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Translation and psychometric validation of the chinese version of the engineering identity scale

Lingling Lu[1,2], Hidayah Mohd Fadzil[3,*], Peng Yen Liew[4], An Jie Lye[2,5] and Chan Choong Foong[5,*]

[1]*Department of Education Science and Technology, Jinzhong University, Jinzhong, Shanxi, China*
[2]*Institute for Advanced Studies (IAS), Universiti Malaya, Kuala Lumpur, Malaysia*
[3]*Department of Mathematics and Science Education, Faculty of Education, Universiti Malaya, Kuala Lumpur, Malaysia*
[4]*Department of Chemical and Environmental Engineering (ChEE), Malaysia-Japan International Institute of Technology (MJIIT), Universiti Teknologi Malaysia (UTM), Kuala Lumpur, Malaysia*
[5]*Medical Education and Research Development Unit (MERDU), Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Malaysia*

**Correspondence: Hidayah Mohd Fadzil,* hidayahfadzil@um.edu.my*; Chan Choong Foong,* foongchanchoong@um.edu.my
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Abstract: The availability of a psychometrically robust instrument is essential for assessing professional identity, while there are relatively few validated measures of engineering identity in cross-cultural settings. This study aimed to translate and validate the Engineering Identity Scale (EIS) in the China context. The sample comprised 1024 engineering students in Shanxi, China (females = 42.3%, chemical and material engineering = 29.3%). The measure validation involved four stages: translation with back-translation, cognitive interviews to assess face validity, confirmatory factor analysis (CFA) to examine the validity and reliability of the instrument, and multi-group CFA (MGCFA) to test measurement invariance across gender, academic year, and engineering discipline. Cognitive interview results with the participants indicated that the translated instrument was clear and comprehensible. CFA supported the original one-factor structure, with adequate validity and reliability of scores. MGCFA supported configural, metric, scalar, and strict invariance across gender and academic year, and scalar invariance across engineering disciplines. Overall, the Chinese version of the EIS is a valid and reliable instrument for use in engineering education research to assess engineering students' identity development and facilitate meaningful comparisons across student groups.

Keywords: professional identity; translation; cognitive interview; confirmatory factor analysis; measurement invariance; engineering students; psychometric validation

Introduction

Professional identity refers to the relatively stable and persistent characteristics, motives, experiences, values, and principles that people use to identify themselves in a professional capacity (Ibarra, 1999). It evolves through self-discovery via involvement in activities related to the professional field of study, networking, forming relationships with others in the professional setting, and considering themselves as members of the profession (Ibarra, 2003; Tong et al., 2025). A high professional identity fosters commitment and engagement in learning and is able to produce more learning outcomes, such as employability and academic success (Knissarina et al., 2024).

In engineering education, professional identity specifically reflects students' identification with the engineering discipline and their self-concept as future engineers (Han & Rideout, 2022; Jones et al., 2024). Therefore, reliable and valid instruments to assess professional identity among engineering students are essential for supporting research and practice in engineering education.

Measures of professional engineer identity

A review of existing instruments regarding engineering identity reveals three main limitations: focusing only on clarity of identity (Dehing et al., 2013), lacking evidence of construct validity or relying solely on internal consistency (Liu et al., 2023; Tomlinson & Jackson, 2021), and being adapted from non-engineering populations (Kapoor & Gardner-McCune, 2019). In contrast, the Engineering Identity Scale (EIS) (Major et al., 2018; Burleson et al., 2021) demonstrates comprehensive validity evidence and is therefore adopted in this study. Specifically, it was developed using exploratory factor analysis (EFA), which identified a single-factor structure consisting of five items (Major et al., 2018). Although relatively brief, the scale meets methodological recommendations that each factor should be represented by at least four to five items to ensure measurement validity (Costello & Osborne, 2005; Diamantopoulos et al., 2012). The structure was further confirmed through confirmatory factor analysis (CFA), and evidence of internal consistency reliability, convergent validity, discriminant validity, and predictive validity was reported (Burleson et al., 2021; Major et al., 2018). In addition, it has been employed in several empirical studies conducted among engineering students (Burleson et al., 2021; Major et al., 2018; Major et al., 2019, 2020). However, to the authors' knowledge, it has not yet been translated into Chinese or validated among engineering students in China. Due to linguistic and cultural differences between English and Chinese, such as syntax, morphology, and grammar, it is necessary to translate and validate the EIS among the targeted population to enhance its validity with the native language of the participants (Sousa & Rojjanasrirat, 2011).

