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Latent profiles of role identity among first-year STEM students and their associations with personal characteristics and social interactions

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The transition to university represents an important period of adjustment for students entering STEM programs, as they encounter new academic demands and negotiate their roles as college students. Using a person-centered approach, this study examined heterogeneity in college student role identity among 518 first-year STEM students at a comprehensive research university in China. Latent profile analysis identified three distinct role identity profiles, namely *Adaptive*, *Maladaptive*, and *Confusing*, revealing meaningful differences in how students combine role affirmation and role-related strain during the first year. Furthermore, both demographic characteristics and social interactions were associated with profile membership. In particular, first-generation college students were more likely to belong to the *Maladaptive* profile. Meanwhile, higher levels of reported social interaction and perceived institutional support were associated with a lower likelihood of belonging to the *Maladaptive* profile. Overall, the findings reveal substantial variation in patterns of college student role identity and indicate that strong affirmation of the college student role can coexist with considerable role-related strain. Recognizing this heterogeneity may help institutions better understand the different ways in which first-year STEM students experience and negotiate their roles as college students.

KEYWORDS
academic adjustment, latent profile analysis, role identity, social interaction, STEM freshmen

1 Introduction

The transition into university represents an important period during which students are required to negotiate new academic demands, social expectations, and role responsibilities. For students entering science, technology, engineering, and mathematics (STEM) majors, this transition is often accompanied by particularly intensive academic challenges and competitive learning environments. Despite sustained policy attention and labor market demand for STEM professionals, a consistent body of research has documented disproportionately high attrition rates from STEM majors during the first 2 years of college, even among students who enter with strong academic preparation (Chang and Liu, 2023; Seymour and Hunter, 2019). This pattern has motivated closer attention to STEM students' first-year experiences, including how they understand their roles within the university. Existing research on STEM persistence has

largely emphasized motivational and decision-making processes. From an expectancy–value perspective, students' willingness to persist is shaped by their expectations for success and the value they assign to STEM learning tasks. When academic demands intensify and early setbacks accumulate, declines in self-efficacy or perceived task value may undermine commitment to the major (Eccles and Wigfield, 2002; Wang, 2013). Complementing this view, rational choice perspectives highlight students' evaluations of the costs associated with STEM learning, such as sustained effort, time investment, and opportunity costs, weighed against uncertain long-term returns. Although these frameworks offer important insights into why students leave, they are less effective in explaining why some students remain, particularly when they continue to experience strain, uncertainty, or academic difficulty (Harackiewicz et al., 2012).

In particular, these perspectives primarily capture students' evaluations of learning tasks rather than their evolving sense of who they are within the academic system. Especially during the first year of college, students are not only evaluating whether particular courses are worth the effort but also negotiating what it means to occupy the role of a college student under new academic and social demands. Students may differ substantially in how clearly they understand this role, how positively they experience it, and how much conflict or strain accompanies it. These differences may be particularly salient in demanding STEM learning environments. Examining college student role identity therefore provides a complementary perspective on students' adjustment during the transition to university.

1.1 Patterns of college student role identity among STEM students

An identity-based perspective provides a complementary lens for understanding students' experiences of their roles during the early college years. Rather than focusing solely on proximal motivational judgments, role identity concerns how individuals understand who they are within a given social and institutional context (Reitzes and Burke, 1980; Stryker and Burke, 2000). For first-year college students, who are typically navigating the developmental stage of emerging adulthood (Arnett, 2000), successful adaptation involves not only mastering academic tasks but also developing an understanding of themselves in the role of a college student (Scanlon et al., 2007). Students in STEM programs may also develop disciplinary or professional identities as scientists, engineers, or members of other STEM fields (Chemers et al., 2011), but such identities are conceptually distinct from the college student role identity examined in the present study (Carlone and Johnson, 2007). When students experience persistent discrepancies between their expectations of the college student role and the demands they perceive in that role, they may experience role-related strain (Machovcová et al., 2025; Scanlon et al., 2007). In this sense, role identity provides a framework for examining how students understand, experience, and negotiate the expectations associated with being a college student.

