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A study on the characteristics and development path of virtual teaching and research rooms: taking data analysis courses as an example

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Abstract: In the context of educational digital transformation, virtual teaching and research rooms have emerged as a vital practical form for grassroots teaching organizations in higher education institutions to respond to changes. Taking data analysis-related course clusters as an example, this paper explores the essence, characteristics, and development pathways of virtual teaching and research rooms. The study shows that the virtual teaching and research room at Beijing Wuzi University has established an integrated collaborative education system comprising "teaching and research – resources – teams – systems" through pathways such as teaching resource development, teaching team building, and institutional framework construction. This system has achieved significant results in enhancing course quality, strengthening faculty educational capabilities, and establishing a shared resource system.

Keywords: virtual teaching and research room; data analysis courses; intrinsic characteristics; construction path

1 Introduction

As digitalization continues to advance, educational digitalization has become the core driving force behind educational reform [1]. The *Report to the 20th National Congress of the Communist Party of China* proposes advancing the digital transformation of education and building a learning society and a learning nation where lifelong learning is accessible to all. In the *Opinions on Accelerating the Advancement of Educational Digitalization* issued by the Ministry of Education and seven other departments, it was positioned as the core breakthrough point for "opening up new avenues for educational development and shaping new competitive advantages". Against this backdrop, practical explorations in higher education have accelerated. In 2021, the Higher Education Division of the Ministry of Education launched the pilot construction of virtual teaching and research rooms for the first time. By 2024, three batches totaling 787 pilot projects had been approved, covering professional development, course cluster teaching, and teaching research and reform topics. The construction of virtual teaching and research rooms focuses on exploring the construction standards, implementation pathways, and operational models for new types of grassroots teaching organizations in the "smart+" era, serving as the implementation vehicle for the education digitization strategy at the grassroots teaching unit level in universities [2].

In the process of educational digital transformation, data analysis courses face challenges such as interdisciplinary collaboration difficulties, fragmented practical resources, rapid technological iteration, and lagging teaching updates, making it hard for traditional models to achieve personalized teaching [3]. Virtual teaching and research rooms integrate

interdisciplinary faculty and heterogeneous resources through digital platforms, systematically reconstruct the logical framework of course clusters, establish technology-enabled teacher development pathways, and achieve precise teaching based on learning behavior data, providing innovative solutions to overcome these bottlenecks.

2 Core characteristics of virtual teaching and research rooms

Against the backdrop of the deepening development of the information society, virtual teaching and research rooms—as an innovative practice form in the education sector responding to digital transformation—are driving a systematic reconfiguration of teaching and research paradigms [4].

From an essential attribute perspective, virtual teaching and research rooms are academic communities formed spontaneously by teachers across regions, institutions, and disciplines (or specialties) based on shared teaching objectives. This community facilitates knowledge sharing, experience exchange, and collaborative innovation through digital platforms. The fluid organizational structure of virtual teaching and research rooms allows them to flexibly adjust their composition based on teaching reform needs, thereby effectively integrating the professional strengths and resource endowments of different entities.

From an organizational structure perspective, the virtual teaching and research room does not disrupt the existing teaching and research room framework or affect the original teaching teams and members. It breaks through the physical space constraints of traditional teaching and research rooms, enabling teachers from diverse backgrounds to transcend geographical, institutional, and disciplinary boundaries. It gathers around shared research topics, academic frontiers, or teaching issues to collectively discuss and conduct teaching activities. This organizational form advocates the philosophy of "research promoting teaching and teaching driving research". While advancing academic progress, it actively applies research findings to educational practices, fostering a mutually reinforcing and synergistic relationship between academic research and teaching.

In terms of functional positioning, virtual teaching and research rooms are dedicated to addressing issues such as scattered resources and inefficient collaboration in traditional teaching organizations. By establishing standardized collaborative mechanisms and digital support environments, they promote the updating of teaching content, methodological innovation, and quality improvement, providing organizational guarantees and practical support for the high-quality development of higher education [5].

In summary, virtual teaching and research rooms, with their unique connotations and diverse characteristics, inject new momentum into educational and teaching reforms. They play an increasingly important role in improving teachers' teaching levels, promoting the sharing of high-quality resources, and enhancing the quality of talent cultivation, becoming a key innovative force in the process of educational digital transformation.

