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Article

Exploration and Reform of Undergraduate Education in Urban and Rural Planning in the Era of Artificial Intelligence

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Abstract: Against the backdrop of the intelligent era, this study aims to explore pathways for the reform of undergraduate education in urban and rural planning to address evolving social demands and industry transformations. Employing literature review, case analysis, and survey research, this paper systematically examines domestic and international research progress and practical experiences. The findings indicate that curriculum reform must focus on the deep integration of cutting-edge technologies with traditional professional courses, establishing a full-chain technological framework encompassing "tools, analysis, and generation." Concurrently, core competencies such as digital intelligence application, ecological resilience awareness, and social governance coordination must be strengthened. Furthermore, establishing collaborative teaching bases involving universities, local governments, and enterprises, alongside integrating sociological and legal perspectives, can effectively enhance graduates' capacity to solve practical problems. This research provides theoretical and practical references for undergraduate education reform in urban and rural planning, facilitating the cultivation of high-quality, interdisciplinary talents tailored to the needs of the intelligent era.

Keywords: intelligent era; urban and rural planning; undergraduate education reform; curriculum system; competency model

1. Introduction

The rapid development of the intelligent era is profoundly transforming societal production and daily lifestyles, thereby presenting new imperatives for higher education. To date, intelligent technologies such as artificial intelligence, big data, and cloud computing have experienced an unprecedented explosion. This technological surge has not only driven deep structural transformations across industries but also introduced unprecedented opportunities and challenges to the discipline of urban-rural planning. Concurrently, the establishment of China's territorial spatial planning system has further clarified the core position of the urban-rural planning discipline within the broader framework of spatial governance. As a highly comprehensive and interdisciplinary field, urban-rural planning must undergo a fundamental paradigm shift from traditional morphological design to holistic, territory-wide governance, in order to meet the rigorous demands of spatial governance in the new era (Chen et al., 2020).

In the face of the rapid advancement of the intelligent era and the profound evolution of societal needs, the reform of undergraduate education in urban-rural planning at higher education institutions holds immense theoretical and practical significance. Primarily, this educational reform aligns with the urgent demand for high-caliber planning professionals driven by new-type urbanization and ecological civilization construction. It

empowers students to master interdisciplinary knowledge and intelligent technologies necessary to navigate and resolve complex spatial governance issues. Furthermore, by optimizing curriculum systems and pedagogical methodologies, this reform promotes a deep integration between educational content and industry demands, effectively bridging the gaps inherent in traditional educational models. Ultimately, by cultivating talents equipped with innovative mindsets and robust practical capabilities, the reform provides vital intellectual support for regional coordinated development, ecological protection and restoration, and the modernization of social governance, thereby better serving national strategies and the sustainable development of urban and rural areas.

To systematically explore the pathways for undergraduate education reform in urban-rural planning during the intelligent era, this study employs a robust mixed-methods research design, integrating literature review, case study analysis, and empirical survey research. Specifically, the literature review method clarifies the current research landscape and identifies existing deficiencies in urban-rural planning education reform through a comprehensive analysis of domestic and international academic achievements. The case study method selects representative higher education institutions, including Tsinghua University, Beijing University of Civil Engineering and Architecture, and Beijing University of Technology, to conduct an in-depth analysis of their practical experiences in curriculum system reform and technological innovation. Additionally, the survey research method utilizes in-depth interviews to gather insights, opinions, and suggestions from educators and industry experts regarding curriculum design, thereby providing solid empirical support for the study. Through the synergistic application of these diverse methodologies, this research aims to construct a scientifically rigorous framework, ensuring the reliability and targeted nature of the research conclusions, and ultimately providing theoretical foundations and practical guidance for undergraduate education reform.

Expanding upon this methodological framework, it is crucial to recognize that the transition toward an intelligent, territory-wide governance model requires more than just the addition of new technical courses; it necessitates a holistic reimagining of the planner's professional identity. Future urban-rural planners must evolve into "spatial data scientists" and "policy facilitators" simultaneously. The integration of big data and AI into the curriculum must be carefully scaffolded to ensure that students do not merely learn to operate software, but rather develop computational thinking and critical data literacy. They must be taught to question algorithmic biases and understand the socio-spatial implications of automated planning decisions.

