INSTITUTIONALIZED PERFORMANCE ENCODING AND ACADEMIC CAPITAL CONVERSION IN CHINA'S NATIONAL STEM EDUCATION SYSTEM A STRUCTURAL ANALYSIS OF THE ACCUMULATION-CAPABILITY-IDENTITY CONVERSION MECHANISM*

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Abstract

This research aims to study the structural mechanisms by which the institutionalized performance encoding process in China's national STEM education system influences the transformation of academic capital, specifically focusing on how teachers' national competitive achievements are transformed into perceived professional advancement evaluations. this study develops and validates an original theoretical framework with empirical evidence: the Academic Capital Accumulation-Capacity Building-Professional Identity Transformation (ACCM) model. This model describes the complex, multi-layered psychological and institutional pathways linking competitive achievement to perceived professional advancement outcomes. The target group for this study was all teachers who had served as mentors or formal instructors to student teams participating in national STEM competitions. The final sample size was **326** individuals. The findings confirmed that Competition Achievement positively influenced Multiple Intelligence, STEM Professional Identity, and Perceived Title Promotion Performance both directly and indirectly through sequential mediation pathways.

The results showed that the overall measurement model fit was excellent across all evaluated indices, with CMIN/DF = 1.218, GFI = 0.932, RMSEA = 0.026, CFI = 0.992, NFI = 0.959, and IFI = 0.992 all of which met or exceeded

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their respective conventional benchmarks. In **conclusion,** this is a precondition for designing institutions that generate the conditions under which such a teacher can, in the fullest sense of the phrase, come into her own professionally.

Keywords: Academic Capital Conversion, STEM Education, Academic Identity

Introduction

Within the context of China's education, science, and technology systems, established forms of achievement are increasingly transformed into forms of professional capital through institutional mechanisms of recognition, evaluation, and legitimation. However, existing literature has paid relatively limited attention to the specific mechanisms, processes, and consequences through which educational and scientific achievements are converted into professional value within the Chinese context. The concept of **institutional decoding of achievement** may be understood as a process through which institutions recognize, classify, interpret, and legitimize particular forms of achievement according to established standards, subsequently assigning them value and converting them into forms of professional capital. Grounded in institutional and capital-conversion perspectives, this process involves not only the recognition of achievement but also its institutional valorization and subsequent exchange into professional qualifications, opportunities, status, and career resources. Understanding this process is therefore important for clarifying how institutional structures shape the accumulation and conversion of professional capital in education, science, and technology.

Within the global movement toward outcomes-based governance, China represents a highly systematic and institutionally complex context in which achievement is increasingly made formally legible, assessable, and convertible within national education and professional systems. The development of STEM education provides a particularly important context for examining this phenomenon. Over the past two decades, China has substantially expanded its investment in STEM education and established policy and institutional mechanisms intended to strengthen national scientific and technological capabilities (Zhong et al., 2022). This development has been closely associated

with national strategies concerning science and technology, including the *Medium- and Long-Term National Science and Technology Development Plan* and the *New Generation Artificial Intelligence Development Plan*. Within these policy directions, competencies in science, technology, engineering, and mathematics have been positioned as foundational capacities for national economic development, technological innovation, and human-capital development (Yujie et al., 2026). Consequently, STEM-related achievements increasingly function not merely as indicators of educational attainment but also as institutional resources that can be recognized, evaluated, and converted into professional opportunities and status.

Accordingly, examining the institutional conversion of achievement is important because the process extends beyond formal policy structures to include the ways in which individuals interpret and respond to institutional expectations. Teachers and other educational professionals are not merely passive recipients of institutional achievement codes; rather, they actively interpret, internalize, and negotiate these expectations through their professional competence, identity commitments, and learning experiences. This suggests that the conversion of achievement into professional capital involves a dynamic interaction among **institutional recognition, accumulated capital, professional capability, and professional identity**. Nevertheless, the relationships among these dimensions and the mechanisms through which accumulated achievements are transformed into capabilities and subsequently incorporated into professional identity remain insufficiently explained, particularly within China's national STEM education system. Addressing this gap, therefore, provides a basis for examining the structural mechanism through which achievement is accumulated, institutionally encoded, converted into professional capability, and ultimately incorporated into professional identity.

