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Inter-Institutional Collaborative Resource Co-Construction in Building Architecture: Model Innovation and Pathway Exploration

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Abstract: The Emerging Engineering Education (EEE) initiative has imposed higher requirements on talent cultivation in Building Architecture. However, under the traditional model, rigid inter-institutional barriers, duplicated investment, and the inability of high-quality resources to radiate across campuses have constrained improvements in teaching quality. Grounded in the pedagogical characteristics of Building Architecture, this paper systematically analyzes the practical demands and bottlenecks of inter-institutional resource sharing and co-construction, and constructs a multi-dimensional content system encompassing faculty teams, curricular resources, practical training bases, and digital platforms. It proposes a co-construction model of "alliance collaboration, tiered sharing, and dynamic iteration," together with an operational mechanism of "demand alignment—resource integration—platform support—evaluation feedback." Drawing upon the practice of a regional alliance of architecture-related universities, the paper summarizes the remarkable achievements of resource sharing and co-construction in improving teaching quality, promoting educational equity, and advancing collaborative discipline development. Furthermore, it proposes optimization strategies addressing critical issues such as intellectual property attribution, benefit distribution, and quality assurance, thereby providing theoretical references and practical insights for inter-institutional collaborative education in civil engineering and construction courses.

Keywords: Building Architecture; Inter-Institutional Sharing; Resource Co-Construction; Collaborative Education; Emerging Engineering Education.

1. Introduction

Building Architecture is a core fundamental course for majors such as Architecture, Civil Engineering, and Construction Management, bearing the critical responsibility of cultivating students' spatial cognition, comprehension of building construction, and preliminary architectural design capabilities.[4] This course is characterized by both theoretical depth and practical orientation, involving interdisciplinary knowledge spanning architectural history, building physics, architectural construction, and building codes, thereby demanding exceptionally rich, cutting-edge, and practice-oriented teaching resources. However, for a long time, the development of teaching resources for Building Architecture has been plagued by a structural contradiction of "severe inter-institutional barriers, redundant investment, and concentration of high-quality resources": on the one hand, some high-level institutions possess abundant historical building survey data, advanced virtual simulation laboratories, and strong faculty resources; on the other hand, a large number of local institutions and newly established undergraduate colleges face obvious shortcomings in curricular resources, practice bases, and faculty staffing, making it difficult to meet the urgent demand for cultivating interdisciplinary architectural talents under the EEE framework.[3][9]

Since 2020, the Ministry of Education has continuously advanced initiatives such as "MOOC Goes West," "Virtual Teaching and Research Offices," and "First-Class Undergraduate Courses," providing policy momentum for breaking down inter-institutional resource barriers.[1] Meanwhile, the digital transformation of the construction industry, the popularization of green building concepts, and the promotion of prefabricated construction technologies have posed entirely new challenges to the content and pedagogy of Building Architecture.[10] It is difficult for any single institution to independently cope with these rapid changes; therefore, inter-institutional collaboration is urgently needed to achieve resource sharing, complementary advantages, and mutual improvement. Based on this context, this paper takes Building Architecture as an entry point to explore the theoretical framework, practical models, and optimization pathways for inter-institutional resource sharing and co-construction, with the aim of providing references for the high-quality development of civil engineering courses.

2. Analysis of Practical Demands and Bottlenecks for Inter-Institutional Resource Sharing and Co-Construction in Building Architecture

(1) Practical Demands

The content of Building Architecture is closely linked to the development of the construction industry. In recent years, green building assessment standards, technical specifications for prefabricated construction, and building energy efficiency design codes have been continuously updated, while new technologies such as BIM, parametric design, and intelligent construction have rapidly permeated the field.[3][9] It is often difficult for a single institution's faculty team to fully grasp these cutting-edge developments. Through inter-institutional sharing, the disciplinary strengths of different institutions can be aggregated to achieve rapid iteration of curricular content and optimized restructuring of knowledge systems.

