

Research on the Symbiotic Integration Mechanism of “Foreign Language + Industry” in Internationalized Talent Cultivation at Application-Oriented Universities

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Abstract: To explore the mechanisms underlying the integration of “foreign language + industry”, this study develops a conceptual model based on Symbiosis Theory (ST) and Competency-Based Education Theory (CBET), incorporating Curriculum and Instruction (CI), Faculty and Industry Alignment (FIA), University-Enterprise Cooperation and Institutional Support (UECIS), and Integration Outcome (IO). Data were collected from 618 valid questionnaires completed by foreign language students at an application-oriented university in China, and structural equation modeling (SEM) was employed to examine the hypothesized relationships and mediation effects. The results show that CI has a significant positive effect on FIA and IO, while FIA has a significant positive effect on IO. UECIS exerts significant positive effects on both FIA and IO. Moreover, FIA significantly mediates the relationship between CI and IO, while UECIS influences IO both directly and indirectly through FIA. Finally, the findings indicate that “foreign language+industry” integration is a systematic and faculty-mediated process supported by university-enterprise cooperation and institutional mechanisms. The study provides empirical evidence for optimizing curriculum design, strengthening faculty-industry alignment, and deepening university-enterprise cooperation in the cultivation of internationalized interdisciplinary talents at application-oriented universities.

Keywords: Foreign Language + Industry; Internationalized talent cultivation; Curriculum and instruction (CI); Faculty and industry alignment (FIA); University-enterprise cooperation and institutional support (UECIS)

Online publication: October 27, 2026

1. Introduction

With the deepening advancement of the New Liberal Arts (NLA) initiative and the industry-education integration strategy, the cultivation of “foreign language + industry” interdisciplinary talents in foreign language programs at application-oriented universities has become a dual focus of policy guidance and

market demand. However, the strong demand from enterprises for talents proficient in both foreign language and industry has long faced a structural mismatch in supply and demand. The traditional “language-centered” orientation of foreign language talent cultivation can no longer match the real employment logic of internationalized enterprises. Although existing studies have identified problems such as unscientific curriculum design, weak teaching staff, and inadequate university-enterprise collaboration mechanisms ^[1-2], most remain at the level of qualitative description and rarely examine the comprehensive effects and mediating pathways of multiple factors—including curriculum, faculty, and university-enterprise cooperation—on integration outcomes simultaneously.

Accordingly, based on symbiosis theory (ST) and competency-based education theory (CBET), this study constructs a conceptual model of “Curriculum and Instruction (CI)—Faculty and Industry Alignment (FIA)—University-Enterprise Cooperation and Institutional Support (UECIS)→Integration Outcome (IO)”, and employs structural equation modeling (SEM) to test 618 valid questionnaire items empirically. It aims to reveal both the direct and indirect mechanisms through which multiple factors influence the effectiveness of “Foreign Language + Industry” integration, hence providing empirical evidence for application-oriented universities to optimize curriculum systems, promote faculty transformation, and deepen university-enterprise cooperation.

2. Literature review

2.1. Language-content integration and industry-education integration

Internationally, Content and Language Integrated Learning (CLIL), Content-Based Instruction (CBI), and English for Specific Purposes (ESP) are the three main approaches to achieving the integration of language and content. A systematic review of 199 global studies by Domke & Cerrato indicated that teachers’ understanding of the language-content relationship was uneven, and they generally faced challenges such as insufficient training, tight teaching schedules, and a lack of curriculum guidance ^[3]. Tzoannopoulou proposed restructuring ESP curriculum design using CLIL’s “4Cs framework” (Communication, Content, Cognition, Culture), providing an operational theoretical tool for the deep integration of language and industry ^[4]. With regard to industry-education integration, the European Union’s “dual system” model of school-enterprise collaborative talent development emphasized deep enterprise involvement throughout the entire talent cultivation process ^[5-6]. Its success hinges on clear legal definitions of the rights and responsibilities of schools and enterprises, as well as the effective integration of industry and educational resources.

