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Conceptual Framework and Practical Approaches of Virtual Teaching and Research Offices in the Context of "Intelligence+": A Case Study of Computer Science

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Abstract: This paper, set in the context of higher education teaching reform in the "Intelligence+" era, addresses issues such as functional weakening, resource fragmentation, and insufficient collaboration in traditional teaching and research offices. Focusing on computer science programs in local applied universities, it systematically explores the conceptual framework and practical pathways for virtual teaching and research offices. Based on connectivism, constructivism, and learning sciences theories, the study proposes a systematic conceptual framework centered on "organizational structure—operational mechanisms—resource development—teacher development." It elaborates on the theoretical rationale and implementation strategies of virtual teaching and research offices in breaking spatiotemporal constraints, promoting cross-disciplinary collaboration, and advancing the deep integration of teaching and research. Practice demonstrates that by establishing a networked teaching and research community, implementing closed-loop operational mechanisms, and promoting the sharing of high-quality resources and continuous teacher development, virtual teaching and research offices can effectively enhance faculty development, advance disciplinary and curriculum construction, strengthen students' innovative and practical abilities, expand social service functions, and provide an implementable paradigm for reforming grassroots teaching organizations in local universities. Finally, the paper outlines future development directions from three perspectives: mechanism refinement, technological empowerment, and ecosystem construction, aiming to offer theoretical reference and practical guidance for the high-quality development of higher education.

Keywords: Intelligence+; virtual teaching and research office; grassroots teaching organization; computer science; teaching and research community

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1. Introduction

1.1. Research Background

The Teaching and Research Office (TRO) in higher education institutions is a grassroots organization responsible for teaching, research, and management. It serves as the fundamental unit for organizing instruction, conducting teaching-related research, and nurturing talent in universities. The comprehensive revitalization of undergraduate education relies on the foundational support of grassroots teaching organizations, which are critical for implementing the "the final stage of implementation" of curriculum delivery and instruction.

1.2. Problems and Development of Teaching and Research Offices

However, in the context of the ongoing reform of higher education, traditional TROs face several prominent challenges:

1) Excessive emphasis on scientific research at the expense of studying teaching content, methodologies, and educational reforms.
2) Overemphasis on the administrative functions of schools and departments, neglecting the expansion of the core teaching and research functions of grassroots TROs.
3) The excessive burden of administrative tasks has encroached upon the work of TROs, weakening their essential roles in organizing teaching discussions and research activities.
4) A lack of long-term development planning for academic discipline construction, program development, curriculum design, and faculty capacity building.
5) Insufficient common time, collaboration, and teamwork among TRO members have led to challenges in scheduling teaching and research activities, low attendance rates, and activities becoming mere formalities.

These issues clearly hinder the important role TROs should play in enhancing teachers' educational capabilities and professional competencies.

Virtual Teaching and Research Offices (VTROs) represent a new type of grassroots teaching organization in the “Intelligence+” era. They leverage information technology and smart teaching methods to facilitate blended online and offline teaching research activities and classroom practices. In China, Nankai University began exploring VTRO construction in 2019, establishing university-level VTROs in various faculties to promote innovative grassroots teaching practices (compiled from a news report, 2021). Strengthening the development of grassroots teaching organizations and comprehensively improving teachers' instructional and nurturing abilities are essential requirements and important supports for advancing the high-quality development of higher education. VTROs represent a significant exploration in constructing new grassroots teaching organizations in the information age.

To implement the spirit of policy documents such as the *Opinions of the Ministry of Education on Accelerating the Construction of High-Quality Undergraduate Education and Comprehensively Improving Talent Cultivation Capabilities* (Jiao Gao [2018] No. 2) and the *Opinions of the Ministry of Education on Deepening the Reform of Undergraduate Education and Teaching and Comprehensively Improving the Quality of Talent Cultivation* (Jiao Gao [2019] No. 6), and to explore new forms of grassroots teaching organizations, the Ministry of Education launched pilot construction projects for Virtual Teaching and Research Offices (VTROs) in July 2021. This initiative was formally announced in the *Notice of the Department of Higher Education on Launching Pilot Construction of Virtual Teaching and Research Offices* (Ministry of Education of the People’s Republic of China, 2021; policy document/news report).