Furthermore, the shift toward territory-wide governance demands that educational institutions break down the traditional silos between planning, ecology, economics, and public administration. This requires the establishment of interdisciplinary teaching teams and the creation of capstone projects that mimic real-world, multi-stakeholder planning scenarios. By grounding theoretical knowledge in the complex realities of China's territorial spatial planning system, universities can ensure that graduates are not only technologically proficient but also deeply attuned to the socio-political and ecological contexts in which they will practice. Ultimately, this comprehensive educational reform serves as a vital catalyst for modernizing China's spatial governance capabilities, ensuring that the built environments of the future are resilient, equitable, and sustainably managed in the face of rapid technological and environmental changes.

2. Literature Review and Research Assessment

2.1. Current Status of International Research

International scholars have achieved significant progress in urban-rural planning education reform, particularly regarding the integration of intelligent technologies and interdisciplinary approaches. Michael Batty, a foundational figure in urban complex systems and smart cities, argues in his seminal works, *The New Science of Cities* (Batty, 2013) and *Inventing Future Cities* (Batty, 2018), that planning education must transition from a traditional design-oriented paradigm to a science-oriented one. He emphasizes a fundamental shift in the underlying logic of planning education. Rather than relying solely on qualitative expert experience, curricula should incorporate data science, network analysis, and computational design into their core knowledge frameworks. Consequently, planning education should cultivate talents equipped with computational thinking, enabling them to solve modern urban challenges through data-driven methods and achieve scientific quantification and optimization of urban form and function.

Concurrently, Professor Zhong-Ren Peng from the University of Florida explores the application of distributed geographic information services over the Internet and wireless networks in his representative work, *Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks* (Peng, 2003). Peng advocates for human-machine collaboration rather than the replacement of human planners by artificial intelligence, highlighting the irreplaceable value of human judgment in intelligent planning processes. This

perspective is crucial as it prevents the alienation of planners from the design process, ensuring that technology serves as an empowering tool rather than a substitute for professional intuition and ethical responsibility.

Furthermore, top-tier international universities, including the University of California, Berkeley, Cornell University, and the Massachusetts Institute of Technology (MIT), have accumulated extensive experience in reforming urban-rural planning curricula to embrace intelligence and interdisciplinary integration. These institutions universally emphasize reshaping traditional educational systems through data-driven approaches and computational thinking. For instance, the urban informatics and visualization courses at UC Berkeley combine tools such as Python and GIS with real-world urban data workshops to strengthen students' quantitative problem-solving capabilities. Similarly, Cornell University's Urban Tech program, particularly through its Cornell Tech campus initiatives like the Master of Engineering in Data Science & Decision Analytics, fosters the development of interdisciplinary planners through cross-functional team-based learning models. These programs often integrate advanced coursework in operations research and information engineering, ensuring that students are not merely passive observers of technology but active creators of urban solutions.

Collectively, these international practices vividly demonstrate the prevailing trend in frontier education: a comprehensive transition from traditional morphological design toward a paradigm characterized by scientific rigor, intelligent integration, and interdisciplinary fusion. This global shift underscores the necessity of equipping future planners with advanced technological proficiencies while maintaining critical human-centric perspectives in spatial governance. By integrating computational tools and fostering collaborative environments, leading institutions are successfully bridging the gap between theoretical knowledge and practical application in complex urban settings. Ultimately, these educational reforms prepare graduates to navigate the multifaceted challenges of contemporary urbanization, ensuring that planning practices remain both technologically advanced and socially responsive in an increasingly data-driven world.

2.2. Domestic Research Progress

Chinese scholars have also achieved substantial outcomes in the reform of urban-rural planning education, particularly regarding theoretical innovation in planning education and the adjustment of curriculum systems. Wu Zhiqiang, an academician of the Chinese Academy of Engineering, has advocated for establishing a conceptual framework and theoretical foundation for rational planning. He emphasizes leveraging frontier technologies, such as big data and artificial intelligence, to drive innovation in both the theory and practice of the planning discipline, thereby facilitating a paradigm shift from experience-driven to science-driven planning. In his book *Principles of Territorial Spatial Planning* (Wu, 2023), he constructed an open ecological system of territorial spatial planning principles. Furthermore, leveraging the World Urban Planning Education Network (WUPEN), he has built an integrated online-and-offline knowledge-sharing space, significantly propelling the innovation of the planning education system (Sun, 2021).

