



Mechanisms for Transforming Heterogeneous Educational Resources into Student Competencies in Sino-Foreign Cooperative Education—A Case Study of the Sino-Russian Mechatronics Engineering Program at Southwest Forestry University

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Abstract. Current quality evaluations of Sino-foreign cooperative education rely heavily on resource-input indicators such as foreign partner course share and foreign faculty teaching hours, which fail to capture the effectiveness of transforming heterogeneous educational resources into student competencies. Using the Sino-Russian Mechatronics Engineering Program at Southwest Forestry University as a case, this study constructs an analytical chain of resource conditions, learning mechanisms and feedback adjustment to examine the resource-to-competency conversion logic. The program features a three-tier resource architecture of Chinese foundational courses, Russian advanced courses and practical application, with Russian-language instruction and joint management embedded throughout training. The findings identify four core transformation mechanisms: curriculum coordination lowers cross-system learning costs; tiered practical training translates theoretical knowledge into concrete engineering practice; overseas study activates professional communication and autonomous adaptation; process feedback enables continuous resource recalibration and closed-loop improvement. The study argues that quality evaluation should shift from single input indicators to process dimensions like curriculum articulation and task progression, adopting an integrated perspective of resources, tasks and performance.

Keywords: Sino-foreign cooperative education; heterogeneous educational resources; student competency development; resource-to-competency transformation; Sino-Russian Mechatronics Engineering Program

1 Introduction

Sino-foreign cooperative education is critical for introducing high-quality overseas resources, expanding international talent pathways and enhancing higher education openness [1–2]. Existing approval procedures, annual reports and quality assessments typically measure cooperation intensity via input indicators such as foreign partner course proportion, foreign faculty teaching hours, overseas textbook adoption and

international exchange scale [3–4]. While quantifiable and verifiable, these indicators cannot confirm whether imported resources actually enter students' learning processes or translate into corresponding professional and international competencies [5].

Resource inputs have no inherent linear link with competency development. Cross-national differences in knowledge systems, instruction languages and teaching rhythms create articulation barriers between foreign courses and local curricula. Practice platforms and overseas study support engineering practice, innovation and intercultural communication only when converted into participatory tasks with targeted support. Training quality thus depends not on imported resource scale, but on organizational design and instructional implementation that transform heterogeneous resources into applicable integrated competencies.

Existing studies mostly evaluate outcomes from resource input, governance, satisfaction, employment and further study perspectives, but rarely integrate resource organization, learning tasks and competency development into one analytical chain. To fill this gap, this study constructs an analytical chain of resource conditions, learning mechanisms and evidence-based feedback adjustment, using the joint Mechatronics Engineering Program of Southwest Forestry University and South Ural State University as a case. Launched in 2018, the program features divergent curriculum standards and covers knowledge acquisition, experimental verification and system design, making it suitable for observing cross-institutional resource transformation. Research data include training schemes, operation records, grades, mobility data, employment figures and competition results, supporting systematic process analysis.

2 Resource Structure

The program adopts a three-tier resource structure. The engineering foundation tier comprises Chinese-delivered courses covering mathematics, engineering drawing, electrical and electronic technology, sensing measurement and programmable logic controllers. The advanced professional tier consists of Russian-delivered courses on mechanics, manufacturing, industrial networks, automatic control and mechatronic systems. The knowledge application tier includes experiments, engineering training, course designs, comprehensive practical training, graduation projects and overseas study. Russian instruction and joint management run through all three tiers, providing linguistic and organizational support.

The 2024 cohort scheme includes 61 courses, 21 of which are core professional courses delivered by the Russian partner, accounting for 34.43 percent of all courses. Russian faculty provide 1,312 teaching hours (33.52 percent of the total), along with instructors, textbooks and syllabi, while the Chinese side handles course review and implementation. The two partners coordinate training schemes, teaching plans and quality monitoring via the joint management mechanism.

The three tiers form a progressive sequence. Chinese foundational courses prepare prerequisite knowledge for Russian professional courses; Russian language courses support professional comprehension and expression; practical instruction and overseas study facilitate knowledge application. Effective integration of Russian courses thus

relies on sufficient prerequisite preparation, matching linguistic support and coordinated teaching arrangements between partners.

Based on this structure, the 2026 cohort scheme decomposes seven engineering requirement categories into 11 graduation requirements. Aligned with the discipline plus Russian language plus internationalization positioning, student competencies fall into four dimensions: engineering knowledge integration and complex problem solving; engineering practice and innovative application; professional communication and intercultural collaboration; autonomous learning and continuous development.

