Exploration on the Teaching Reform and Practice of General Education Courses in China—A Case Study

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***Abstract*—General education is an important way to cultivate interdisciplinary talents, but current general education courses in China generally face problems such as single teaching content, low student engagement, and rigid evaluation systems. Taking the general education master course-Fluid Power Transmission and Control Technology, which at a technological university in Shanghai as a case, this paper analyzes the causes of problems through mixed research methods (questionnaire survey, interview, classroom observation) and proposes a "three-dimensional drive" reform framework: 1) Content-driven—constructing interdisciplinary knowledge integration modules and hierarchical case libraries; 2) Method-driven—adopting the "Terminology Mapping Framework (TMF)" to resolve disciplinary barriers, and designing scenario-based teaching activities such as "simulated climate negotiations"; 3) Evaluation-driven—developing a dynamic scoring model (30% for classroom performance + 40% for team projects + 30% for innovative proposals). Empirical data show that after the reform, students' classroom engagement increased by 42%, and the adoption rate of interdisciplinary proposals increased by 13%. This study provides a replicable, practical path for solving the dilemma of general education courses being regarded as "low-quality courses".**

***Keywords*—general education reform, interdisciplinary teaching, dynamic assessment, student engagement**

I. Introduction

Against the background of the rapid development of globalization and the knowledge economy, higher education is faced with the challenge of cultivating interdisciplinary talents with both an international perspective and local awareness. As a key carrier to break disciplinary barriers and shape students' core literacy, general education has become an important direction of education reform [1]. However, current general education courses in China generally have structural imbalance: as shown in Table I, the average credit ratio of general education courses in most American universities exceeds 25%, while that of similar courses in China is less than 10%, and most of them are weakened into accessories of professional education, leading to low student engagement, vague course objectives, and even being labeled as "low-quality courses" [2].

TABLE I. Credit Ratio of General Education Courses in Typical Chinese and Foreign Universities

	Indicator	Average total Credits	Average General Education Credits	Credit Ratio of General Education Courses
U.S. Universities	Harvard University	128	32	25.0%
	University of Chicago	4,200	1,250	29.8%
	Stanford University	180	60	33.3%
	Vanderbilt University	132	44	33.3%
	Yale University	36	4.5	12.5%
	William & Mary	120	47	39.2%
Domestic Universities	Peking University	140	12	8.6%
	Tsinghua University	154	12	7.8%
	Nanjing University	165	10	6.1%
	Donghua University	169	6	3.6%
	University of Shanghai	168	10	6.0%
	Jiangsu University	170	4	2.4%

Note: The general education course types of domestic universities participating in the comparison do not include general courses for large categories, but only those of humanities literacy, artistic aesthetics, natural science and technology, and economic and social fields. For some foreign universities, this paper only counts the overall requirements of the universities for majors.

The differences between domestic and foreign general education models further highlight the urgency of reform. American universities cultivate critical thinking and civic awareness through core courses, while China focuses more on knowledge breadth, but both face the challenges of interdisciplinary integration and teaching method innovation [3]. In recent years, interdisciplinary education has become a global trend. UNESCO points out that 75% of the Sustainable Development Goals need to be achieved through multi-disciplinary collaboration [4]: Harvard University's "Environmental Science and Public Policy"

Manuscript received December 1, 2025; accepted February 10, 2026; published March 19, 2026.

course promotes students' proposals to be applied in municipal planning through simulated climate negotiations; MIT has developed the "Terminology Mapping Framework (TMF)" [5], which maps engineering academic terms to policy language, increasing the efficiency of interdisciplinary communication by 32%. These practices provide references for solving the dilemma of general education.

Based on this, this study takes the course—Fluid Power Transmission and Control Technology, at the University of Shanghai for Science and Technology as a case, focusing on three core issues: 1) How to resolve the contradictions between disciplinary barriers and mixed-age teaching; 2) How to construct a dynamic evaluation system to quantify interdisciplinary abilities; 3) How to improve student engagement through the matching of teaching strategies. Through mixed research methods, a "content-method-evaluation" three-dimensional reform framework is proposed, aiming to provide an empirical basis for the transformation of general education courses from "low-quality courses" to "high-quality courses" [6].

The theoretical basis of this study is mainly established on the classic theories of pedagogy and psychology, shows as Fig. 1. First, this paper draws on Bloom's Taxonomy of Educational Objectives, emphasizing the cultivation of three domains: cognitive, affective, and psychomotor [7, 8]. Bloom's theory provides a systematic framework for designing and evaluating educational courses, which helps to clarify the teaching objectives of general education courses at different levels [9]. Second, this paper combines the Constructivist Learning Theory. Vygotsky's "Zone of Proximal Development (ZPD)" theory [1] points out that education should build a bridge between students' current level and potential abilities, and promote students' development through appropriate support [10]. This theory is of great guiding significance for designing challenging general education courses and stimulating students' learning interest [11]. In addition, this paper cites the Adult Learning Theory, including autonomy, experience basis, learning motivation, and application orientation. This theory emphasizes that education should focus on learners' actual needs and interests, and design course content that can stimulate learning motivation and engagement, which has important reference value for improving the effectiveness of general education courses[12, 13].