The practical teaching of Building Architecture heavily

relies on physical building cases, constructional node displays, and on-site cognitive internships. Different types of institutions possess markedly different resource endowments: the "Old Eight" architecture schools have rich archives of historical buildings and physical survey resources, whereas local institutions are closer to regional architectural characteristics and engineering practices.[7][10] Inter-institutional sharing can revitalize practical resources scattered across different campuses, constructing a three-dimensional practical teaching resource library that covers ancient and modern, eastern and western, and northern and southern architectures.

Under the background of mass higher education, local institutions and private colleges undertake the majority of architectural talent cultivation tasks, yet their teaching resources are relatively weak. Through inter-institutional resource sharing and co-construction, high-quality resources such as curriculum-based ideological and political education cases, exemplary courseware, and virtual simulation projects from top-tier institutions can be radiated to weaker institutions, thereby safeguarding educational equity while holistically improving the quality of talent cultivation.[2][6]

(2) Bottlenecks

The management of teaching resources in current universities is generally school-based, exhibiting problems such as unclear property rights, insufficient motivation for sharing, and ambiguous boundaries of responsibility. A lack of stable cooperative covenants and interest coordination mechanisms between institutions means that resource sharing often remains at the level of temporary exchanges among individual faculty members, making it difficult to form an institutionalized and normalized co-construction pattern.[6]

Teaching resources for Building Architecture are highly diverse, including textbooks, drawing collections, photographs, videos, 3D models, and virtual simulation programs. Different institutions adopt different software platforms, data formats, and classification standards, creating technical barriers to resource interoperability.[8] Furthermore, strong awareness of intellectual property protection means that faculty members are concerned about the misuse of their resources after sharing.

In the current faculty evaluation system of Chinese universities, the recognition of achievements in teaching resource construction is weaker compared to academic research outputs. The workload involved in inter-institutional resource sharing and co-construction is difficult to quantify and assess, affecting faculty enthusiasm for resource development. The tendency to "emphasize research over teaching and individual work over collaboration" constrains the in-depth development of co-construction and sharing. [1] [6]

Existing inter-institutional cooperation is mostly confined to universities within the same city or province, with limited cross-regional and cross-level collaboration. Building Architecture has distinct local characteristics; construction details and design concepts vary significantly across different climate zones and regional cultures. An overly limited scope of collaboration restricts the breadth and depth of resource complementarity.[6]

3. Construction of a Content System for Inter-Institutional Resource Sharing and Co-Construction in Building Architecture

Based on the disciplinary attributes and pedagogical demands of Building Architecture, inter-institutional resource sharing and co-construction should establish a "four-dimensional integrated" content system encompassing faculty teams, curricular resources, practice bases, and digital platforms.[4][6]

(1) Collaborative Construction of Faculty Teams

Breaking down inter-institutional personnel barriers, cross-institutional course groups should be formed according to modules such as "Architectural Design Principles," "Building Construction Technology," "Architectural History and Heritage Conservation," and "Green Building and Sustainable Design." Each module should be jointly undertaken by 2–3 institutions with comparative advantages, enhancing teaching quality through collective lesson preparation, joint lecturing, and mutual evaluation.[4] For example, institutions with strengths in historical building conservation can lead the module on ancient building construction, while those with engineering practice advantages can lead the module on prefabricated building construction.

An inter-institutional teaching assistant system for young faculty should be established, allowing newly hired faculty to spend one semester at benchmark institutions within the alliance for course auditing, participation in teaching seminars, and classroom observation. Meanwhile, regular cross-institutional teaching competitions and micro-lecture design contests should be organized to provide platforms for young faculty to demonstrate and exchange ideas.

Consolidating the external mentor resources of each institution, a shared industry expert database should be established. Renowned architects, structural engineers, and heritage conservation experts should be invited to participate in teaching at multiple institutions through formats such as "cloud lectures," "workshops," and "design reviews," expanding students' exposure to industry frontiers.