Research Objectives

To analyze the institutional structure of China's national STEM competition governance system and to develop theories regarding various mechanisms To develop and validate the Academic Capital Accumulation–Capacity Building–Identity Conversion (ACCM) model

Research Hypotheses

Summary of Research Hypotheses and Theoretical Foundations

Hypothesis	Path	Theoretical Foundation
H1	CA ⟶ MI (+)	Deliberate practice theory; Gardner's MI theory
H2	MI ⟶ SPI (+)	Holland's congruence; Bandura's self-efficacy; Carlone & Johnson
H3	SPI ⟶ PTP (+)	Wenger's CoP theory; Social cognitive theory
H4	CA ⟶ PTP (+)	Spence's signaling theory; Ajzen's TPB
H5	CA ⟶ MI ⟶ PTP	Single mediation; Bourdieu's capital conversion
H6	CA ⟶ MI ⟶ SPI ⟶ PTP	Serial chain mediation; ACCM full model

Note. CA = Competition Achievement; MI = Multiple Intelligence; SPI = STEM Professional Identity; PTP = Perceived Title Promotion Performance; MI Theory = Theory of Multiple Intelligences; CoP = Community of Practice; TPB = Theoryof Planned Behavior; ACCM = Academic Capital Accumulation-Capability Construction-Identity Conversion Model.

Scope of the Study

This section delineates the empirical, spatial, participant-related and variable boundaries within which the present study operates. The boundaries established here define what the study addresses and what falls beyond its analytical perimeter. They are not justificatory claims about the value of the chosen scope but precise definitional statements that delimit the inferential domain of the findings.

STEM Competition Success

Miller Et al (2018). The importance of student success in STEM competitions as an indicator of academic excellence, problem-solving skills, and creativity is discussed. These achievements contribute to motivation, self-

confidence, and future educational or career opportunities in STEM fields. Academic Capital Theory

Literature Review

Academic capital theory refers to the accumulation of academic qualifications, knowledge, skills, and social networks that enhance an individual's academic and professional opportunities. It focuses on the role of academic capital in accessing resources and opportunities within academic and career circles. (Liou, & Chang,2008) Professional Identity TheoryProfessional identity theory describes the process by which individuals develop a sense of self based on roles, values, and norms within professional groups. This includes participation in academic or specialized competitions that support the formation and reinforcement of a professional identity. (Willetts, & Clarke, 2014) Multiple Intelligences TheoryThe theory of multiple intelligences proposes that intelligence has multiple dimensions encompassing various areas, such as logical-mathematical, linguistic, spatial, interpersonal, and intrapersonal intelligence. It discusses how recognizing the differences in each intelligence can impact educational strategies and explains the diverse strengths of students participating in STEM competitions. (Visser, Et al 2006) Capital Transformation TheoryCapital transformation theory is the process by which individuals change one form of capital (e.g., social, cultural, or economic) into another to gain an advantage or achieve goals. This theory is linked to the case where students use their performance in STEM competitions to transform social recognition and academic capital into academic or career advancement. (Róna-Tas, 1997)

Research GapsThis highlights research gaps, particularly on issues that are underexplored in the literature, such as the relationship between success in STEM competitions and the development of professional identity or the influence of different types of capital transformation on long-term academic and career outcomes. This underscores the need for empirical research that integrates these frameworks to understand the holistic impact of participation in STEM competitions. (Tarlochan, Et al 2025) The COVID-19 pandemic offered a particularly vivid illustration: models trained on pre-pandemic behavioral data were deployed into a post-pandemic world with fundamentally altered

consumer patterns, traffic flows, and healthcare utilization rates, producing widespread degradation in the performance of models from demand forecasting to credit risk assessment (Bellamy et al., 2019). the dramatic global expansion of organized science, technology, engineering, and mathematics competitions at national and international levels. (Boudreau & Kaushik, 2023) The earliest scholarly engagement with science and mathematics competitions emerged primarily from cognitive developmental psychology, with researchers examining the relationship between competitive performance and underlying mathematical or scientific reasoning abilities. (Pasigon, 2024) This foundational literature established the intellectual terrain for later investigations by demonstrating that competition performance was not simply a function of innate talent but was substantially shaped by the quality and intensity of preparation, mentorship, and institutional support. Gao, (2014). China's national STEM competition system is among the most institutionally elaborate and extensively governed in the world. The system's architecture reflects the distinctive features of China's educational governance—a hierarchical state-society relationship in which the central government sets.

Research Methodology

Research Design

This study employed a quantitative cross-sectional survey design to develop and validate the **Academic Capital Accumulation–Capability Building–Identity Conversion (ACCM) model** and examine the structural relationships among Competition Achievement (CA), Multiple Intelligence (MI), STEM Professional Identity (SPI), and Perceived Title Promotion Performance (PTP) using Structural Equation Modeling (SEM).