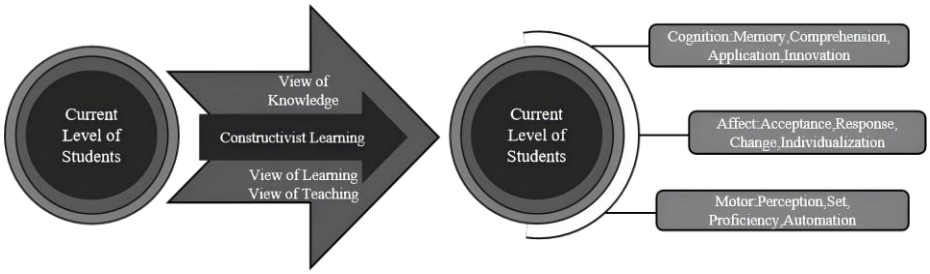

Fig. 1. Logical diagram of the combination of Bloom's taxonomy of educational objectives and constructivist learning theory.

II. Research Framework and Methods

Combining the experience and problems of general education courses at home and abroad, this study takes the Energy Power and Environment course at the University of Shanghai for Science and Technology as a specific case for analysis, and adopts a Sequential Exploratory Design, conducting qualitative exploration and quantitative verification in turn to ensure the depth and breadth of research results. Guided by Bloom's taxonomy of educational objectives, it carries out mixed-method research around three core issues in general education course reform: the resolution of contradictions between disciplinary barriers and mixed-age teaching, the construction of a dynamic evaluation system for interdisciplinary abilities, and the improvement of student engagement through the matching of teaching strategies.

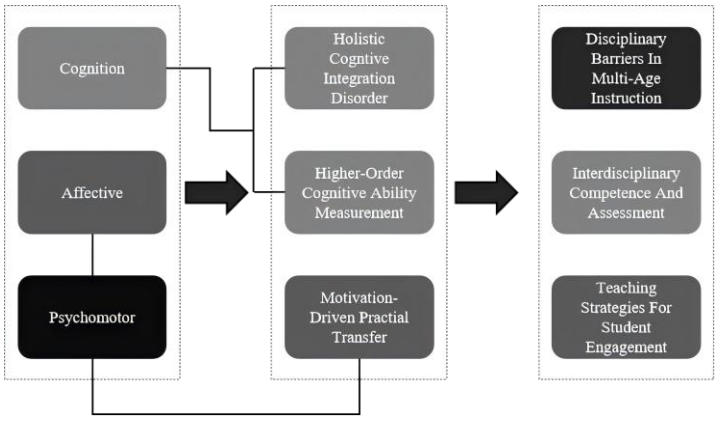

Fig. 2. Diagram of three core issues of general education courses mapped to corresponding levels of bloom's theory.

As Fig. 2 shows, through the "content-method-evaluation" three-dimensional reform framework, it systematically promotes the transformation of general education courses from "low-quality courses" to "high-quality courses" and provides empirical support for reform practices.

This study adopts a theory-guided sequential exploratory design, emphasizing the iterative dialogue between theoretical presuppositions and empirical data. The research is divided into three spiral advancing stages:

(1) Theoretical modeling stage: Based on Bloom's Taxonomy and Constructivist Learning Theory, construct a "content-method-evaluation" three-dimensional course reform theoretical framework, and propose theoretical hypotheses about student types, interdisciplinary integration paths, and evaluation methods.
(2) Qualitative exploration stage: Obtain an in-depth understanding of teachers and students on the course implementation process through in-depth interviews, classroom observations, and document analysis, and revise and enrich the variable relationships and mechanism hypotheses in the theoretical model.
(3) Quantitative verification stage: Develop scales and evaluation tools with good reliability and validity, conduct questionnaire surveys and academic performance data analysis, and test the causal relationships and structural effects between various variables in the theoretical model.

III. Resolution Mechanism of Contradictions between Disciplinary Barriers and Mixed-Age Teaching

Disciplinary barriers are essentially the "incommensurability" between different disciplines; mixed-age teaching highlights the differentiated challenges of Vygotsky's "Zone of Proximal Development" in heterogeneous learning groups.