Role identity, however, is neither unidimensional nor uniformly experienced. Drawing on role theory and identity development perspectives (Schwartz, 2001; Stryker and Burke, 2000), students' role identities may encompass both affirming and straining elements. On the one hand, students may experience clarity of role orientation, effective adaptation to academic demands, and positive emotional experiences associated with learning. On the other hand, they may simultaneously encounter role conflict, feelings of exhaustion or burnout, and internal contradictions regarding expectations and self-evaluation. Importantly, these dimensions need not be mutually exclusive. Especially in demanding STEM environments, students may report strong commitment and engagement alongside emotional exhaustion (Klinkenberg et al., 2024). Approaches that conceptualize role identity along a single continuum from "low" to "high" therefore risk obscuring meaningful heterogeneity in how students experience and negotiate their roles.

Despite growing recognition of the complexity of identity development in higher education, most empirical studies have adopted variable-centered approaches, examining linear associations between role identity indicators and outcomes or predictors (Reitzes and Burke, 1980; Stets and Burke, 2014). While informative, such approaches implicitly assume population homogeneity and do not directly identify subgroups with qualitatively distinct configurations of identity experiences. A person-centered approach offers a more nuanced alternative by allowing for the identification of subgroups of students who share similar patterns across multiple dimensions of role identity (Berlin et al., 2014; Spurk et al., 2020). From this perspective, maladaptive, adaptive, and internally conflicted identity configurations can be empirically distinguished.

1.2 Social and individual correlates of role identity profiles

Beyond individual identity configurations, students' role-related experiences are embedded within a broader social and institutional ecology that provides a context for how students interpret role expectations, evaluate feedback, and make sense of their position within the academic community (Stryker and Burke, 2000). During the first year of college, students encounter multiple, and sometimes inconsistent, sources of role-related information. Interactions with significant others and perceptions of institutional support may provide important interpretive frames through which students make sense of their college student role and their place within the academic community (Machovcová et al., 2025; Scanlon et al., 2007). These social and institutional experiences may be associated with qualitatively distinct patterns of role affirmation and strain.

Among these social sources of role-related information, family interactions continue to play a formative role during the college transition, even as students gain physical and psychological independence. Supportive family relationships may provide emotional security and reinforce students' long-term educational values, enabling them to interpret early academic difficulties as temporary and surmountable rather than as evidence of poor fit (Baumrind, 1966). In contrast, families that convey rigid expectations, heightened pressure, or ambiguous messages about academic success may inadvertently intensify role conflict and emotional strain, particularly when students struggle to meet perceived standards (Barber, 1996). Thus, family interactions may function as a stabilizing resource for some students while amplifying identity tension for others, depending on how familial messages are internalized during the transition to college.

Interactions with faculty constitute a particularly salient source of role-related feedback in STEM contexts, where norms of competence, autonomy, and persistence are often communicated implicitly. Faculty behaviors, such as accessibility, feedback quality, and informal mentoring, serve as powerful signals of academic legitimacy and future

possibility within the discipline (Lamport, 1993). For first-year students, positive faculty interactions may foster a sense of being recognized as a capable college student and may be associated with stronger role orientation and adaptive engagement even under high academic demands. Conversely, limited or impersonal faculty contact may leave students uncertain about expectations and belonging, potentially increasing role-related strain.

Peer interactions may also be relevant to role identity by providing opportunities for social comparison, mutual validation, and normalization of difficulty. Through peer exchanges, students learn how others interpret academic challenges, negotiate workload demands, and balance effort with well-being. In supportive peer environments, shared struggle may reduce feelings of isolation and help students make sense of effort and stress in relation to their college student role. However, in highly competitive peer climates, upward social comparisons may exacerbate self-doubt and intensify perceptions of inadequacy, particularly for students who already experience identity vulnerability. As such, peer interactions may be associated with adaptive, maladaptive, or internally conflicted identity configurations (Pugh and Hart, 1999; Verhoeven et al., 2019).