3 Transformation of Resources into Student Competencies

Resource integration is only a prerequisite for competency development; actual transformation occurs through continuous student participation in learning activities. The program has four interconnected transformation mechanisms: curriculum coordination lowers cross-system learning barriers; practice-based reinforcement converts knowledge into engineering action; overseas study activates competencies in authentic contexts; process feedback recalibrates resources and tasks using operational data. They serve as the foundation, core, advanced stage and closed-loop support for competency development.

3.1 Curriculum Coordination

In course sequencing, Russian language courses are scheduled mainly before or during the advanced professional stage. Chinese foundational courses in mathematics, physics, engineering drawing and electrical technology precede most Russian professional courses in mechanics, manufacturing, control and mechatronic systems, while comprehensive practical training and graduation projects follow professional courses. This sequence forms a learning chain from knowledge preparation to system-level application.

Curriculum coordination operates through three interfaces: knowledge, language, and task interfaces. The knowledge interface enables Chinese foundational courses to support Russian professional courses; the language interface facilitates professional concept comprehension and expression; the task interface requires students to integrate mechanical, electronic, control and linguistic resources to solve engineering problems. Linking these interfaces makes cross-system course resources accessible to students.

Given intensive Russian instruction and cross-linguistic learning, language tutoring, collaborative teaching and after-class Q&A are core to maintaining knowledge interface continuity, preventing concept misunderstandings from affecting subsequent design and system integration tasks.

3.2 Practice-Based Reinforcement

In the 2024 cohort scheme, experimental and practical training accounts for 53 credits, or 27.18 percent of minimum graduation credits. The program has built a tiered

progressive practical teaching system ranging from course experiments, engineering training and course designs to comprehensive mechatronic training, internships and graduation projects. Tasks evolve from principle verification to multi-domain integration, system commissioning and open problem solving, forming a complex engineering task chain aligned with shared competency requirements of both partners.

Practical tasks at different levels perform distinct transformation functions. Course experiments focus on standardized operation and principle verification to build basic skills. Engineering training and course designs promote preliminary multi-course knowledge integration. Comprehensive training and graduation projects require full-process problem solving from requirement analysis to result interpretation. Rising task complexity drives competency development from individual skill mastery to complex engineering problem solving.

This mechanism works through task-driven knowledge mobilization, observable output production and process correction. Students translate dispersed knowledge into drawings, programs, devices and reports, while testing and defense expose knowledge gaps. Abstract knowledge is thus converted into assessable engineering action, and competencies develop through iterative design-implementation-verification-correction cycles.

Required practical tasks serve universal competency transformation, while open tasks such as competitions provide advanced practice for capable students, confirming that curriculum coordination makes resources learnable and practice-based reinforcement makes knowledge usable.

3.3 Overseas Study

The program has established a stable annual overseas study pathway covering selection, admission, pre-departure education, coursework at the Russian partner and credit articulation. Students must complete learning tasks and academic communication under different course norms and team environments, deploying professional knowledge, Russian proficiency and autonomous learning strategies in authentic intercultural professional contexts.

Overseas contexts function through task authenticity, language as a professional tool and learning strategy adjustment. Russian courses follow original local syllabi and standards to enhance task authenticity. Cross-linguistic interaction turns Russian from a subject into a professional communication tool. The heterogeneous environment requires proactive learning adjustment. Overseas study is thus an integrated mobilization and contextual test of existing competencies.

Academic data show that overseas study participants outperform non-participants in overall grades, Russian course scores and pass rates, indicating selection effects. Its role can be understood through four links: prior academic preparation, overseas tasks, contextual activation and subsequent performance.

3.4 Process Feedback

Through the Sino-Russian joint management mechanism, the program has built a routine feedback chain connecting course operation and student performance to resource allocation. Information on course pacing, language support and workload is collected via student forums, bilateral teaching meetings and faculty guidance, based on which the program adjusts course schedules, strengthens collaborative teaching, adds review sessions and optimizes language course arrangements. This process dynamically identifies interface problems and supports training optimization.

The core of this mechanism is to translate student competency performance into adjustment basis for precise optimization. Course learning misunderstandings trigger adjustments to prerequisites and language support; practical application weaknesses lead to improved task design and guidance; overseas adaptation difficulties result in refined selection criteria and pre-departure preparation, forming a continuous recalibration closed loop.

The 2026 cohort scheme revision directly reflects this mechanism. It optimizes the language course system, establishes graduation requirement and course mappings, and restructures the practical teaching chain, aligning training objectives, course responsibilities and assessment tasks based on accumulated operational experience.

3.5 Synergistic Pathways of Competency Development

The four mechanisms do not operate independently, but form a closed loop of progressive advancement and feedback-driven recalibration. Each preceding stage lays foundational conditions for subsequent transformation, while each later stage tests and revises upstream resource allocation and task design based on actual performance.