In response to the new requirements of territorial spatial planning, several domestic universities have repositioned the talent cultivation objectives of undergraduate urban-rural planning education, clearly defining their role in territory-wide governance. For instance, Inner Mongolia University of Science and Technology has adjusted its curriculum system to incorporate knowledge and skills related to territorial spatial planning, while simultaneously strengthening a multidisciplinary collaborative education model. Against the backdrop of the "New Engineering" initiative, local universities such as Hunan University of Science and Technology have actively explored curriculum reform pathways adapted to the demands of new technologies. They have systematically optimized their educational frameworks, ranging from the cultivation of moral character and values to the construction of theoretical courses and practical training (Liu & Guo, 2024).

These research achievements reflect the active exploration of domestic universities in reforming urban-rural planning education; however, certain limitations remain. In particular, the full-chain integration of intelligent technologies into the curriculum system requires further deepening. Expanding upon these current reforms, it is evident that future educational models must transcend the mere addition of isolated technical modules. True full-chain integration demands that intelligent technologies be seamlessly embedded as core analytical tools throughout the entire planning pedagogy—from initial site analysis and data-driven problem identification to computational design generation and policy evaluation. Moreover, as planning education shifts toward territory-wide governance, universities must cultivate students' holistic systems thinking, enabling them to synthesize spatial data with complex socio-economic and ecological variables. Ultimately, bridging this gap requires continuous collaboration between academia and industry to ensure that the next generation of planners is not only proficient in cutting-edge technologies but also capable of applying them ethically and effectively to achieve sustainable, equitable, and resilient spatial development.

2.3. Research Entry Point of This Paper

Despite the significant achievements made by domestic and international scholars in the field of urban-rural planning education reform, existing research still exhibits notable deficiencies. The majority of current studies tend to focus on macro-level theoretical discussions or the isolated integration of single technological courses, lacking systematic research on the comprehensive reconstruction of a full-chain technological system tailored for the intelligent era. For instance, contemporary research on the application of Geographic Information Systems (GIS) in urban-rural planning education predominantly concentrates on the operational use of specific tools, failing to integrate them holistically with full-process technologies such as big data analysis and generative design (Chen et al., 2023). Furthermore, current curriculum systems demonstrate insufficient integration between technology-oriented and governance-oriented courses, which ultimately deprives students of the comprehensive problem-solving capabilities required to tackle complex, real-world challenges (Song et al., 2024).

To address these critical gaps, this paper aims to provide strategic pathway recommendations for the undergraduate education reform of urban-rural planning in the intelligent era by resolving two core issues. First, it explores how to achieve a deep, full-process integration between frontier technologies and traditional professional courses, thereby constructing a more scientific and robust talent cultivation system. Second, it investigates effective strategies to enhance graduates' practical problem-solving abilities, ultimately expanding new research directions and practical pathways for educational reform in this discipline.

Expanding upon these foundational objectives, it is imperative to recognize that overcoming these limitations requires a fundamental pedagogical paradigm shift. Future educational frameworks must transcend the traditional siloed approach to technical training. Instead of treating intelligent technologies as supplementary tools, planning education must embed computational thinking, spatial data analytics, and algorithmic design as core cognitive frameworks across the entire curriculum. This holistic integration ensures that students do not merely learn to operate software, but rather develop the critical ability to synthesize complex multi-source data with socio-spatial governance theories. Furthermore, bridging the gap between technical proficiency and governance capabilities necessitates the creation of interdisciplinary, project-based learning environments. By engaging students in authentic, real-world scenarios that require both quantitative analysis and qualitative policy evaluation, higher education institutions can cultivate a new generation of adaptive planners. These professionals will be fully equipped to navigate the multifaceted challenges of modern spatial governance, ensuring that urban and rural developments remain sustainable, equitable, and technologically resilient in the face of rapid societal transformations.

3. Research Methodology

3.1. Sample Selection and Data Sources

Against the backdrop of the intelligent era, research on the undergraduate education reform of urban-rural planning in higher education institutions necessitates in-depth analysis based on representative samples. This study selects Tsinghua University, Beijing University of Civil Engineering and Architecture, and Beijing University of Technology as the primary research subjects, primarily considering their high representativeness and distinct regional characteristics within the field of undergraduate urban-rural planning education.

As a top-tier comprehensive university in China, Tsinghua University is renowned for its interdisciplinary integration and the application of frontier technologies in its urban-rural planning program, demonstrating significant advantages, particularly in the domains of intelligent technologies and data science. Beijing University of Civil Engineering and Architecture takes architecture and urban-rural planning as its traditional core disciplines, emphasizing a close alignment between practical teaching and industry demands, which vividly reflects the characteristics of local universities serving regional development. Meanwhile, as a key municipal university in Beijing, Beijing University of Technology has accumulated extensive experience in the construction of territorial spatial planning and governance-oriented curriculum systems, while also exhibiting strong regional adaptability (Yan et al., 2024). By acquiring comprehensive data and materials from these three universities, including their talent cultivation programs, curriculum settings, and teaching syllabi, this study can comprehensively reflect the characteristics and variations in the curriculum structures of urban-rural planning programs under different institutional positioning, thereby providing a solid foundation for subsequent quantitative comparative analysis.

