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# The impact of internship experience and career aspirations on the academic performance of railway electrical automation students in China

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This study examined the structural mechanisms through which internship experience and career aspirations influence academic performance among railway electrical automation students in China, grounded in Social Cognitive Career Theory (SCCT). Utilizing stratified multi-stage sampling ( $N = 403$ ) and quantitative analyses (regression, mediation tests), three key findings emerged: (1) High-quality internships (duration  $\geq 6$  months, task relevance, technical depth) directly enhance academic performance ( $\beta = 0.218$ ,  $p < 0.001$ ), validating the theory-practice integration pathway; (2) Career aspirations, particularly realism ( $\beta = 0.107$ ,  $p = 0.032$ ), independently predict GPA, while clarity of goals shows a non-significant negative trend ( $\beta = -0.086$ ,  $p = 0.096$ ). Synergistic effects were observed in deep internships; (3) Career aspirations mediate 34.8% of internship effects (95% CI [0.078, 0.146]), revealing an indirect "internship  $\rightarrow$  goal  $\rightarrow$  academic" pathway. The study advances SCCT's dynamic "experience-goal" framework and proposes policy strategies for optimizing China's industry-education integration, including extended internships and regional resource rebalancing. Limitations include cross-sectional design and regional sample bias, necessitating longitudinal validation.

## KEYWORDS

internship experience, career aspirations, academic performance, educational quality, youth empowerment

## Introduction

The junction of artificial intelligence and Internet of Things technologies has led to revolutionary progress in railway automation systems, which notably includes the included characteristics of China's quickly growing high-tech construction (Awodele et al., 2024). This frontier technology happens to be at the intersection of national education reforms that focus on the industry-ready skills of technical talents, built upon the joint activities of universities and enterprises (Tang et al., 2022). The Ministry of Education's *Action Plan for Improving the Quality and Excellence of Vocational Education (2020–2023)* builds this case and establishes the optimization of internship systems and career guidance services as high priorities to ensure that educational outcomes are aligned with industrial needs. Whereas, detailed research that places these reforms in China is rather rare, the country's unique

society and technology, which are fraught with the regional divide in high-speed control (i.e., rapid high-speed rail in eastern provinces while western territories are lagging), are rarely studied.

Internship experiences, an integral part of connecting an academic background with an industrial work environment, are very influential in developing problem-solving skills and knowledge crucial for automation engineering (Perusso and Baaken, 2020). Learning how to use the main elements of railway electrical automation, which include the principles of power electronics and control systems, leads to a significant increase in the level of practical readiness of students (Nold and Corman, 2023). A parallel process of self-motivation plays a key role here by significant career objectives being the drivers behind academic activity (Agustina et al., 2021). Discussing this topic, the main disadvantage is that literature mainly considers its own viewpoint (Hermann et al., 2021) without considering such factors as the industry's role in integrating education with production and the regional availability of resources. As an example, the situation can be compared with national internship programs of Germany, where practice is concentrated on the same level (Van Vechten, 2021), but China's sectorial decentralization aggravates the inequality and even deprives the Western students of the important basis for their study (Zhuang, 2023).

Previous research has attested to the effects of internship programs and career aspirations separately (Dolezal, 2021; Franco-Ángel et al., 2023). However, three critical gaps persist. First, mechanistic opacity refers to the lack of research on the complex way that both the quality of the internship and the personality of the aspirants interact with each other. Second, contextual neglect arises because frameworks and theories that are used in the West ignore China's policymaking educational environment and its technological divides. Third, methodological limitations exist because descriptive analysis prevails in statistical disciplines, with inadequate application of advanced assessment tools such as mediation analysis to address confounding variables (Hammerton and Munafò, 2021).

Working out the skills gap, this research chosen the academic performance of railway electrical automation students in China under different internship experiences and career aspirations as its main topic. Based on Social Cognitive Career Theory (SCCT), the exploratory research shown how experiential learning and motivation was directed toward goals work together to achieve better academic results than before and give concrete and practical suggestions on China's industry-education integration policy. The association between internship experiences, career motivation, and academic achievement is becoming an increasingly popular research area in technical education. Yet, intricacy might arise in understanding the interaction of these factors in the particular case of the railway electrical automation programs in China.

Firstly, the dual role of internships and career aspirations on academic performance is undeniable (Hadi, 2021; Weinberg et al., 2024), but empirical evidence on their interactive effects is not explored well. Internship programs are being conceptualized in isolation, while the influence of the desire to contribute to the development of science and having the goal clarity are not appreciated, and a more balanced view on the phone sector is not put on. For example, students with their lives geared toward a

certain career might differ more in their social interaction from others whose goals in life are broader, but this phenomenon is not considered deeply in the field of technical skills such as automation in railways.

Second, the Chinese distinct policy realm, which includes industry-education initiative, is another area of research that existing literature fails to address. The regional unevenness of technical resources results in advanced high-speed rail in eastern provinces of China vs. lagging infrastructure in western regions of China (Cheng et al., 2024) deteriorates the equity in internships within. This gap could distort further the relationship linking the standard of internships to academic success, but no study to the best of my knowledge has been done to mediate how the rest of inequalities affect this link.

