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Research on the Cultivation of GIS Professionals in Application-Oriented Undergraduate Universities in the Digital Intelligence Era

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Abstract

The training plan is an important guiding document for colleges and universities to carry out teaching activities, teaching management, and implement talent training. With the advent of the era of intelligence and digital, big data, artificial intelligence and digital twin are developing rapidly. It is urgent to revise the talent training program of GIS major in application-oriented undergraduate colleges to meet the demands of the times. Based on the needs of the GIS industry in the era of digital intelligence, this paper analyzes the current situation and problems of GIS major training in application-oriented undergraduate colleges, and proposes a "intelligence-oriented, application-driven" reconstruction plan for the GIS talent training system. It reshapes the training goals of the geographical information science major of Henan University of Urban Construction, and introduces in detail the construction of the curriculum system and the update and optimization of the curriculum content of the 25-edition training plan. The "trinity" ability training characteristics demonstrate the scientific nature and rationality of the training model proposed in this article. The plan proposed in this paper can provide reference for the cultivation of GIS majors in application-oriented undergraduate colleges.

Keywords: Big data intelligent era, application-oriented undergraduate colleges, geographical information science, talent training plan

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1. Introduction

In the digital intelligence era, the explosive growth of geographic information data is driving the intelligent transformation of the geographic information industry. Profound changes have occurred in the architecture, development models, and service modes of Geographic Information Systems (GIS) (Wang 2022a, 2022b). As a crucial pillar of China's higher education system, application-oriented undergraduate universities should proactively adapt to the demands of technological and industrial changes in the new era and strategically enhance the quality of GIS talent cultivation programs. This paper conducts research on the reform of the cultivation model for GIS professionals in application-oriented undergraduate universities during the digital intelligence era, which holds significant importance for cultivating high-quality application-oriented technical talent to support regional economic and social development.

Domestic and international scholars have conducted extensive teaching research on GIS education in universities (Niu 2025; Dong et al. 2025). Regarding the reform of GIS curriculum systems, studies have focused on reconstructing teaching frameworks for individual courses (such as geography courses(Wu et al. 2024) and spatial analysis courses(Li et al. 2023; Shu et al. 2023)), specific categories of courses (such as GIS development courses (Zhao et al. 2024)), specific course modules (such as core professional courses (Kang et al. 2023)), and GIS course clusters(Wang et al. 2024). In terms of innovating practical ability cultivation models, emphasis has been placed on project-guided approaches, enriching course experiment content, innovating teaching methods, integrating industry and education, promoting disciplinary competitions, and implementing process-based course assessments to enhance students' ability to solve practical problems(Li & Dang. 2023; Wang et al., 2024). In the research on cultivating application-oriented talent, studies have explored skill-based talent cultivation by combining the characteristics of GIS as a discipline and the industry advantages of application-oriented

undergraduate universities(Zhang et al. 2014; Zhao & Fan 2021). Although some scholars have extracted advanced technological methods such as big data, AI, and cloud computing and integrated them into GIS courses(Zhao et al. 2018; Chen et al. 2023), conducting research on the impact of technological changes on GIS education, most studies focus on research-oriented universities. There is relatively limited specialized, systematic, and in-depth research on the comprehensive reconstruction of the cultivation model for GIS professionals in application-oriented undergraduate universities in the context of the digital intelligence era.

The author's institution is a urban construction-oriented university. Against the backdrop of the digital intelligence era, how to leverage the characteristics of the urban construction industry to cultivate high-quality application-oriented GIS talent serving new urbanization and smart city construction, and how to reconstruct a talent cultivation system that aligns with the characteristics of the times, highlights application-oriented features, and meets the needs of regional development, have become core issues urgently requiring resolution for the survival and development of the program.

2. Restructuring of "Intelligence-Oriented, Application-Driven" GIS Talent Cultivation System

2.1 Overall Framework of the Curriculum System

In the digital intelligence era, our university's Geographic Information Science (GIS) program is committed to cultivating high-level applied technical talents who:

- Master the fundamental theories, knowledge, and skills of geography, geomatics, and spatial information science;
- Are familiar with the basic principles and methods of geographic information, remote sensing, and image processing;
- Understand the application prospects of 3D spatial information and spatial big data;
- Possess capabilities in big data analysis and mining, in-depth application of geospatial information, GIS engineering design, and software system development;
- Can meet the needs of smart city construction, integrating geomatics, computational science, and urban sciences.

Classical foundational GIS courses ensure students acquire solid basic GIS knowledge. Hidden Learning Path 1 ("Computational Thinking and Artificial Intelligence" → "Python Language and Programming" → “GIS Principle”→ "GIS Spatial Analysis" → "Spatial Data Modeling and Analysis" → "Python Development and Applications" → "Geographic Big Data and Artificial Intelligence") and Hidden Learning Path 2 ("GIS Visualization Program Design" → "Computer Graphics" → "VR Technology and Applications" → "The principle and application of WebGIS" → "GIS 3D Modeling" → "UAV Oblique Photography and Modeling") ensure students are exposed to cutting-edge technologies and disciplines such as big data, artificial intelligence, and 3D visualization, comprehensively enhancing their professional competitiveness. The main logical relationship structure of the four types of courses in the restructured curriculum system—"General Education Platform, Discipline Foundation Platform, Professional Education Platform, and Practical Education Platform"—is shown in Figure 1.