(2) Co-Construction and Sharing of Curricular Resources

The teaching content of Building Architecture should be decomposed into several knowledge modules, with each module developed as a standardized resource package containing syllabi, electronic lesson plans, multimedia courseware, case libraries, exercise banks, and test questions.[1] The resource library should adopt a "foundation layer + extension layer" structure: the foundation layer should be freely open to all alliance institutions to guarantee basic teaching needs; the extension layer should include frontier thematic lectures and advanced case analyses, providing value-added services to institutions with specific demands.

Institutions should be encouraged to transform their disciplinary characteristics into shared resources. For example, institutions in northern regions can share cases of building energy efficiency construction in severe cold zones, while southern institutions can share ventilation and moisture-proofing technologies for hot-humid regions; institutions with traditions in regional architectural research can share survey drawings and research findings on local traditional dwellings; and institutions with access to major engineering projects can share construction videos and drawing materials.[5]

Building Architecture contains rich ideological and political education elements, such as the craftsman spirit in traditional architecture, the concept of ecological civilization in green building, and the sense of national commitment embodied in major projects. Institutions should jointly excavate curriculum-based ideological and political education cases and build a shared ideological and political education material library, including video clips, figure interviews, and engineering documentaries, achieving the organic integration of value guidance and knowledge transmission.

(3) Sharing of Practical Teaching Bases

Alliance institutions should be organized to jointly conduct building surveys and investigations, establishing a digital archive library of physical buildings covering different regions, types, and eras. Utilizing technologies such as 3D laser scanning, oblique photography, and BIM modeling, physical buildings should be transformed into digital resources available for remote teaching.[10] Students can "enter" classic buildings thousands of miles away through virtual reality technology, achieving the "cloudification" of cognitive internships.

The internship bases and industry-university-research cooperation bases signed by each institution should be opened to alliance institutions, establishing an inter-institutional mutual recognition mechanism for practice bases. After completing the basic internship requirements at their home institution, students can apply for expanded internships at characteristic buildings or engineering projects in the cities of alliance institutions, enriching the diversity of their practical experience.

Addressing teaching difficulties in Building Architecture that are "invisible, inaccessible, and difficult to reproduce," such as the disassembly of constructional nodes, building physics environment simulation, and historical building restoration processes, virtual simulation experiment projects should be jointly developed.[8] Through a virtual simulation experiment teaching sharing platform, cross-institutional course selection and credit mutual recognition for experimental projects can be realized.

(4) Co-Construction of Digital Technology Platforms

A cloud-based collaborative teaching platform for Building Architecture should be constructed, integrating functions such as curricular resource management, online teaching, peer assignment evaluation, and learning analytics. The platform should support students from multiple institutions taking the same course and working on the same projects, allowing instructors to monitor the learning status and knowledge mastery of cross-institutional students in real time.

Building Information Modeling (BIM) is an important tool for Building Architecture teaching. A shared BIM component library and case library should be co-constructed, with unified data standards and exchange formats, supporting faculty and students from all institutions to conduct collaborative design and model sharing on a unified platform, thereby cultivating students' digital design capabilities.

Utilizing virtual teaching and research office tools, a cross-institutional teaching and research community for Building Architecture should be established. Regular online teaching and research activities, including teaching salons, academic lectures, and curricular construction seminars, should be organized to form a new normal of "research anytime, discuss anywhere."[1]

4. Design of Models and Mechanisms for Inter-Institutional Resource Sharing and Co-Construction

(1) Co-Construction Model: "Alliance Collaboration, Tiered Sharing, Dynamic Iteration"

The establishment of "Regional Building Architecture Teaching Alliances" or "Collaborative Education Communities for Fundamental Architecture Courses" should be advocated, with voluntary participation by institutions of different types and levels. The alliance should establish a council, an expert committee, and a secretariat responsible for overall planning, standard setting, and daily coordination. Alliance members should cooperate according to the principles of "equality, voluntariness, complementary advantages, and mutual benefit," avoiding an unequal pattern of "dominance by strong institutions and dependence by weak ones."[2][6]