Population and Sample

The target population comprised teachers in China who had served as mentors, coaches, or instructors for students participating in national STEM competitions. Purposive sampling was employed to recruit qualified participants. Following Hair et al. (2019), a minimum sample of 200 was considered adequate for SEM. After data screening, **326 valid questionnaires** were retained for analysis.

Research Instrument

Data were collected using a structured questionnaire consisting of five sections: demographic information and four latent constructs—Competition Achievement (CA), Multiple Intelligence (MI), STEM Professional Identity (SPI), and Perceived Title Promotion Performance (PTP). The instrument contained 5 CA items, 12 MI items, 6 SPI items, and 6 PTP items. Items were adapted from relevant theoretical and empirical literature and contextualized for China's STEM education system. All substantive items were measured on a **seven-point Likert scale** ranging from 1 (Strongly Disagree) to 7 (Strongly Agree).

Validity and Reliability

Content validity was assessed by experts using the **Item-Objective Congruence (IOC) index**. The questionnaire was then pilot-tested with respondents similar to the target population but excluded from the final sample. Internal consistency was assessed using **Cronbach's alpha**. Confirmatory Factor Analysis (CFA) was subsequently conducted to evaluate construct validity and reliability. Composite Reliability (CR) ranged from **0.920 to 0.957**, and Average Variance Extracted (AVE) ranged from **0.657 to 0.788**, indicating satisfactory reliability and convergent validity.

Data Collection and Analysis

Data were collected through an online questionnaire. Participation was voluntary, and responses were treated confidentially. Descriptive statistics were used to summarize participant characteristics. **Exploratory Factor Analysis (EFA)** was initially conducted to examine the empirical factor structure, followed by CFA to validate the measurement model. **SEM** was then used to test the hypothesized direct and indirect relationships among CA, MI, SPI, and PTP. Model fit was assessed using **CMIN/DF, GFI, CFI, NFI, IFI, and RMSEA**. Potential common method bias was examined using the unrotated single-factor approach. Mediation effects, including **CA ⟶ MI ⟶ PTP** and **CA ⟶ MI ⟶ SPI ⟶ PTP**, were examined using **bootstrapping** at a significance level of **.05**.

Results

The analytical sequence follows the two-stage structural equation modeling (SEM) approach recommended by Anderson and preliminary data

examination and descriptive analysis are presented first, followed by measurement model validation through confirmatory factor analysis, common method bias diagnosis, structural model estimation and hypothesis testing, mediation effect analysis, alternative model comparison, and robustness checks with control variables. Each section is organized to present statistical results with accompanying evaluative commentary that situates findings within the analytical framework while reserving theoretical interpretation discussion section Preliminary Analysis

First-Order Confirmatory Factor Analysis

An initial exploratory factor analysis (EFA) was conducted prior to CFA to verify the empirical factor structure of the 23-item instrument and to screen for any item-factor misalignment. The Kaiser-Meyer-Olkin measure of sampling adequacy yielded a value of 0.940, substantially exceeding the minimum acceptable threshold of 0.70, and Bartlett's test of sphericity was significant ($\chi^2(253) = 6{,}437.803$, $p < .001$), jointly confirming that the inter-item correlation matrix was suitable for factor extraction. Principal components analysis with Varimax rotation extracted four factors with eigenvalues exceeding 1.0, collectively explaining 77.285% of total item variance, comfortably surpassing the 60% threshold conventionally regarded as indicating adequate factor saturation (Hair et al., 2019). The first unrotated factor accounted for 39.622% of total variance, a value relevant to the subsequent common method bias assessment Examination of the rotated component matrix confirmed clean factor-item correspondence with no cross-loadings. All five CA items loaded exclusively on Factor 4 (loadings: CA1 = 0.890, CA2 = 0.875, CA3 = 0.865, CA4 = 0.867, CA5 = 0.858), all twelve MI items loaded exclusively on Factor 1 (loadings ranging from 0.853 to 0.890), all six SPI items loaded exclusively on Factor 3 (loadings ranging from 0.780 to 0.806), and all six PTP items loaded exclusively on Factor 2 (loadings ranging from 0.797 to 0.843). No item exhibited a secondary loading exceeding 0.30 on any non-target factor, satisfying the criterion for simple structure proposed by Thurstone (1947) and confirming the four-factor solution as empirically appropriate for the instrument's structure.