3 Construction path of virtual teaching and research rooms

Based on the nationally approved Level 1 course "Statistics" in 2023, the virtual teaching and research office at Beijing Wuzi University has integrated functional modules including teaching activities, teaching teams, and teaching resources. This integration has established a collaborative teaching and research innovation mechanism that transcends university boundaries, teaching and research offices, and individual courses. This effectively breaks the time and space constraints of traditional teaching and research activities, promotes the exchange of teaching experiences and the sharing of resources among different course teams, enhances the spillover effect of the achievements of national first-class course construction, and provides sustainable teaching and research support for building a student-centered teaching model and promoting the deep integration of curriculum-based ideological and political education with professional teaching (see Figure 1).

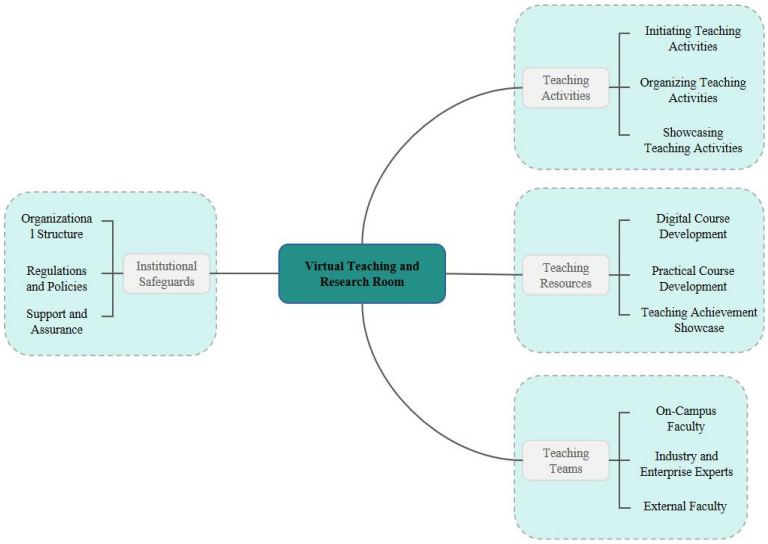

Figure 1. Basic functions of the virtual teaching and research room

The virtual teaching and research room is led by Beijing Wuzi University and jointly established with various enterprises and government departments. It has formed a multi-dimensional teaching and research system that includes the "statistics first-class course teaching and research room", "mathematics and science professional teaching and research room", "statistics professional teaching and research room", and "mathematics general education course teaching and research room", covering 13 foundational and core professional courses. The virtual teaching and research room leverages modern information technology in the "smart+" era to conduct teaching activities through the Superstar education platform.

3.1 Teaching resource development

The construction of teaching resources is co-built and shared by governments, industries, enterprises, and academia, forming a three-dimensional resource pool that spans multiple fields and types. Resource sources cover: government (policy guidance, grassroots governance cases), enterprises (practical business scenarios, operational data, technology application cases), industry (data standards, development trends), and universities (academic resources, teaching materials). Through the virtual teaching and research room, these resources are efficiently circulated and integrated.

Specifically, teaching resources can be categorized into three types: digital repositories (MOOCs, micro-courses, case analyses, and animated demonstrations); practical teaching resources (real business scenarios from enterprises and grassroots government practice projects); teaching achievement resources (the teaching outcomes of various teaching and research rooms). All resources are opened and shared via the virtual teaching and research room platform. They not only support contextualized and practice-oriented teaching processes, but also provide a foundation for scientific research innovation and achievement transformation, thus maximizing resource utilization.

From the perspective of achievement management and resource utilization, the virtual teaching and research room embodies both cumulative development and collaborative sharing. On the one hand, over time, teaching content expands and research outcomes accumulate, creating a rich knowledge base. On the other hand, the collective participation of teachers in the construction and sharing of outcomes breaks the traditional limitations of scattered and exclusive teaching resources. In the joint development of course resources and the sharing of teaching cases, resource utilization efficiency is effectively improved, thereby maximizing the value of teaching and research achievements.

3.2 Teaching team development

The development of teaching teams is guided by cross-disciplinary collaboration, integrating diverse stakeholders such as university faculty, government experts, and industry mentors. Virtual teaching and research rooms serve as

collaborative platforms, breaking down spatial and temporal barriers to facilitate regular interaction between university faculty, government think tank experts, and corporate technical leaders. This fosters a collaborative model of "academic guidance + practical mentoring". Through specialized teaching research, joint lesson planning, and collaborative project development, the capabilities of university faculty and industry mentors are complemented, collectively enhancing the comprehensive educational capabilities of teaching teams and providing diverse faculty support for talent cultivation.