While VTROs have not yet been developed internationally, several domestic universities have actively explored their construction. Since 2013, Tsinghua University has promoted cross-institutional teaching collaborations with institutions such as Harbin Institute of Technology and Guizhou Institute of Technology by opening its MOOC resources on circuit principles, fostering two-way interactions in resource sharing and teaching reform. Since 2019, Nankai University has established 13 interdisciplinary teaching and research teams, conducting regular online activities that effectively promote "intellectual collisions" and collaborative innovation among teachers from different disciplines. Additionally, universities such as Beijing Information Science and Technology University, Nanjing University, and Zhejiang University have engaged in diverse teaching discussions and resource co-construction practices through VTROs, providing valuable experience for cross-institutional and interdisciplinary collaboration.

The experiences of these institutions offer reference insights and practical lessons for the construction of VTROs in our college. However, there is currently a lack of systematic research on the development pathways of VTROs in local universities, particularly in engineering disciplines such as computer science. The theoretical foundations, organizational mechanisms, and practical models for such efforts remain underexplored.

2. Theoretical Foundation

As a new form of grassroots teaching organization in the "Intelligence+" era, the construction and development of virtual teaching and research offices (VTROs) must be grounded in solid theoretical foundations. This study primarily adopts connectivism, constructivism, and learning sciences as its theoretical framework to systematically support the functional design, organizational operation, and pedagogical innovation of VTROs.

2.1. Connectivism and Its Guiding Significance

Connectivism, proposed by George Siemens, emphasizes that in the digital age, learning is no longer merely an individual process of knowledge internalization but a social activity centered on "forming connections" and "building networks" [1]. According to this theory, knowledge is distributed across network nodes, and the key capability for learning lies in forming and navigating these networks.

When applied to the construction of VTROs, the guiding value of connectivism is manifested in three main aspects: First, VTROs are essentially networks of teaching and research relationships that transcend time, space, disciplines, and institutions. This aligns with the connectivist principle that "connections are more important than content," promoting effective interconnections among diverse educational stakeholders, including teachers, experts, and students. Second, the theory emphasizes that "the pipe is more important than the content within the pipe." As a "pipe" for the flow and creation of knowledge, VTROs can leverage digital platforms to facilitate the dynamic circulation and sharing of teaching resources, pedagogical ideas, and instructional methods. Third, connectivism emphasizes continuous learning and knowledge renewal. By establishing open, collaborative, and evolving teaching and research mechanisms, VTROs can effectively support teachers in adapting to rapidly changing intelligent technological environments, thereby enabling the continuous evolution of their teaching capabilities.

2.2. Constructivism and Its Implications

Constructivism, represented by theorists such as Jean Piaget and Lev Vygotsky, posits that knowledge is not passively received through instruction but actively constructed by learners within specific socio-cultural contexts [2]. This theory particularly emphasizes the critical role of social interaction and collaboration in knowledge construction.

The construction of VTROs fully embodies the core concepts of constructivism: First, by creating a community of collaborative inquiry, VTROs provide teachers with a "socio-cultural context" in which they can collectively engage in instructional design, reflect on teaching practices, and collaborate to solve problems, thereby constructing and deepening pedagogical knowledge through collective wisdom. Second, VTROs support cross-institutional collaborative lesson preparation, co-teaching, and joint evaluation. Through sustained interaction with peers from other institutions and domain experts, teachers can continuously break cognitive boundaries and reconstruct and enhance their teaching concepts and strategies. Finally, constructivism emphasizes learning in authentic contexts. VTROs facilitate teaching and research activities focused on real teaching issues, such as lesson study, teaching observation, and case development, enabling teachers to achieve effective professional growth through cycles of teaching practice and reflection.

2.3. The Support of Learning Sciences

Learning sciences, as an interdisciplinary field, integrates insights from cognitive science, education, computer science, and other disciplines to study "how people learn" and "how to design effective learning environments" [3]. Its core tenet is to view learning as an active, situated, and social process, and to promote educational innovation through design-based research.

