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MAPPING THE LOGIC OF VIRTUAL TEACHING AND RESEARCH TO PHYSICS CURRICULUM DEVELOPMENT AND IN-DEPTH SCIENCE POPULARIZATION

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Abstract: Under the background of deepening the pilot construction of virtual teaching and research offices in China's higher education development, it is necessary to leverage the driving role of various pilot projects, emphasizing the trend of "AI+teaching reform." By integrating theoretical research with practical applications through scientific methods, this paper explores the triple logic underlying the development of virtual teaching and research offices. Based on this analysis, a multidimensional development model for virtual teaching and research offices is proposed. Taking the construction of foundational physics courses as an example, the integration path between virtual teaching and research offices and in-depth science popularization is analyzed.
Keywords: Virtual teaching and research; Physics curriculum development; In-depth science popularization

1 INTRODUCTION

The Higher Education Department of China's Ministry of Education proposed in its 2022–2024 work priorities the need to deepen the pilot construction of virtual teaching and research offices. Additionally, our team was awarded the Shaanxi Province Virtual Teaching and Research Office Construction Project in October 2021. This necessitates research into the development mechanisms of "AI+teaching reform" virtual teaching and research offices, aiming to provide theoretical guarantees and model references for grassroots teaching organization construction, thereby supporting the high-quality development of universities.

2 THE TRIPLE LOGIC OF VIRTUAL TEACHING AND RESEARCH OFFICE

2.1 Historical Logic

Cheng Jieming, former Vice President of the University of Hong Kong, who has extensively studied and compared the educational systems and school cultures of China and Western countries, remarked, "*China's teaching and research habits and systems over the past 70 years are almost unique globally*" [1]. However, since the 1990s, the increasing emphasis on research in higher education evaluations has altered the positioning, functions, and forms of teaching and research offices as grassroots organizations, leading to a decline in teaching quality [2–5]. Although the "Undergraduate Teaching Quality and Reform Project" during China's 10th and 11th Five-Year Plans partially mitigated this decline, the operational practices of universities increasingly prioritized research teams.

To resolve the conflict between prioritizing research over teaching, Professor Sang Xinmin proposed improving teaching standards, quality, and efficiency while fostering mutual promotion and collaborative innovation between the two. Drawing on the concept of "virtual communities," he pioneered virtual teaching and research activities in China, publishing *The Conception and Practice of Virtual Teaching and Research Models* in 2001 [6].

In February 2017, the Ministry of Education initiated the "New Engineering Education" reform, culminating in the "Fudan Consensus," "Tianjin University Action," and "Beijing Guidelines," later expanding to the "Four New Constructions." These efforts aimed to develop a globally leading Chinese educational model, emphasizing interdisciplinary, innovative, and cross-boundary talent cultivation. This necessitated establishing long-term mechanisms to support interdisciplinary teaching and academic integration [5]. Consequently, teaching and research offices, as grassroots organizations, required functional revitalization to create teacher communities that integrate teaching and academic research [7–9]. Early explorations were led by scholars such as Sang Xinmin, Zeng Jianchao, and Hong Zhizhong at institutions like Nanjing University, South China Normal University, and Zhejiang University [2,4–11].

Thus, virtual teaching and research offices are rooted in the functional and organizational innovation of university grassroots entities in the information age. They transform courses developed by outstanding faculty teams into open online resources, fostering cross-institutional virtual teaching and research teams, updating teaching materials, enhancing platforms and tools, and nurturing creative learning capabilities [7–9]. The Ministry of Education's 2020–2024 priorities, including "strengthening grassroots teaching organizations," "launching virtual teaching and research office pilots," and "developing virtual teaching platforms," further affirm this national trend.

2.2 Value Logic

2.2.1 Academic value

This paper pioneers detailed research on the theoretical logic, platform models, and implementation pathways of virtual teaching and research offices, addressing the lack of systematic guidance in prior practices. For instance, among 3,168 national projects in education over the past five years, only one 2019 project by Hu Fangang of Qufu Normal University discussed "educational virtual communities," focusing on ethical issues rather than virtual teaching and research offices. Therefore, rigorous theoretical frameworks are essential to guide this transformative shift in teaching culture and organizational paradigms, ultimately fostering innovative talent development.

2.2.2 Practical value

Compared to existing literature, this study innovates the practice model of "intellectual collision fields" for cross-disciplinary, cross-regional teaching reform under the Shaanxi Province Virtual Teaching and Research Office Project. It promotes digital application and classroom innovation in central and western Chinese universities. Unlike discipline- or course-specific virtual offices, teaching reform-oriented virtual offices bear the mission of enhancing educational quality. By exploring their theoretical foundations, organizational models, and implementation strategies, this research addresses the shortcomings of traditional teaching and research activities confined to physical offices.

2.2.3 Promotion value

Compared to existing practices, this study explores virtual teaching and research offices across three regional universities in central and western China. Its clear implementation pathways make it easily adaptable to numerous local universities nationwide. The Chinese Ministry of Education's "Document No. 2 [2022]" marks the launch of 439 national pilot virtual teaching and research offices, with platforms like *DingTalk* supporting these initiatives. Due to our university's long-term commitment to teaching and research office reforms, we secured one of Shaanxi Province's 37 provincial-level virtual teaching and research office pilots in October 2021. Leveraging this project, the findings of this study can be widely disseminated among local universities.

2.2.4 Practical value

Unlike prior literature, this paper introduces the concept of "AI + teaching reform" platform-based virtual teaching and research offices for foundational courses. The proposed pathways and strategies are readily applicable to other foundational disciplines. Using the Central and Western Basic Physics Cloud-Based Teaching Reform Virtual Teaching and Research Office as a case study, we establish development pathways and operational strategies for such offices. These results are easily implementable and scalable across foundational courses, benefiting large student populations.