The confirmatory four-factor model was then estimated to verify the theoretically hypothesized factor structure and assess its statistical adequacy. All

23 standardized factor loadings were significant at $p < .001$ and ranged from 0.784 (SPI1) to 0.908 (LMI4), substantially exceeding the minimum threshold of 0.708 recommended by Hair et al. (2019) as indicative of items explaining more than 50% of their construct's variance. The overall measurement model demonstrated excellent fit to the data across all evaluated indices, as reported

Figure 1.

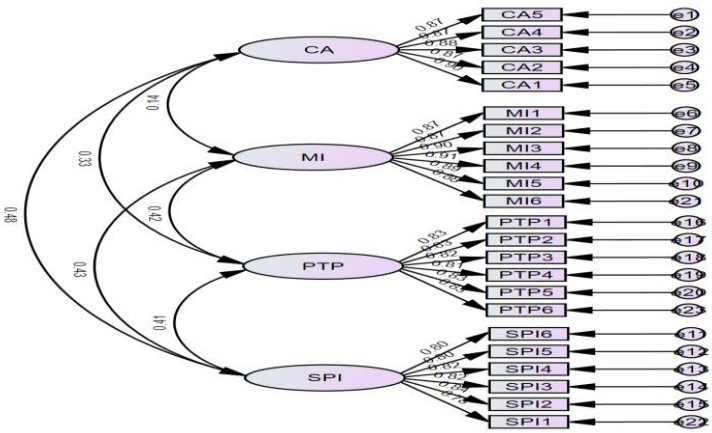
First-Order Confirmatory Factor Analysis: Factor Loadings, Reliability, and Validity Indices

Construct / Item	**Std. Loading (λ)**	**S.E.**	**C.R.**	**p**	**CR**	**AVE**
Competition Achievement (CA)					0.944	0.770
CA1	0.895	ref.	—	—		
CA2	0.873	0.045	21.667	***		
CA3	0.878	0.048	21.900	***		
CA4	0.872	0.048	21.620	***		
CA5	0.870	0.048	21.413	***		
Multiple Intelligence (MI)					0.957	0.788
LMI1 (⟶ LMI factor)	0.874	ref.	—	—		
LMI2	0.873	0.048	22.202	***		
LMI3	0.896	0.046	23.461	***		
LMI4	0.908	0.045	24.168	***		
INTER1 (⟶ INTER factor)	0.893	0.049	23.316	***		
INTER2	0.882	0.047	22.699	***		
INTER3	0.888	0.048	23.011	***		
INTER4	0.876	0.049	22.387	***		
INTRA1 (⟶ INTRA factor)	0.891	0.048	23.218	***		
INTRA2	0.885	0.047	22.854	***		
INTRA3	0.879	0.048	22.513	***		
INTRA4	0.884	0.047	22.779	***		

STEM Professional Identity (SPI)					0.920	0.657
SPI1	0.784	0.065	15.658	***		
SPI2	0.836	0.064	17.058	***		
SPI3	0.817	0.065	16.538	***		
SPI4	0.823	0.064	16.702	***		
SPI5	0.801	0.063	16.113	***		
SPI6	0.800	ref.	—	—		
Perceived Title Promotion Performance (PTP)					0.927	0.680
PTP1	0.826	ref.	—	—		
PTP2	0.832	0.059	17.868	***		
PTP3	0.823	0.059	17.598	***		
PTP4	0.806	0.059	17.052	***		
PTP5	0.833	0.057	17.924	***		
PTP6	0.828	0.058	17.762	***		

Note. Std. Loading = standardized factor loading; S.E. = standard error of unstandardized loading; C.R. = critical ratio (unstandardized loading / S.E.); ref. = reference indicator (loading fixed to 1.0 for identification). CR = Composite Reliability; AVE = Average Variance Extracted. CR > 0.70 and AVE > 0.50 indicate satisfactory convergent validity (Hair et al., 2019). *** p < .001.

