the relevant cases provided by the "Big Data Regional Analysis" course. Students rationally handle, analyze and utilize these resources, and independently think and research issues with the help of WeChat public accounts, CSDN technology forum and other platforms. The rational use of online learning resources can effectively compensate for theoretical teaching based on teaching materials and overcome the disadvantages of monotonous teaching contents and single form of teaching.

Basic operations include data processing and analysis modeling. The main teaching method is students' self-operation, followed by teachers' timely inspection and guidance. In view of the frequent misunderstandings, teachers provide concentrated explanations and demonstrations, and further expand the teaching content. In this stage, the comprehensive LBL and RBL teaching mode strengthens the basic application skills of level 1, and lays the foundation for the development of PBL mode with higher requirements for students ' ability and teacher-student communication.

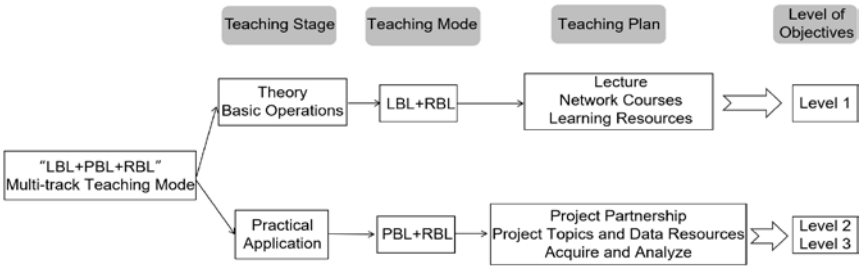

Figure 2. Schematic Diagram of Multi-track Teaching Mode.

4.2 Practical Application Stage under the "PBL + RBL" Teaching Mode

PBL teaching mode is a link of applying theory to real situations. Students gradually improve their practical ability by discussing and solving problems in the project. According to the hierarchical practical skills objectives of GIS course, it is divided into integrated application projects and innovative development projects. The RBL teaching mode is integrated into the project development process, where students learn new data processing and analysis techniques through independent access to information, resources and data and then promote the implementation of the project.

4.2.1 Integrated Application Projects

The training of basic operation skills is carried out around relatively independent knowledge points in textbooks, and there are few cases closely related to real life, which hinders students from applying technology to research and teaching in real situations. This project is arranged after the theoretical explanation and basic operation stage, and requires students to selectively apply what they have learned to real projects in combination with the established knowledge base, so as to train students' comprehensive practical ability of data "acquisition-processing-analysis" integration. This stage selects "measurement of street vitality in Tianhe district based on multi - source data" as an example, the specific project process is shown in Figure 3. In the project, teachers only conduct guidance and partial operation demonstration, and set questions to students: Based on data analysis of the city's vitality status. Students use the online learning platform to obtain data resources and explore ways of data processing and analysis. And discuss, communicate and research with each other within the team to solve problems. According to the teacher's demonstration of the processing and analysis process of POI (Point of Interest) functional density, students repeat each step in the process by using the obtained data and knowledge. After the experiment, it is necessary to submit: learning report, experimental result chart and urban vitality status analysis report.

Taking "POI functional density" as an example, the operation steps are as follows:

1) After acquiring POI data by Python, it is necessary to clean the data with unclear classification and duplication.

2) According to the classification of POI, the categories that can represent the functions of production and life are selected and merged.

3) Clipping: when POI is obtained, the minimum circumscribed rectangle of the administrative region is taken as the acquisition range, so the data outside the administrative region need to be eliminated.

4) Kernel density: according to the spatial distribution of POI point data, the density of point elements in the surrounding neighborhood is calculated.

5) To evaluate the urban vitality at the street scale, it is necessary to take 50 meters around the road as the axis to establish a buffer to characterize the overall situation of the road, and extract the density value according to the mask.

Under the RBL teaching mode, students need to master the connotation and practical significance of urban vitality and the connection between experiments and knowledge points in textbooks. In terms of data collection, it is necessary to strengthen students' Python code writing skills, and guide students to learn to use open platforms e.g., Gaode map and Baidu map to obtain POI and housing prices. In the processing of street view data, teachers need to popularize the knowledge of visual image semantic segmentation based on deep learning full convolution network (FCN) to students (Yao, Liang, Yuan, Liu, Yong, Zhang, et al., 2019). Guiding students to think about the direction of applying deep learning to geography research, and expanding students' thinking.

The project can guide students to contact frontier research, update their way of thinking, cultivate prospective consciousness and stimulate their enthusiasm for innovation. The practical teaching through cases from real-life scenarios and scientific research results can overcome the disadvantage of relatively independent teaching materials, establish a close connection between various operations and knowledge points, and enrich students' experience and ability of practical application.