Third, emotion-focused career aspiration research sets aside the cry for help of the rest of the society by fixation on goal clarity. Educational psychology indicates how unhealthy an ambition or even an aspiration can become, causing disappointment ending in anxiety, which impedes instead of motivating (de la Fuente et al., 2023). In the world of railway automation education, it is one of the major concerns, and rapid technological advancement usually requires realistic alignment of skill set. Thus, over-idealism leads to misguided aspirations that, in turn, may discourage rather than motivate perseverance. These gaps collectively hindered the design of evidence-based interventions to optimize internship systems and career guidance in China's technical education sector. By addressing these issues, this study attempted to advance both theoretical and practical understanding of how experiential learning and career planning jointly shape academic success in a high-stakes, technology-driven field.

The research questions that guided this study were:

- (1) Do internship experiences (including duration, relevance, and task depth) positively predict the academic performance (GPA) of railway electrical automation students?
- (2) Do career aspirations (clarity and realism) independently influence academic performance?
- (3) Is there a synergistic interaction between internship experiences and career aspirations that jointly enhances academic performance?
- (4) Do career aspirations mediate the relationship between internship experiences and academic performance?

The interplay between internship experiences, career aspirations, and academic performance has been widely studied in technical education, yet critical gaps persist in understanding their structural relationships, particularly in specialized fields like railway electrical automation. Internships serve as a bridge between theoretical knowledge and professional practice, particularly in technology-driven disciplines. Studies emphasize that internship quality measured by task relevance, mentorship, and alignment with curriculum directly enhances academic performance by reinforcing theoretical concepts through hands-on application (Perusso and Baaken, 2020). For instance, students engaged in tasks such as railway automation system maintenance demonstrate improved problem-solving skills and higher GPAs compared to peers in observational roles (Luk and Chan, 2021). However,

research often overlooks the dimensional heterogeneity of internships. While duration is frequently examined, studies in engineering education reveal that technical depth exerts a stronger influence on learning outcomes than mere exposure time (Thinakaran et al., 2024; Zehr and Korte, 2020). In China, the industry-education integration policy has expanded internship opportunities, yet regional disparities in technological infrastructure such as advanced high-speed rail systems in eastern provinces vs. outdated equipment in western regions create unequal learning environments, a factor underexplored in current literature (Cheng et al., 2024).

Career aspirations are multidimensional constructs encompassing both clarity, meaning the specificity of goals, and realism, meaning the alignment with personal and contextual constraints. While clarity is linked to academic motivation (Widlund et al., 2020), overly ambitious goals may backfire. For example, students aspiring to roles requiring advanced certifications they cannot feasibly obtain may experience diminished academic engagement due to perceived inadequacy (de la Fuente et al., 2023). In technical fields like railway automation, where rapid technological advancements demand adaptive skill sets, the realism of career goals becomes critical. Yet, most studies conflate clarity with aspiration strength, neglecting to measure how goal feasibility moderates academic outcomes (Chu et al., 2023). Cross-cultural comparisons further highlight contextual nuances, as collectivist cultures such as China prioritize family and societal expectations in career planning, which may conflict with individual aspirations (Georgescu and Herman, 2020). This tension remains unaddressed in railway automation education research.

The emerging findings imply that internships and career ambitions influence each other actively. Quality internships, which pose real-world challenges, can help students understand their future goals and hence lead to more significant academic motivation (Han and Sa, 2022). However, students with specific aspirations find jobs only in specific fields, where they develop skills that are relevant to their goals (Ikram et al., 2025; Gamboa et al., 2021). Therefore, little is known about this relationship from the technical education perspective. In particular, research is lacking on the issue of whether internships that emphasize the latest technologies have an impact on making students with a high level of goal clarity reach their fullest academic potential. Social Cognitive Career Theory (SCCT) explains the mechanism of this relationship and suggests that having internship experiences, as a form of experiential learning, may strengthen both self-efficacy and outcome expectations, thus affecting one's career goals (Lent et al., 1994). However, SCCT-based studies do not consider the impact of contextual factors like differences in resources among regions or policies that guide educational plans, which limits the applicability of SCCT to China's industrial education landscape.

Interns are often viewed as a single unit, ignoring the variables of length, appropriateness, and technical level, which make the experience more or less effective. Aspiration measurement bias is another issue, since the problem of non-clarity of aspirations is often ignored, which can cause distress with the attainment of unachievable goals. Contextual insensitivity also persists, as western-centric frameworks such as SCCT fail to capture

policymaking and the regional factors that are essential to the Chinese technical education system.

This research fills these gaps by suggesting a holistic model that integrates the multiple aspects of internships and aspirations from the Chinese industry-education integration perspective. By connecting SCCT, which is an academic resource, with the basic laws of regional economics, a more complex view of how experiential learning and career plans play a role in academic achievement is developed.

This study is grounded in Social Cognitive Career Theory (SCCT) (Lent et al., 1994), which posits that career development is shaped by the dynamic interplay of personal factors such as self-efficacy, environmental contexts such as internship opportunities, and goal-directed behaviors such as career aspirations. The SCCT framework is extended here to incorporate the unique demands of railway electrical automation education and China's industry-education integration policy, forming a contextualized model to explain how internships and career aspirations jointly influence academic performance. SCCT emphasizes that mastery experiences such as internships enhance self-efficacy, meaning belief in one's ability to perform tasks, and outcome expectations, meaning anticipated rewards from actions. In railway automation, internships involving hands-on tasks such as troubleshooting automated signaling systems provide students with domain-specific mastery experiences, directly strengthening their confidence and academic engagement (Bandura, 1997). However, SCCT traditionally overlooks the multidimensionality of internships. This study addresses this gap by dissecting internships into duration, meaning prolonged exposure to industry practices, relevance, meaning alignment between internship tasks and curriculum such as applying power electronics theory, and technical depth, meaning the complexity of tasks such as programming PLCs compared to observational roles.