Theoretical basis. Professional identity can be understood as a form of social identity. Social Identity Theory (SIT) posits that an individual's self-concept is partly

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derived from both personal traits and membership in social groups (Tajfel, 1978; Tajfel & Turner, 1979). Individuals are motivated to achieve a positive social identity, which helps them maintain or enhance their self-esteem (Abrams & Hogg, 1988). This positive identity is typically constructed through social categorization and social comparison, whereby individuals tend to evaluate their in-group more favorably than relevant out-groups in pursuit of positive distinctiveness (Abrams & Hogg, 2006). Contemporary research further conceptualizes social identity as a multidimensional construct comprising cognitive, emotional, and behavioral components (Ellemers et al., 1999; Ouwerkerk et al., 1999). In this study, engineering students' professional identity is conceptualized as a specific form of social identity, reflecting how students cognitively categorize themselves as members of the engineering profession, emotionally value this membership, and behaviorally demonstrate commitment and engagement toward their professional community.

The China context

In the China context, engineering education is a major component of higher education, with a large and diverse student population. Every year, China graduates approximately 1.3 million engineering students. However, the development and assessment of professional identity among Chinese engineering students remain underexplored (Ju & Zhu, 2023). This highlights the need for validated measurement tools in the Chinese context. Moreover, most existing instruments were originally developed in Western contexts and should be applied to Chinese students after careful translation and validation (Chen et al., 2025; Zhang et al., 2025).

The present study

Therefore, this study aimed to translate the EIS into Chinese and evaluate its psychometric properties among engineering students in Shanxi, China. Specifically, it addressed the following questions:

1. Does the Chinese version of the Engineering Identity Scale (EIS) demonstrate adequate validity and reliability among engineering students in Shanxi, China?

2. Does the Chinese version of the EIS demonstrate measurement invariance across subgroups defined by gender, academic year, and engineering discipline?

Findings from this study contribute to the cross-cultural literature on engineering identity by providing evidence from a non-Western educational context. The study results also provide a validated instrument that can be used by educators and researchers to better understand engineering students' identity development in higher education in the China context.

Methods

Study design

This study employed a multi-stage design encompassing translation and face validity assessment, followed by psychometric validation using CFA and multigroup CFA. First, the translation process included forward and backward translation, and a Chinese version of the EIS was produced. Second, face validity was evaluated through cognitive interviews to determine the clarity and comprehensibility of the translated items. Third, a CFA was performed to examine construct validity, convergent validity, and composite reliability. Finally, a multigroup CFA was conducted to examine measurement invariance across subgroups categorized by gender, academic year, and engineering discipline. The research design of this study is summarized in Figure 1.

Participants and setting

A total of 1024 engineering students participated in this study. To better understand the respondents, their demographic details were analyzed (Table 1). Among the 1024 engineering respondents, males accounted for 57.7% (n = 591). Respondents in their 1st to 4th academic years accounted for 30.7% (n = 314), 25.6% (n = 262), 23.6% (n = 242), and 20.1% (n = 206), respectively. In addition, the participants covered major engineering disciplines, with 29.3% (n = 300) from Chemical and Material Engineering, 28.3% (n = 290) from Mechanical, Civil, and Resource Engineering, 22.2% (n = 227) from Energy & Environmental Engineering, and 20.2% (n = 207) from Information, Systems, and Control Engineering. In summary, the sample may reflect the characteristics of the engineering students in this context.

Procedure

Research ethics approval was obtained from the Universiti Malaya Research Ethics Committee before data collection (reference number: UM.TNC2/UMREC_2803). Participants provided informed consent prior to participation. Data were collected through an online questionnaire distributed to engineering students.

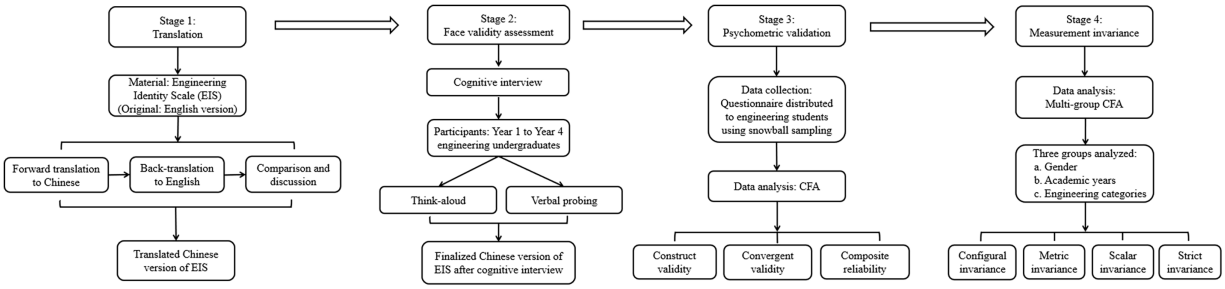

Figure 1. Research design of this study

Table 1. Demographic characteristics of the participants (n = 1024)

