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Exploration of the Practice of Curriculum Reform in Chinese Vocational Education

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ABSTRACT: In secondary vocational education, the coherence and connection of curriculum content are crucial for students' holistic development. This study focused on the logistics major in vocational schools and applied Pearson correlation coefficients to analyze learning transfer effects between courses, providing data-based support for curriculum design and integration. The results showed that among the three basic courses of language arts, mathematics, and English, mathematics demonstrated the strongest internal coherence. The high correlation among specialized courses indicated that their arrangement was more conducive to systematic and in-depth knowledge acquisition. Variations in correlation coefficients over time provided a basis for optimizing early course planning, strengthening academic early warning mechanisms in vocational schools, preventing academic difficulties, and ensuring a smooth and effective learning process for students.

KEYWORDS: Vocational education; curriculum; course articulation; course coordination; Pearson correlation coefficient

1. Introduction

In 2022, the Chinese government issued the Opinions on Promoting the High-Quality Development of Modern Vocational Education, which emphasized strengthening curriculum integration and establishing a comprehensive and coordinated vocational education system. The revised Vocational Education Law created new opportunities for educational reform by setting clear requirements for curriculum design and teaching content in secondary and higher vocational education. Curriculum optimization was identified as a key focus of vocational education reform [1].

Curriculum occupies a central and complex position within the school system and forms the core of educational activities [2]. Educational reform cannot be separated from curriculum reform. With rapid social development, traditional educational concepts have been increasingly challenged, making curriculum reform particularly significant. Since the founding of the People's Republic of China, basic education has undergone eight major reforms and is currently experiencing the ninth [3]. Understanding how curriculum reform addresses emerging challenges and examining its development trends and outcomes are essential for evaluating the progress of China's basic education system [4].

1.1. Curriculum and course coordination.

In Chinese secondary and higher vocational education, courses are generally classified into cultural foundation courses, practical courses, and professional theoretical courses based on their content [5]. Each course category plays a critical role in cultivating vocational talents, and their content constitutes an essential element in integrating secondary and higher vocational education. Although these course categories differ in nature, curriculum design must simultaneously consider students' sustainable development and ensure both stability and flexibility in course structures. Course coordination refers to the systematic interconnection of courses that enables students to develop an overall understanding and coherent learning experience [6]. The importance of course coordination has been widely emphasized in higher education quality studies. However, vocational education in China continues to face challenges in both vertical and horizontal curriculum integration. These issues affect not only foundational courses but also professional courses at both secondary and higher vocational levels.

1.2. Relationship between prerequisite and subsequent courses.

Prerequisite courses provide the foundational knowledge, skills, and concepts that students must acquire before progressing to subsequent courses, which further develop and deepen this foundation. This curriculum structure ensures continuity and coherence in learning, allowing students to gradually accumulate knowledge and construct a systematic understanding of their field. Proper planning of prerequisite and subsequent course relationships enhances students' comprehension and mastery of content, thereby improving learning efficiency and outcomes [7]. In curriculum design, prerequisite courses play a vital role for both instructors and students. Understanding the relationship between prerequisite and subsequent courses ensures continuity and consistency in teaching and learning processes. Knowledge acquired in prerequisite courses is transferred to subsequent courses, effectively linking them and establishing a necessary foundation for advanced learning. This linkage is particularly critical in vocational education, as it supports coherence and progression across the curriculum [8], [9].

1.3. Limitations of the current study.

In international educational psychology and learning theory, scholars have extensively discussed knowledge transfer and learning transfer, examining how prior learning influences subsequent learning within the same or different subjects, as well as how school learning affects extracurricular achievements [10]. However, many of these studies remain theoretical and lack sufficient empirical data, limiting the reliability and applicability of their conclusions. Research on inter-course relationships also often lacks long-term tracking and detailed analysis of dynamic changes. International higher education curricula are frequently organized as independent modules rather than integrated systems [11]. Similar challenges exist in China, including disconnections between cultural foundation courses and redundancy in course content [12]. Although vocational education typically follows a progression from foundational to practical courses, articulation between secondary and higher vocational education remains fragmented [13], [14]. While scholars have proposed solutions such as curriculum standards and enhanced content alignment, these recommendations often lack concrete implementation guidance.