At the institutional level, perceived support structures and campus climate provide a broader context for students' experiences of their college student role. Institutions that communicate clear expectations, offer accessible academic and psychological resources, and promote inclusive norms may facilitate students' exploration and confirmation of their emerging role. In contrast, institutional environments characterized by "weed-out" cultures, opaque evaluation criteria, or limited support may undermine students' sense of fit, particularly during the first year when students are still becoming familiar with role expectations. These institutional experiences may not be associated with all students in the same way and may be particularly relevant for those who report high role-related strain (Newman and Newman, 1978).

In addition to contextual influences, students' demographic backgrounds may condition how role-related experiences are interpreted and integrated. Gender and first-generation college status, in particular, have been associated with differential access to cultural resources, role models, and anticipatory socialization in STEM domains. Female students may encounter implicit stereotypes regarding competence and belonging, increasing the likelihood that academic challenges are internalized as personal inadequacy rather than situational difficulty (Seymour and Hunter, 2019). First-generation college students, who often enter college with limited familiarity with academic role norms and fewer familial role models, may face additional uncertainty in interpreting expectations and navigating institutional structures (Lile et al., 2018). These demographic factors may therefore be associated with differences in how students report the dimensions of their college student role identity during the first year of college.

1.3 The present study

Building on the foregoing theoretical and empirical considerations, the present study adopts a person-centered approach to examine patterns of college student role identity among first-year STEM students. Rather than assuming that all students show the same combination of role identity dimensions, we use latent profile analysis (LPA) to identify distinct configurations of role identity characterized by different combinations of role orientation, role adaptation, emotional experience, role conflict, role burnout, and role contradiction. This approach allows us to capture heterogeneity in how students simultaneously experience role affirmation and role strain during the critical first year of college.

In addition, we examine whether students' demographic characteristics (i.e., gender, first-generation college status, and socioeconomic background) and their interactions with family, faculty, peers, and institutional support are associated with membership in these role identity profiles. By linking identity configurations to multiple layers of students' social and institutional contexts, this study aims to clarify how different forms of support and background characteristics may be differentially related to adaptive, maladaptive, or internally conflicted patterns of role identity.

Through this person-centered and ecologically informed approach, the present study seeks to advance understanding of early college adjustment among STEM students by documenting heterogeneity in their experiences of the college student role and examining how these patterns are associated with individual and contextual characteristics. In doing so, the study may provide a more differentiated empirical basis for future research and support efforts during the transition to university.

2 Methods

2.1 Participants

Data were collected from a public comprehensive research university located in the eastern part of China. This institution features a complete range of disciplines and was recognized as a Class A university under China's "Double First-Class" initiative in 2017, enrolling approximately 3,500 undergraduate students annually. The survey was administered online in March 2025, at the beginning of the second semester for the 2024 freshman cohort. This timing ensured that students had completed one semester at the university and were familiar with the university environment, allowing them to report on faculty interactions, peer interactions, and institutional support. Information regarding the study scope, potential risks, and data confidentiality was provided, and informed consent was obtained from all students before participation. The study was approved by the Institutional Review Board (IRB) of the university. The questionnaire was distributed to all first-year students in STEM disciplines. After excluding invalid responses, the final valid sample consisted of 518 students (M_{age} = 18.81, SD = 0.65, 51% being males).

2.2 Measures

All survey items were written in Chinese and used five-point Likert-type scales ranging from 1 (*completely disagree*) to 5 (*completely agree*). To assess the reliability of the measures, Cronbach's α coefficients were utilized. Scales that were initially developed in English were subjected to the translation and backtranslation process proposed by Brislin (1970).