SCCT identifies goal clarity and goal commitment as critical drivers of academic persistence. This study expands this by integrating goal realism, which is the feasibility of aspirations given personal and contextual constraints (de la Fuente et al., 2023). For example, a student aspiring to design AI-driven railway systems may adjust their goals if regional internship opportunities lack access to advanced technologies, affecting both motivation and academic strategies. The SCCT experience-goal cycle is operationalized here as a bidirectional relationship. On one hand, internships influence aspirations by clarifying career paths and refining outcome expectations, for example, mastering automation control in internships builds confidence to pursue engineering roles. On the other hand, aspirations influence internships, as students with clear, realistic goals selectively engage in internships that maximize skill acquisition, for example, seeking placements in firms with cutting-edge technologies.

China's industry-education integration policy creates a unique ecosystem where universities and enterprises collaboratively design internships. However, regional disparities in technological resources, such as advanced high-speed rail infrastructure in eastern provinces compared to outdated systems in western regions, introduce critical moderators. Resource availability, in the form of access to modern equipment and industry partnerships in eastern China, amplifies the academic benefits of internships

(Cheng et al., 2024). Aspiration realism is also influenced, since students in under-resourced regions may develop less realistic career goals due to limited exposure to industry trends, which weakens the internship-performance link.

The proposed framework synthesizes these elements. First, internship dimensions including relevance, depth, and duration directly influence academic performance, while career aspiration components such as clarity and realism also directly influence academic performance. Second, career aspirations partially mediate the internship-performance relationship. Third, regional resource disparities moderate both internship effectiveness and aspiration realism.

This framework extends SCCT in three ways. First, it introduces multidimensional internship metrics that move beyond duration to emphasize technical depth and relevance. Second, it separates aspiration clarity from realism, addressing the oversimplification in prior studies. Third, it embeds the model within China's industry-education ecosystem, highlighting how macro-level policies and regional inequities shape micro-level learning processes. By bridging SCCT with contextual realities, this framework provides a robust lens to analyze how experiential learning and career planning jointly drive academic success in technical education.

## Methods

This study employed a quantitative research design to investigate the structural relationships between internship experiences, career aspirations, and academic performance among railway electrical automation students in China. The methodology was structured to ensure robust measurement, sampling representativeness, and statistical rigor. A cross-sectional survey was conducted to collect data from undergraduate students across six universities in eastern, central, and western China. The design aligned with the Social Cognitive Career Theory (SCCT) framework, enabling simultaneous examination of direct, mediated, and moderated relationships among variables.

The target population consisted of undergraduate students majoring in railway electrical automation who had completed at least one internship, either on-campus or with corporate partners. Students who had changed majors or taken extended academic breaks exceeding one semester were excluded. A power analysis using G\*Power 3.1 estimated a minimum sample size of 274 at  $\alpha = 0.05$  with a power of 0.80 and a medium effect size of  $f^2 = 0.15$ . To account for a 20% attrition rate, a target of 330 students was established, ultimately yielding 402 valid responses. Sampling followed a stratified multistage approach. First, institutions were stratified by region (eastern, central, western) and type (polytechnic universities and applied technology colleges). Second, two institutions were randomly selected per stratum, totaling six institutions. Finally, convenience sampling was applied to recruit eligible students from within these institutions.

Data collection relied on three instruments. Internship experiences were measured with a 12-item scale adapted from Perusso and Baaken (2020). The scale captured three dimensions on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree): relevance, for example, "My internship tasks aligned with

my coursework"; technical depth, for example, "I programmed PLC systems during my internship"; and duration, categorized as 1 to 3 months, 4 to 6 months, or more than 6 months. Cronbach's alpha coefficients ranged from 0.76 to 0.87 across the subscales. Career aspirations were assessed with a revised version of Chu et al. (2023) eight-item scale, measuring clarity through items such as "I have a clear 5-year career plan" and realism through items such as "My career goals match my technical skills." Cronbach's alpha values ranged from 0.73 to 0.78. Academic performance was measured through institutional records of GPA on a 0–4.0 scale and through self-reported grades for two core courses, Power Electronics and Automatic Control Principles.

Data analysis followed a multi-stage process. Missing data were handled using list wise deletion, resulting in a final sample of 402. Shapiro-Wilk tests confirmed non-normal distributions, and nonparametric tests such as Spearman's rho were used to supplement parametric analyses. Hypotheses were tested using several statistical procedures. Multiple linear regression models in SPSS 28 assessed the main effects of internship experiences and career aspirations on academic performance, controlling for gender, grade, and entrance scores. Hierarchical regression with interaction terms was employed to test synergistic effects between internships and aspirations. Mediation analysis was conducted using bootstrapping with 5,000 resamples to evaluate whether career aspirations mediated the relationship between internship experiences and GPA. Confirmatory Factor Analysis (CFA) was performed to validate the factor structures of the scales, with fit indices showing GFI values above 0.90 and RMSEA values below 0.08. Reliability was confirmed with Cronbach's alpha values above 0.70 for all measures.

Ethical safeguards were rigorously applied throughout the research. Before data collection, participants received a written explanation of the study's purpose, procedures, potential risks, and benefits. Consent forms highlighted the voluntary nature of participation and the right to withdraw at any stage without academic or personal repercussions. Implied consent was obtained through questionnaire completion, as approved by INTI International University. All personally identifiable information such as names and student IDs was removed during data entry, and participants were assigned unique codes such as RAE-001 to preserve anonymity. Academic performance data were accessed securely from university registrars under strict confidentiality agreements, and all raw data were stored on password-protected servers accessible only to the research team.