1.4. Strategies for improvement.

To address these challenges, this study conducted an in-depth analysis of student academic performance over three academic years. Student scores were normalized, and Pearson correlation coefficients were applied to quantify interdependencies between courses. A dynamic tracking approach was used to examine intrinsic course relationships across different semesters. Empirical results enabled the identification of course combinations with significant learning transfer effects and informed the development of targeted improvement strategies. Courses were further categorized to explore interactions among similar course types, providing practical insights and recommendations for curriculum design and sequencing aimed at improving educational effectiveness and learning outcomes.

2. Research Process and Methodology

2.1. Participants.

This study selected the logistics program at Shanghai Lingang Science and Technology School, Shanghai Dianji University, as the research subject. The participants were graduates from the logistics program in the classes of 2021, 2022, and 2023, with an initial total of 171 students. To ensure data validity and reliability, students who transferred classes or took a leave of absence were excluded from the analysis. The final sample consisted of 22 students from the class of 2021, 56 students from the class of 2022, and 56 students from the class of 2023, resulting in a total of 134 participants.

2.2. Methods and data processing.

Courses were classified into two main categories based on subject type: foundational courses and specialized courses. Specialized courses were further divided into logistics courses and business courses. Course sequencing was used to distinguish between prerequisite and subsequent courses, where courses offered earlier were defined as prerequisite courses and those offered later were considered subsequent courses. To reduce the influence of uneven grade distributions across different subjects, the original grade data were normalized to a range between 0 and 1 using the min–max normalization method, as shown in Equation (1). In this equation, X represents a specific course, $X_{\min}$ denotes the minimum grade among all students enrolled in the course, $X_{\max}$ represents the maximum grade, X_i indicates the original grade of the ith student, and x_i is the normalized grade. Based on the normalized grade data, Pearson correlation coefficients were then calculated, as shown in Equation (2). In Equation (2), $A = (a_1, a_2, a_3, \ldots, a_n)$ and $B = (b_1, b_2, b_3, \ldots, b_n)$ represent the normalized grade vectors of two different courses. The variables a_i and b_i denote the observed normalized grades for individual students, while a and b represent the mean values of the respective vectors. The sample size is represented by n. By substituting the normalized grade data into this equation, the correlation coefficient between two courses was obtained, thereby indicating the strength of their association and the degree of learning transfer between courses.