In China, scholars have actively explored foreign language reform in application-oriented universities. For example, Shi Liangliang pointed out that “against the backdrop of the development of the NLA and policies on industry-education integration, foreign language micro-majors at application-oriented undergraduate institutions have become an important vehicle for cultivating interdisciplinary talents with “foreign language + industry skills”, and the dual-track school-enterprise education model can effectively promote the alignment of curriculum content with industry standards ^[7]. Meanwhile, Wang Jing also declared that “foreign language programs need to restructure their curriculum systems, reform teaching models, and update teaching content to improve the quality of talent cultivation” ^[8]. Nevertheless, industry-education integration at application-oriented universities still faces structural challenges. Based on research into cross-border e-commerce enterprises, Zhang Jing found that “current talent cultivation in higher education institutions suffers from significant disconnects in curriculum systems, technical training, and university-enterprise collaboration. The

imbalance between talent supply and demand, coupled with insufficient technical application capabilities, has become a key factor constraining improvements in training quality”^[9]. Li Yu directly pointed out “the current training of applied foreign language professionals suffers from unclear training objectives, unscientific curriculum design, outdated teaching methods, and inadequate faculty resources. It is essential to optimize training objectives, the curriculum system, and administrative management mechanisms”^[10]. Furthermore, Wang Songjun noted that “from the perspective of industry-academic colleges, the foreign language education ecosystem suffers from an imbalance in ecological niches, with curriculum content severely disconnected from industry needs”^[11]. Besides, in terms of university-industry collaboration mechanisms, the joint establishment of industry colleges and order-based classes by universities and enterprises has become the mainstream model, yet substantial participation by enterprises in joint curriculum development and project research remains insufficient.

2.2. Symbiosis Theory (ST) and Competency-Based Education Theory (CBET)

This study is grounded in two complementary theories: ST and CBET. ST, first proposed by Anton de Bary in 1879 and later systematized by Yuan Chunqing in 1998, holds that symbiotic relationships consist of three elements—symbiotic units, symbiotic models, and the symbiotic environment—and evolve from simple coexistence toward mutualistic, bidirectional empowerment^[12,13]. In this study, it defines the “symbiotic integration mechanism” and structures the conceptual model: universities and enterprises serve as symbiotic units; university-enterprise cooperation and faculty-industry alignment function as symbiotic models; policy and institutional support constitute the symbiotic environment; and integration status represents the evolutionary outcome.

Then, CBET, originating in the United States in the 1960s–1970s and represented by Robert Mager and Benjamin Bloom, asserts that education should be oriented toward real job competency demands, emphasizing observable, applicable abilities and practice-integrated instruction^[13,14]. It provides the pedagogical rationale for CI and FIA, explaining why curricula need to be reverse-designed from industry needs and why faculty should possess industry experience to implement competency-based teaching. Together, the two theories form a dual foundation with complementary roles: ST addresses who integrates, in what environment, and through what models, while CBET explores what content and by what competency standards. They jointly support the chain proposition that symbiotic integration is a multi-factor, faculty-mediated process—“industry resources→faculty competency→CI→IO”—in which faculty act as the transformer linking external industry resources with internal instructional practice.

2.3. Research gaps

A review of domestic and international research on the integration of “foreign language + industry” in internationalized talent cultivation reveals significant gaps in existing findings across three areas. First, concerning research methods, studies have primarily relied on qualitative descriptions and policy advocacy, lacking large-scale quantitative tests of the mechanisms underlying multidimensional factors. Second, from a research perspective, few studies have simultaneously examined the combined effects of curriculum, faculty, and school-enterprise collaboration on integration outcomes, as well as the pathways through which these factors influence one another. Third, in the field of “foreign language + industry” integration, quantitative mechanism testing using SEM is virtually nonexistent. The innovation of this study lies precisely here—introducing SEM to construct a multidimensional structural model of the symbiotic relationship between “foreign language + industry” integration, testing the direct and indirect mechanisms through which these

multidimensional factors influence integration outcomes, and thus providing empirical materials and a reference for quantitative mechanism testing in this field.

3. Theoretical model and hypothesis

This study is grounded in two theoretical pillars: ST and CBET. ST emphasizes the synergistic evolution of symbiotic units (universities and enterprises), symbiotic models (cooperation mechanisms), and symbiotic environments (policies and institutions). Simultaneously, CBET requires the design of curricula and instruction to be guided by job competency requirements. Based on this, a conceptual model is constructed: CI, FIA, and UECIS serve as exogenous latent variables, while IO serves as the endogenous latent variable (see **Figure 1**).