Learning sciences provide direct theoretical support and design principles for the construction of VTROs: First, it emphasizes the design of learning environments. As a technology-supported new type of teaching and research environment, the design of VTROs should follow principles such as collaboration, scaffolding, and feedback to promote deep teaching and research interactions. Second, it prioritizes knowledge construction within communities. VTROs should serve as professional communities where teachers collectively explore teaching issues and co-construct pedagogical knowledge. Research on the social and interactive nature of knowledge construction in learning sciences provides a design basis for their operational mechanisms. Third, it advocates evidence-based teaching improvement. By promoting the empirical turn in educational research, learning sciences enable VTRO platforms to record process data from teaching and research activities, supporting multidimensional analysis of teacher participation, interaction patterns, and the generation and application of resources. This facilitates precise evaluation and continuous optimization of teaching and research activities.

These three theories are not isolated but together form a clear, hierarchical, and mutually supportive theoretical system: Connectivism establishes the organizational form and functional positioning of VTROs as "connection networks" and "knowledge pipelines" at the macro level. Constructivism lays the foundation for their social interaction mechanisms as "collaborative construction communities" at the meso level. Learning sciences provide specific principles and evidence-based support for the design, implementation, and evaluation of teaching and research activities at the micro level.

In summary, this study adopts connectivism as a guide for constructing organizational forms, constructivism for designing interaction mechanisms, and learning sciences for optimizing teaching and research processes, thereby forming a "structure-process-evaluation" tripartite theoretical framework [4].

3. Construction Pathways for Virtual Teaching and Research Offices in Computer Science

3.1. Organizational Structure: Building a New Form of Cross-Domain Collaborative Teaching and Research

The organizational structure of a virtual teaching and research office (VTRO) should transcend the spatial and disciplinary boundaries of traditional teaching and research offices, forming an open, collaborative, and dynamic networked community. Its construction unfolds in the following three dimensions:

1) Multi-Stakeholder Collaborative Membership Mechanism

Core faculty members with extensive experience in research-based teaching should serve as the heads of the VTRO, responsible for overall planning and coordination. Members should include frontline teachers from across colleges, disciplines, and institutions, while also incorporating external intellectual resources such as industry experts and educational technology specialists. This diverse composition not only helps break down disciplinary barriers but also promotes the cross-fertilization of teaching philosophies and methods.

2) Technology-Empowered Platform-Based Organizational Carrier

By leveraging existing digital tools such as online teaching platforms, video conferencing systems (e.g., Tencent Meeting, DingTalk), and cloud-based resource-sharing platforms, a "cloud-based teaching and research space" can be constructed.

Platform selection should balance usability, interactivity, and data retention capabilities, supporting a combination of asynchronous discussions and real-time collaboration to provide a stable and reliable technological environment for cross-domain teaching and research [5].

3) Problem-Oriented Open Activity Design

Regular online activities such as thematic seminars, teaching observations, and case diagnoses should be organized around common issues in computer science curriculum development, challenges in teaching reform, and applications of cutting-edge technologies. Activity design should emphasize participation, generativity, and practicality, encouraging teachers to transition from being "organized participants" to "active co-creators."

3.2. Operational Mechanism: Implementing a Closed-Loop Collaborative Teaching and Research Model

The operation of a VTRO forms a closed-loop system of "design–practice–reflection–improvement," promoting systematic, regular, and outcome-oriented teaching and research.

1) Regular Thematic Teaching and Research Mechanism

Using course groups as units, a series of integrated online and offline teaching and research activities should be organized around themes such as blended learning design, integration of ideological and political education into curricula, innovative practical teaching, and reforms in learning assessment. Each semester, a teaching and research plan should be developed, clearly outlining timelines, discussion topics, and expected outputs to ensure the orderly progression of activities.

2) Teaching Practice and Reflection Loop

A complete chain of "collective lesson preparation–teaching implementation–classroom observation–reflective discussion" should be established. For example, for a core knowledge point, the VTRO can organize collaborative lesson preparation to develop diverse teaching design plans. After instruction, a multidimensional review—including video analysis of teaching sessions and student feedback—can be conducted to distill effective teaching strategies.

3) Transformation and Dissemination Mechanism for Teaching and Research Outcomes

Teachers should be encouraged to systematically organize discussions, cases, and design plans from teaching and research activities into shareable resources such as teaching resource packages, teaching reform papers, and course construction reports. An outcome recognition and incentive mechanism should be established to promote the application and dissemination of outstanding teaching and research outcomes within and beyond the institution [6].

3.3. Resource Development: Promoting Cross-Disciplinary Collaborative Sharing of High-Quality Resources

One of the core advantages of VTROs lies in their ability to integrate and generate high-quality teaching resources, forming an open, dynamic, and evolvable resource ecosystem.