2.2.1 College students' role identity

College students' role identity was measured using the revised College Student Role Identity Scale adapted from Zhou (2008). The

scale consists of 28 items that cover six dimensions, categorized into positive and negative identity confirmation. The positive identity dimensions include role orientation ($\alpha = 0.85$), role adaptation ($\alpha = 0.85$), and feeling experience ($\alpha = 0.91$). The negative identity dimensions include role conflict ($\alpha = 0.82$), role burnout ($\alpha = 0.75$), and role contradiction ($\alpha = 0.87$). A confirmatory factor analysis (CFA) revealed that the six-factor model with factors representing role orientation, role adaptation, feeling experience, role conflict, role burnout, and role contradiction, respectively, demonstrated good fit (χ^2 (335) = 1109.643, CFI = 0.920, TLI = 0.907, RMSEA [90% CI] = 0.045 [0.042, 0.048], and SRMR = 0.045).

2.2.2 Family interaction

Family interaction was measured by five items, adapted from the Family APGAR index developed by Smilkstein (1978). In the present study, the Cronbach's alpha coefficient for this scale was 0.95.

2.2.3 Faculty interaction

Nine items measuring faculty interaction were adopted from the Student Survey of Learning and Development (SSLD) developed by Bao and Lei (2024). In the present study, the Cronbach's alpha coefficient for this scale was 0.95.

2.2.4 Peer interaction

Six items measuring peer interaction were adapted from the China College Student Adjustment Scale (CCSAS) (Fang et al., 2005). The scale includes two reverse-scored items (items 1–2). The scores for the reverse-scored items were recoded to ensure consistency in the scoring direction. In the present study, the reliability coefficient for this scale was $\alpha = 0.82$.

2.2.5 Institutional support

Six items measuring institutional support were adopted from the Student Survey of Learning and Development (SSLD) developed by Bao and Lei (2024). In the present study, the scale demonstrated a reliability coefficient of $\alpha = 0.95$.

2.2.6 Demographic variables

The students reported their demographic information, including gender, major, parental education level, and SES. To measure parental education level, we include one item each for paternal and maternal education level, e.g., "What is the highest level of education your father has completed?" The four answer options for this question were: 1. secondary degree or below; 2. vocational college degree; 3. bachelor's degree; and 4. master's degree or above. Students who reported that both parents had a secondary degree or below were classified as first-generation college students.

To measure the SES, we utilized nine items from the Organization for Economic Co-operation and Development (OECD) (2012). We computed the SES index based on total scores regarding home possessions (seven items, e.g., "How many mobile phones do you have?" The four answer options for this question are: 1. 0; 2. 1; 3. 2; 4. 3 or above), and home educational resources (two items; e.g., "How many books do you have at home?" The five answer options for this question are: 1. 0–10; 2. 11–25; 3. 26–100; 4. 101–200; 5. 200 or above). This scale has been used effectively in prior research with Chinese adolescent students (e.g., Zhang et al., 2024). In the present study, SES scores ranged from 14 to 43 (M = 23.57, SD = 4.36), with higher scores indicating greater levels of SES.

2.3 Statistical analysis

The data were analyzed using Mplus 8.3 with the robust maximum likelihood estimator (MLR). Missing data in achievement were addressed using full information maximum likelihood (FIML) estimation (Schafer and Graham, 2002). We first conducted confirmatory factor analyses (CFA) to examine whether a six-factor model of college students' role identity would fit the data well. Several indices were consulted to determine model fit, including the chi-square value and associated degrees of freedom, comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root-mean-squared residual (SRMR). According to the recommendations of Kline (2016) and Marsh et al. (2004), RMSEA and SRMR values below 0.05 and CFI and TLI values above 0.90 indicate good fit.

