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Reform and Practice of Integrated Teaching of Remote Sensing and Geographic Information System Courses for Geographical Science Majors Oriented to National Land Space Planning

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Abstract: Based on the outcome-based education concept, the integrated teaching of professional courses for land space planning in the human geography and urban and rural planning majors was reformed and practiced. Focusing on the fundamental task of "establishing morality and cultivating people," the reform of the teaching mode was proposed to clarify the industry needs, revise and improve the training program and teaching syllabus, innovate the teaching mode, and optimize the practical teaching resources and conditions. A new "multi-dimensional, interactive, and three-dimensional" teaching mode was constructed, and the integrated teaching method of enterprise projects, professional internships, and scientific research training was innovated, realizing the talent training mechanism of "demand-driven and integration of industry and education."

Keywords: Outcome-based education concept; National land space planning; Human geography and urban and rural planning; Higher education

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1. Introduction

In recent years, the continuous development and widespread application of technologies such as cloud computing, big data, and artificial intelligence have put forward higher requirements and challenges for classroom teaching in colleges and universities. Remote sensing (RS) and geographic information system (GIS) courses are offered in majors such as geographical science, physical geography and resources and environment, human geography and urban and rural planning, and geographic information science. In order to adapt to the needs of society and improve the competitiveness of education, the construction and application of modern classrooms is the general trend [1]. Guided by the "National Standards for Teaching Quality of Undergraduate Majors in Ordinary Colleges and Universities," with the goal of building applied undergraduate majors, and

with “cultivating morality and educating people” as the fundamental task, the reform and practice of integrated teaching of RS and GIS courses in geographical science majors for national land space planning is a positive response to the “Guiding Opinions on Guiding Some Local Ordinary Undergraduate Colleges and Universities to Transform into Application-Oriented Majors,” and a beneficial exploration of the transformation and development of local ordinary colleges and universities.

2. Main problems in teaching

2.1. Extensive and complex teaching content and inconspicuous professional characteristics

In the current remote sensing and geographic information course teaching, the content covers a wide range and many knowledge points. The course setting pursues a large and comprehensive subject system, which includes both basic geographical theories and application skills such as programming and remote sensing technology, but lacks core courses that focus on industry needs [2]. RS and GIS should be the key technologies to support ecological sustainability research, but they are often used only as tools in teaching, and are not deeply related to specific application fields such as national land planning and environmental monitoring, and the professional characteristics are not prominent.

2.2. Unrelated basic and professional courses and teaching content

Remote sensing courses and geographic information system courses are interrelated, and the arrangement of related courses needs to ensure orderliness and logic. Basic courses such as geography and surveying are set as independent modules with professional courses such as remote sensing technology and GIS spatial analysis, and no progressive knowledge chain is formed. Basic courses are still mainly based on knowledge memorization, while professional courses directly require the ability to solve complex spatial problems. The transitional teaching link of “simple case simulation-real scene migration” is missing in the middle, resulting in students’ knowledge being relatively scattered and not forming a complete knowledge system. Ultimately, the cultivation effect of students’ comprehensive application ability and thinking ability is poor [3].

2.3. Abstract teaching content and limited teaching methods

The theories of electromagnetic wave radiation transmission and atmospheric correction involved in remote sensing teaching rely on abstract mathematical formulas and physical models, and lack dynamic visualization tools to display the energy transfer process [4]. GIS topology analysis is mostly based on static diagrams or text descriptions and cannot dynamically display the impact of node connectivity changes on path planning, making it difficult for students to understand the dynamic correlation of spatial relationships. Courses mostly rely on PPT presentations and software operation demonstrations, without combining virtual simulation laboratories or real-life three-dimensional modeling platforms, resulting in students only mastering basic tool operations and lacking the ability to solve complex spatial problems.

2.4. Disconnect between teaching content and industry practice and students’ weak practical application ability

Teaching is still mainly based on traditional desktop software such as ArcGIS and ENVI 5.3 [5], and cloud tools such as ArcGIS Online and Google Earth Engine are not introduced, resulting in students being unable to master distributed computing and collaborative workflow construction skills. Experimental data are mostly static GeoTIFF images or Shapefile vector data, and do not involve new data forms such as real-life 3D models and spatiotemporal databases. In industry practice, the demand for real-life 3D modeling has reached 62%.

Technology application scenarios mostly remain at basic mapping and simple spatial analysis, and are not connected to actual project needs, such as natural resource rights registration and smart city traffic simulation, resulting in 60% of students believing that the skills they have learned are out of touch with their positions [6].

3. Strategies for solving teaching problems

3.1. Conducting in-depth research in local areas and enterprises to clarify industry needs

In order to solve the problem of "lack of professional characteristics," an in-depth research in local front-line enterprises and institutions with RS and GIS as core components of national land space planning technology has shown widespread and continuously growing demand in multiple industry fields.