Characteristics	Frequency	Percentage (%)
Gender		
Male	591	57.7
Female	433	42.3
Academic year		
Year 1	314	30.7
Year 2	262	25.6
Year 3	242	23.6
Year 4	206	20.1
Engineering discipline		
Chemical and Material Engineering	300	29.3
Mechanical, Civil, and Resource Engineering	290	28.3
Information, Systems, and Control Engineering	207	20.2
Energy and Environmental Engineering	227	22.2

Table 2. Items of the Engineering Identity Scale (EIS)

No.	Original English items (Major et al., 2018)
1	Engineering is an important part of who I am.
2	I feel a personal attachment to engineering.
3	Engineering has a great deal of personal meaning for me.
4	I see engineering as a significant part of my life.
5	I spend a lot of time in casual conversations about engineering.

Measures

The EIS is a single-factor instrument with five items, each answered on a 5-point Likert scale from "strongly disagree (1)" to "strongly agree (5)" (Table 2). The average of the 5 items produced the total score of professional identity, ranging from 1.00 to 5.00.

Stage 1. Translation

The translation process followed well-established standards in this field (Maneesriwongul & Dixon, 2004). A native Chinese speaker with a bachelor's degree in English conducted the forward translation from English to Chinese. Another English-Chinese bilingual speaker back-translated the Chinese version into English. Next, the two translators discussed and compared the two versions to ensure linguistic and cultural equivalence between the two languages. The discussion continued until a consensus was reached regarding the final Chinese version.

Stage 2. Face validity assessment

Face validity refers to the extent to which an instrument appears to measure the intended construct (DeVellis & Thorpe, 2021). It is advisable to assess face validity using cognitive interviews (Orth & Van Wyk, 2023). In this study, the face validity of the translated EIS was assessed through cognitive interviews.

Participants in the cognitive interview were selected from the target population of engineering students in Shanxi. Inclusion criteria included: (1) being enrolled as an engineering student, (2) aged 18 years or above, and (3) representing both genders and different academic years (Year 1 to Year 4) to ensure variability in item comprehension across student subgroups. In addition, a purposive sampling technique was used to recruit informative participants in this study (Dabbagh et al., 2020). With the assistance of a student counsellor at a university offering engineering programs in Shanxi, eligible students who expressed interest and volunteered to participate were invited to take part in the study.

Cognitive interviews are grounded in the premise that researchers can access participants' underlying cognitive processes through language-based techniques. These techniques allow researchers to examine how participants interpret questionnaire items and formulate their responses (Willis & Artino, 2013). Based on this premise, cognitive interviews typically involve two primary approaches, namely the "think-aloud" and "verbal probing" techniques (Knafl et al., 2007; Priede & Farrall, 2011; Willis & Artino, 2013).

This study adopted Orth and Van Wyk (2023)'s method for conducting cognitive interviews. The first author functioned as the interviewer. First, the first author explained the aim of the study and read the instructions to the participants. Second, in the think-aloud stage, participants were asked to express their ideas when responding to each item, to provide their reasons for each particular option (Karpen & Hagemeier, 2017), and to inform the first author of whatever came to their mind as they completed the scale. Third, during verbal probing, the first author asked questions that focused on particular facets of each item, such as "Can you explain the meaning of [key term] in your own words?" (Orth & Van Wyk, 2023). Finally, at the end of each section, the participants were invited to provide their comments on the overall clarity, comprehensibility, and relevance of the instrument (Tse et al., 2020).

Following the completion of cognitive interviews, participants' feedback was recorded, summarized, and reviewed to identify unclear wording and potential misinterpretations. Necessary wording refinements were then made where appropriate based on the feedback to improve clarity and ensure face validity.

Stage 3. Psychometric validation

After the translation and cognitive interviews ensured that the items were clear and culturally appropriate, a survey was administered to collect data for psychometric validation. CFA was then applied to examine the psychometric properties of the Chinese EIS, including construct validity, convergent validity, and composite reliability.