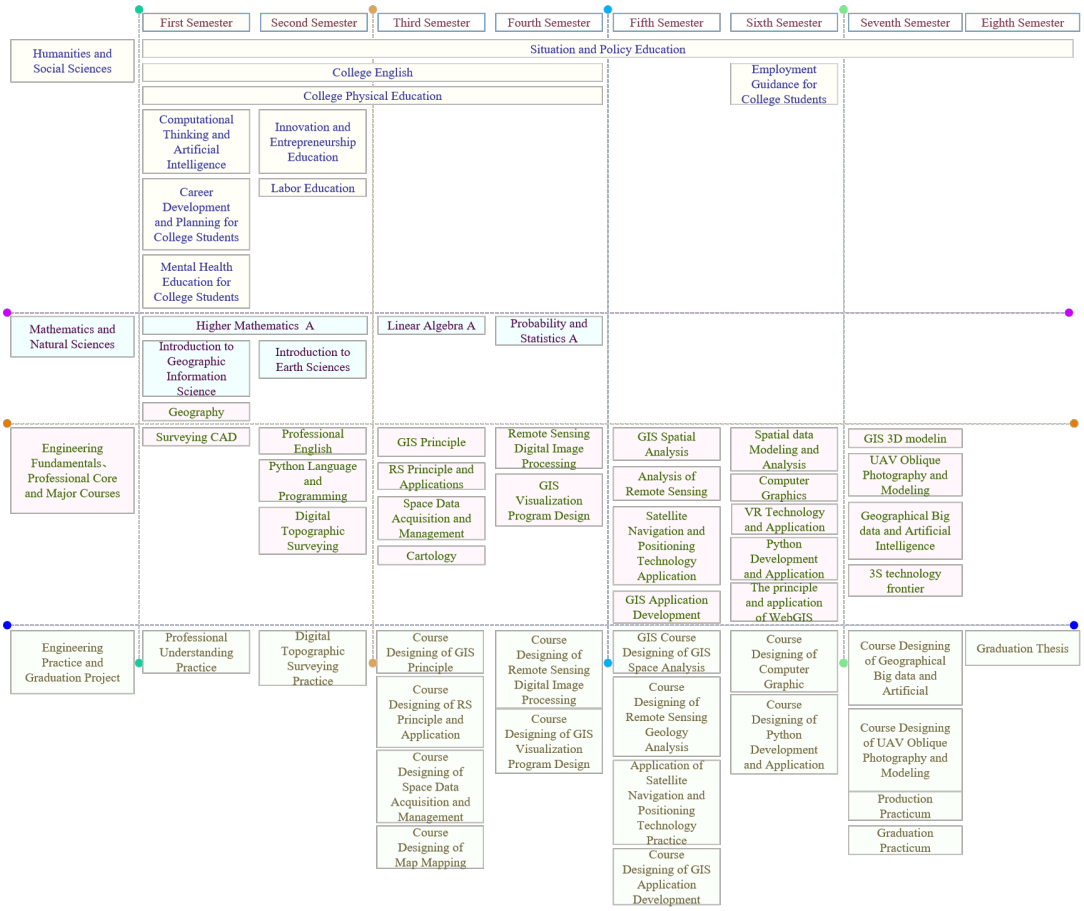

Figure 1. Diagram of logical relationship between main courses

2.2 Updating and Optimizing Course Content

To equip students with skills that meet market demands, the new cultivation program has eliminated some overly basic or repetitive content and incorporated more applied and forward-looking courses. The restructured curriculum's total credits have been reduced from 172 to 165, with the credit distribution detailed in Table 1.

(1) General Education Platform

The course "Fundamentals of College Computer" has been updated to "Computational Thinking and Artificial Intelligence" to better align with current societal demands for talent. This change effectively cultivates students' ability to master cutting-edge technologies and lays a solid foundation for their applications in emerging GIS fields. The credit allocation for the revised general education module remains unchanged, accounting for 29.7% of the total credits.

(2) Discipline Foundation Platform

Considering that the content of the courses "Surveying CAD" and "Introduction to Earth Sciences" is relatively basic and offers limited support for students' subsequent professional studies, the discipline foundation platform module has reduced the credit hours for these two courses. This adjustment allows students more time to engage with advanced courses. After restructuring, the courses in the discipline foundation platform account for 15.4% of the total credits.