We then conducted LPA with two to five profiles (k = 2–5) to determine the number of profiles reflected in students' role identity. The factor scores computed by CFA for the six dimensions (role orientation, role adaptation, feeling experience, role conflict, role burnout, and role contradiction) in college students' role identity served as indicators for the LPA. All LPA models were freely estimated with 1,000 random starts, 100 iterations in the initial stage, and 200 final-stage optimizations. To facilitate the decision regarding the optimal number of profiles, we considered both statistical evaluations and the conceptual grounding and interpretability of the profiles. We assessed the fit of the models using several fit indices, including the Akaike information criteria (AIC), Bayesian information criteria (BIC), sample size-adjusted BIC (SABIC), and the Vuong–Lo–Mendell–Rubin likelihood ratio test (VLMR). Lower values of AIC, BIC, and SABIC suggest a better fit, while a significant p-value of VLMR implies that the k-profile model fits better than the k-1 profile model. BIC, which has a high reliability for model fitting according to Nylund et al. (2007), was considered the primary reference indicator. Additionally, we inspected the entropy value, which ranges from 0 to 1 and describes the classification's precision. A value above 0.70 indicates a relatively accurate classification. Once the latent profile solution was identified, students were assigned to profiles based on their highest membership probability. To facilitate the interpretation of the profiles, factor mean scores were computed for each of the six profile indicators. We also took into consideration the interpretability and sample size of the profiles as criteria, aiming for the most parsimonious solution for which each type of profile nevertheless had a substantial sample size.

To examine whether individual characteristics (i.e., gender and first-generation college students), interactions with significant others, and institutional support were associated with membership in the latent profiles, we utilized the R3STEP procedure for auxiliary variables in Mplus 8.3 (Asparouhov and Muthén, 2014). The R3STEP

procedure estimates the associations between covariates and profile membership while accounting for classification uncertainty and provides odds ratios (ORs) for comparisons between profiles.

3 Results

3.1 Descriptive statistics and CFA

Table 1 shows the means, standard deviations, Cronbach's α coefficients, and bivariate Pearson correlation coefficients among the observed variables. Specifically, role orientation, role adaptation, and feeling experience correlated positively with family interaction, faculty interaction, peer interaction, and institutional support ($0.39 \leq r_s \leq 0.56$, $p_s < 0.01$) and correlated negatively with role burnout and role contradiction ($-0.44 \leq r_s \leq -0.20$, $p_s < 0.01$\$). Role conflict, role burnout, and role contradiction correlated positively with each other ($0.41 \leq r_s \leq 0.63$, $p_s < 0.01$), but generally correlated negatively with institutional support, peer interaction, and faculty interaction ($-0.37 \leq r_s \leq -0.12$, $p_s < 0.01$). CFA was conducted to examine the factor structure of the measurement model. Results indicated that the measurement model exhibited good model fit: χ^2 (242) = 3534.160, CFI = 0.902, TLI = 0.901, RMSEA [90% CI] = 0.047 [0.045, 0.049], and SRMR = 0.046.

3.2 Role identity LPA

Fit criteria for the LPA models with two to five latent profiles are displayed in Table 2. The AIC, BIC, and SABIC values kept decreasing as additional profiles were added, suggesting that each additional profile improved model fit from a statistical perspective. In addition, the entropy for all models was above 0.81. However, when examining the four- and five-profile solutions, the smallest profile characterized only 3.7% ($N = 19$) and 2.7% ($N = 14$) of the sample, respectively. Existing evidence (e.g., Berlin et al., 2014; Lubke and Neale, 2006) suggests that if group sizes are less than 5%, the risk of low power and precision indicates the exclusion of the model. Furthermore, the VLMR likelihood ratio test for the four-profile solution was not significant ($p = 0.09$). Therefore, we ruled out solutions with four or more profiles. The three-profile solution provided a significant VLMR ($p < 0.01$), high entropy (0.88), and the smallest class size was acceptable ($N = 27$, 5.2%). Thus, the three-profile solution was retained as the final model.