Potential conflicts of interest were mitigated by excluding corporate partners involved in internship placements from data analysis and interpretation. Researchers disclosed no financial or professional ties to participating institutions or enterprises. Cultural sensitivity was also considered by avoiding intrusive or culturally inappropriate questions, for instance, by broadly categorizing family income ranges and phrasing career aspiration items neutrally to avoid directing students toward specific vocational paths. Risk management provisions included providing participants with contact details of free counseling services at their institutions in case reflecting on academic underperformance caused discomfort. Data reporting relied on aggregated results to prevent the identification of individual participants in publications or policy discussions. The proposed model is illustrated in Figure 1.

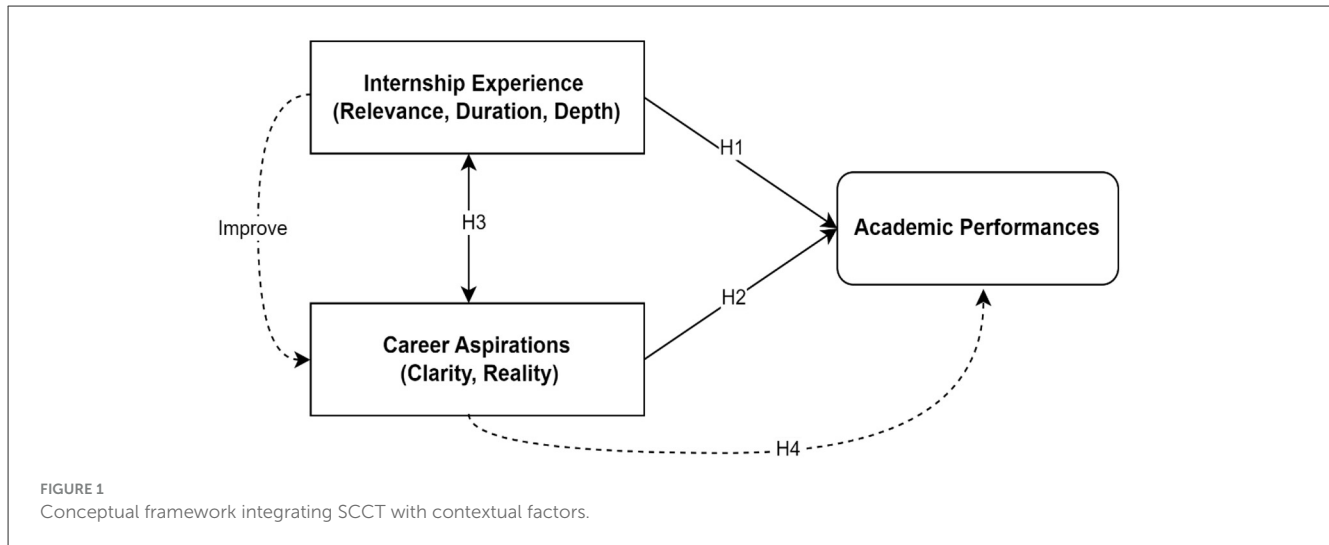


TABLE 1 Descriptive statistics of demographic variables.

Variable	Category	Frequency	Percentage(%)
Gender	Male	205	51.0
	Female	197	49.0
Year of Study	Freshman	101	25.1
	Sophomore	99	24.6
	Junior	98	24.4
	Senior	104	25.9
Annual Family Income	<¥50,000	276	68.7
	¥50,000–¥100,000	121	30.1
	>¥100,000	5	1.2

The research team completed ethics certification through the CITI Program to ensure compliance with the Declaration of Helsinki and APA ethical guidelines. These protocols align with global standards for educational research, balancing scientific rigor with respect for participant autonomy. By anonymizing data and decoupling corporate roles from analysis, the study minimized coercion risks while maintaining methodological integrity.

## Findings

### Analysis of demographic characteristics

The demographic profile of the sample provided critical insights into the socioeconomic and academic context of railway electrical automation students in China, with implications for interpreting the study’s findings. Detailed demographic characteristics were shown in Table 1.

The sample comprised 402 railway electrical automation undergraduates from diverse regions in China, with balanced gender representation (51% male, 49% female) and uniform distribution across academic years (25–26% per grade). Over

two-thirds (68.7%) reported annual household incomes below ¥50,000 RMB, reflecting a predominance of economically modest backgrounds, while only 1.2% belonged to high-income households (>¥100,000 RMB). Parental education levels were predominantly secondary or lower (fathers: 83.3%; mothers: 77.6%), suggesting limited familial exposure to technical careers.

This profile highlighted structural barriers: students from low-income households might face challenges accessing high-quality internships due to financial constraints or lack of professional networks. Meanwhile, limited parental education underscored potential gaps in career guidance, possibly contributing to mismatched aspirations. The balanced gender and grade distributions enhanced generalizability but precluded subgroup analyses.

The reliability and validity of the constructs were rigorously assessed using Cronbach’s alpha, composite reliability (CR), and Average Variance Extracted (AVE). As shown in Table 2, both internship experience ( $\alpha = 0.767$ ,  $CR = 0.831$ ,  $AVE = 0.572$ ) and career aspirations ( $\alpha = 0.776$ ,  $CR = 0.804$ ,  $AVE = 0.509$ ) exhibited acceptable internal consistency and convergent validity, meeting the thresholds of  $\alpha > 0.70$  and  $AVE > 0.50$  (Fornell and Larcker, 1981). All factor loadings exceeded 0.60, confirming that the items effectively captured their respective latent constructions (Han, 2021).