Figure 2. Confirmatory factor analysis (CFA)



Convergent validity was assessed through composite reliability (CR) and average variance extracted (AVE) following the criteria established by Fornell and Larcker (1981) and subsequently refined by Hair et al. (2019). For a construct to demonstrate adequate convergent validity, CR must exceed 0.70 (with values above 0.80 considered good) and AVE must exceed 0.50. All four constructs exceeded both thresholds: CR values ranged from 0.920 (SPI) to 0.957 (MI), and AVE values ranged from 0.657 (SPI) to 0.788 (MI), confirming that the latent constructs explain substantially more than half of the variance in their respective observed indicators. Overall measurement model fit was excellent across all evaluated indices, with CMIN/DF = 1.218, GFI = 0.932, RMSEA = 0.026, CFI = 0.992, NFI = 0.959, IFI = 0.992 , all meeting or exceeding their respective conventional benchmarks Conclusions

The difficulty of this positioning is precisely what gives it value: it prevents the analytical errors that arise from each of its simpler alternatives, and it generates theoretical propositions that are simultaneously sociologically grounded and psychologically specific. The ACCM is a product of this positioning, and its value as a theoretical resource will ultimately be determined by the extent to which it enables future researchers to ask more precise questions, design more revealing studies, and produce more explanatorily adequate accounts of how teachers grow, identify, and flourish within the institutional structures that simultaneously enable and constrain their professional lives.

While national competition outcomes are progressively encoded within formal title-promotion rubrics, the mechanisms through which such encoding translates into tangible capability growth and perceived career advancement have remained theoretically underspecified. The present study addressed this gap by constructing and empirically testing a four-variable structural model linking Competition Achievement (CA), Multiple Intelligences (MI), STEM Professional Identity (SPI), and Perceived Title Promotion Performance (PTP) among a nationally recruited sample of 326 STEM competition-coaching teachers in China.

Discussion

This study advances the theoretical literature on educational capital, institutional governance, and professional identity in four distinct but mutually reinforcing directions. Each contribution addresses a gap identified in the foundational review of extant scholarship and produces conceptual resources applicable beyond the specific institutional context under investigation. What has been comparatively underdeveloped is a specification of the psychological conversion process — the series of cognitive, affective, and identity-related transformations through which institutionally recognized performance is transmuted into the subjective experience of institutional reward. The present study moves beyond correlation-based validation by articulating a mechanism-based structural explanation of how educational performance becomes institutionally convertible capital. By inserting multiple intelligences development and STEM professional identity as sequential mediating stages, the model reveals the internal workings of capital conversion rather than simply confirming that conversion occurs.

Policy and Practical Implications

The theoretical and empirical results of this study generate a layered set of implications for educational policy and institutional practice, organized across three governance levels: national systemic design, institutional organizational strategy, and individual professional development architecture. These implications are grounded in the mechanism-based account provided by the ACCM and are therefore more analytically specific than conventional prescriptions for "improving professional development" or "strengthening evaluation systems."

Limitations and Future Research Directions

The present study advances theoretical understanding and provides a rigorous empirical foundation for the ACCM framework, but it does so within a set of methodological and contextual constraints that must be candidly acknowledged. These constraints define both the boundaries of the study's claims and the productive agenda for future research.

Future research might also extend the ACCM by exploring variables that moderate the efficiency of each conversion stage rather than simply

mediating the overall CA-to-PTP pathway. Candidate moderators include principal instructional leadership quality at the school level, which may accelerate or retard the MI⟶SPI conversion by providing or withholding the social recognition that identity consolidation requires; teacher regulatory focus orientation (promotion-focused versus prevention-focused), which may interact with institutional encoding strength to determine whether high-coded performance generates intrinsic developmental motivation or merely extrinsic credential-seeking behavior; and temporal proximity to title evaluation, which creates incentive structures that may either concentrate or diffuse teachers' developmental.

Concluding Reflection

This dissertation began from the observation that contemporary educational governance in China has progressively formalized the institutional pathways through which teacher performance is recognized, evaluated, and rewarded, with national STEM competition achievement occupying an increasingly prominent position within this formalization. The intellectual motivation for the present inquiry was not to evaluate the wisdom or equity of this governance trajectory in normative terms but to understand its structural logic — to articulate the mechanism through which institutionalized performance coding generates its effects on teachers' professional development and institutional experiences. The findings reported in this dissertation, and the theoretical framework constructed to interpret them, represent this study's contribution to that understanding.

The ACCM makes this full conversion sequence explicit, gives each stage a theoretically grounded analytical identity, and embeds the entire process within an account of how institutional governance structures — specifically, the state's authority to code performance as capital — set the conversion cycle in motion and determine its structural parameters.

The teacher who engages in competition coaching is not merely executing an institutional script; she is simultaneously accumulating credentials, developing competencies, constructing identity, and making meaning within a governance architecture that she did not design and cannot fully control. Understanding the structural logic of that architecture — and the mechanisms

through which it translates into the texture of her professional experience — is not merely an academic exercise. It is the precondition for designing institutions that generate the conditions under which such a teacher can, in the fullest sense of the phrase, come professionally into her own.

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