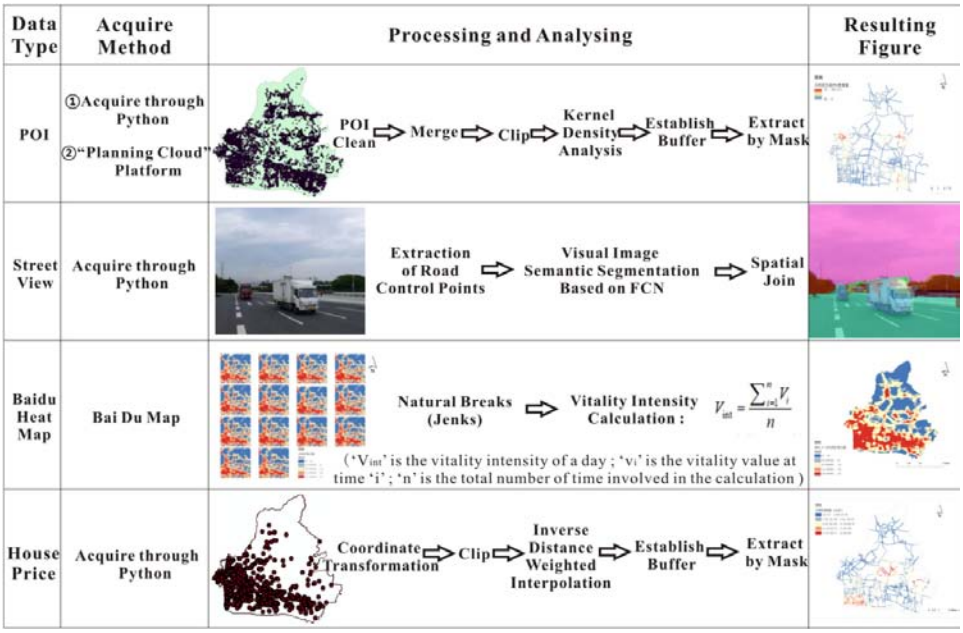

Figure 3. Flow Chart of Big Data Project Experiment.

4.2.2 Innovative Development Projects

This project is carried out by the students completely independently, and the teacher only assumes the auxiliary role of guidance. The project requires the completion of thematic map production or curriculum resource development that organically integrates big data, GIS technology, and middle school geography teaching through group cooperation. The purpose is to enhance students' awareness and skills of applying GIS technology and geographic big data to middle school geography teaching according to the characteristics of professional application, and overcome the shortcomings of unclear professional guidance. The student teams need to independently complete the project topic selection, project plan formulation, data resource acquisition, processing, analysis and mapping. The final assessment is in the form of group reporting of innovative achievements and expounding the specific application methods in teaching. Teachers need to guide and comment on project alternatives and results. RBL teaching mode is embodied in project selection and data acquisition. Students retrieve the application research of GIS technology and geographical big data in middle school teaching through CNKI, and then determine the topic selection of the project, such as "urbanization process based on nighttime remote sensing data visualization", "location selection based on GIS overlay analysis" and "urban internal spatial structure based on multi-source geographic big data". On the premise of determining the teaching content, the students independently choose the type of data to be used and obtain corresponding resources with the help of the network platform, such as obtaining digital elevation data and remote sensing image data through the "Geo-spatial Data Cloud" platform, obtaining POI data through the "Planning Cloud" platform, and obtaining road network data through the "Open Street Map" website.

Taking "the industrial location factor of Dongguan city" as an example to develop teaching resources, it is necessary to obtain the data of administrative area, road network, POI, housing price, Baidu heat map and the latitude and longitude position of main schools, scientific research institutions and scenic spots in Dongguan city. According to the name and category of POI, general industry and high-tech industry in Dongguan City are distinguished, and various data are processed to manufacture images. In the actual teaching, students can be guided to explore the location choice of different industries in Dongguan by overlaying the layers to complete the course.

5. Conclusion

1) In the multi-track teaching mode of 'LBL + PBL + RBL', LBL mode is the construction of basic theoretical knowledge system dominated by teachers' teaching. PBL mode is to cultivate students' autonomous practical ability. The RBL mode relies on the network platform and undertakes the role of resource update and supplementation during the implementation of the LBL and PBL modes. Due to the difficulty of GIS practice course, teaching practice shows that multi-track teaching mode should be carried out in a certain sequence. In the early stage, LBL mode is the main mode, and in the later stage, PBL mode is the main mode. Students complete the project independently in the form of teams. In

the process of analyzing and solving problems, the principal part of active resource acquisition is transform from teachers to students, and complete by RBL mode.

2) Teachers of geography need to adapt to the new trend of integrating big data into geography teaching, and turn big data into a booster of geography practice teaching innovation. Integrating geographic big data into "LBL+PBL+RBL" multi-track teaching mode, which is connected with the digital information age from the aspects of teaching content and teaching form, can optimize the teaching effect, and students have high recognition and learning interest in this reform mode.

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