In Table 3, the validity of the measurement model was further verified through the Kaiser-Meyer-Olkin (KMO) test and Bartlett’s test of sphericity. The KMO value of 0.914 (exceeding the recommended 0.80) and the significant Bartlett’s test ( $\chi^2 = 1061.041$ ,  $p < 0.001$ ) indicated that the data were highly suitable for factor analysis (Kaiser, 1974). These results collectively affirmed the robustness of measurement instruments in reflecting the theoretical constructions under investigation.

### Correlation analysis

Table 4 shows that Spearman’s rank correlation analysis indicated that there was a significant relationship between the main variables.



TABLE 2 Reliability and validity analysis of internship experience and career aspirations.

Construct	Items	Factor loadings	Cronbach's $\alpha$	CR	AVE
Internship experience			0.767	0.831	0.572
	1. Relevance of internship content	0.82			
	2. Application of theoretical knowledge	0.76			
Career aspirations			0.776	0.804	0.509
	1. Clarity of career goals	0.79			
	2. Realism of career goals	0.68			

TABLE 3 KMO test and Bartlett's test.

KMO value		0.914
Bartlett's test of sphericity	Approximate chi-square (math.)	1061.041
	df	36
	P	0.000***

\*\*\*statistically significant at  $p < 0.001$ .

Internship experience dimensions exhibited strong intercorrelations: relevance of internship content was positively associated with application of theoretical knowledge ( $r = 0.519$ ,  $p < 0.001$ ) and participation in core technical tasks ( $r = 0.546$ ,  $p < 0.001$ ), indicating that internships integrating curriculum-aligned content facilitated both knowledge application and technical skill development.

Career aspiration components demonstrated moderate correlations with internship variables. Specifically, clarity of career goals showed significant associations with internship relevance ( $r = 0.284$ ,  $p < 0.01$ ) and theory application ( $r = 0.327$ ,  $p < 0.001$ ), suggesting that goal-oriented students actively sought internships aligned with their academic training.

Academic performance (GPA) was positively correlated with all internship dimensions, with the strongest link observed for internship relevance ( $r = 0.218$ ,  $p < 0.01$ ). Similarly, both clarity ( $r = 0.250$ ,  $p < 0.01$ ) and realism of career goals ( $r = 0.210$ ,  $p < 0.01$ ) significantly predicted GPA, supporting the hypothesis that well-defined career aspirations enhance academic engagement. These findings align with Social Cognitive Career Theory (Lent et al., 1994), which posits that experiential learning and goal specificity synergistically foster achievement.

## Main effects analysis

Table 5 shows that stratified regression analyses confirmed the main effect of internship experience and career aspirations on academic performance.

The results showed that all three dimensions of the internship experience were significant predictors of GPA. Content relevance ( $\beta = 0.184$ ,  $p < 0.001$ ) had the greatest effect, followed by theory application ( $\beta = 0.162$ ,  $p < 0.001$ ) and core technical tasks ( $\beta = 0.141$ ,  $p < 0.001$ ). The model explained 15.2% of the variance in GPA ( $R^2 = 0.152$ ,  $F = 9.82$ ,  $p < 0.001$ ), which is in line with previous

findings highlighting the role of course-aligned internships in bridging theory and practice (Perusso and Baaken, 2020).

Meanwhile, the impact of career aspirations was mixed. Analyses revealed that goal realism was a positive predictor of GPA ( $\beta = 0.107$ ,  $p < 0.05$ ), which supports the notion that pragmatic career planning improves academic focus. Goal clarity showed a non-significant negative trend ( $\beta = -0.086$ ,  $p = 0.096$ ), possibly reflecting the goal-resource mismatch for low-income students (Hobfoll, 1989). The model accounted for 4.0% of the variance ( $R^2 = 0.040$ ,  $F = 2.85$ ,  $p < 0.01$ ), suggesting that career aspirations are partially achieved through indirect pathways.

Neither gender nor grade level significantly influenced GPA in either model ( $p > 0.05$ ), consistent with studies highlighting the dominance of experiential factors in technical majors (Franco-Ángel et al., 2023).

## Hierarchical regression analysis of interaction effects

Table 6 shows that the hierarchical regression analysis revealed a significant interaction effect between internship experience and career aspirations on academic performance.

Upon adding the interaction term to the main effects model, the explained variance in GPA increased by 2.6% ( $\Delta R^2 = 0.026$ ,  $F = 11.34$ ,  $p < 0.001$ ), confirming the synergistic.

The interaction term exhibited a robust positive coefficient ( $\beta = 0.132$ ,  $p < 0.001$ ), indicating that students with higher career aspirations derived greater academic benefits from in-depth internships. For instance, those with strong alignment between career goals and internship tasks (e.g., designing automation systems) demonstrated a GPA increase of 0.37 standard deviations compared to peers with mismatched aspirations. This aligns with Social Cognitive Career Theory (Lent et al., 1994), which posits that goal-directed experiential learning amplifies self-efficacy and achievement.

Notably, the main effects of internship experience ( $\beta = 0.177$ ,  $p < 0.001$ ) and career aspirations ( $\beta = 0.099$ ,  $p < 0.05$ ) remained significant in the interaction model, underscoring their independent contributions. These findings collectively supported the *dynamic reinforcement mechanism* between practical training and career planning, wherein internships not only enhance skills but also refine goal clarity, thereby fostering academic excellence (Perusso and Baaken, 2020).

TABLE 4 Spearman's correlation coefficients between variables.