Table 3 presents the average latent profile probabilities for the most likely profile membership, indicating that this solution led to a clear classification. The diagonal values, representing the probability of assignment to the correct profile, ranged from 0.907 to 0.954. Specifically, students classified into profile 1 ($N = 297$, 57.3% of the sample) had a 0.954 probability of membership. Students in profile 2 ($N = 194$, 37.5% of the sample) had a 0.940 probability of membership. Finally, students in profile 3 ($N = 27$, 5.2% of the sample) had a 0.907 probability of membership.

The three distinct profiles were labeled based on their factor scores of role identity (see Table 4; Figure 1). The first profile was characterized by negative factor scores on role orientation (−0.311), role adaptation (−0.460), and feeling experience (−0.348), combined with positive scores on role conflict (0.126), role burnout (0.236), and role contradiction (0.383). We thus labeled this profile *Maladaptive*. The second profile was characterized by positive scores for the adaptive dimensions, which were role orientation (0.383), role adaptation (0.588), and feeling experience (0.454); and negative scores for the maladaptive dimensions, reporting the lowest levels of role conflict (−0.320), role burnout (−0.501), and role contradiction (−0.752). We labeled this profile *Adaptive*. The third profile was distinct in that it displayed the highest scores across all dimensions. Students in this profile reported very high levels of role orientation (0.673) and role adaptation (0.820), and feeling experience (0.561), but simultaneously reported the highest levels of role conflict (0.988), role burnout (1.083), and role contradiction (1.308). We thus labeled this profile *Confusing*.

3.3 Social and individual correlates of profile membership

We also investigated whether students' demographic characteristics and social covariates were associated with their profile membership (see Table 5), with each association accounting for the other covariates. The results indicated that gender, first-generation college status, family interaction, faculty interaction, peer interaction, and institutional support were significantly associated with profile membership in at least one comparison, whereas SES was not significantly associated with profile membership.

TABLE 1 Descriptive statistics and bivariate Pearson correlations among observed variables.

Variable	M	SD	α	1	2	3	4	5	6	7	8	9
1. Role orientation	3.66	0.78	0.85	–								
2. Role adaptation	3.53	0.74	0.85	0.66**	–							
3. Feeling experience	3.77	0.79	0.91	0.57**	0.62**	–						
4. Role conflict	3.36	0.81	0.82	−0.10*	−0.06	−0.12**	–					
5. Role burnout	3.16	0.81	0.75	−0.21**	−0.28**	−0.20**	0.45**	–				
6. Role contradiction	2.52	0.87	0.87	−0.29**	−0.38**	−0.44**	0.41**	0.63**	–			
7. Family interaction	3.82	0.84	0.95	0.42**	0.41**	0.52**	−0.02	−0.15**	−0.25**	–		
8. Faculty interaction	2.76	0.90	0.95	0.47**	0.47**	0.40**	−0.12**	−0.18**	−0.26**	0.27**	–	
9. Peer interaction	3.53	0.70	0.82	0.40**	0.39**	0.54**	−0.15**	−0.21**	−0.32**	0.53**	0.34**	–
10. Institutional support	3.99	0.80	0.95	0.50**	0.47**	0.56**	−0.15**	−0.16**	−0.37**	0.41**	0.44**	0.36**

*$p < 0.05$, **$p < 0.01$.

TABLE 2 The model fit results of latent profile analyses.

No. of profiles	LL	#par	AIC	BIC	SABIC	Entropy	VLMR	*N* smallest class
2	−2827.88	19	5693.76	5774.51	5714.20	0.81	<0.001	177 (34.2%)
3	−2670.52	26	5393.03	5503.53	5421.00	0.88	0.01	27 (5.2%)
4	−2510.02	33	5086.03	5226.28	5121.53	0.91	0.09	19 (3.7%)
5	−2373.47	40	4826.94	4996.93	4869.97	0.89	0.02	14 (2.7%)

LL, model log likelihood; #par, number of free parameters; AIC, Akaike information criterion; BIC, Bayesian information criterion; SABIC, sample-size-adjusted BIC; VLMR, Vuong–Lo–Mendell–Rubin likelihood ratio test.