The four competency dimensions correspond to different mechanism links. Knowledge integration and problem solving rely mainly on curriculum interfaces and integrated tasks. Practical innovation is reflected in design and open tasks. Intercultural collaboration is strengthened through Russian courses and overseas contexts. Autonomous learning runs through task iteration, environmental adaptation and feedback adjustment. This means one resource can support multiple competencies via different tasks, and one competency requires joint support from multiple resources and mechanisms.

4 Manifestations of Training Outcomes

As resources integrate into coursework, practice and overseas study, their effects appear in student mobility, innovation achievements, employment and enrollment. Program data cover study in Russia, competition results, employment and enrollment appeal. Notably, all these data serve only as indirect evidence for the transformation mechanisms, and cannot be over-interpreted as definitive proof of cohort-wide competency improvements. Though not equivalent to direct competency attainment, they can verify whether the aforementioned mechanisms have generated corresponding effects.

Seventy-two students have studied in Russia, showing overseas contexts have evolved from isolated cases into a stable training pathway. Achievements in competitions, patents and paper publication show that some students can integrate professional knowledge, Russian proficiency and autonomous learning strategies in open tasks. These outcomes correspond to practice-based reinforcement and overseas study mechanisms, but involve clear selection effects, as participating students tend to have stronger prior academic foundations. They reflect partial upper-level performance, and cannot represent the overall cohort competency level.

The employment rate of 2023–2025 graduates remained above 86 percent. Employment outcomes are partially associated with program learning and training, but also affected by labor market conditions, industry demand and individual career choices, serving only as indirect circumstantial evidence for curriculum coordination and practice mechanisms.

Enrollment has remained robust for four consecutive years, with a 100 percent first-choice admission rate in 2025, reflecting the program's appeal to applicants. This is positive external market feedback, but cannot replace evaluation of internal learning processes and competency performance.

Overall, the four types of outcomes corroborate the transformation mechanisms from different perspectives. Practical tasks and overseas study generate observable advanced outcomes for participating students; professional learning is indirectly reflected in employment; operational effectiveness feeds back into enrollment attractiveness. All data should be interpreted with caution, and no causal claims about cohort-wide competency gains should be drawn solely from these indicators.

5 Conclusion

This case shows that resource-to-competency transformation in Sino-foreign cooperative education is not automatic, but progresses through a closed-loop system of curriculum coordination, practice-based reinforcement, overseas study and process feedback. Curriculum coordination reduces cross-system learning costs via three interfaces and lays the transformation foundation. Tiered practical tasks translate knowledge into engineering action and build problem-solving competencies through iterative cycles. Overseas study activates professional communication and adaptability in authentic contexts. Process feedback forms a continuous improvement loop by converting performance into resource and task adjustments. The four competency dimensions thus develop progressively within this system.

Observable outcomes corroborate the above mechanisms, but advanced achievements carry selection effects and cannot be generalized to all students. Cooperative education quality evaluation should therefore shift from input indicators such as course share and teaching hours to process dimensions including curriculum alignment support, practical task progression, overseas study support and dynamic feedback adjustment, establishing an integrated analytical perspective of resources, tasks, performance and feedback. As a single-case study, this research can be extended via multi-case comparisons across disciplines to further verify the mechanisms' generalizability.

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References

1. Lin, J. H., & Ling, Q. High-quality development of Sino-foreign cooperative education: Policy trajectory and policy provision [J]. *Journal of Higher Education Management*, 2021, 15(6): 1–12. DOI:10.13316/j.cnki.jhem.20211013.001.
2. Jing, T. T., & Chen, P. Achievements, problems, and prospects of structural reform in Sino-foreign cooperative higher education in the new era [J]. *Heilongjiang Researches on Higher Education*, 2022, 40(7): 38–45. DOI:10.19903/j.cnki.cn23-1074/g.2022.07.010.
3. Lin, M. Q., Zhang, J., Wang, J. B., et al. Symposium: Institutional safeguards for the high-quality development of Sino-foreign cooperative education [J]. *Modern University Education*, 2022, 38(5): 35–57.
4. Liao, D. S., Song, Z. Y., & Shen, Y. F. Quality evaluation of Sino-foreign cooperative education programs in universities and its implications: A case study of four universities including Guangxi Minzu University [J]. *Education and Teaching Forum*, 2023, (10): 30–34.
5. Yao, J. C., Qiao, X. L., Tian, Y., et al. An evaluation system for teaching quality in Sino-foreign cooperative software engineering programs [J]. *Journal of Nanjing Institute of Technology (Social Science Edition)*, 2023, 23(2): 46–51. DOI:10.13960/j.issn.2096-238X.2023.02.008.

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