3.1.1. Natural resources and ecological environment management

In the field of resource monitoring and assessment, RS obtains data on land cover, forest resources, land use, etc., in real time through platforms such as satellites and drones, providing a dynamic data source for GIS. In the field of disaster warning and emergency response, GIS integrates multi-source data to conduct resource distribution analysis, environmental carrying capacity assessment, and ecological restoration planning. RS monitors the dynamic changes of natural disasters in real time. GIS predicts the impact range of disasters through spatial modeling and formulates emergency plans, which are applied to disaster risk assessment and post-disaster reconstruction [7].

3.1.2. Urban planning and smart cities

In the field of urban space optimization, RS provides high-resolution image data. GIS combines population, transportation, economic, and other data to assist urban planning decisions. In the field of intelligent management, GIS integrates the Internet of Things and sensor data to build an urban information platform to support intelligent applications such as traffic dispatch, public facilities management, and pollution monitoring [8].

3.1.3. Agriculture and precision agriculture

In the field of crop monitoring and yield prediction, RS uses multispectral and thermal infrared remote sensing to identify crop growth, pests and diseases, and soil moisture. GIS combines meteorological and topographic data to generate farmland management zoning maps to guide precise fertilization and irrigation. In the field of land resource management, GIS analyzes changes in arable land quality, and RS dynamically monitors illegal occupation of arable land to ensure food security and sustainable land use [9].

3.1.4. Integration of emerging technologies and industry expansion

In the field of cloud computing and big data, RS relies on cloud computing platforms to process massive data, and GIS combines big data technology to explore spatial laws and promote in-depth applications in smart cities, climate change research, and other fields. In emerging fields such as carbon neutrality, digital twins, and metaverse, RS and GIS provide a spatial database to support interdisciplinary needs such as carbon emission monitoring and virtual scene construction [10].

3.2. Revising and improving the training program and teaching syllabus, and strengthening the connection between the course teaching content

In order to solve the problem of "lack of connection between course teaching content," based on in-depth

research, the talent training program and teaching syllabus were revised and improved based on the OBE concept, following the principle of step-by-step progression to strengthen the connection between course content [11]. The first year mainly offers basic courses such as physical geography, basic geology, cartography, remote sensing principles and applications, and land resources. Through the teaching of the basic elements of the natural environment and their mutual relationship, a good concept of human-land coordination and sustainable development is established; through the teaching of basic theories such as GIS and RS, the acquisition and processing skills of natural resource data are mastered. The second year mainly offers professional courses such as urban planning principles, economic geography, GIS principles and applications, digital mapping, land management, and land economics. Through the teaching of urban planning, economic geography, and land management courses, a good planning and management knowledge system and thinking are established; through the teaching of GIS spatial analysis and mapping, the data analysis and processing methods of resources and planning are mastered. The third year mainly offers industry integration courses such as ecology, planning CAD, national land space planning, urban and rural planning GIS application, urban and rural planning management regulations, and big data technology. Through actual case teaching and the integration of cutting-edge technologies such as big data, practical application capabilities can be improved.

3.3. Building school-based characteristic resources and innovating teaching models

In order to solve the problem of "insufficient teaching methods," we have built online courses such as "Physical Geography," "Cartography," "Remote Sensing Principles and Applications," "GIS Principles and Applications," "Land Resources Management," and "Surveying and Mapping (City) Geographic Information Virtual Simulation Experiment" platform and other teaching resources based on the Super Star platform. In order to adapt to the requirements of outcome-oriented education, the following five transformations should be achieved [11]: from indoctrination classroom to dialogue classroom, forming knowledge exchange and interaction, "question mark" classroom, to stimulate students' enthusiasm for learning; from closed classroom to open classroom, forming an extension from in-class to extracurricular, from classroom to library and laboratory, and from textbooks to reference materials; from knowledge classroom to ability classroom, ability classroom is to form high-level knowledge through high-level teaching activities; from emphasizing learning and neglecting thinking to combining learning and thinking, which requires critical thinking, thinking is the key to innovation; from emphasizing teaching and neglecting learning to teaching as the main thing to learning, teaching students to "enjoy learning," "know how to learn," and "learn," and "how well we teach" should be evaluated by "how well we learn."

3.4. Deepening school-enterprise cooperation and optimizing practical teaching resources and conditions

In order to solve the problem of "disconnection between classroom teaching content and industry practice," the school-enterprise cooperation internship bases that have been established include Leshan Natural Resources Bureau, Leshan Housing and Urban-Rural Development Bureau, Sichuan Lihang Surveying and Mapping Co., Ltd., etc. In order to better adapt to social needs and promote the development of disciplines, under the background of industry-education integration, deepen school-enterprise cooperation, introduce enterprise projects into the classroom, combine real training projects with teaching, and combine project practice with professional learning to cultivate practical, application-oriented, and innovative talents with both theoretical knowledge and practical skills [12]. At the same time, comprehensively consider integrating the existing scattered

course practice and professional internships, and through comprehensive practical training and scientific research ability training, train and exercise students' comprehensive application ability of theories, methods, and technologies of relevant professional courses, so that students can consolidate the basic theories and experimental skills learned in class [13].