Expanding upon this methodological framework, the deliberate selection of these three distinct institutions serves a critical analytical purpose beyond mere representation. By juxtaposing a comprehensive research-intensive university, a specialized industry-oriented institution, and a regionally focused municipal university, this study captures a highly diverse spectrum of educational paradigms currently operating within China's higher education landscape. This comparative approach allows for a nuanced examination of how varying institutional missions,

resource allocations, and regional policy environments shape curriculum design in response to the intelligent era. Furthermore, the granular data extracted from their teaching syllabi and cultivation programs enables the identification of specific pedagogical gaps and structural bottlenecks. Ultimately, this robust empirical foundation not only validates the quantitative comparisons but also ensures that the resulting reform strategies are not overly generalized. Instead, they are highly contextualized, offering differentiated, actionable recommendations that respect the unique developmental trajectories and regional responsibilities of diverse higher education institutions in cultivating next-generation planning professionals.

3.2. Quantitative Comparative Analysis of Curriculum Structure

Through a quantitative comparative analysis of the undergraduate curriculum structures of urban-rural planning at Tsinghua University, Beijing University of Civil Engineering and Architecture, and Beijing University of Technology, the varying emphases of these institutions on technology-oriented and governance-oriented courses, as well as their intrinsic relationship with institutional positioning, can be clearly revealed. In terms of credit distribution, Tsinghua University exhibits the highest proportion of technology-oriented courses, with frontier courses such as data science, artificial intelligence, and computational design occupying a pivotal position. This curriculum arrangement is highly congruent with its science-oriented educational philosophy, aiming to cultivate students' capabilities to utilize intelligent technologies to resolve complex urban challenges (Yan et al., 2024). In contrast, the technology-oriented courses at Beijing University of Civil Engineering and Architecture place greater emphasis on the integration of architectural design foundations and engineering technology, reflecting its traditional strengths rooted in architectural design. Meanwhile, Beijing University of Technology features a notably higher proportion of governance-oriented courses. By establishing multiple core courses specifically in the domains of territorial spatial planning and public policy, it highlights its distinctive characteristics and competitive advantages in the field of spatial governance.

A further analysis of the characteristics of curriculum content reveals distinct pedagogical strategies. The technology-oriented courses at Tsinghua University emphasize the combination of instrumental utility and practical application. For instance, the Python programming language has been extensively integrated into traditional planning and design courses to support data collection, analysis, and visualization. Conversely, the technology-oriented curriculum at Beijing University of Civil Engineering and Architecture leans more heavily toward engineering technology practice, exemplified by the integrated application of architectural engineering technology and Geographic Information Systems (GIS). Regarding governance-oriented courses, the curriculum at Beijing University of Technology spans multiple dimensions, ranging from macro-level policy formulation to micro-level management. Core offerings such as Principles of Territorial Spatial Planning and Social Governance and Spatial Justice are specifically designed to cultivate students' comprehensive understanding and operational capabilities in territory-wide governance (Yan et al., 2024). Overall, the structural differences in the curricula among these three universities not only reflect their respective institutional positioning but also provide a crucial empirical basis for subsequent discussions on existing curriculum deficiencies.

Expanding upon these structural and pedagogical distinctions, it becomes evident that the divergent curriculum designs represent complementary responses to the multifaceted demands of modern urban-rural planning. Tsinghua University's heavy investment in computational design and data science essentially treats the city as a complex, quantifiable system, preparing graduates to act as urban data scientists and technologists. This approach is vital for addressing large-scale spatial optimization and smart city infrastructure. On the other hand, Beijing University of Civil Engineering and Architecture's focus on the intersection of architectural engineering and GIS ensures that students maintain a strong grasp of the physical and material realities of urban development. This grounding in engineering practice is indispensable for translating abstract data-driven insights into tangible, buildable, and structurally sound urban environments.

Furthermore, Beijing University of Technology's emphasis on territorial spatial planning and social governance addresses the critical policy and regulatory dimensions of contemporary planning. As China transitions toward holistic territory-wide governance, planners must be adept at navigating complex legal frameworks, public policies, and socio-spatial equity issues. The inclusion of courses like Social Governance and Spatial Justice ensures that future planners are not merely technocratic managers, but socially conscious professionals capable of mediating between state policies, market forces, and community needs.