TABLE 3 Average latent profile probabilities for most likely profile membership (row) by latent profile (column) and profile sizes.

Profile	1	2	3	*N* (%)
1. Maladaptive	0.954	0.043	0.003	297 (57.3%)
2. Adaptive	0.058	0.940	0.002	194 (37.5%)
3. Confusing	0.068	0.025	0.907	27 (5.2%)

N (%) indicates the profile sample size based on most likely profile membership, with percentages representing the proportion of the total analytic sample.

Gender was significantly associated with profile membership in two comparisons. Male students were more likely to be assigned to the adaptive profile than the confusing profile compared with female students (OR = 3.41, 95% CI [1.10, 10.60]). Conversely, female students were less likely to be assigned to the maladaptive profile than the confusing profile compared with male students (OR = 0.26, 95% CI [0.08, 0.90]). The gender difference was not significant for the maladaptive versus adaptive comparison. First-generation college status was also associated with profile membership; students identified as first-generation college students were more likely to be assigned to the maladaptive profile than the adaptive profile (OR = 2.68, 95% CI [1.09, 6.59]). The other profile comparisons for first-generation status were not significant. SES was not significantly related to profile membership.

Regarding the other covariates (family interaction, faculty interaction, peer interaction, and institutional support), significant associations were found primarily in comparisons between the maladaptive profile and the adaptive profile. Specifically, higher scores on family interaction (OR = 0.36, 95% CI [0.17, 0.77]), peer interaction (OR = 0.47, 95% CI [0.37, 0.61]), faculty interaction (OR = 0.34, 95% CI [0.18, 0.64]), and institutional support (OR = 0.22, 95% CI [0.12, 0.38]) were associated with lower likelihood of being assigned to the maladaptive profile than to the adaptive profile. Furthermore, peer interaction and faculty interaction were significantly associated with membership in the confusing profile compared to the maladaptive profile. Students with higher peer interaction scores (OR = 4.18, 95% CI [1.66, 10.56]) and faculty interaction scores (OR = 6.75, 95% CI [2.52, 18.05]) had higher odds of membership in the confusing profile than in the maladaptive profile. Neither peer nor faculty interaction significantly distinguished the adaptive and confusing profiles.

4 Discussion

The present study adopted a person-centered approach to examine patterns of college student role identity among first-year STEM students and to explore how demographic characteristics and social interactions are associated with distinct identity configurations. Through LPA, three qualitatively distinct profiles emerged: an Adaptive profile, a Maladaptive profile, and a Confusing profile. These findings underscore the heterogeneity of identity experiences during the first year of college and provide empirical support for conceptualizing role identity as a multidimensional and configurational construct rather than a linear continuum.

4.1 Heterogeneity in college student role identity profiles

The three profiles identified in this study reflect distinct patterns of role affirmation and strain. First, the *Adaptive* profile was characterized by high levels of role orientation, role adaptation, and positive emotional experience, alongside low levels of role conflict, burnout, and contradiction. This configuration reflects a relatively affirmative and low-strain experience of the college student role. Students in this group appear to experience the expectations of the college student role more positively and with less role-related strain than students in the other profiles. Importantly, because exploration and commitment were not directly assessed, this profile should not be interpreted as equivalent to an identity status in Marcia's (1966, 1980) framework.

In contrast, the *Maladaptive* profile, which constituted the largest subgroup in the sample, was marked by low scores on positive identity dimensions and elevated levels of role conflict, burnout, and contradiction. This pattern reflects a less affirmative and more strained experience of the college student role. Although broader identity theories describe uncertainty and tension in relation to role expectations (Erikson, 1968; Marcia, 1966, 1980), the present profile should not be classified as an identity status because the defining dimensions of exploration and commitment were not directly measured. The substantial proportion of students in this profile highlights the importance of attending to role-related strain during the first-year transition in demanding STEM contexts.