According to the attributes of resources and the actual conditions of institutions, sharing should be divided into three tiers: the basic sharing tier, open to all alliance institutions with general resources such as course standards, syllabi, and basic courseware; the collaborative co-construction tier, comprising premium resources jointly invested in and co-constructed by several institutions, such as virtual simulation experiments and joint case libraries, with participating institutions enjoying priority usage rights; and the characteristic output tier, whereby each institution opens its characteristic resources to the alliance under specific conditions, with other institutions obtaining them through resource exchange or paid usage, safeguarding the legitimate rights and interests of resource providers.[1][6]

A continuous resource updating mechanism should be established. At the end of each semester, alliance institutions should organize reviews and updates of the resource library, eliminating outdated content and supplementing frontier knowledge. Faculty and students should be encouraged to propose improvement suggestions during usage, forming a closed-loop iteration of "usage—feedback—optimization—re-usage." Meanwhile, based on the development of the construction industry and technological progress, resource construction guidelines should be regularly issued to guide the direction of co-construction.[3]

(2) Operational Mechanism: "Demand Docking—Resource Integration—Platform Support—Evaluation Feedback"

At the beginning of each semester, the alliance secretariat should organize each institution to submit resource demand lists and sharable resource lists. Through demand-matching algorithms or manual coordination, the priorities for co-construction and sharing plans for the semester should be determined. Demand docking should not only focus on resource gaps but also on common challenges in teaching reform, such as the integration of curriculum-based ideological and political education and the design of online-offline hybrid teaching.

A cross-institutional resource construction working group should be formed to carry out resource integration and processing according to unified technical standards and quality specifications. For existing high-quality resources from each institution, standardized transformation should be conducted before inclusion in the shared library; for gap resources, joint development or commissioned development should be organized. Metadata standards and classification

systems for resources should be established to ensure resource retrievability and reusability.[8]

Relying on national smart education platforms, provincial higher education platforms, or alliance self-built platforms, centralized storage and distributed access of resources should be achieved. The platform should possess functions such as copyright protection, usage statistics, and quality evaluation, providing technical guarantees for the sustainable operation of resources. Meanwhile, big data analytics should be used to analyze resource usage, providing data support for resource optimization and teaching improvement.[10]

A multi-dimensional evaluation system should be established: from the student perspective, evaluating the learning effectiveness and satisfaction of resources; from the faculty perspective, evaluating the teaching applicability and convenience of resources; and from the management perspective, evaluating resource utilization rates and co-construction participation. Evaluation results should be linked to resource construction funding allocation and faculty teaching workload recognition, forming positive incentives. An alliance teaching quality report should be published each semester, disclosing sharing achievements and improvement directions.[2]

(3) Guarantee Mechanisms

Alliance institutions should be encouraged to sign binding cooperation agreements clarifying the attribution of intellectual property rights, scope of usage, principles of benefit distribution, and liability for breach of contract. Each institution should introduce supporting policies to incorporate participation in inter-institutional resource sharing and co-construction into faculty teaching workload calculations, professional title evaluation, and performance assessment systems.[1][2]

A diversified funding model of "institutional self-funding + alliance coordination + external solicitation" should be adopted. Each institution should extract a certain proportion of teaching reform funds for resource construction; the alliance should establish a co-construction fund focusing on supporting cross-institutional joint projects; and active applications should be made for provincial and national teaching reform projects and virtual teaching and research office construction projects to secure external funding support.