Ultimately, this comparative analysis highlights that there is no single optimal curriculum for the intelligent era. Instead, the future of urban-rural planning education lies in recognizing these distinct institutional strengths while encouraging cross-pollination. A truly comprehensive educational model should ideally synthesize Tsinghua's computational rigor, Beijing University of Civil Engineering and Architecture's engineering

pragmatism, and Beijing University of Technology's governance acumen. By doing so, higher education institutions can cultivate a versatile cohort of planners who are equally proficient in algorithmic problem-solving, physical design execution, and equitable spatial governance, thereby fully addressing the complex, multi-dimensional challenges of modern urbanization.

3.3. Existing Major Problems

Despite the significant achievements made by these three universities in constructing undergraduate curriculum systems for urban-rural planning, the current educational frameworks still face three prominent structural issues: the superficiality of technology-oriented courses, the hollowing out of governance-related content, and the formalization of industry-education integration. These systemic challenges have imposed obvious constraints on the enhancement of talent cultivation quality.

Firstly, the phenomenon of superficial technology education is quite prevalent. In the technology-oriented courses of certain universities, the application of intelligent technologies is largely confined to theoretical introductions or basic operational training, lacking the cultivation of students' in-depth understanding and comprehensive application capabilities. For example, GIS courses offered by some institutions merely cover the use of fundamental functions without integrating them with real-world problem-solving scenarios. Consequently, students find it difficult to effectively apply technical tools in practical planning and design practices (Song et al., 2024).

Secondly, the issue of hollowed-out governance courses cannot be ignored. Although some universities have introduced a substantial number of governance-oriented courses, their content is often overly broad, lacking specificity and practical relevance. For instance, courses such as Urban and Rural Planning Management predominantly focus on policy interpretation while neglecting the cultivation of students' decision-making capabilities within specific management contexts. This pedagogical gap makes it challenging for students to cope with complex, real-world governance demands (Song et al., 2024).

Furthermore, the formalization of industry-education integration urgently needs to be addressed. Although many universities have attempted to strengthen practical teaching through university-enterprise cooperation and the establishment of internship bases, industry-education integration often becomes a mere formality in actual practice. It fails to genuinely achieve an effective alignment between educational resources and industry demands. For example, practical teaching projects at certain universities are mostly limited to basic field research tasks. These assignments lack authenticity and challenge, making it difficult to stimulate students' innovative consciousness and problem-solving abilities (Song et al., 2024).

The existence of these issues not only restricts the development of students' comprehensive competencies but also, to a certain extent, weakens the adaptability and competitiveness of undergraduate education in urban-rural planning. Therefore, there is an urgent need to implement systematic reforms to address these structural deficiencies. By transitioning from superficial tool training to deep computational thinking, shifting from broad policy reading to scenario-based governance decision-making, and transforming token internships into authentic, challenge-driven industry collaborations, universities can fundamentally elevate the quality of planning education. Only through such comprehensive and targeted reforms can the discipline effectively prepare future planners to navigate the multifaceted challenges of modern spatial governance in the intelligent era.

4. Research Findings

4.1. Integration of Frontier Technologies with Traditional Professional Courses

4.1.1. Reconstructing Core Competencies for Digital-Humanities Composite Talents

Against the profound backdrop of the intelligent era, the complexity of the urban-rural planning discipline has significantly intensified. Its research subjects have expanded far beyond traditional physical spaces to encompass multidimensional systems that integrate socio-economic dynamics, ecological environments, and information technologies. To adapt to this paradigm shift, it is particularly imperative to construct a talent cultivation system anchored by core competencies in digital-intelligent technology application, ecological resilience cognition, and social governance collaboration.

The competency in digital-intelligent technology application emphasizes equipping students with frontier technologies such as artificial intelligence and big data analytics, enabling them to achieve precise identification and scientific decision-making regarding urban-rural spatial issues. Ecological resilience cognition focuses on enhancing students' understanding of and response capabilities to global challenges like climate change and resource constraints, cultivating their sensitivity to integrating sustainable development concepts into planning practices. Meanwhile, social governance collaboration aims to improve students' communication and coordination

skills among diverse stakeholders, ensuring the implementability and equity of planning proposals (Wei et al., 2022; Liu & Guo, 2024). The integration of these core competencies not only reflects the intelligent era's demand for compound planning talents but also injects new vitality into traditional urban-rural planning practices. By combining technical proficiency with humanistic literacy, students can flexibly utilize data analysis tools in complex spatial governance scenarios while balancing social equity and ecological values, thereby forming a cultivation orientation supported by technology and guided by humanistic care.