2.3 Problematic Logic

Previous studies on virtual teaching and research offices [2–12] addressed general theoretical, logical, and practical challenges but lacked depth in theoretical refinement and practical implementation. For instance, under the "Western Triangle" framework in higher education, new theories, practices, and exemplary models for "AI+teaching reform" virtual offices face unresolved issues, such as institutional mechanisms.

2.3.1 Weak theoretical foundation

In central and western universities of China, the theoretical foundations of "AI+" grassroots teaching organizations are weak. Existing explorations [2–12] tackled preliminary theoretical and practical questions but failed to refine theories for efficient organizational development.

2.3.2 Lack of hierarchical and categorized platform solutions

The national virtual teaching and research office initiative, launched in February 2020 on the "*DingTalk*" platform, overlooked hierarchical and categorized platform designs, resulting in poor theoretical applicability.

2.3.3 Scarcity of exemplary cases

As virtual teaching and research offices are emerging innovations, there are no national, provincial, or institutional benchmarks. Thus, there is an urgent need to develop practical strategies for teaching reform-oriented virtual offices in central and western China, providing actionable models for grassroots teaching organizations.

3 METHODS AND GUARANTEE MEASURES

3.1 Methods

Maxwell's "cross design method" was adopted in each research stage, and different degrees of qualitative and quantitative combinations were applied to each stage.

In the early stage of the research, the "grounded theory" research path (literature review and interview methods) of qualitative research (Mr. Chen Xiangming from Peking University) was the main approach, while the quantitative research path (literature review and questionnaire methods) was used as an auxiliary approach. This combination mainly focuses on the principles, concepts, mechanisms, and other tasks included in research content one and two, and requires the establishment of theoretical viewpoints based on empirical data.

In the later stage of the research, the quantitative research path (literature review and questionnaire methods) is the main approach, while the qualitative research path of "grounded theory" (literature review and interview methods) is used as an auxiliary approach. This combination is mainly aimed at the practical application strategies and other tasks included in research content two and three, which require obtaining statistical data and common experience of teaching practice,

and providing timely feedback.

3.2 Four Guarantee Conditions

3.2.1 Platform guarantee

The practical platform is unique. The "Central and Western Basic Physics Cloud Education Reform Virtual Teaching and Research Room" led by Xu Shijun was approved as one of the first 37 provincial-level virtual teaching and research rooms for pilot construction in October 2021, and is the only construction project of the Xi'an Technological University in China.

3.2.2 Academic guarantee

We have a solid academic foundation. The person in charge and members have project support in the preliminary basic research and have achieved many results. Please refer to "Research Fundamentals" for details.

3.2.3 Team guarantee

Our team has a high level of proficiency. The "Central and Western Basic Physics Cloud Education Reform Virtual Teaching and Research Room" approved by our team in October 2021 is not only the only construction project of our university, but also the only physics virtual teaching and research room in Shaanxi Province. It was promoted again on February 14, 2022, indicating that the team's academic level and construction ability have been recognized by experts. There are 2 professors, 2 associate professors, and 1 lecturer among the members of this project, whose disciplines and job responsibilities are in line with the professional development and training of teachers.

3.2.4 Policy guarantee

The policy environment of this paper is superior. In addition to the base guarantee of the virtual teaching and research office in Shaanxi Province mentioned above, each participating unit will provide a venue for research and application; The project undertaking school has a sound management policy for various levels and types of teaching and research projects, and possesses the basic information and equipment required for project research; In addition, all cooperating units have a favorable environment and conditions for the implementation of this project.

4 RESULTS

The theoretical objective of this paper is to explore the theoretical structure and organizational model of virtual teaching-research rooms for educational reform in different industries or regional backgrounds. Focusing on full-time teachers from three universities with backgrounds in light industry and teacher education, this study aims to investigate the theoretical structure and organizational model of a teacher training community for educational reform that integrates general and specialized education and cross school collaboration. Particularly, it will explore the new features of using information technology to transform traditional teaching-research rooms in the era of "AI+".

Many practical objectives of this paper is to establish the development path of virtual teaching and research rooms for basic course education reform on the platform, and refine their operational strategies. Taking the virtual teaching and research room for cloud based teaching reform of basic physics in the central and western regions as an example, this paper explores its specific construction path and operation strategy, in order to assist in realizing a powerful virtual teaching and research room with advanced concepts, forging a high-level teaching team of 30 people, cultivating a group of teaching research and practical achievements, building a teaching development community and quality culture for teachers, and comprehensively improving teachers' teaching abilities.

Based on the triple logic of virtual teaching and research offices, this study theoretically explores their developmental elements, connotations, and boundaries across "learning" and "organizational" dimensions. Practically, we focus on the university basic physics course,with a high-impact subject, to innovate its technical platform, develop intelligent resource databases, organize student teams, and collect online learning data. Notably, the in-depth physics science popularization serves as a unique feature and quality-enhancing tool for the virtual office.

5 CONCLUSION

This paper investigates regional teaching reform-oriented virtual teaching and research office pathways, clarifying their core philosophy: serving dynamic, open grassroots teaching organizations and inspiring teachers to return to, cherish, and research teaching. We propose three practical pathways for "AI+teaching reform" virtual offices: prioritizing moral education, fostering collaboration and resource-sharing, and advancing categorized exploration. Thus, this study provides theoretical and practical frameworks for grassroots teaching organization development, supporting high-quality advancement in higher education.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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