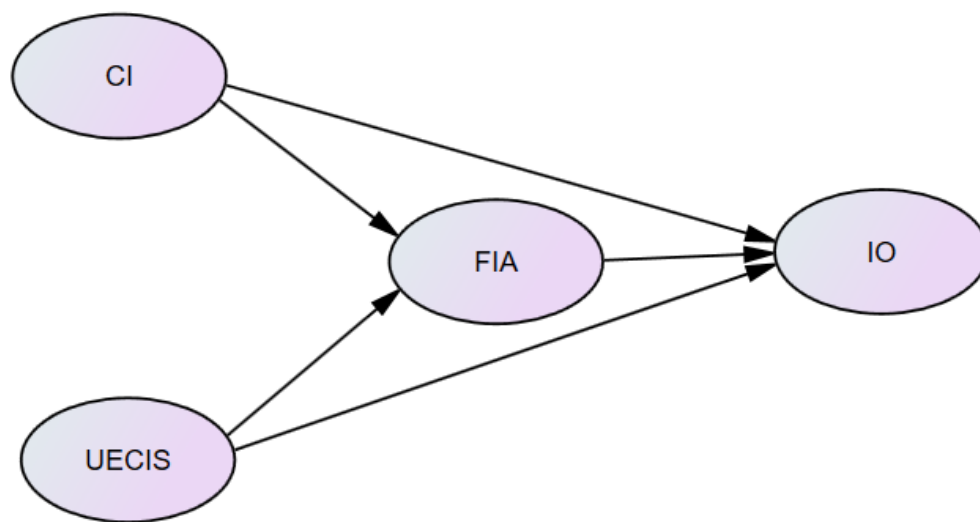


Figure 1. Theoretical model of the study.

At the same time, the following hypotheses are proposed in this research:

- H1: CI has a significant positive effect on IO.
- H2: FIA has a significant positive effect on IO.
- H3: UECIS has a significant positive effect on IO.
- H4: FIA mediates the relationship between CI and IO.
- H5: UECIS indirectly influence IO through FIA.

4. Methodology

4.1 Research design

This study utilized a quantitative, cross-sectional survey. The research design followed a four-step empirical pathway: constructing the theory, developing the questionnaire, collecting the data, and testing the model. Drawing on ST and CBET, the research converted the “foreign language + industry” symbiosis idea into measurable variables. Here, CI, FIA, and UECIS are treated as exogenous latent variables, and IO is the endogenous one. SEM was selected because it handles multiple latent variables at the same time, minimizes measurement error, and tests direct and mediating effects in one model.

4.2. Participants

The target population consisted of foreign language majors at an application-oriented undergraduate university in China. Cluster sampling was chosen here because foreign language students are naturally grouped by class and grade. This approach helps cover different academic years and majors. The survey distributed and collected 684 questionnaires. After removing incomplete or invalid responses, 618 valid questionnaires were kept. The valid response rate reached roughly 90.35%. This sample size meets the typical threshold for SEM (normally at least 200 cases). It also provides enough data for confirmatory factor analysis (CFA) and structural model estimation.

4.3. Data collection

Data were collected using a self-administered structured questionnaire. This questionnaire was created based on the conceptual model and the study's two theoretical foundations. Items CI 1-4 and FIA 1-4 were used to measure CI and FIA. These items followed the competency-oriented logic of CBET. In contrast, items UECIS 1-4 and IO 1-4 measured UECIS and IO, drawing upon ST. All items used a Likert-type scale. Before formal distribution, the questionnaire was reviewed for content validity. Participation remained voluntary and anonymous. Respondents were also informed that their answers would only be used for academic research. All responses were screened for completeness, straight-lining, and logical consistency, and the final dataset of 618 valid responses (see **Table 1**) was used for reliability testing, CFA, and structural model estimation.

Table 1. Demographic Characteristics of Participants (N=618)

Variable	Category	Frequency (n)	Percentage (%)
Academic Year	Freshman	127	20.60
	Sophomore	244	39.50
	Junior	187	30.30
	Senior	42	6.80
	Graduates	18	2.90
	English	266	43.00
Major	Business English	131	21.20
	Japanese/Korean	60	9.70
	English Translation	17	2.80
	Others	144	23.30
Internship/Part-Time Job Experience	No Experience	447	72.30
	≤ 3 months	108	17.50
	> 6 months	33	5.30
	3–6 months	30	4.90
Total		618	100