Furthermore, the deep integration of digital-intelligent technologies with traditional planning practices requires concrete curriculum reforms and instructional designs. For instance, while adding foundational technical courses such as Python programming and GIS spatial analysis to the curriculum system, it is essential to integrate content from humanities and social sciences like ecology and sociology to form interdisciplinary knowledge modules. This integration not only helps students establish a comprehensive professional vision but also enhances their practical application capabilities in real-world projects. For example, by introducing teaching cases that combine ecological footprint analysis with participatory community planning, students can build upon their mastery of technical means to further understand the dynamic balance between social equity and ecological protection (Liu & Guo, 2024). Thus, reconstructing the core competencies of "digital intelligence + humanities" compound talents is not only an inevitable choice for addressing the challenges of the intelligent era but also a crucial pathway for advancing the modernization of urban-rural planning education.

Expanding upon this framework, it is evident that the successful implementation of this interdisciplinary model requires a fundamental shift in pedagogical methodologies. Traditional lecture-based teaching must evolve into experiential, problem-based learning environments where students actively grapple with real-world complexities. In these collaborative settings, students can work in multidisciplinary teams to simulate authentic planning scenarios, utilizing Python scripts to process vast urban datasets while simultaneously engaging with local communities to understand their socio-cultural needs. This hands-on approach ensures that technical skills are not developed in a vacuum but are continuously contextualized within human and ecological realities.

Moreover, the integration of social governance collaboration necessitates the inclusion of ethics and public policy within technical curricula. Students must be trained to critically evaluate the socio-spatial implications of algorithmic decision-making, recognizing that data-driven solutions can inadvertently perpetuate existing inequalities if not guided by strong ethical frameworks. By embedding courses on spatial justice and environmental ethics directly alongside advanced computational modules, educational institutions can foster a generation of planners who view technology as a means to achieve social good rather than an end in itself. Ultimately, this holistic educational transformation ensures that urban-rural planning graduates are not merely proficient technicians, but visionary leaders capable of designing resilient, equitable, and sustainable cities for the future (Zeng et al.,2025).

4.1.2. Constructing a Full-Chain Technology Integration System: Tools-Analysis-Generation

To achieve the full-process integration of frontier technologies with traditional urban-rural planning courses, it is imperative to construct a stepped technological integration system that progresses from foundational tool empowerment to intelligent assisted design. This comprehensive framework initiates with the integration of the Python programming language into traditional courses, gradually extends to the profound application of big data and Geographic Information Systems (GIS) technologies in planning and design, and ultimately realizes the comprehensive coverage of Artificial Intelligence Generated Content (AIGC) and computational design technologies across the entire planning workflow.

Specifically, Python serves as a highly efficient and accessible programming language, providing students with foundational capabilities in data processing and algorithm implementation, thereby laying a solid groundwork for their subsequent learning of more complex intelligent technologies. For instance, introducing Python for data collection and cleaning within the Principles of Urban and Rural Planning course can assist students in rapidly mastering the extraction of valuable insights from multi-source heterogeneous data. This practical engagement significantly elevates their cognitive understanding of urban and rural spatial characteristics (Liu & Guo, 2024).

Building upon this foundational tool layer, the integration of big data and GIS technologies further enhances the scientific rigor and precision of planning design. By combining GIS with remote sensing technologies, students are empowered to conduct multi-scale analyses of urban and rural spatial structures, successfully revealing spatial patterns and laws hidden beneath massive datasets. For example, during the curriculum design phase of territorial spatial planning, instructors can guide students to utilize GIS platforms for land-use change monitoring and scenario simulation. This allows them to systematically evaluate the impacts of different planning schemes on regional development. Such data-driven design methodologies not only improve the scientific validity of planning

proposals but also cultivate students' abilities to apply quantitative analytical tools to solve practical, real-world problems (Chen et al., 2023).

Finally, the introduction of AIGC and computational design technologies marks the comprehensive penetration of intelligent technologies within the urban-rural planning domain. Utilizing deep learning models such as Generative Adversarial Networks (GANs), students can rapidly generate highly diversified design alternatives and optimize design outcomes through iterative parameter adjustments. For instance, in urban renewal projects, computational design technologies can automatically generate architectural layout schemes that comply with specific constraint conditions, thereby providing designers with abundant creative inspiration. Concurrently, the application of these advanced technologies compels students to transition from traditional hand-drawing mental models to computational code-based thinking, enabling them to better adapt to the planning demands of the intelligent era (Liu & Guo, 2024).