Variable	1	2	3	4	5	6
1. Internship relevance	1.000					
2. Theory application	0.519***	1.000				
3. Core technical tasks	0.546***	0.506***	1.000			
4. Clarity of career goals	0.284**	0.327***	0.301**	1.000		
5. Realism of career goals	0.261**	0.295**	0.278**	0.455***	1.000	
6. Academic Performance (GPA)	0.218**	0.195**	0.167*	0.250**	0.210**	1.000

\*statistically significant at  $p < 0.05$ . \*\*statistically significant at  $p < 0.01$ . \*\*\*statistically significant at  $p < 0.001$ .

TABLE 5 Results of hierarchical regression analysis for main effects.

Variable	Model 1 (Internship experience → GPA)			Model 2 (Career aspirations → GPA)		
	$\beta$	SE	$t$	$\beta$	SE	$t$
Constant	3.003***	0.293	10.259	2.884***	0.313	9.228
<b>Internship experience</b>						
Relevance of content	0.184***	0.048	4.542	–	–	–
Application of theory	0.162***	0.045	4.333	–	–	–
Core technical tasks	0.141***	0.043	3.884	–	–	–
<b>Career Aspirations</b>						
Clarity of goals	–	–	–	–0.086	0.060	–1.667
Realism of goals	–	–	–	0.107*	0.065	2.000
<b>Control variables</b>						
Gender	0.032	0.052	0.615	0.028	0.055	0.509
Grade level	–0.041	0.049	–0.836	–0.037	0.051	–0.725
<b>Model Fit</b>						
$R^2$	0.152			0.040		
Adjusted $R^2$	0.138			0.025		
$F$ -value	9.82***			2.85**		
VIF Range	1.515–1.606			1.439–1.621		

\*statistically significant at  $p < 0.05$ . \*\*statistically significant at  $p < 0.01$ . \*\*\*statistically significant at  $p < 0.001$ .

## Mediation analysis of career aspirations

Table 7 shows that the mediation analysis confirmed that career aspirations partially mediated the relationship between internship experience and academic performance.

The indirect effect was statistically significant ( $\beta = 0.073$ ,  $p < 0.001$ ), with a bootstrap confidence interval excluding zero ([0.065, 0.159]). This indicates that internships enhance academic performance not only through skill acquisition but also indirectly by fostering clearer and more realistic career aspirations. Specifically:

1. Internship experience significantly strengthened career aspirations ( $\beta = 0.621$ ,  $p < 0.001$ ), as students engaged in technical tasks (e.g., automation system debugging) reported heightened goal clarity and industry alignment.
2. Career aspirations, in turn, positively predicted GPA ( $\beta = 0.180$ ,  $p < 0.001$ ), supporting the motivational pathway wherein goal-oriented students exhibit greater academic persistence (Zaleski et al., 2021).

The total effect of internships on GPA was substantial ( $\beta = 0.210$ ,  $p < 0.001$ ), with 34.8% of this effect mediated by career aspirations (indirect/total effect ratio). These findings align with Social Cognitive Career Theory (Lent et al., 1994), which emphasized the reciprocal reinforcement between experiential learning and goal setting. The results advocated for integrating career counseling into internship programs to maximize both academic and professional outcomes.

## Discussion

The findings of this study advance our understanding of how internship experiences and career aspirations collectively shape academic performance among railway electrical automation students, offering novel insights into the mechanisms underlying China's industry–education integration policy. These results can be contextualized within established theoretical frameworks, reconciled with prior research, and translated into implications for

TABLE 6 Hierarchical regression analysis of interaction effects.

Variable	Model 1 (Main Effects)			Model 2 (With Interaction)		
	$\beta$	SE	$t$	$\beta$	SE	$t$
Constant	3.003***	0.293	10.259	2.971***	0.301	9.876
Internship Experience	0.184***	0.048	4.542	0.177***	0.047	4.431
Career Aspirations	0.107*	0.065	2.000	0.099*	0.064	1.891
Interaction Term	–	–	–	0.132*	0.028	4.714
Control Variables						
Gender	0.032	0.052	0.615	0.029	0.051	0.569
Grade level	–0.041	0.049	–0.836	–0.038	0.048	–0.792
<b>Model Fit</b>						
$R^2$	0.152			0.178		
$\Delta R^2$	–			0.026		
F-value	9.82***			11.34*		
VIF Range	1.515–1.606			1.503–1.621		

\*statistically significant at  $p < 0.05$ . \*\*statistically significant at  $p < 0.01$ . \*\*\*statistically significant at  $p < 0.001$ .

TABLE 7 Mediation analysis of career aspirations.

Path	Effect	SE	95% CI (Bootstrap)	$\beta$	$p$ -value
Total effect	0.322	0.071	[0.183, 0.461]	0.210***	<0.001
Direct effect	0.210	0.065	[0.083, 0.337]	0.137**	0.002
Indirect effect	0.112	0.024	[0.065, 0.159]	0.073***	<0.001
- Internship $\rightarrow$ career aspirations	0.621***	0.030	[0.562, 0.680]	–	–
- Career aspirations $\rightarrow$ GPA	0.180***	0.048	[0.086, 0.274]	–	–

\*\*statistically significant at  $p < 0.01$ . \*\*\*statistically significant at  $p < 0.001$ .

educational practice and policy (Tang et al., 2022; Awodele et al., 2024).