4.4. Data analysis

Data analysis was conducted using SPSS 25 and AMOS 24. In Step 1, descriptive statistics and reliability testing were performed. SPSS was used to calculate frequencies, means, and standard deviations for all demographic variables and measurement items, and Cronbach's α was computed for each latent variable, with a threshold of $\alpha > 0.70$. In Step 2, CFA was carried out to assess the measurement model. Convergent validity was evaluated using standardized factor loadings (> 0.50), composite reliability ($CR > 0.70$), and

average variance extracted (AVE > 0.50), while discriminant validity was assessed using the Fornell-Larcker Criterion (The square root of the AVE for each construct must be greater than its correlation with any other construct). In Step 3, SEM was estimated using maximum likelihood estimation to test the hypothesized path relationships among CI, FIA, UECIS, and IO. Model fit was evaluated by means of using $\chi^2/df < 3$, NFI > 0.90, RFI > 0.90, IFI > 0.90, CFI > 0.90, TLI > 0.90, and RMSEA < 0.08. All analyses were performed on the 618 valid responses, and the results are reported.

5. Results

5.1. Reliability test results

Table 2 presents the reliability analysis. On the whole, the scale shows good reliability. The Cronbach's α values for the four dimensions are all above 0.90: CI=0.943, FIA=0.921, UECIS=0.946, and IO=0.938. The overall scale's α is 0.973. These values point to strong internal consistency across the dimensions. The items also show high homogeneity, which supports using the scale for further structural analysis. Among the four dimensions, UECIS has the highest value. This reflects strong consistency among items related to school support. FIA scored slightly lower but still meets common standards in research. The item-total correlation coefficients for all items are also high (> 0.50). This suggests that each item aligns well with its respective dimension. No item clearly needs to be removed.

Table 2. Reliability Test

Variable	Items	Sample Size	Cronbach's α
CI	4	618	0.943
FIA	4	618	0.921
UECIS	4	618	0.946
IO	4	618	0.938
Total	16	618	0.973

5.2. Validity test results

Table 3 reports the model fit indices for the CFA of the scale. It includes seven metrics, their reference standards, and the actual values. All indices met the recommended criteria. For CMIN/DF (Chi-square to degrees of freedom ratio), the value is 2.844, which falls within the 1-3 range. The RMSEA (Root Mean Square Error of Approximation) is 0.047, lower than the 0.05 threshold. The five relative fit indices are also above 0.9: NFI (0.943), RFI (0.930), IFI (0.951), TLI (0.940), and CFI (0.951). Overall, these indices suggest a good model fit. The measurement model aligns well with the empirical data and demonstrates good construct validity. It also meets the requirements for the subsequent SEM analysis.

Table 3. CFA Model Fit Indices for the Scale

Index	Reference Standard	Actual Results
CMIN/DF	1-3 Excellent, 3-5 Good	2.844
RMSEA	<0.05 Excellent, <0.08 Good	0.047
NFI	>0.9 Excellent, >0.8 Good	0.943
RFI	>0.9 Excellent, >0.8 Good	0.930

IFI	>0.9 Excellent, >0.8 Good	0.951
TLI	>0.9 Excellent, >0.8 Good	0.940
CFI	>0.9 Excellent, >0.8 Good	0.951

Table 4 reveals the standardized factor loadings for the four dimensions (CI, FIA, UECIS, and IO). These values range from 0.816 to 0.941, which are all above the recommended threshold of 0.50. The AVE values range from 0.743 to 0.818, above the 0.50 cut-off. The CR values range from 0.920 to 0.947, exceeding 0.70. These results indicate that the scale dimensions have good convergent validity and internal consistency reliability.

Table 4. Convergent Validity and CR of the Scale Dimensions

Path Relationship			Standardized Factor Loadings	AVE	CR
CI 4	<---	CI	0.885	0.807	0.944
CI 3	<---	CI	0.937		
CI 2	<---	CI	0.875		
CI 1	<---	CI	0.895		
FIA 4	<---	FIA	0.816	0.743	0.920
FIA 3	<---	FIA	0.887		
FIA 2	<---	FIA	0.861		
FIA 1	<---	FIA	0.882		
UECIS 4	<---	UECIS	0.879	0.818	0.947
UECIS 3	<---	UECIS	0.854		
UECIS 2	<---	UECIS	0.940		
UECIS 1	<---	UECIS	0.941		
IO 1	<---	IO	0.873	0.794	0.939
IO 2	<---	IO	0.911		
IO 3	<---	IO	0.888		
IO 4	<---	IO	0.891		

Table 5 indicates the results for discriminant validity. The Fornell-Larcker criterion ^[15] was used to test the discriminant validity of the scale dimensions. The square root of the AVE ($\sqrt{\text{AVE}}$) for each dimension is between 0.862 and 0.904. This data is presented in the bottom row. These values are greater than their correlations with other dimensions. Those correlation values range from 0.277 to 0.473. These results indicate good discriminant validity among the four dimensions: CI, FIA, UECIS, and IO.