From the perspective of participating entities, virtual teaching and research rooms exhibit distinct openness, allowing teachers to dynamically join or leave as needs and assemble members across institutions and disciplines, including not only faculty from the same institution but also peers from other institutions, and even corporate experts, achieving cross-institutional and cross-disciplinary integration of diverse entities to significantly expand the scope of participation in teaching and research activities. Additionally, virtual teaching and research rooms are based on the principle of a contract spirit as the foundation for regulating the behavior of participants, embodying the qualities such as equal interaction, shared objectives, and mutual responsibility. This ensures that diverse participants can establish an orderly interaction framework in cross-border collaborations, jointly promoting the in-depth development of teaching and research activities.

3.3 Institutional development

In the process of establishing and operating research departments, the school has established a multi-dimensional institutional framework, providing a solid foundation for the in-depth advancement of educational and teaching reforms.

At the institutional level, the school has formulated the "regulations on teaching and research room operations", clearly defining the authority and responsibility boundaries of the management and organizational structure of teaching and research rooms. Specific provisions have been made for core processes such as research project approval, the conduct of teaching and research activities, and the evaluation of outcomes, establishing a closed-loop management mechanism of "approval - implementation - assessment" to ensure that teaching and research room operations are conducted in accordance with established procedures and operated in a standardized manner.

In terms of resource support, the school has empowered department activities through dual hardware and software resources. It has established an online research platform to break through spatial and temporal constraints and facilitate real-time communication and resource sharing among teachers. Additionally, it has established a special fund for virtual department construction within the school to support teachers' participation in training, visits, and academic exchanges, providing a material foundation for research innovation.

4 Achievements in the construction of virtual teaching and research rooms

After nearly three years of development, the virtual teaching and research room for data science courses has achieved notable results in teaching activities, faculty development, and team building, and has accumulated valuable experience.

In terms of course development, the quality of courses and teaching outcomes have significantly improved. Through the deep integration of course-based ideological and political education with professional teaching, core courses such as "Statistics" and "Modern Logistics Statistics" now feature more contemporary and ideological content, with student satisfaction ratings maintaining above 95% for two consecutive years. The promotion of blended learning models has increased student classroom engagement by 30% and significantly enhanced their self-directed learning abilities.

In terms of faculty development, the educational capabilities of the multidisciplinary teaching team have been comprehensively enhanced. The virtual teaching and research room has attracted over 20 government experts and industry mentors for teaching activities, including joint lesson planning and specialized teaching research. This has facilitated several faculty members from our institution to engage in practical training at government agencies and enterprises. Students' participation in subject-specific competitions has yielded an average of over 100 awards annually.

In terms of resource development, the virtual teaching and research room has established a multi-domain shared resource system. The digital resource repository integrates a large number of teaching cases, micro-lecture videos, MOOC videos, and industry data, covering multiple fields such as grassroots governance, providing rich materials for teaching.

5 Conclusion

Over the past three years, the development of virtual teaching and research rooms has established a four-pronged collaborative education system integrating teaching and research, resources, teams, and institutional frameworks. This approach has broken down the closed nature of traditional education and achieved deep resource integration. Moving forward, virtual teaching and research rooms must further deepen the collaborative mechanism among government, industry, academia, research, and application to drive the digital transformation and high-quality development of higher education [6]. Regarding teaching resource development, efforts should focus on enriching industry-leading case studies and MOOC resources, promoting the deep integration of ideological and political education with specialized instruction, and constructing a "theory + practice" teaching system tailored to disciplinary characteristics and industry demands. In terms of collaborative education mechanisms, sustained advancement of university-enterprise partnerships is essential, including the establishment of industry-academia-research innovation laboratories. Strengthening practical teaching components through resource sharing and complementary strengths will enhance the alignment of talent cultivation with industry needs, deepening the collaborative development philosophy of government, industry, academia, research, and application. Platform development, as the cornerstone for the efficient operation of virtual teaching and research rooms, should enhance technological empowerment and continuously optimize platform functional architecture. Simultaneously, existing development experiences should be actively promoted to expand coverage, enabling the virtual teaching and research room model and its achievements to exert greater influence. This will provide a robust platform foundation for the digital transformation of higher education and inject stronger momentum into its high-quality development.

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Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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