In summary, constructing a full-chain technological integration system that encompasses "tool-application-generation" not only facilitates the seamless docking between frontier technologies and traditional planning curricula but also significantly elevates students' technological literacy and innovative capabilities. This systematic approach ensures that future planners are equipped with the multidisciplinary skills necessary to navigate the complexities of modern spatial governance. By embedding intelligent tools at every educational stage, planning education can effectively bridge the gap between theoretical knowledge and practical innovation, ultimately fostering a new generation of professionals capable of leveraging technology to create sustainable, equitable, and resilient urban environments.

4.2. Enhancing Graduates' Practical Problem-Solving Capabilities

4.2.1. Establishing University-Government-Enterprise Collaborative Teaching Bases

In the intelligent era, urban-rural planning practices are increasingly characterized by complexity and dynamism. Relying solely on internal educational resources within universities has become insufficient to meet the demands of cultivating students' comprehensive capabilities. Consequently, establishing collaborative teaching bases involving universities, local governments, and enterprises has emerged as a crucial pathway to enhance graduates' abilities to solve practical problems. This collaborative model integrates the academic resources of universities, the policy support of local governments, and the practical experience of enterprises, thereby constructing a multi-stakeholder immersive teaching platform.

Within these university-government-enterprise collaborative teaching bases, the sources of practical projects primarily include specialized planning tasks commissioned by local governments, horizontal research projects conducted by enterprises, and community service projects of a public welfare nature. These projects typically feature strong authenticity and high timeliness, providing students with valuable opportunities to engage with real-world issues and hone their problem-solving skills within authentic contexts (Yan et al., 2024; Song et al., 2024).

Immersive teaching serves as the core of this collaborative teaching base, emphasizing students' deep involvement throughout the entire lifecycle of a project. For instance, in a territorial spatial master planning project, students can begin at the preliminary research stage, gaining insights into regional development status and existing challenges through field visits and data analysis. During the scheme design phase, students are required to integrate multi-source data with intelligent technologies to generate preliminary planning outcomes. Ultimately, during the scheme review and implementation phases, students must communicate and coordinate with government departments, enterprise representatives, and other stakeholders. This full-process participation not only helps students consolidate their theoretical knowledge but also significantly improves their teamwork, communication, and expression skills. Furthermore, the teaching base broadens students' professional horizons by regularly organizing special lectures and workshops, inviting industry experts to share their practical experiences (Yan et al., 2024).

In conclusion, the establishment of university-government-enterprise collaborative teaching bases provides students with abundant practical resources and authentic learning environments. This comprehensive educational ecosystem effectively bridges the gap between academic theory and industry practice, laying a solid and indispensable foundation for their future careers in urban-rural planning. By immersing students in real-world challenges, these collaborative platforms ensure that graduates are well-equipped with the practical competencies, interdisciplinary perspectives, and professional networks necessary to navigate the complexities of modern spatial governance.

4.2.2. Cross-Boundary Integration: Introducing Sociological and Legal Perspectives

In the intelligent era, the challenges confronting urban-rural planning have become increasingly complex, involving multifaceted intersections across economic, social, and environmental domains. Against this backdrop, relying solely on singular technological means is no longer sufficient to effectively address the multiple challenges

inherent in planning practices. There is an urgent need to integrate sociological and legal perspectives to refine students' knowledge structures and enhance their comprehensive capabilities (Xu & Wang,2025).

The introduction of a sociological perspective enables students to gain a profound understanding of the underlying social mechanisms and behavioral logic behind urban and rural spaces. For instance, by analyzing social phenomena such as community structures and population mobility, students can uncover the root causes of spatial differentiation in urban and rural areas and its subsequent impacts on residents' quality of life. This deep comprehension not only facilitates the integration of a human-centric philosophy into planning and design but also strengthens students' focus on social equity and inclusive development (Wei et al., 2022). Concurrently, the integration of a legal perspective provides students with a robust cognitive framework for governance under the rule of law. It equips them to fully consider the constraints and guiding roles of laws and regulations in their planning practices. For example, in the context of territorial spatial planning, students must be well-versed in relevant legal provisions, such as the Land Administration Law and the Urban and Rural Planning Law, to ensure the legality and practical operability of their planning proposals (Sun, 2021).