1) Diversified Resource Co-Construction System

Resource types should encompass all elements, including talent cultivation programs, course syllabi, knowledge graphs, micro-lecture videos, project cases, experimental datasets, exercise banks, and ideological-political educational materials. Resource development should adopt a collaborative model of "core team leadership with full member participation," with clear resource standards and co-construction processes.

2) Platform-Based Sharing and Dynamic Update Mechanism

A hierarchically classified resource repository should be established using cloud storage, supporting version management, access control, and usage tracking. A resource evaluation and iteration mechanism should be implemented to encourage teachers to provide feedback during use and optimize resources through sharing, creating a virtuous cycle of "co-construction–sharing–co-evaluation–co-advancement."

3) Incentive Mechanisms and Intellectual Property Norms

Measures such as point systems and recognition of teaching achievements should be used to incentivize teachers to actively participate in resource development. At the same time, clear guidelines for resource usage rights and attribution rules should be established to respect teachers' intellectual labor and ensure that resource sharing operates within a standardized and orderly framework [7].

3.4. Teacher Development: Establishing a Sustainable System for Enhancing Teaching and Research Capabilities

A VTRO should not only serve as a platform for teaching and research but also act as a "refueling station" for teachers' professional growth, facilitating their transition from "teaching practitioners" to "teaching researchers."

1) Tiered and Categorized Training Support System

Tailored training programs on topics such as digital teaching capabilities, course design skills, and teaching scholarship should be offered to meet the needs of teachers at different career stages. A combination of "workshops + mentorship + peer support groups" should be adopted to enhance the relevance and practicality of training.

2) Integration of Science and Education and Teaching Transformation Mechanism

The research backgrounds of computer science teachers should be fully leveraged to establish pathways for transforming research outcomes into teaching resources. For instance, teachers should be encouraged to convert real-world cases, datasets, and algorithmic tools from research projects into teaching materials, building a "research-feeding-teaching" case repository.

3) Developmental Evaluation and Growth Portfolio Development

A multidimensional developmental evaluation system should be established, assessing factors such as teacher participation, resource contributions, and the effectiveness of teaching improvements. An electronic growth portfolio should be created for each teacher, documenting their involvement in teaching and research activities, contributions to resource development, and publication of teaching and research outcomes. This portfolio can serve as a basis for professional title evaluations, awards, and recognition [8].

4. Implementation Outcomes

The aforementioned measures for constructing virtual teaching and research offices (VTROs) have yielded significant results in faculty development, program enhancement, talent cultivation, and social services.

In recent years, two team members have been promoted to professorship. The team has secured approval for one provincial key industry-academy collaboration institute, one provincial first-class undergraduate course, and ten provincial-level or higher research projects. Additionally, ten high-quality research papers have been published, one textbook has been compiled, and one first prize for teaching achievements at the university level has been awarded. The team has guided undergraduate students in publishing three papers, supervised three outstanding undergraduate theses, and mentored students in multiple innovation and entrepreneurship projects, including three at the national level, two at the provincial level, and several at the university level.

The practical and innovative capabilities of students have also improved substantially. In recent years, students have achieved notable success in disciplinary competitions, securing thirteen national awards, eighty-nine provincial first prizes, and

134 other awards. This reflects the significant role of VTRO initiatives in enhancing students' comprehensive competencies and innovative capacities.

The social service functions of faculty members have also been significantly strengthened. In recent years, the team has undertaken numerous industry-sponsored projects focused on technology development, technical services, and the transformation of research outcomes tailored to practical enterprise needs. As of the latest data, the cumulative funding for such horizontal research projects has reached 13.64 million yuan, spanning fields such as information technology, artificial intelligence, ecological conservation, and educational innovation. This fully demonstrates the team's capacity to respond to societal needs and address practical challenges. These collaborations have not only facilitated technological upgrades and product innovations in enterprises but have also effectively promoted the transformation of academic research outcomes into practical productivity, thereby enhancing the institution's influence and contributions within the local and industrial contexts.

In summary, the construction of virtual teaching and research offices has achieved remarkable outcomes. Faculty capabilities have continued to strengthen, research outputs have been substantial, and significant breakthroughs have been made in program and curriculum development. Students' practical and innovative abilities have been comprehensively enhanced, while the social service functions of faculty members have become increasingly prominent.