From the perspective of questionnaire data, the practical performance of disciplinary barriers is particularly prominent: nearly 50% of students are distracted in general education classes due to the need to complete professional course assignments, about 26.7% of students think that general education courses are "unimportant" and only regard them as "low-quality courses for obtaining credits". This cognitive difference stems from students' separation of general education courses from their own majors, forming an implicit barrier between professional courses and general education courses. At the same time, the heterogeneity of student groups further exacerbates teaching challenges: some students can actively absorb interdisciplinary knowledge, while others struggle to keep up with the teaching rhythm due to professional burdens, lack of interest and other issues, resulting in a polarization phenomenon.

The "Terminology Mapping Framework (TMF)" is introduced as an intermediary tool for interdisciplinary communication, realizing the transferability of knowledge among multiple cognitive subjects through concept mapping and scenario reconstruction. For mixed-age teaching, "hierarchical task design" and "collaborative problem-solving" are adopted to promote intergenerational and cross-grade learning while maintaining cognitive challenges.

In terms of breaking disciplinary barriers: first, integrate interdisciplinary knowledge into course content, organically combine the content of different disciplines to help students understand problems from multiple perspectives, and dilute traditional disciplinary boundaries by demonstrating disciplinary connections. Second, construct an interdisciplinary collaboration model, establish a special interdisciplinary institution to coordinate various resources, and form a curriculum development team involving multiple departments to effectively avoid resource dispersion and fragmentation. Third, guide the cultivation of students' interdisciplinary abilities through a diversified evaluation system, and encourage students to actively integrate multi-disciplinary knowledge by increasing the scoring weight of classroom discussions and practical links.

In adapting to the differentiated needs of "mixed-age teaching", based on student group classification: first, set hierarchical goals according to the "Zone of Proximal Development" theory, and build adaptive learning scaffolding for different students; second, design hierarchical teaching strategies, and adopt different methods for different types of students, such as adding cutting-edge dynamics and practical activities for active learning students, and creating a low-pressure learning environment and enhancing psychological support for students with high pressure; third, implement a flexible evaluation mechanism, adjust the weight of course assessment for students who have not fully participated in the course, and accommodate individual differentiated learning processes.

IV. Construction Logic of the Dynamic Evaluation System for Interdisciplinary Abilities

Interdisciplinary ability is essentially systematic thinking and knowledge integration ability. In general education courses, the core performance is students' ability to combine the knowledge of general education courses with professional scenarios to solve practical problems. Traditional scoring (single final paper scoring) is difficult to capture its dynamics and complexity—the survey shows that only 9% of students believe that general education courses "have improved their independent learning and problem-solving abilities", which reflects that the traditional evaluation system only focuses on students' "knowledge mastery" and ignores the dynamics of "cognitive process" and "ability generation", and cannot fully measure the development of students' interdisciplinary abilities. Therefore, the evaluation of interdisciplinary abilities needs to shift from "assessing knowledge" to "evaluating cognitive process", realizing the whole-process tracking and dynamic evaluation of the development of interdisciplinary abilities.

From the quantitative scoring dimension, a "three-dimensional scoring scale" is designed:

(1) The "classroom participation dimension", corresponding to the real-time performance in classroom interaction;
(2) The "practical application dimension", evaluating team collaboration ability;
(3) The "knowledge integration dimension" requires students to analyze the knowledge of general education courses in combination with professional scenarios, reflecting the transfer and integration of interdisciplinary knowledge.

From the qualitative evaluation dimension, an evidence collection mechanism with dual carriers of "learning portfolio" and "project report" is established: the learning portfolio records students' class notes, discussion outline, and interdisciplinary thinking records (such as "the connection between general education courses and majors"), reflecting the dynamic changes of their cognitive process; the project report focuses on students' roles, contributions, and problem-solving ideas in group collaboration, comprehensively presenting their thinking methods and team collaboration abilities.

At the same time, focusing on the optimization of general education course score distribution and teaching management, by setting clear and reasonable score ratios, machine learning methods are introduced for pattern recognition and validity verification of evaluation data, shows as Fig. 3. Five machine learning algorithms are used for prediction: linear regression, decision tree regression, random forest regression, gradient boosting regression, and support vector regression. 80% of student performance data is used as the training set and 20% as the test set. The model is optimized through hyperparameter adjustment and cross-validation, and the model with the smallest Mean Squared Error (MSE) is selected for performance prediction and ability correlation analysis. The residual plot and box plot analysis of the survey data show that the predicted data of the optimization scheme has a higher dispersion degree (more reasonable Interquartile Range (IQR)), is less affected by local accidents (such as the performance fluctuation of absent students), and can more objectively identify the development law of students' interdisciplinary abilities, providing data support for the iteration of the evaluation system.