4. Promotion and application of the results

4.1. Significant achievements in professional construction

The Human Geography and Urban and Rural Planning major was approved as the 2023 Leshan Normal University undergraduate professional construction progressive cultivation project "Excellent Professional Team Construction." "Deepening the Universal Sharing Research on Ideological and Political Teaching of Human Geography and Urban and Rural Planning Majors in the New Era" was approved as the 2021–2023 Sichuan Higher Education Talent Training Quality and Teaching Reform Project. In 2022, "Physical Geography" was approved as a provincial-level ideological and political demonstration course, "Surveying and Mapping (Urban) Geographic Information Virtual Simulation Experiment" was approved as a provincial-level first-class course, and "Physical Geography" was approved as a school-level first-class course. In addition, there are more than 10 curriculum reform projects, such as the construction of an intelligent application practice base based on the integration of Haochen Software and GIS. The teaching team has published six teaching and research papers, such as Land Management Course Teaching Reform Research under the Background of Big Data. The teaching team has participated in more than 10 related teaching and research academic conferences, such as the 10th Cartography and Geographic Information System Academic Conference, and the "Remote Sensing Digital Image Processing" Course Teaching and Resource Construction Exchange Conference in Colleges and Universities.

4.2. Significant improvement in the quality of applied talent training

There are 86 students in the 2018 class of Human Geography and Urban and Rural Planning, with a pass rate of more than 70% for CET-4, 35% for CET-6, and 90.55% for Mandarin. They have been awarded the titles of "Excellent Learning Style Class at School Level" and "Advanced Class at School Level" by Leshan Normal University. Students have successfully applied for more than 20 provincial and national innovation projects and published five academic papers. More than 10 students have won national awards in the 9th, 11th, and 13th National College Students' GIS Application Skills Competition, Internet+, "Challenge Cup," and other competitions, 10 provincial first prizes, and more than 30 second prizes and winning prizes. Six students have obtained the Sichuan Provincial College Students' Comprehensive Quality A-level Certificate, one student has won the National College Students' Self-improvement Star, and six students have won the Sichuan Provincial Outstanding University Graduates and the School Outstanding Graduates. 13 students of the 2018 class of this major were admitted to the postgraduate entrance examination, and 11 students of the 2019 class were admitted to the postgraduate entrance examination. The internship units, such as Leshan Natural Resources Bureau, Leshan Urban and Rural Planning and Design Institute, Sichuan Lihang Surveying and Mapping Co., Ltd., etc., gave high praise to the talent training.

4.3. Strong cooperation between schools and universities

The undergraduate major of forestry at Leshan Normal University offers courses such as "Forestry Remote Sensing and Geographic Information System" and "Forestry Remote Sensing and Geographic Information

System Practice." The undergraduate major of geography science offers courses such as "Physical Geography," "Cartography," "Remote Sensing Principles and Applications," and "GIS Principles and Applications." The total number of students attending the courses has reached more than 500. The School of Engineering and Technology of Chengdu University of Technology offers undergraduate majors in geographic information science and urban and rural planning, and offers courses such as cartography, digital mapping, urban remote sensing, geographic information systems, land use master planning, and urban master planning. The total number of students attending the courses has reached more than 300. It has carried out more than 10 exchanges and cooperation with the School of Tourism and Geographical Sciences in teaching and research, student training, practical teaching, subject competitions, professional internships, and local services. In-depth exchanges and discussions have been carried out on how to expand the integration of industry, academia, and research, effectively promote the high-quality development of Leshan's industries, strengthen the construction of scientific research teams, effectively promote the improvement of teaching quality, and subject construction and professional evaluation.

5. Conclusion

In view of the current teaching difficulties, we are guided by industry needs, take industry-education integration and school-enterprise cooperation as breakthroughs, streamline teaching content, and highlight professional characteristics. Reconstruct the curriculum system according to the OBE concept, revise and improve the talent training plan and curriculum syllabus, and ensure the inheritance of the teaching content of basic and professional courses. Innovate the teaching model, carry out classroom teaching reform guided by skill and process assessment, build a batch of school-based characteristic teaching resources, enrich teaching methods, and promote the visualization and concretization of teaching content. Deepen school-local and school-enterprise cooperation, optimize practical teaching resources and conditions, give play to the effectiveness of collaborative education, and enhance students' practical ability. A talent training mechanism of "demand-driven, industry-education integration" has been established, forming an integrated teaching reform and practice of "outstanding professional characteristics, close course connection, rich and specific content, and school-enterprise collaborative education."

Disclosure statement

The authors declare no conflict of interest.

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