A cross-institutional technical support team should be formed, responsible for platform operation and maintenance, resource digital processing, and technical training. Unified technical standards should be formulated, including video recording specifications, courseware production templates, and data exchange formats, to lower the technical threshold for resource interoperability.[8]

5. Practical Exploration and Effectiveness Analysis

(1) Practical Case: Co-Construction Practice of Building Architecture in a Regional Alliance of Architecture-Related Universities

Taking the "North Regional Fundamental Architecture Course Teaching Alliance" participated in by the author's institution as an example, this alliance comprises six different types of institutions within the region, including one of the "Old Eight" architecture schools, two provincial key universities, two local application-oriented undergraduate institutions, and one private institution. Since the launch of inter-institutional co-construction of Building Architecture in 2022, the alliance has mainly carried out the following work:

The alliance organized key faculty from each institution over a period of six months to jointly formulate the "Cross-Institutional Sharing Course Standards for Building Architecture," unifying course objectives, knowledge module divisions, and hour allocations, while allowing each institution to make personalized adjustments within a 20% range according to their major characteristics.

By the end of 2024, the alliance had constructed 86 Building Architecture course resource packages, covering 320 hours of teaching videos, 12 virtual simulation experiments, 45 physical building digital archives, and 60 curriculum-based ideological and political education cases. Among them, the "Virtual Simulation Experiment on Traditional Chinese Timber Frame Construction" was approved as a provincial first-class undergraduate course, and the "Regional Dwelling Cognition" micro-lecture series has been cited by three out-of-province institutions.

The alliance organizes 2–3 cross-institutional live lectures and joint design review activities each semester. For example, in the spring semester of 2024, a professor from an "Old Eight" school delivered a thematic lecture on "Modern Architectural Trends," with students from all six alliance institutions participating in synchronous online learning and discussion; in the fall semester, students from different institutions were mixed into groups to complete the "Age-Friendly Residential Design" course assignment, conducting joint design reviews through a cloud platform to broaden students' design horizons.

The alliance has established a shared cognitive internship base network covering 23 physical buildings, encompassing different regional types such as northern courtyard houses, southern skywell dwellings, southwestern stilted architecture (ganlan), and northwestern cave dwellings. After completing internships at their home institutions, students can experience architectural characteristics of other regions through virtual reality technology, compensating for the limitations of single-institution practical resources.

(2) Implementation Effectiveness

Through alliance co-construction, the excellent teaching evaluation rate for Building Architecture courses at local institutions increased from 62% before co-construction to 85%. The number of student awards in national architecture discipline competitions has also grown noticeably. Cross-institutional joint design reviews have exposed students to design approaches and evaluation standards from different institutions, exercising their design capabilities.

Through sharing high-quality resources, two local institutions and one private institution within the alliance have rapidly caught up in course construction, with significant improvements in student sense of gain and satisfaction during course learning. The sharing mechanism has broken the Matthew effect of high-quality resources concentrating in a few elite institutions, promoting balanced development of architectural education within the region.

The construction of cross-institutional teaching teams has promoted academic exchange and teaching capability improvement among faculty. Since the establishment of the alliance, 28 cross-institutional teaching and research activities have been organized, with cumulative faculty participation exceeding 150 person-times, resulting in 12 teaching reform papers and the approval of 5 provincial-level or above teaching reform projects, achieving a virtuous cycle of "promoting research through co-construction, and promoting teaching through research."

Redundant construction of the same content by each institution has been avoided. It is estimated that compared to a decentralized construction model, the overall resource construction investment of the alliance has been reduced by approximately 35%, while the total volume and quality of resources have significantly improved, achieving intensive and efficient educational investment.

6. Reflections on Problems and Optimization Pathways

Although inter-institutional resource sharing and co-construction have achieved positive results, several problems urgently needing resolution remain in practice.

(1) Intellectual Property and Benefit Distribution Issues

Some faculty members worry that their teaching achievements will be used free of charge or improperly disseminated after sharing, affecting their individual academic competitiveness. In response, intellectual property protection systems should be improved, clarifying the authorization scope and usage period of shared resources; interest compensation mechanisms should be established, providing funding rewards or workload preferences to high-quality resource providers; and a "sharing credit" system should be explored, whereby faculty earn credits for outputting resources that can be exchanged for characteristic resources or training opportunities at other institutions.[6]

(2) Quality Assurance and Standard Unification Issues

Teaching levels and resource quality vary across institutions. Without quality control, shared resource libraries could become "resource dumps." Strict resource admission review systems should be established, with the alliance expert committee conducting quality audits on resources proposed for inclusion; resource grading labels should be implemented, distinguishing "premium resources," "qualified resources," and "resources pending optimization," guiding users to prioritize high-quality resources; and a resource exit mechanism should be established to promptly remove resources with long-term low utilization rates or outdated content.