Table 1. Credit distribution table

Course Module Categories		Compulsory Credits	Elective Credits	Total Credits	Percentage of Total Credits(%)
General Education Platform	Theoretical Teaching	40.5	6	46.5	28.2
	Experimental Teaching	2.5	0	2.5	1.5
Disciplinary Foundation Platform	Theoretical Teaching	23.5	0	23.5	14.2
	Experimental Teaching	2	0	2	1.2
Professional Education Platform	Theoretical Teaching	16.5	8.5	25	15.2
	Experimental Teaching	12	6.5	18.5	11.2
Practical Education Platform	Intensive Practice	37	7	44	26.7
	Comprehensive Practice	3	0	3	1.8
Total		137	28	165	100

(3) Professional Education Platform

The Professional Education Platform consists of core professional courses and personalized development courses. To broaden students' horizons and expose them to more cutting-edge technologies, the personalized development module has introduced a new course titled "3S technology frontier" and renamed "Urban Spatial Big Data" to "Geographical Big data and Artificial Intelligence". These changes not only help students stay abreast of industry technological trends but also equip them with application skills related to big data and artificial intelligence. After restructuring, the courses in the Professional Education Platform account for 26.4% of the total credits.

(4) Practical Education Platform

The Practical Education Platform includes in-class practice, intensive practice, and comprehensive practice. In this module, we have extended the duration of the "Course Designing of GIS Principle" and "Course Designing of Map Mapping" by one week each and added a new "Course Designing of Geographical Big data and Artificial". These adjustments ensure that students build a solid GIS foundation while also gaining hands-on experience in geographic big data and artificial intelligence. After restructuring, the Practical Education Platform accounts for 42.4% of the total credits.

2.3 Features of the Restructured Cultivation Program

The restructured core curriculum comprises foundational courses rooted in traditional geographic information science and technology, technically oriented courses supported by surveying and remote sensing technologies while deeply integrating cutting-edge computer science, and application-focused courses that employ concrete case studies for analytical purposes, as detailed in Table 2.

Foundational courses such as “Geography, Cartology, and GIS Principle” solidify spatial cognitive fundamentals, ensuring students can scientifically and professionally engage in intelligent spatial applications. Technically oriented courses, including "Computing and Programming Development," "Surveying and Remote Sensing Technology," and "Data Analysis and Modeling," are designed with an intelligence-oriented approach, equipping students with essential tools and methodologies for intelligent applications. Application-focused courses like "Geographical Big data and Artificial", "VR Technology and Application" and "UAV Oblique Photography and Modeling" are centered on real-world case scenarios, ensuring that the technologies students learn are practical and implementable.

Table 2. Reconstruct the characteristics of the culture program

Capability Categories	Course Categories	Specific Courses
Foundation Category	Fundamentals of Geographic Information Science	Introduction to Geographic Information Science, Geography, Introduction to Earth Science, GIS Principle, Cartology, Space Data Acquisition and Management
Technical Category	Computing and Programming Development	Python Language and Programming, Python Development and Application, The principle and application of WebGIS, GIS Visualization Program Design, GIS Application Development, Computer Graphics
	Surveying and Remote Sensing Technology	Digital Topographic Surveying, RS Principle and Applications, Remote Sensing Digital Image Processing, Analysis of Remote Sensing, Satellite Navigation and Positioning Technology Application
	Data Analysis and Modeling	Spatial data Modeling and Analysis, GIS Spatial Analysis
Application Category	Advanced Technologies and Applications	VR Technology and Application, Computational Thinking and Artificial Intelligence, Geographical Big data and Artificial Intelligence, 3S technology frontier, UAV Oblique Photography and Modeling, GIS 3D modeling

To address the demands of intelligentization and application-oriented development, the teaching content of foundational courses in the cultivation program has been integrated with intelligent methodologies and application scenarios. The number of "Computer and Programming Development" courses in the technical category significantly exceeds that in traditional GIS curricula. In the application-oriented course category, a new course on 3S technological frontiers has been added, with enhanced emphasis on cutting-edge technologies such as AI, big data, VR, and UAV modeling. By incorporating the "intelligence-oriented" philosophy and the "application-driven" objective into the restructuring of the GIS talent cultivation system, the program effectively nurtures a new generation of GIS professionals capable of mastering intelligent technologies and solving complex geospatial problems.

3. Conclusion

The author's institution has actively explored measures for cultivating GIS professionals in application-oriented universities during the digital intelligence era, accumulating extensive experience and achieving a series of outcomes in areas such as curriculum system design, course content updates, teaching model reforms, and practical teaching optimization. To date, the institution has developed three exemplary ideological and political education courses, four application-oriented courses, two online open courses, and one smart course alongside one high-quality course. It has also secured approval for one national/ministerial-level planned textbook, one university-level application-oriented textbook, and five university-level teaching reform projects. Under the guidance of the teaching team, students in the Geographic Information Science program have actively participated in various academic competitions, achieving notable results in national/provincial surveying and mapping science and technology thesis contests for college students, the National GIS Application Skills Competition for University Students, the SuperMap Cup GIS Competition for Universities, and the Esri Cup GIS Software Development Competition for Chinese University Students. In the future, the institution will continue to reflect on the new demands posed by Internet Plus, big data, artificial intelligence, and other technological trends for cultivating GIS professionals in application-oriented universities. It will further refine the cultivation program to nurture high-quality application-oriented talent that aligns with the trends of the times while incorporating local characteristics.

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