5. Conclusion and Outlook

This study, grounded in the context of higher education reform in the "Intelligence+" era, systematically explores the conceptual framework and practical pathways of virtual teaching and research offices (VTROs). The research indicates that the development of VTROs in local application-oriented universities, particularly in fields such as computer science, should be based on the theoretical foundations of connectivism, constructivism, and learning sciences. A systematic approach encompassing "organizational structure—operational mechanisms—resource development—teacher development" should be constructed, with the core aim of transforming grassroots teaching organizations from closed, static, and task-oriented traditional forms into open, collaborative, and intelligent teaching and research communities.

At the practical level, this study addresses the spatiotemporal limitations and functional weaknesses of traditional teaching and research offices by establishing a **cross-**disciplinary collaborative organizational network, implementing a closed-loop operational mechanism of "design–practice–reflection–improvement," and promoting the sharing of high-quality resources and continuous teacher development. The implementation outcomes demonstrate that VTROs can significantly enhance faculty development, improve the quality of professional and curriculum construction, strengthen students' innovative capabilities, and expand social service functions. This provides an actionable implementation paradigm for local universities to achieve the integration of teaching and research as well as industry-academia collaboration.

Looking ahead, the development of VTROs still holds broad prospects for deepening and refinement. First, at the institutional level, there is a need to further improve the motivational mechanisms for co-construction and sharing, as well as the long-term operational safeguards, to facilitate the transition of VTROs from "project-based operation" to "institutionalized normalization." Second, at the technological level, it is essential to actively explore the deep application of technologies such as artificial intelligence and big data analytics in recording teaching and research processes, intelligent diagnosis of outcomes, and precise recommendation of resources, thereby achieving a leap from "technological support" to "intelligent empowerment." Third, at the ecological level, efforts should be made to build an open teaching and research ecosystem characterized by regional collaboration, industry-academia synergy, and interdisciplinary

integration, enabling VTROs to become an innovative engine and foundational support for promoting the high-quality development of higher education.

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References

1. L. Chen, W. Li, and Y. Zhao, "Reflection and path research on the current situation of online learning among college students from the perspective of connectivism theory (Liantong zhuyi lilun xia gaoxiao xuesheng zaixian xuexi de xianzhuang fansi yu lujing yanjiu)," *National Common Language Teaching and Research*, no. 10, pp. 7–9, 2025 (in Chinese).
2. X. Yang and Y. Li, "Research on the construction of future learning centers from the perspective of constructivist learning theory," *New Century Library*, no. 10, pp. 12–19, 2025.
3. P. Zhang, H. Su, Y. Zhang, et al., "Hidden Markov Models from a learning sciences perspective: analysing learning processes by linking theory and data," *Research in Teaching*, vol. 48, no. 1, pp. 1–10, 2025.
4. X. Huang, H. Li, L. Huang, and T. Jiang, "Research on the development and innovation of online education based on digital knowledge sharing community," *BMC Psychology*, vol. 11, no. 1, p. 295, 2023. doi: 10.1186/s40359-023-01337-6.
5. C. Yang, S. Yi, Y. Ji, and Y. Feng, "Research on personalized learning path for entrepreneurship education in the background of artificial intelligence plus," in *Proceedings of the 2025 5th International Conference on Artificial Intelligence and Education (ICAIE)*, May 2025, pp. 221–225. doi: 10.1109/ICAIE64856.2025.11157995.
6. Z. Zheng, Y. Pan, and L. Li, "Team construction and cooperation mechanism of virtual teaching and research office of logistics specialty in the information age," in *Proceedings of the International Conference on Artificial Intelligence, Medical Engineering, and Education*, Aug. 2022, pp. 436–447. Cham, Switzerland: Springer Nature. doi: 10.1007/978-3-031-24468-1_39.
7. X. Hu, S. Sun, W. Yang, and G. Ding, "Artificial intelligence empowering the high-quality development of education: Demands, visions, and paths," *Frontiers of Education in China*, vol. 18, no. 1, 2023. doi: 10.3868/s110-008-023-0001-4.
8. L. Yuan, S. MacNeill, and W. G. Kraan, *Open Educational Resources—Opportunities and Challenges for Higher Education*. United Kingdom: JISC, 2008.