(3) Inter-Institutional Cultural Differences and Collaboration Depth Issues

Different institutions have differences in educational positioning, talent cultivation objectives, and teaching traditions, which may lead to conceptual conflicts during co-construction. For example, research-oriented institutions emphasize theoretical depth, while application-oriented institutions stress practical skills; how to accommodate different needs within shared resources is a challenge. "Flexible modules" should be set within course standards, allowing each institution to make content selections according to their positioning; in joint teaching activities, teaching objectives and evaluation standards should be communicated in advance to reduce collaborative friction.[4][9]

(4) Sustainable Development Motivation Issues

Inter-institutional co-construction often relies on administrative promotion and faculty enthusiasm in the initial stage, but long-term operation requires a sustainable motivation mechanism. Co-construction and sharing should be incorporated into each institution's "14th Five-Year" discipline development plans and annual teaching work priorities, forming institutional constraints; active efforts should be made to secure policy support and funding investment from education authorities, with alliance co-construction achievements serving as bonus items in institutional teaching assessments; and an academic community culture of co-construction and sharing should be cultivated, shifting collaboration from "task-driven" to "value-identified."[2]

(5) Technical Platform and User Experience Issues

Existing platforms still suffer from poor user experience in areas such as resource retrieval, cross-institutional course selection, and learning data interoperability. Technical investment should be increased to optimize platform user interfaces and interaction design; platform data docking with each institution's academic affairs systems should be promoted to automate cross-institutional course selection and credit mutual recognition; and artificial intelligence technologies should be introduced to provide personalized resource recommendations and learning pathway planning for faculty and students.[8][10]

7. Conclusion

Inter-institutional resource sharing and co-construction for Building Architecture is an effective pathway for addressing EEE construction challenges and promoting high-quality development of architectural education. Through systematic analysis of the demands and bottlenecks of sharing and co-construction, this paper has constructed a content system covering four dimensions—faculty, curriculum, practice, and platform; proposed a co-construction model of "alliance collaboration, tiered sharing, and dynamic iteration" and an operational mechanism of "demand docking—resource integration—platform support—evaluation feedback"; and verified the significant value of sharing and co-construction in improving teaching quality, promoting educational equity, and advancing faculty development through regional alliance practice.

Of course, inter-institutional resource sharing and co-construction is a systematic project that cannot be accomplished overnight. It requires policy guidance from education authorities, institutional innovation from university management, active participation from frontline faculty, and effective support from technical platforms. In the future, as technologies such as artificial intelligence, the metaverse, and digital twins mature, resource sharing and co-construction for Building Architecture will evolve toward intelligent, immersive, and personalized directions. For example, intelligent teaching assistants based on large language models can provide customized learning tutoring for students at different institutions, and virtual building laboratories based on digital twin technology can enable collaborative design among students from multiple institutions at any location worldwide. These technological prospects open broad spaces for teaching reform in Building Architecture.

As an instructor of Building Architecture, the author deeply appreciates that the sharing and co-construction of teaching resources is not merely a material-level flow of resources, but a deep integration of educational concepts, teaching methods, and academic cultures. Only by breaking down inter-institutional barriers and upholding the concept of openness and sharing can we truly achieve the leap of architectural education from "fighting alone" to "collaborative education," cultivating more high-quality talents with patriotic sentiment, international vision, innovation capabilities, and practical skills for the construction industry, and contributing educational strength to the high-quality development of urban

and rural construction.

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