Data collection

The estimated population of engineering students in Shanxi is approximately 28,500. Based on the Sample Size Determination Table (Krejcie & Morgan, 1970) and the Raosoft sample size calculator (http://www.raosoft.com/samplesize.html), a minimum sample size of 380 was considered adequate for a 95% confidence interval and a 5% margin of error. In addition, structural equation modeling (SEM) studies recommended a minimum sample size of 200 for analysis (Greenland et al., 2016).

A survey was conducted among engineering students in Shanxi using an online platform named Sojump. Following Fu et al. (2021) method of conducting snowball sampling, the Chinese version of the EIS was initially distributed to engineering students in one university in Shanxi, with the help of survey enumerators. They were student counselors (who manage students' daily academic and non-academic affairs). Students who answered the questionnaire were invited to share the questionnaire with other engineering students. Furthermore, the link was shared on social media platforms, such as WeChat, to reach students from different engineering majors and academic years to improve the representativeness of the samples.

Data analysis

Structural equation modelling analyses were conducted using IBM SPSS AMOS (AMOS, version 28). The assumption of normality was assessed, and maximum likelihood estimation was applied. These procedures were followed before conducting CFA and MG-CFA to examine the measurement model and measurement invariance across groups.

CFA model

Construct validity was evaluated by examining model fit indices through confirmatory factor analysis (Ahmad et al., 2016). To ensure adequate construct validity, Chi-Square to the degree of freedom (X^2/df) should be less than 5 (Hu & Bentler, 1999), Comparative Fit Index (CFI) (Thakkar, 2020), Incremental Fit Index (IFI) (Bollen, 1989), and Tucker-Lewis Index (TLI) (Bentler & Bonett, 1980) should be higher than 0.90. Standardized Root Mean Square Residual (SRMR) (Hu & Bentler, 1999) and Root Mean Square Error of Approximation (RMSEA) (Thakkar, 2020) should be less than 0.08.

In addition, convergent validity was assessed through two primary methods. The first is Average Variance Extracted (AVE), and a cutoff of ≥0.50 confirms adequate convergent validity (Ahmad et al., 2016). The second is factor loadings. Values exceeding 0.70 per item further support convergent validity (Hair et al., 2019).

Moreover, the reliability of the EIS was assessed using composite reliability (CR), and the value should be higher than 0.70 (Cheung et al., 2023).

Stage 4. Measurement invariance

Measurement invariance of the EIS across groups was examined using MGCFA in AMOS 28. Four levels of measurement invariance were tested, progressing in a hierarchical bottom-up approach, from a model with no parameter constraints to a model with all parameters constrained (Lee et al., 2023; Wu et al., 2007). Specifically, (a) configural invariance refers to the equivalence of the latent structure across groups, indicated by the same number of latent constructs and a consistent pattern of item–factor relationships; (b) metric invariance assumes that the factor loadings across groups are equal; (c) scalar invariance requires the equality of both factor loadings and item intercepts; and (d) strict invariance imposes equality constraints on item residual variances across groups (Lee et al., 2023).

In this study, participants were divided into gender (male and female), academic year (Year 1 to Year 4), and engineering discipline groups to examine measurement invariance across these groups. These grouping variables were selected based on their practical relevance and their common use in prior studies examining measurement invariance in educational contexts (Arifin & Yusoff, 2016).

Following the criteria of Chen (2007) and Cheung and Rensvold (2002) CFI, RMSEA, and SRMR were used as indices to justify measurement invariance. Invariance would be achieved when a change of RMSEA (△RMSEA) by 0.015, a change of CFI (△CFI) by 0.010, and a change of SRMR (△SRMR) by 0.030 (for metric invariance) or 0.015 (for scalar invariance) (Chen, 2007; Cheung & Rensvold, 2002). These criteria were subsequently applied in the interpretation of the MGCFA results in the next section.

Results

Translation of EIS findings

The EIS was translated into Chinese and back-translated into English by two independent bilingual researchers, and the versions were compared and discussed to ensure equivalence. The discussion primarily addressed cultural relevance, linguistic accuracy, and conceptual clarity. For instance, the original expression "personal attachment" in Item 2 conveyed a relatively strong affective bond and an identity-related connection. However, back-translation interpreted it as "personal feelings," suggesting a general emotional state. In order to preserve the emotional intensity of the original expression, the Chinese wording "深厚的" was added to capture the strength of attachment implied in the original item. Moreover, the original phrase "casual conversations about engineering" in item 5 emphasized informal and interpersonal communication.