To promote the internalization and practical application of interdisciplinary knowledge, higher education institutions should incorporate relevant courses or modules into their curriculum systems. For instance, universities can offer an Urban and Rural Sociology course that systematically explains social survey methodologies and community governance theories. Through case study analyses, this course can assist students in mastering the specific application of sociological methods in planning practices. Simultaneously, a course on Urban and Rural Planning Regulations and Ethics should be established. This module would focus on elucidating relevant planning laws, regulations, and professional ethical standards, thereby cultivating students' awareness of the rule of law and their professional sense of responsibility.

Furthermore, universities can encourage the comprehensive application of sociological and legal knowledge in planning projects through interdisciplinary curriculum design. For example, in urban renewal projects, students can employ sociological methods to conduct thorough community needs assessments and subsequently formulate planning schemes that align with local realities based on fundamental legal principles. This interdisciplinary curriculum design not only enhances students' comprehensive analytical capabilities but also provides strong support for their future engagement in complex urban-rural planning endeavors (Wei et al., 2022; Sun, 2021).

Ultimately, bridging the gap between technical planning and socio-legal frameworks ensures that future planners are not merely designers of physical spaces, but holistic problem solvers. By embedding these interdisciplinary perspectives deeply into the educational fabric, planning education can produce graduates who are ethically grounded, legally compliant, and socially empathetic. This holistic approach is indispensable for navigating the intricate socio-spatial dynamics of the modern era, ensuring that urban and rural developments are not only technologically advanced but also legally sound, socially just, and fundamentally sustainable. Through such comprehensive educational reforms, the discipline can successfully adapt to the multifaceted demands of contemporary spatial governance.

5. Conclusions

Against the profound backdrop of the intelligent era, the research outcomes regarding the reform of undergraduate education in urban-rural planning at higher education institutions clearly demonstrate that curriculum system reform and the construction of a comprehensive competency model are the critical pathways to enhancing the quality of talent cultivation. Employing a rigorous mixed-methods approach that integrates literature review, case study analysis, and empirical survey research, this study systematically explores the multifaceted impacts of intelligent technologies on urban-rural planning education and proposes targeted reform strategies.

The empirical findings reveal that achieving a deep, full-process integration between frontier technologies and traditional professional courses is of paramount importance. This integration not only effectively addresses existing structural deficiencies in the current curriculum—such as the superficiality of technology-oriented courses and the hollowing out of governance-related content—but also significantly enhances graduates' practical abilities to solve complex, real-world problems (Sun et al., 2022). Furthermore, the construction of a core competency map for compound talents integrating "digital intelligence and humanities" provides urban-rural planning students with a robust knowledge and skills framework tailored to the demands of the intelligent era. This holistic framework ensures that future planners are better equipped to serve national strategic initiatives and advance the goals of sustainable urban-rural development (Yang et al., 2023).

Expanding upon these findings, it is evident that this research provides a solid theoretical foundation and practical guidance for the ongoing reform of undergraduate urban-rural planning education, possessing significant academic value and profound real-world implications. Beyond merely updating course syllabi, the proposed

reform strategies advocate for a fundamental pedagogical shift. Educators must transition from traditional knowledge transmission to fostering interdisciplinary, project-based learning environments where digital tools and humanistic values are seamlessly intertwined. This requires continuous professional development for faculty members, ensuring they possess both technological fluency and socio-spatial awareness.

Moreover, the successful implementation of these reform strategies necessitates robust institutional support and external collaboration. Universities should actively establish synergistic partnerships with local governments, technology firms, and community organizations to create immersive, real-world learning laboratories. These collaborative platforms allow students to test their digital-intelligent competencies and governance skills in authentic contexts, bridging the critical gap between academic theory and professional practice.

Ultimately, the modernization of urban-rural planning education is not merely an academic exercise but a vital response to the accelerating complexities of modern spatial governance. By systematically reconstructing the educational paradigm to embrace both technological innovation and human-centric governance, higher education institutions can cultivate a new generation of adaptive, ethical, and highly skilled planners. These professionals will be instrumental in navigating the socio-ecological challenges of the 21st century, ensuring that urban and rural environments remain resilient, equitable, and sustainable in the face of unprecedented technological and environmental transformations.

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The authors declare no conflicts of interest.

Use of AI and AI-Assisted Technologies

During the preparation of this work, the authors used Qwen and DeepL in order to improve readability and language. After using the tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication."

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