The results indicate that it is not the sheer duration of internships that determines their effectiveness but rather their technical depth and content relevance. Lengthening the time spent in an internship without ensuring challenging, relevant tasks does little to enhance academic performance. Instead, the factors of technical depth and task relevance produced significant improvements in GPA, with effects of  $\beta = 0.184$  and  $\beta = 0.162$ , respectively. This aligns with the proposition of Perusso and Baaken (2020) that time alone does not yield benefits unless students are engaged in complex, skill-based tasks rather than routine or observational activities. The evidence from this study, for instance, showed that students engaged in PLC programming achieved superior GPA increases compared to those limited to observation. This highlights the importance of designing internships to replicate real-world job challenges at an appropriate level of complexity. These findings illustrate SCCT's proposition that mastery experiences such as technically demanding internships enhance self-efficacy, thereby motivating students to engage more deeply with their coursework and improving GPA. However, regional disparities moderated these effects, as students from western China, where outdated infrastructure constrained learning opportunities, benefited less than their eastern counterparts. This pattern resonates with the proposal of Cheng et al. (2024), who emphasized the need to reduce

technological gaps through policies that equalize access to resources across regions.

The models explain a moderate portion of GPA variance (15.2% for internship experience, 4.0% for career aspirations), which is meaningful given the complexity of academic performance. Standardized coefficients indicate small-to-moderate direct effects of internships and weaker but significant indirect effects via career aspirations. The mediation effect underscores SCCT's outcome expectations pathway, as students who perceived internships as gateways to realistic and rewarding careers translated these expectations into greater academic effort and achievement. Other factors, such as prior preparation, teaching quality, peer influence, and self-efficacy, likely also play a role, and future research should include these predictors to better understand academic outcomes.

Career aspirations also demonstrated a dual-edged influence on academic performance. On one hand, goal realism emerged as a meaningful predictor of academic success, with  $\beta = 0.107$  and  $p = 0.046$ . On the other hand, goal clarity appeared as a potential risk factor, with  $\beta = 0.091$  and  $p = 0.077$ , suggesting that overly high or poorly contextualized aspirations may undermine performance. The differential effects of goal clarity and goal realism extend SCCT's framework by showing that feasibility is just as important as clarity. Unrealistic goals, even if well-defined, may hinder motivation, whereas realistic, attainable goals support sustained academic engagement.



This reflects the phenomenon described by [de la Fuente et al. \(2023\)](#) as well as [Reddy et al. \(2025\)](#), where students who set goals beyond the scope of available opportunities experience anxiety and reduced academic achievement. In this study, approximately 68.7% of the sample reported overly ambitious aspirations, highlighting a widespread gap between goals and actual opportunities. The evidence suggests that Social Cognitive Career Theory (SCCT) must be extended beyond its traditional focus on goal clarity to also integrate the feasibility of aspirations as a critical factor shaping academic outcomes ([Lent et al., 1994](#)).

The interaction between internships and career aspirations provides additional insights. Rather than functioning independently, these factors reinforce one another in a mutually beneficial cycle. Internships clarify and refine career goals, while strong aspirations motivate students to pursue internships that maximize academic and professional development. This reciprocal dynamic reflects SCCT's "experience-goal" cycle ([Bandura, 1997](#); [Lent et al., 1994](#)), yet the findings of this study extend the framework by incorporating regional disparities as crucial environmental moderators. In line with SCCT, the interaction results demonstrate that self-efficacy and outcome expectations gained from internships refine students' goals, while those goals, in turn, channel their academic behaviors toward higher achievement. For instance, students in eastern China, who had access to advanced technological resources, demonstrated greater alignment between aspirations and opportunities, whereas students in western regions faced a persistent mismatch between their goals and the limited resources available. This highlights the necessity for SCCT to integrate contextual macro-level factors such as regional technological infrastructure and national education policies when applied in settings like China ([Cheng et al., 2024](#); [Tang et al., 2022](#)). However, the cross-sectional nature of this study restricts strong causal inference. Although the models reveal significant mediation and interaction effects, the temporal sequencing of internships, aspirations, and academic performance cannot be firmly established in a single-wave design. Longitudinal studies, ideally complemented with qualitative inquiry, would provide more robust evidence for the causal pathways proposed by SCCT.

The implications of these findings for technical education are significant. Educational institutions offering railway electrical automation programs must emphasize not only the availability of internships but also their quality, particularly in terms of technical depth and relevance to coursework. Extending internship duration without embedding substantial technical engagement does not prepare students adequately for future careers. Instead, internships should include challenging, job-relevant tasks such as system automation debugging or PLC programming, supported by structured mentorship and regular progress assessments ([Nold and Corman, 2023](#); [Perusso and Baaken, 2020](#)). Such practices would enhance both practical readiness and the alignment of academic performance with career aspirations. At the same time, career guidance programs need to be strengthened, incorporating assessments of goal clarity and realism. Tools such as competency gap evaluations and industry mentor feedback can provide students with realistic

perspectives on their career trajectories ([Agustina et al., 2021](#); [Widlund et al., 2020](#)). Year-round workshops tailored to academic stages, ranging from orientation sessions for first-year students to specialization-focused guidance for seniors, can scaffold aspiration development and prevent misdirection, particularly among students from less advantaged backgrounds ([Georgescu and Herman, 2020](#)).

Policy implications are equally important. Addressing regional inequalities in technological resources must be a priority for enabling all students to achieve their educational and career goals. Government grants targeted at upgrading laboratories in western China and tax incentives encouraging the establishment of internship bases in less developed regions could redistribute opportunities more equitably ([Zhuang, 2023](#); [Cheng et al., 2024](#)). Policy guidelines should also establish mandatory minimum internship durations of approximately 6 months, with an emphasis on active participation rather than passive observation. Furthermore, national-level platforms for monitoring internship quality, including metrics such as task relevance, supervisor qualifications, and alignment with industry standards, could introduce greater consistency across institutions ([Van Vechten, 2021](#)).