$$x_i = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}}$$

$$\sum_{i=1}^{n} (a_i - \bar{a})(b_i - \bar{b})$$

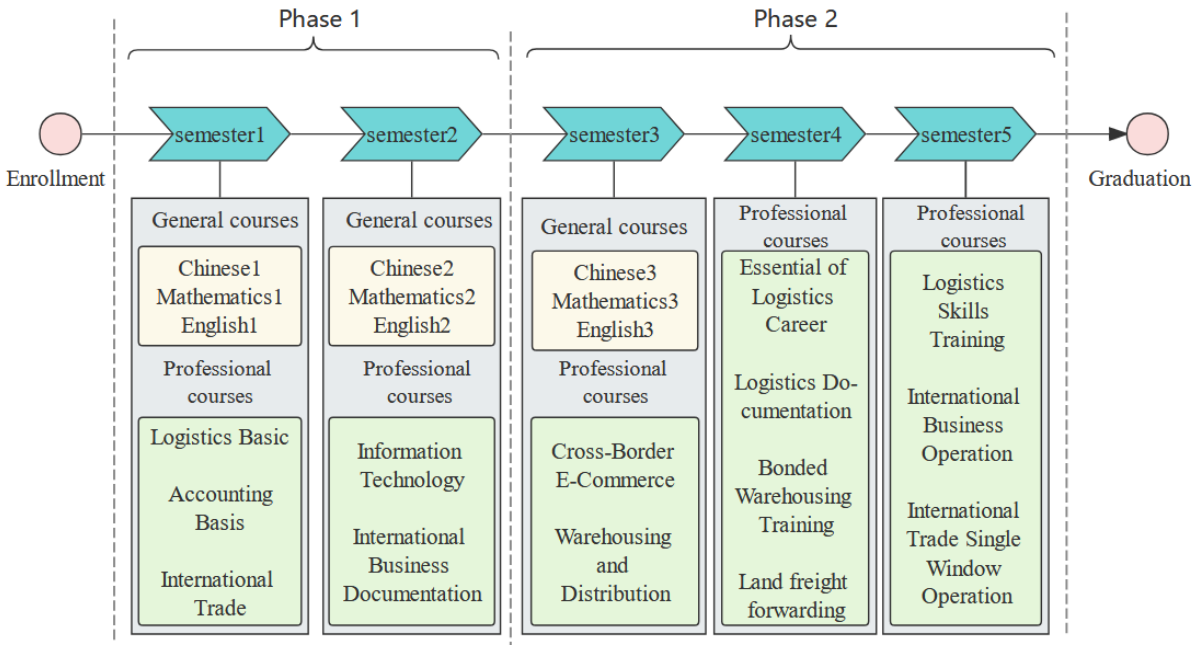

Figure 1. Course phase allocaition diagram.

To adapt to curriculum reforms, the school has made adjustments to the logistics program, including the addition, cancellation,andreschedulingof courses.These changes have resulted in differences in the curriculum across different cohorts. In this study, we excluded subjects that were exclusively offered to the 2021 to 2023 cohorts to minimize data variability without affecting the overall analysis. The curriculum analysis was conducted by semester for foundational courses, while specialized courses were divided into two phases.Thepracticalcourses in the second half of the third academicyear did notprovidequantitative gradedata, so they were included in the second phase. The specificgrouping is detailed in Figure 1. Additionally, the study quantified the distribution of grades for each subject by calculating percentiles (first quartile, median, and third quartile), as illustrated in Figure 2, 3, and 4.

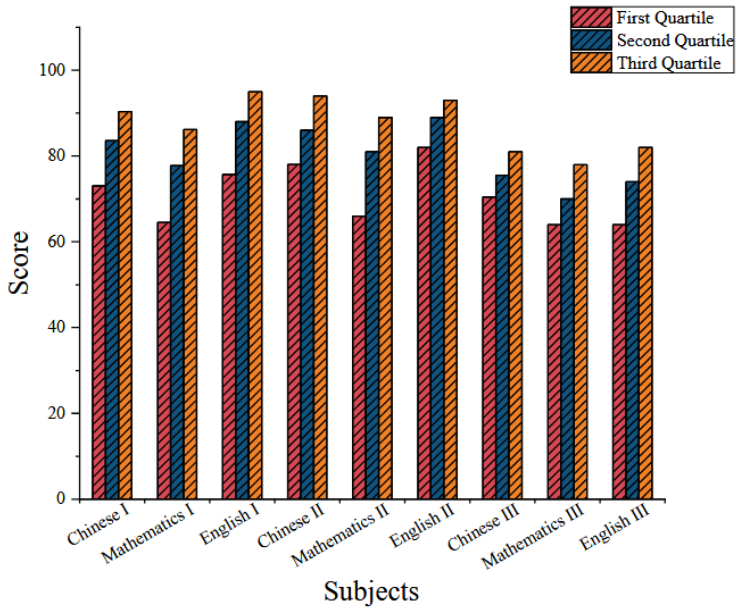

Figure 2. Quartile distribution chart for basic courses.