Table 3. The translated versions of the Engineering Identity Scale

Original items	Forward translation to Chinese	Back-translation to English	Chinese version after back translation
1. Engineering is an important part of who I am.	工程专业是我的一个重要组成部分.	The engineering profession makes up a big part of who I am.	工程专业是我的重要组成部分.
2. I feel a personal attachment to engineering.	我对工程专业抱有个人情感.	I have personal feelings about the engineering profession.	我对工程专业怀有深厚的个人感情.
3. Engineering has a great deal of personal meaning for me.	工程专业对我个人来说意义重大.	The engineering profession means a lot to me personally.	工程专业对我个人来说意义重大.
4. I see engineering as a significant part of my life.	我认为工程专业是我生活中的一个重要部分.	In my opinion, the engineering profession is crucial in my life.	我把工程专业当作我生活中的一个重要部分.
5. I spend a lot of time in casual conversations about engineering.	我花了很多时间在有关工程专业的闲谈中.	I spend a lot of time on subjects related to the engineering profession.	我常在闲谈中提起工程专业.

Table 4. Demographics of the participants in the cognitive interview

Demographic information	Frequency
Gender	
Male	5 (62.5%)
Female	3 (37.5%)
Age	
Mean	21
Range	19–24
Academic year	
Year 1	2 (25%)
Year 2	2 (25%)
Year 3	2 (25%)
Year 4	2 (25%)

In contrast, back-translation broadened this meaning to "subjects related to the engineering profession." Therefore, the term "casual conversation" was retained in the Chinese translation as "闲聊" to preserve its informal and interpersonal nature. The discussion continued until both sides reached a consensus on the final Chinese version.

The original, forward, and back-translated versions of the EIS are presented in Table 3.

Face validity assessment

Eight engineering students participated in the cognitive interviews. The participants included both male and female students from Year 1 to Year 4. The demographics of the participants are shown in Table 4.

After all the participants had been identified, a soft copy of the informed consent was sent to each participant and collected with their e-signature before the interviews. The cognitive interviews were conducted one-on-one using Tencent Meeting (an online meeting software).

Participants responded to each EIS item while verbalizing their thought processes, with additional probing questions posed by the first author. For example, for item 5 (I spend a lot of time in casual conversations about engineering), when asked, *"Would you please speak out what comes to your mind and what is your choice of this item?"* One student responded, *"This question is a bit difficult to answer. I do often discuss coursework with my classmates, but if it says 'casual conversations,' I don't usually talk about engineering with my friends in everyday chats... so I probably wouldn't choose 'agree.' My choice may be 'disagree.'"* To clarify the term "casual conversations," the participants were asked, *"What do you think 'casual conversations' refers to here?"* The student explained, "*I understand it as relaxed conversations, like when having meals or tea with friends. In those situations, I usually talk about daily life, and only occasionally bring up engineering.*" Finally, when asked, "*Do you think the wording should be changed for better understanding?"* the student replied, *"No, it is clear*."

After all participants had responded to every item, it was found that they did not make any suggestions to amend any terms. The feedback on the five items of the EIS indicated that they were clearly expressed, easy to answer, relevant to engineering students, and easy to follow, with a 5-point Likert scale format. The results demonstrated that the translated version of the EIS achieved face validity, confirming its appropriateness for use in this study.

Psychometric validation results

Descriptive statistics of the EIS

According to the descriptive statistics of the EIS in Table 5, the mean of each item fell between 3.93 and 4.15, and the standard deviation varied from 0.85 to 0.98. Additionally, the skewness (−0.79 to −0.61) and kurtosis (−0.02 to 0.32) values of the items were within acceptable thresholds, indicating no severe violation of univariate normality (Kline, 2011).

Results of CFA

CFA was performed through AMOS 28 to assess the validity and reliability of the SEM. Assumptions of normality were further examined at both univariate and multivariate levels prior to model estimation. Univariate normality was assessed using skewness and kurtosis (skewness ranged from −0.791 to −0.615; kurtosis ranged from −10.335 to −8.034), indicating acceptable skewness but relatively high kurtosis. Multivariate normality was assessed using

Table 5. Descriptive statistics of EIS

Items	Mean	SD	Skewness (SE)	Kurtosis (SE)
1	4.15	0.85	−0.79 (0.08)	0.32 (0.15)
2	3.98	0.92	−0.61 (0.08)	−0.02 (0.15)
3	4.03	0.91	−0.69 (0.08)	0.17 (0.15)
4	4.02	0.92	−0.70 (0.08)	0.15 (0.15)
5	3.93	0.98	−0.65 (0.08)	−0.01 (0.15)

Table 6. CFA results: Standardized loadings and significance tests

Item	β	S.E.	t	*p*
1	0.85	0.024	36.34	<0.001
2	0.93	0.023	43.71	<0.001
3	0.91	0.024	41.74	<0.001
4	0.93	0.023	43.33	<0.001
5 (reference)	0.86	—	—	—

Note. β = standardized loading; S.E. = standard error.