Table 5. Discriminant Validity of the Scale Dimensions

Variable	CI	FIA	UECIS	IO
CI	0.898			
FIA	0.473	0.862		
UECIS	0.325	0.342	0.904	
IO	0.277	0.331	0.329	0.891

5.3. Normal distribution test results

Table 6 illustrates the descriptive statistics for 618 respondents. It covers four core variables: CI, FIA, UECIS, and IO. These variables include 16 items in total. The questionnaire uses a 5-point Likert scale. The minimum and maximum values are 1 and 5 for all items. Overall, the data show a positive trend. Mean scores range from 3.37 to 3.89. FIA 4 has the highest mean, while CI 2 has the lowest. Standard deviations range from 0.864 to 1.041. This suggests some variance in responses, but the distribution is generally concentrated. For data distribution, all variables show negative skewness. The skewness values range from -0.563 to -0.146, indicating a slight left skew. Kurtosis values range from -0.114 to 0.481. In a word, the absolute values of skewness and kurtosis fall within good ranges, indicating that the data approximately follows a normal distribution and is suitable for subsequent parametric testing analyses.

Table 6. Normal Distribution Test (N=618)

Variable	Sample Size	Mean	Std. Deviation	Skewness	Kurtosis
CI 1	618	3.44	1.031	-0.333	-0.091
CI 2	618	3.37	1.041	-0.327	-0.114
CI 3	618	3.52	0.978	-0.361	0.020
CI 4	618	3.64	0.929	-0.465	0.305
FIA 1	618	3.70	0.919	-0.444	0.245
FIA 2	618	3.66	0.925	-0.487	0.368
FIA 3	618	3.72	0.896	-0.489	0.406
FIA 4	618	3.89	0.864	-0.563	0.413
UECIS 1	618	3.70	0.890	-0.444	0.457
UECIS 2	618	3.70	0.881	-0.384	0.347
UECIS 3	618	3.75	0.868	-0.369	0.293
UECIS 4	618	3.62	0.910	-0.444	0.481
IO 1	618	3.39	0.966	-0.146	-0.031
IO 2	618	3.48	0.908	-0.232	0.235
IO 3	618	3.61	0.896	-0.284	0.140
IO 4	618	3.57	0.898	-0.319	0.287

5.4. Correlation analysis results

Table 7 shows the Pearson correlation analysis results among four core research variables (CI, FIA, UECIS, and IO) based on 618 respondents. The data reveals significant positive correlations between all pairs of variables. Specifically, the correlation coefficients (r values) range from 0.232 to 0.487, indicating strong positive linear relationships, with the highest correlation observed between FIA and UECIS ($r = 0.487$) and the lowest between CI and IO ($r = 0.232$). Furthermore, the two-tailed significance probabilities (p-values) for all paired variables are 0.000, and the correlations are significant at the 0.01 level (2-tailed), revealing that these strong positive relationships are statistically highly significant.

Table 7. Correlation Analysis (N=618)

Variable	CI	FIA	UECIS	IO
CI	1			

FIA	0.450**	1		
UECIS	0.380**	0.487**	1	
IO	0.232**	0.368**	0.393**	1

** Correlation is significant at the 0.01 level (2-tailed).

5.5. SEM test results

First, according to the model fit test results of SEM, CMIN/DF is 2.321, which falls within the range of 1–3. RMSEA is 0.038, which is within the excellent range of < 0.05 . Besides, the test results for NFI (0.925), RFI (0.902), IFI (0.914), TLI (0.939), and CFI (0.931) all reached the excellent level of above 0.90. Therefore, it can be concluded that the SEM model for the analysis of factors influencing IO demonstrates good model fit.