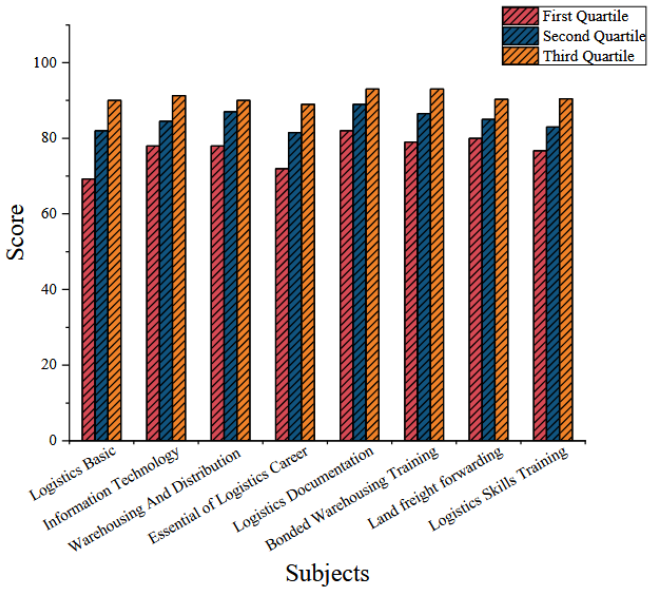

Figure 3. Quartile distribution chart for logistics specialized courses.

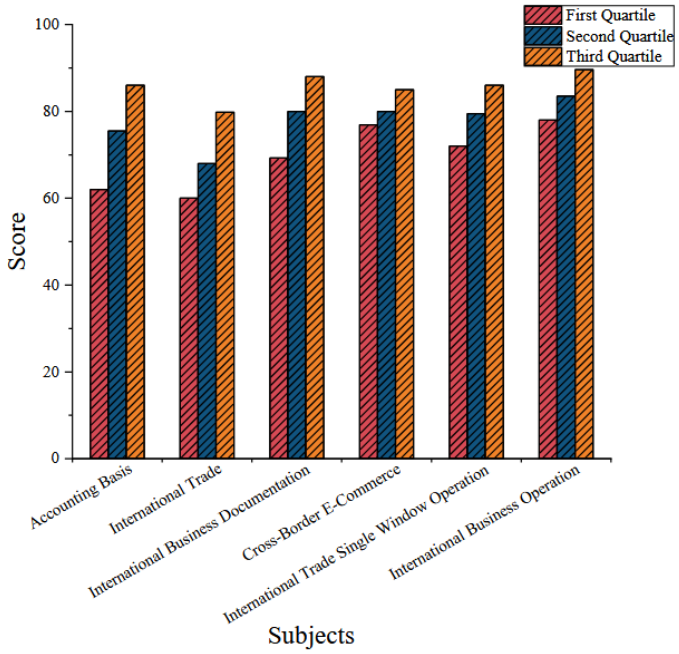

Figure 4. Quartile distribution chart for business specialized courses.

3. Quantitative Analysis Results

3.1. Basic courses.

The analysis of foundational courses is presented in Figure 5. The results show a moderate to strong correlation among the three foundational courses, namely Chinese, Mathematics, and English. The correlation coefficients between Chinese I and Chinese II and between Mathematics I and Mathematics II both exceeded 0.4, with the strongest relationship observed between the mathematics courses, reaching 0.63. Further analysis indicates that Mathematics II had correlation coefficients above 0.4 with Mathematics III and English III, with values of 0.57 and 0.42, respectively. For English II, only English III showed a correlation coefficient above 0.4, at 0.41. Chinese I exhibited correlation coefficients exceeding 0.4 with Chinese III

and English III, with values of 0.43 and 0.48, respectively. Mathematics I also demonstrated strong associations with Mathematics III and English III, with correlation coefficients of 0.55 and 0.57, respectively. Similarly, English I showed correlation coefficients above 0.4 with Mathematics III and English III, reaching 0.43 and 0.64, respectively. These findings provide quantitative evidence of the interrelationships among foundational courses and highlight the mutual influence of learning outcomes across different subjects, offering valuable insights for curriculum optimization and instructional improvement.