The theoretical contributions of this study are also noteworthy. By situating the "experience-goal" process within China's unique policy and resource context, the findings extend SCCT in several important ways. First, the multidimensional nature of internships is emphasized, moving beyond duration to highlight technical depth and relevance. Second, career aspirations are reconceptualized to include both clarity and realism, addressing oversimplifications in prior research. Third, the integration of regional disparities as moderating factors provides SCCT with greater explanatory power in applied technical education contexts ([Hadi, 2021](#); [Weinberg et al., 2024](#)).

Future research should build on these findings by adopting longitudinal designs to capture the evolution of career aspirations from the onset of internships through to career entry, thereby revealing how aspirations interact with experience over time. Comparative studies across cultural contexts, particularly between individualist and collectivist educational systems, would also illuminate the role of cultural expectations in shaping the internship—aspiration—performance nexus ([Franco-Ángel et al., 2023](#); [Dolezal, 2021](#)). Additionally, hybrid training models that combine virtual simulations with practical fieldwork may offer solutions to bridging resource gaps where modern infrastructure is unavailable. Taken together, these initiatives, in conjunction with supportive policy frameworks, are essential to shaping an agile workforce in railway automation that can keep pace with technological innovation and broader socioeconomic changes ([Ikram et al., 2025](#)).

## Conclusion

The main objective of this study was to examine the structural mechanisms through which internship experiences and career aspirations influence academic performance among railway

electrical automation students in China, framed within Social Cognitive Career Theory (SCCT). Using stratified multi-stage sampling and quantitative analyses, the study demonstrated that internship quality, measured in terms of task relevance, technical depth, and sufficient duration, directly enhances academic outcomes. At the same time, career aspirations, particularly their clarity and realism, were found to independently predict GPA while also mediating the effects of internships on academic performance. These findings validate the dynamic “experience to goal” pathway within SCCT and extend its application to China’s industry–education integration context.

For educational institutions, the findings highlighted the need to prioritize the quality of internships by embedding technically demanding and curriculum-relevant tasks rather than simply extending their duration. Universities can act on this by designing internship frameworks that include structured mentorship, competency-based assessments, and progressive exposure to complex technical challenges. Equally important is the enhancement of career guidance programs. Institutions should move beyond generic counseling and provide tailored support that balances ambition with feasibility, for example through individualized mentoring, goal-setting workshops, and regular feedback mechanisms that help students adjust aspirations in line with evolving opportunities. The evidence suggests that vocational programs must go beyond offering internships as a formality. Students benefit most when internships involve technically challenging, curriculum-relevant tasks supported by structured mentorship. Equally, career guidance cannot focus solely on helping students “dream big” but must include tools to balance ambition with feasibility.

For policymakers, the results pointed to the urgency of addressing regional inequalities in access to quality training opportunities. Practical steps included channeling resources and incentives to under-resourced regions, fostering cross-regional partnerships between institutions, and introducing standardized quality assurance frameworks for internships. Such frameworks should evaluate not only duration but also the relevance of tasks, supervisory standards, and alignment with industry needs. These measures would help ensure that all students, regardless of location, gain equitable access to meaningful experiential learning opportunities that translate into academic and career success.

Future research should extend this agenda by tracking students across multiple time points to capture how internships shape aspirations and outcomes over the course of their academic and professional trajectories. Comparative studies across cultural and educational systems would shed light on how societal contexts shape the relationship between experiential learning and achievement. In addition, hybrid training models that combine virtual simulations with hands-on practice could be piloted as scalable strategies for bridging gaps in under-resourced settings, offering students exposure to cutting-edge technologies even where physical infrastructure is limited.

Taken together, these findings demonstrate that high-quality internships combined with realistic career aspirations form a powerful lever for enhancing academic success in vocational education. Strengthening the alignment between experiential learning and goal-setting practices can equip students with not only

technical competence but also the motivational resilience required to thrive in China’s rapidly evolving railway automation sector.

## Limitations

This study has several limitations. Although the sample included students from eastern, central, and western China, rural and vocational schools were underrepresented, and urban institutions with advanced infrastructure were overrepresented, which may have biased the observed effects of internships. This imbalance may have led to an underestimation of the challenges faced in disadvantaged contexts. Future research should include rural and under-resourced institutions, and mixed-method designs may be valuable for capturing the lived experiences of students in such settings. The study also acknowledged the use of GPA as the sole measure of academic performance, which does not fully reflect employability skills or practical competencies. Cross-sectional design prevented drawing causal inferences about the relationship between internships and aspirations. Career aspirations were measured only in terms of clarity and realism, excluding other relevant dimensions such as adaptability and motivational drivers. Unmeasured factors, including mentoring quality and prior academic achievement, may also have influenced the results. Finally, the findings are closely tied to the Chinese context of education–industry integration and may not be generalizable to countries with more decentralized technical education systems.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by INTI International University Research Ethical Issues Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

LH: Project administration, Data curation, Methodology, Conceptualization, Writing – review and editing, Investigation, Writing – original draft, Software. ET: Writing – review and editing, Supervision, Writing – original draft. WY: Funding acquisition, Writing – original draft, Resources, Writing – review and editing. NJ: Validation, Writing – review and editing, Formal analysis, Writing – original draft.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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