Mardia's coefficient (kurtosis = 64.14), indicating violation of multivariate normality assumptions. Therefore, maximum likelihood estimation with bootstrapping (2000 resamples, 95% CI) was applied. This approach is suggested in the literature to obtain robust standard errors when normality is violated (Byrne, 2013; Nevitt & Hancock, 2001) and has been widely adopted in CFA-based measurement validation (Arifin & Yusoff, 2016; Lee et al., 2023; Spagnoli & Weng, 2019).

The results of the CFA were presented in Table 6. All standardized factor loadings were above the recommended threshold of 0.70, and all factor loadings were statistically significant at $p < 0.001$. These findings suggest that all items loaded significantly on the intended latent construct, and no item needed to be removed. Therefore, the CFA model provided a basis for further analyses, including validity and reliability assessment.

Construct validity

The goodness-of-fit indices shown in Table 7 indicate that the model achieved an adequate fit. The χ^2/df was found to be 3.702; CFI, IFI, and TLI were all higher than 0.90, and SRMR and RMSEA were 0.007 and 0.051, respectively. These indicators suggest that the model satisfied the requirements and achieved construct validity.

Convergent validity

Convergent validity can be examined through the value of Average Variance Extracted (AVE) and factor loading. According to Table 6, the factor loading of each item ranged between 0.85 and 0.93, which were all above the recommended threshold, indicating strong item representation of the latent construct. In addition, the AVE was found at 0.80, indicating adequate convergent validity of the measurement model.

Composite reliability

Furthermore, the CR value was 0.95, indicating that this model achieved adequate composite reliability.

To sum up, the results of the CFA analysis showed that the model demonstrated adequate construct validity, convergent validity, and composite reliability. As the study involved only a unidimensional scale, other aspects such as discriminant validity were not assessed.

Results of measurement invariance

After establishing the validity and reliability of the CFA model, measurement invariance was conducted to examine whether the EIS operated equivalently across different engineering subgroups. Measurement invariance was assessed using MGCFA through AMOS 28. The results of the measurement invariance across subgroups of gender, academic year, and engineering discipline are reported in Table 8.

Based on Table 8, regarding gender, the configural invariance model was supported (CFI = 0.995, RMSEA = 0.052, SRMR = 0.012), indicating that the factor structure was consistent between male and female engineering students. Subsequent testing showed that metric invariance was established (ΔCFI = 0.001, ΔRMSEA = 0.004, ΔSRMR = 0.000), suggesting that factor loadings were equivalent across gender subgroups. Moreover, scalar invariance was also established (ΔCFI = 0.007, ΔRMSEA = 0.012, ΔSRMR = 0.000), allowing for valid comparisons of latent means between gender subgroups (Swami et al., 2024). Finally, strict invariance was confirmed (ΔCFI = −0.003, ΔRMSEA = −0.003, ΔSRMR = 0.003), showing that item residual variances did not differ significantly across gender subgroups. Overall, these results indicated full measurement invariance across gender, suggesting that comparisons of factor structure, factor loadings, item intercepts, and item residuals would be meaningful between male and female engineering students.

Similarly, for subgroups of academic year, configural invariance was established (CFI = 0.991, RMSEA = 0.034, SRMR = 0.031), indicating that the factor structure remained stable across groups. Metric invariance was then supported (ΔCFI = −0.001, ΔRMSEA = 0.001, ΔSRMR = −0.001) followed by scalar invariance (ΔCFI = −0.002, ΔRMSEA = −0.002, ΔSRMR = 0.000), and strict invariance (ΔCFI = −0.008, ΔRMSEA = 0.007, ΔSRMR = 0.004). Therefore, full measurement equivalence was supported across academic year groups, indicating that comparisons of engineering identity would be meaningful across different academic years.