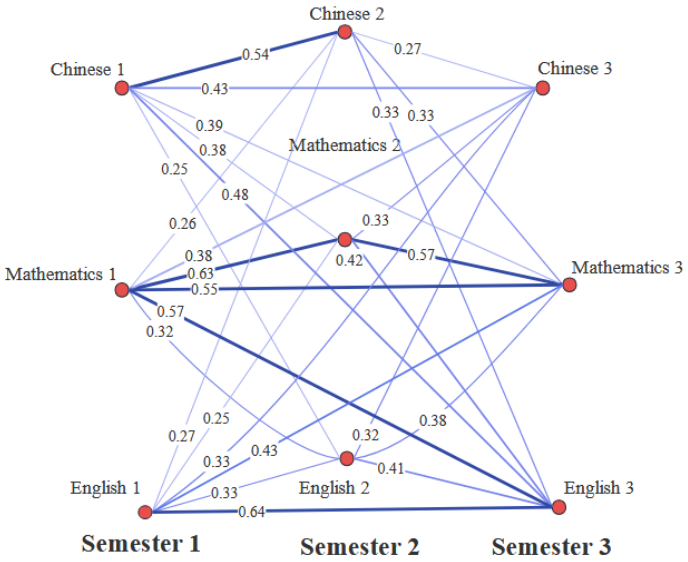

Figure 5. Correlation coefficient network graph of basic courses.

A dynamic time-series analysis of foundational courses is illustrated in Figure 6. The results reveal distinct developmental patterns across the three courses. The analysis uses the terms “Semester 1 to 2,” “Semester 2 to 3,” and “Semester 1 to 3” to represent continuity across academic semesters. The correlation coefficient for English courses increased significantly between the second and third semesters, reaching 0.64, which indicates a strong knowledge transfer effect. In contrast, the correlation coefficient for Chinese courses showed an initial decline followed by an increase, suggesting fluctuating learning continuity. Although the correlation coefficient for mathematics courses exhibited a slight downward trend over time, it consistently remained above 0.5, reflecting high stability in knowledge accumulation. These results emphasize the importance of strengthening early-stage mathematics learning to prevent difficulties in subsequent courses. Meanwhile, the gradual increase in English course correlations suggests that students are able to compensate for early knowledge gaps as learning progresses. Overall, these findings provide important implications for curriculum sequencing, teaching schedule design, and strategies aimed at enhancing students’ cumulative learning outcomes.

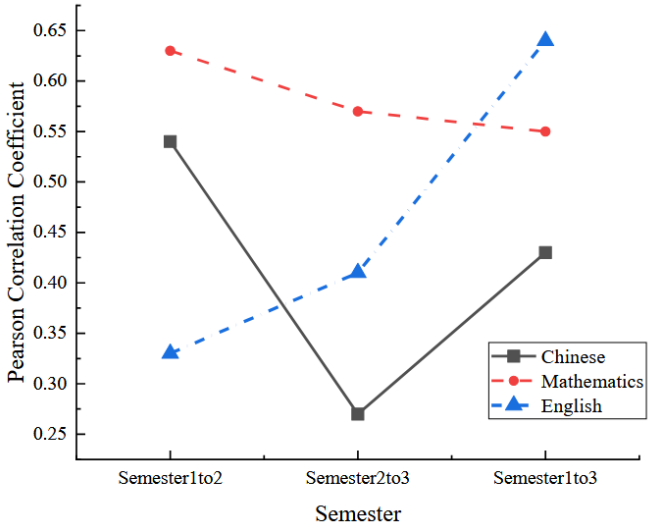

Figure 6. Dynamic correlation coefficient graph for basic courses.

3.2. Major-specific courses.

The analysis of logistics specialized courses is shown in Figure 7. The correlation coefficients between the Logistics Basic course and its subsequent courses generally exceeded 0.4, indicating strong knowledge continuity among these subjects. In contrast, the correlation coefficients between Introduction to Information Technology and courses such as Warehousing and Distribution, Land Freight Forwarding, and Logistics Skills Training were all below 0.4, suggesting relatively weak knowledge connections. These results highlight the central role of Logistics Basic within the logistics curriculum, as it shares substantial overlapping knowledge with subsequent courses, leading to stronger correlations. Conversely, Introduction to Information Technology contains fewer shared knowledge elements with practical logistics and training-oriented courses, resulting in lower correlation values. This analysis underscores the importance of aligning course content and ensuring logical knowledge progression to enhance learning efficiency in logistics education.