Second, regarding path analysis and hypothesis testing shown in Table 8, all five structural paths were statistically significant ($p < 0.001$). CI had a significant positive effect on FIA ($\beta = 0.447$, $p < 0.001$) and IO ($\beta = 0.269$, $p < 0.001$), UECIS had a significant positive effect on FIA ($\beta = 0.481$, $p < 0.001$), FIA had a significant positive effect on IO ($\beta = 0.551$, $p < 0.001$), and UECIS had a significant positive effect on IO ($\beta = 0.528$). Thus, H1, H2, and H3 are supported. H4 is also supported. FIA plays a significant partial mediating role between CI and IO. The indirect effect value (CI→IO) is 0.447×0.551 , which equals 0.246. H5 is supported. UECIS indirectly affects IO through FIA. Here, the indirect effect (UECIS→IO) is 0.481×0.551 , which equals 0.265. These results indicate partial mediation.

Table 8. SEM Path Relationship Test

	Path Relationship		Estimate	S.E.	C.R.	P
FIA	<---	CI	0.447	0.018	24.833	***
FIA	<---	UECIS	0.481	0.029	16.586	***
IO	<---	CI	0.269	0.056	4.804	***
IO	<---	FIA	0.551	0.063	8.746	***
IO	<---	UECIS	0.528	0.073	7.233	***

6. Discussion

The empirical results support the proposed mechanism of “Foreign Language + Industry” integration in talent cultivation at application-oriented universities. The structural model demonstrates a good overall fit. The significant relationships among CI, FIA, UECIS, and IO confirm that this integration is not driven by a single factor. Instead, it depends on the interaction of multiple elements. These include curriculum, faculty, university-enterprise cooperation, and institutional support. These findings are consistent with the theoretical assumptions of ST and CBET. They also reveal a few key characteristics of this integration mechanism.

First, FIA acts as a key mediator between CI and IO. CI has a significant positive effect on FIA ($\beta = 0.447$, $p < 0.001$). It also has a positive effect on IO ($\beta = 0.269$, $p < 0.001$). The indirect effect of CI on IO through FIA reaches 0.246, supporting H4. This finding suggests that simply adding industry-oriented content into foreign language curricula may not directly lead to effective “Foreign Language + Industry” integration. The same applies to practical courses or competency-based approaches. The success of curriculum reform largely depends on teachers. They must translate curriculum requirements into authentic industry-related learning experiences. This is consistent with CBET. CBET highlights the alignment among educational content,

teaching practices, and actual occupational competencies. It also supports the idea that faculty play a crucial role. They act as a bridge between external industry resources and internal educational practice.

Second, FIA shows a strong positive effect on IO ($\beta = 0.551, p < 0.001$). This suggests FIA is a key mechanism for improving internationalized talent cultivation. Faculty members need to understand industry standards and enterprise expectations. They also need to be familiar with practical workflows and occupational requirements. With this knowledge, they can better integrate professional knowledge and foreign language skills into classroom teaching. Therefore, foreign language faculty should move beyond traditional language-teaching skills. They should develop interdisciplinary and industry-oriented competences. This finding also echoes earlier studies. Those studies pointed out that insufficient faculty resources and weak connections between education and industry are major barriers in applied talent cultivation.

Third, UECIS has the strongest effect on FIA. The standardized coefficient is 0.481 ($p < 0.001$). UECIS also has a significant direct effect on IO ($\beta = 0.528, p < 0.001$). These findings show that UECIS is a main driver for the symbiotic development of “foreign language + industry”. More importantly, UECIS affects IO both directly and indirectly through FIA. The indirect effect is 0.265. This supports H5 and points to a partial mediation mechanism. In other words, university-enterprise cooperation can improve integration outcomes. It provides resources such as practical training, industry information, and internship opportunities. It also provides institutional conditions. These resources become more effective when industry-aligned faculty apply them to educational practices. This finding supports the ST perspective. Effective integration is not just about having universities and enterprises working together. It requires developing stable and mutually beneficial symbiotic relationships.

Fourth, these results show that the integration mechanism works as a transformation chain rather than a simple additive relationship. Several paths are significant, including CI to FIA, CI to IO, UECIS to FIA, FIA to IO, and UECIS to IO. These paths indicate that curriculum reform and institutional cooperation are linked through faculty development and industry alignment. This supports the theoretical proposition of “industry resources $\rightarrow$ faculty competency $\rightarrow$ CI $\rightarrow$ IO” proposed in this study.