Finally, regarding subgroups of engineering disciplines, the results supported configural invariance (CFI = 0.991, RMSEA = 0.049, SRMR = 0.012), implying that different engineering disciplines shared the same factor structure. Metric invariance was then established (ΔCFI = 0.000, ΔRMSEA = 0.011, ΔSRMR = 0.001), followed by scalar invariance (ΔCFI = −0.002, ΔRMSEA = −0.002, ΔSRMR = 0.000). However, strict invariance was not supported (ΔCFI = −0.025, ΔRMSEA = 0.019, ΔSRMR = 0.018). Overall, partial measurement invariance was observed across engineering disciplines, with equivalence established at the structural, factor loading, and intercept levels, but not at the residual level. These results indicated

Table 7. The CFA model fit indices

Indices	χ^2	df	χ^2/df	CFI	IFI	TLI	RMSEA	SRMR
SEM model	18.510	5	3.702	0.997	0.997	0.995	0.051	0.007

Table 8. Measurement invariance of the EIS across subgroups

Subgroups	Model	χ^2	df	CFI	RMSEA	SRMR	ΔCFI	ΔRMSEA	ΔSRMR	Result of invariance
Gender	Configural invariance	37.519	10	0.995	0.052	0.012				Supported
	Metric invariance	47.020	14	0.994	0.048	0.012	−0.001	−0.004	0.000	Supported
	Scalar invariance	88.699	19	0.987	0.060	0.012	−0.007	0.012	0.000	Supported
	Strict invariance	109.350	25	0.984	0.057	0.015	−0.003	−0.003	0.003	Supported
Academic year	Configural invariance	85.962	40	0.991	0.034	0.031				Supported
	Metric invariance	98.201	44	0.990	0.035	0.030	−0.001	0.001	−0.001	Supported
	Scalar invariance	123.727	59	0.988	0.033	0.030	−0.002	−0.002	0.000	Supported
	Strict invariance	173.685	65	0.980	0.040	0.034	−0.008	0.007	0.004	Supported
Engineering discipline	Configural invariance	69.036	20	0.991	0.049	0.012				Supported
	Metric invariance	78.541	32	0.991	0.038	0.013	0.000	−0.011	0.001	Supported
	Scalar invariance	107.881	46	0.989	0.036	0.013	−0.002	−0.002	0.000	Supported
	Strict invariance	263.660	65	0.964	0.055	0.031	−0.025	0.019	0.018	Not supported

Note. ΔCFI, ΔRMSEA, and ΔSRMR are changes relative to the previous model.

that comparisons of engineering identity across disciplines would be appropriate, whereas comparisons involving item-level residuals should be interpreted with caution.

Discussion

The Chinese version of the EIS demonstrated adequate reliability and validity in this study, consistent with the findings of the original validation conducted in the United States (Major et al., 2018). These findings supported the applicability of the EIS for assessing engineering students' professional identity in the context of this study. From the perspective of Social Identity Theory, engineering identity reflects individuals' sense of belonging to the engineering profession, which may help explain why a psychometrically stable measurement of this construct is important for understanding differences in students' engagement and persistence. As a validated measure of professional identity, the EIS may therefore be useful for future research in engineering education in Shanxi.

This study emphasized that establishing measurement invariance is essential for valid cross-group comparisons in psychological research, especially when populations differ in demographic or contextual characteristics (Sterner et al., 2025). Without such tests, the observed differences may be attributed to measurement bias rather than genuine differences in the latent construct (Vandenberg & Lance, 2000), which may compromise the validity of cross-group comparisons (Sterner et al., 2025). Overall, this study contributed to the robustness of the EIS across multiple subgroup classifications,

Specifically, across gender and academic year subgroups, the establishment of configural, metric, scalar, and strict invariance in this study demonstrated that the Chinese version of the EIS had a consistent overall structure, factor loadings, item intercepts, and item residuals. These results provided evidence that meaningful comparisons of engineering identity across these groups were not affected by measurement bias (Vandenberg & Lance, 2000), and that latent mean differences can be interpreted with confidence.

In contrast, across engineering discipline subgroups, configural, metric, and scalar invariance were supported, while strict invariance was not achieved, suggesting that item residual variances may differ slightly across disciplines. This may be due to differences in learning experiences, disciplinary context, or professional orientation among students in different engineering majors in Shanxi. However, as strict invariance is a highly restrictive criterion and is often difficult to achieve in applied research (Chen & Tang, 2006), the establishment of scalar invariance is generally considered sufficient for meaningful comparisons of latent means (Lee et al., 2023; Millsap, 2012). Therefore, comparisons of engineering identity across disciplines remain appropriate at the latent level, although residual differences should be interpreted with caution.