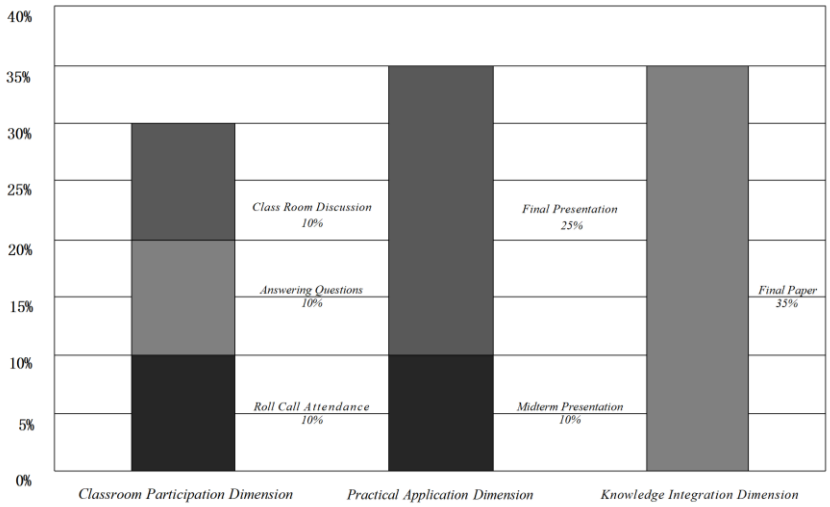

Fig. 3. Course score distribution.

V. Adaptation Theory of Teaching Strategies and Student Engagement

Student engagement is affected by the interaction of learning motivation, cognitive load, and teaching scenarios. According to Knowles' Adult Learning Theory, general education courses need to take into account students' autonomy, experience basis, and application orientation.

Based on motivation theory and cognitive load theory, students are divided into "active learning type", "stress relief type", and "interest-stimulated type", and differentiated teaching intervention strategies are designed for different types, such as cognitive activation tasks, scenario-based cases, and independent inquiry projects. Teaching strategies with high adaptability are adopted for different types of students: for "active learning type" students, efforts are made from three aspects—stimulating and maintaining interest (optimizing teaching methods, designing multi-level teaching objectives combined with Bloom's Taxonomy of Educational Objectives), optimizing course design (adding practical cases, cutting-edge dynamics, and practical activities), and paying attention to and encouraging (helping maintain learning enthusiasm and classroom interaction enthusiasm)—to improve their learning effects; for "stress relief type" students, measures such as creating a quiet learning environment (strengthening classroom management), setting clear learning goals, and providing psychological support and emotional attention (providing appropriate support combined with Vygotsky's "Zone of Proximal Development" theory, adding relaxed and interesting course content) can be taken to help reduce pressure and improve their classroom experience; for

"interest-stimulated type" students, efforts can be made around demonstrating disciplinary connections (explaining the intersection with students' majors, setting challenging goals), improving the scoring system (enhancing students' attention, guiding learning attitudes), and adopting independent learning and personalized teaching strategies (adding interdisciplinary content with reference to interdisciplinary education achievements, designing course content that meets needs combined with Knowles' Adult Learning Theory)—to stimulate their learning desire and engagement, and promote their integration into classroom activities.

VI. Conclusion and Prospect

Based on the case study, this research addresses common issues in Chinese higher education general education courses, such as monotonous teaching content, low student engagement, and rigid evaluation systems. It proposes a "three-dimensional drive" reform framework encompassing content, method, and evaluation. By introducing interdisciplinary knowledge integration modules, the Terminology Mapping Framework (TMF), scenario-based teaching activities, and a dynamic scoring model, the reform effectively enhanced student classroom engagement and interdisciplinary skills. Empirical data shows a 42% increase in student classroom participation and a 13% rise in the adoption rate of interdisciplinary proposals post-reform.

Looking ahead, the reform of general education in Chinese universities should further deepen interdisciplinary integration and teaching innovation. On one hand, teaching methods like "hierarchical case libraries + terminology mapping" can be promoted to enhance the adaptability and practicality of course content. On the other hand, the dynamic evaluation mechanism should be continuously optimized, incorporating technologies like artificial intelligence to achieve comprehensive, multi-dimensional tracking of students' ability development throughout the entire process. Furthermore, it is essential to strengthen teacher training in interdisciplinary teaching capabilities, promoting the transformation of general education from "knowledge transmission" to "literacy cultivation". Gradually, a general education system with Chinese characteristics that meets contemporary needs should be constructed, ultimately realizing the shift from "low-quality courses" to "high-quality courses".

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Jia Yi Jin conducted the research and wrote the paper. Zhuo Wang conducted the research. Tielin Wang analyzed the data. Yiting Yang and Yiheng Cao assisted with data analysis and paper writing; all authors had approved the final version.

Funding

The financial supports of this paper are from Shanghai University Young Teachers Training Key Program (10-24-112-005-043) by Jia Yi Jin, and also funded by the Faculty Development Research Project of the University of Shanghai for Science and Technology (CFTD2025YB24) of Zhuo Wang.

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