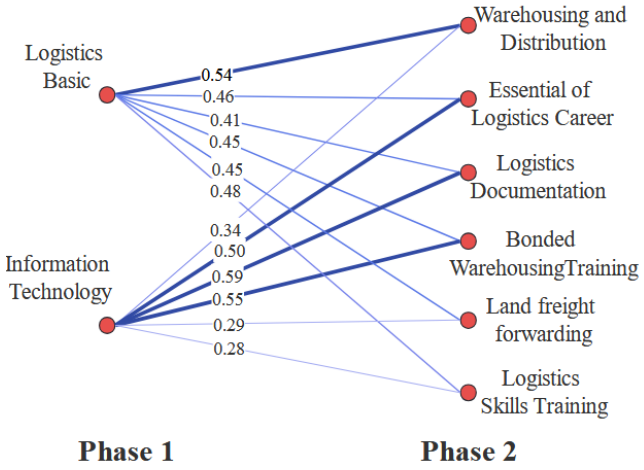

Figure 7. Correlation coefficient network graph of logistics specialized courses.

The analysis of business specialized courses is presented in Figure 8. Among these courses, the highest correlation coefficient was observed between International Business Documentation and Single Window Operation, with a value of 0.50. In contrast, the correlation

coefficient between International Business Documentation and International Business Operation was the lowest, at 0.18. Although these courses are all categorized as practical subjects, their operational focus and skill requirements differ considerably, leading to weak inter-course correlations in some cases. These findings emphasize the necessity of carefully examining course content and practical competencies when designing and evaluating business curricula, in order to ensure meaningful integration and effective knowledge transfer across courses.

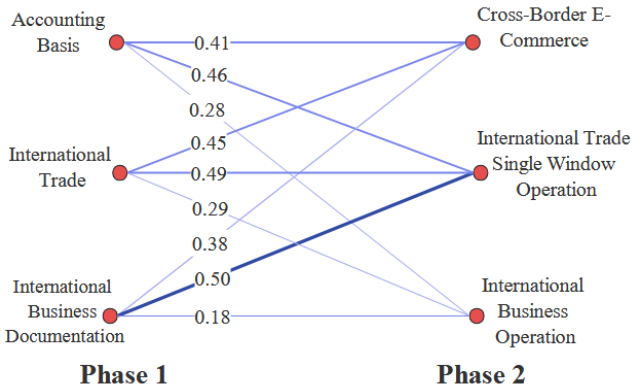

Figure 8. Correlation coefficient network graph of business specialized courses.

4. Practical Implications and Suggestions

To effectively connect courses at different levels, a strategy of vertical curriculum integration is recommended. The data analysis shows that correlation coefficients between courses vary over time. Therefore, during the course design stage, courses with high correlation coefficients should be evenly distributed across different learning stages to enhance continuity from foundational courses to subsequent courses. In addition, horizontal integration should emphasize the intrinsic relationships among courses to promote knowledge integration across different subject areas. Curriculum reform should prioritize adjustments to the sequence of course offerings to ensure effective alignment at key knowledge intersection points. For courses with multiple overlapping knowledge areas, such as Logistics Basic and its subsequent courses, scheduling them in adjacent semesters is advisable. Courses with high correlation coefficients should maintain their existing sequence, whereas those with lower coefficients may have their order adjusted to improve learning coherence. Early intervention in curriculum planning can provide theoretical support, optimize curriculum structure, and offer students a more systematically organized learning pathway, thereby improving academic performance prediction and reducing learning difficulties.

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Author Contributions

All authors were involved in data collection, analysis, and interpretation. All authors participated in drafting and revising the manuscript, and all approved the final version for publication.

Competing Interests

The authors declare that they have no competing interests.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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