Implications for research and practice

This study offers several theoretical implications. It supports Social Identity Theory by providing evidence that engineering identity can be meaningfully conceptualized within a higher education context in Shanxi, China. Rather than treating professional identity as a purely abstract construct, the findings suggest that it is meaningfully measurable within students' educational context and can be systematically examined within institutional settings.

Beyond this conceptual support, the study extends Social Identity Theory by situating identity formation within a non-Western context. In Shanxi, China, engineering education is characterized by large-scale, structured training systems that may influence how students internalize and develop their professional identity. Despite these contextual differences, the core mechanisms proposed by Social Identity Theory remain observable, suggesting that

identity formation processes are broadly generalizable across cultural and institutional environments, while still being shaped by local conditions. Overall, these findings extend the applicability of Social Identity Theory to non-Western engineering education and highlight the importance of institutional context in shaping professional identity development.

In addition, several practical implications can be drawn from this study for engineering education in Shanxi. First, the validated Chinese version of the EIS provides a reliable tool for assessing engineering students' professional identity in Shanxi. Given that professional identity develops during university education (Ju & Zhu, 2023) and is closely shaped by structured engineering training under China's outcome-based education (OBE) and engineering accreditation frameworks, the instrument may provide a valid means for describing students' engineering identity levels across different academic stages in future research.

Second, the EIS may function as a needs assessment tool to inform potential support strategies in engineering education. By identifying students with relatively low levels of professional identity, educators and program administrators may gain evidence-based insights (Dos Santos et al., 2020; McVey & Shum, 2024) into whether additional academic support, mentoring, or curriculum enhancement is warranted within engineering programs. Such information can be integrated into existing institutional support mechanisms within universities in Shanxi, including academic advising systems and student counselling structures, to facilitate timely and targeted follow-up actions.

Third, the validated EIS provides a reliable measure that may support future research on professional identity in engineering education. Prior research in engineering education has shown that professional identity is positively associated with persistence, retention, and belongingness in the major (Burleson et al., 2021; Hughes et al., 2019). The Chinese EIS may be used in future studies to examine whether similar associations can be observed in the Shanxi context, which provides an important empirical setting for testing the generalizability of findings from Western engineering education research. Moreover, past studies in medical and nursing education suggest that professional identity is associated with outcomes such as learning motivation and engagement (Lu et al., 2025; Zheng et al., 2025). Future studies may further investigate the extent to which such relationships are applicable to engineering students.

Finally, the availability of a validated Chinese version of the EIS allows future cross-national research. As the original instrument was developed and tested in the United States, future studies may conduct formal cross-cultural measurement invariance analyses to enable meaningful comparisons between Shanxi and U.S. samples. In doing so, Shanxi provides a distinctive context for engineering education, where large-scale talent cultivation systems and institutionalized training structures may shape professional identity formation in ways that differ from Western settings. Such work will contribute to a more global understanding of engineering students' professional identity.

Strengths, limitations and future directions

This study extended prior research on the EIS by contributing to its cross-cultural validation. Unlike earlier validations conducted primarily in Western contexts, this study demonstrated the psychometric robustness of the EIS within a non-Western educational setting. In addition, this study applied cognitive interviews as a qualitative approach to assess the face validity of the translated EIS. This approach helped to ensure that item wording was appropriate and understandable for the target population.

This study has several limitations. First, the participants of this study were drawn from Shanxi, a province in northern China; therefore, the findings may have limited applicability to other regions or populations. Furthermore, as a cross-sectional design, this study captured engineering identity at a single point in time, which may not reflect its potential developmental nature across academic stages. Future research may consider using longitudinal designs and more diverse samples from multiple regions of China to enhance the generalizability of the findings.

Second, this study focused on structural validity and measurement invariance. Therefore, test–retest reliability and criterion-related validity were not examined. Test–retest reliability requires longitudinal data to assess temporal stability, while criterion-related validity requires external outcome variables, which were not included in this study. Future research is encouraged to further establish these forms of validity.

Finally, the absence of strict measurement invariance across engineering disciplines limited the interpretation of observed differences as purely substantive at the item level. Therefore, while comparisons at the latent level may still be appropriate under partial invariance, caution is required when interpreting more fine-grained group differences. Future research should further explore partial invariance or alternative measurement models to improve the comparability of engineering identity across disciplines.

Conclusion

This study translated and validated the Chinese version of the EIS among engineering students. It provides evidence for the cross-cultural applicability of the EIS in a non-Western educational context. The findings support its use as a reliable and valid instrument for assessing engineering identity in engineering education in Shanxi. This validated scale can be used in future research and practice to examine identity development and to support meaningful comparisons across engineering students' groups.

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