Finally, this study offers a symbiotic perspective on “foreign language + industry” integration. Earlier research mainly looked at curriculum reform, teaching models, or university-enterprise cooperation in isolation. Few studies have tested their interactive mechanisms with quantitative methods. This study shows that effective integration is a systemic process. It involves multiple interdependent actors and conditions. Universities and enterprises should go beyond loose cooperation. They need deeper resource sharing and joint curriculum development. Faculty development and practical training are also crucial. Institutional coordination is necessary as well. This mechanism can help application-oriented universities meet the changing competency needs of internationalized industries. It can also drive foreign language education toward an interdisciplinary, competency-oriented model, moving away from a language-centered one.

7. Conclusion

7.1. Summary of key findings

This study tested the symbiotic integration mechanism of “foreign language + industry” in internationalized talent cultivation at application-oriented universities. The empirical analysis used 618 valid questionnaires and SEM. The results imply that the proposed model has good explanatory and structural validity. They also indicate that CI, FIA, and UECIS together affect the effectiveness of “Foreign Language + Industry” integration.

First, the data show that FIA is a key factor in integration outcomes. FIA has a significant positive effect

on IO ($\beta = 0.551, p < 0.001$). This means that the extent to which foreign language teachers understand industry competency requirements directly impacts the effectiveness of interdisciplinary talent cultivation. Second, UECIS has positive effects on both FIA ($\beta = 0.481, p < 0.001$) and IO ($\beta = 0.528, p < 0.001$). This indicates that UECIS serves as an important external driving force for integration. Third, CI has a positive effect on FIA ($\beta = 0.447, p < 0.001$) and IO ($\beta = 0.269, p < 0.001$). CI also affects IO indirectly through FIA, with an indirect effect of 0.246. This finding indicates that curriculum reform needs to be mediated by faculty capability and industry alignment. Only then can it be effectively translated into IO outcomes.

Overall, these findings support H1 through H5. The results point to a faculty-mediated and institutionally supported integration mechanism. In this mechanism, curriculum reform provides the foundation. University-enterprise cooperation supplies external resources and institutional conditions. Faculty-industry alignment acts as the key transmission mechanism. It connects these inputs to actual integration outcomes. This finding adds to the empirical understanding of symbiotic integration. It also offers practical guidance for application-oriented universities. These institutions need to reform their curricula and invest in faculty development. They should also deepen their cooperation with enterprises.

7.2. Research limitations and future research directions

Despite the empirical findings of this study, several limitations should be acknowledged, which also provide directions for future research. First, the sample came from a single application-oriented university in China. It had a relatively high proportion of lower-year students. Also, fewer than 30% of the respondents had internship or part-time work experience. As a result, the generalizability of the findings to students from different types of universities, academic backgrounds, and levels of industry exposure remains limited. Future research could expand the sample to include multiple application-oriented universities and other types of higher education institutions. This would improve the representativeness of the findings. It would also allow for comparisons across institutional contexts.

Second, this study adopted a cross-sectional survey design. It relied mainly on self-reported questionnaire data. The measurement model showed satisfactory reliability and validity. However, cross-sectional data cannot provide strong evidence of causal relationships. Also, self-reported responses may be influenced by social desirability or respondents' subjective perceptions. Future studies could use longitudinal tracking or quasi-experimental designs. They could also conduct pre- and post-test comparisons. This would help test how curriculum reform, faculty-industry alignment, and university-enterprise cooperation influence integration outcomes over time.

Third, the current model focuses mainly on institutional and educational factors, including CI, FIA, and UECIS. It gives little attention to individual student characteristics. Several such factors may influence how students respond to “foreign language + industry” training. These include learning motivation, internship experience, and prior industry exposure. Career-planning clarity may also play a role. Future research could treat these individual characteristics as moderating variables. This would help test whether the proposed mechanism becomes stronger or weaker under different conditions.

Funding

This study is one of the achievements of the 2025 Special Research Project on Foreign Language Teaching Reform and Practice of Guangdong Undergraduate Universities, “Research on the International Talent Training Model of Two-Way Empowerment in the ‘Foreign Language + Industry’ Integration for Application-

oriented Universities Against the Background of the New Liberal Arts” (Project No.: 25GWYB18)

Disclosure statement

The authors declare no conflict of interest.

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