In the present study, we also identified a *Confusing* profile, which was a small but highly distinctive subgroup. Students in this group reported the highest levels of role orientation and role adaptation, even exceeding those in the Adaptive profile, yet simultaneously endorsed the highest levels of role conflict, burnout, and contradiction. Traditional identity models rooted in Erikson's (1968) polarity and subsequent neo-Eriksonian formulations often imply that strong commitment is inversely associated with confusion or distress (Schwartz, 2001; Schwartz et al., 2011). However, the present findings challenge this strictly linear interpretation.

The *Confusing* profile reflects what may be conceptualized descriptively as a "high-investment–high-conflict" configuration. Students in this profile appeared highly oriented toward meeting college student role expectations while also reporting substantial conflict

TABLE 4 Factor scores of role identity in three latent profiles.

Profile	Role orientation	Role adaptation	Feeling experience	Role conflict	Role burnout	Role contradiction
1. Maladaptive	−0.311 (0.044)	−0.460 (0.061)	−0.348 (0.054)	0.125 (0.034)	0.236 (0.037)	0.383 (0.061)
2. Adaptive	0.383 (0.046)	0.588 (0.071)	0.454 (0.053)	−0.320 (0.059)	−0.501 (0.076)	−0.752 (0.086)
3. Confusing	0.673 (0.117)	0.820 (0.153)	0.561 (0.110)	0.988 (0.171)	1.083 (0.136)	1.308 (0.244)

Values represent estimated factor scores for the six role identity indicators within each latent profile. Standard errors are reported in parentheses.

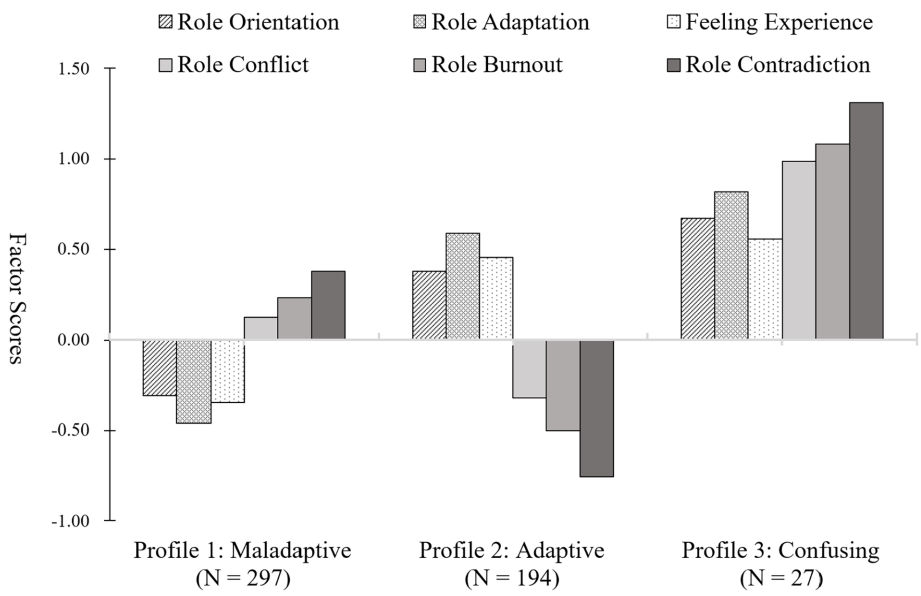


FIGURE 1
Latent profiles with factor scores of indicators.

TABLE 5 Covariates associated with latent profile membership.

Covariate	Maladaptive vs. Adaptive				Adaptive vs. Confusing				Confusing vs. Maladaptive			
	Est.	OR	SE	CI (95%)	Est.	OR	SE	CI (95%)	Est.	OR	SE	CI (95%)
Gender	0.119	1.126	0.372	[0.589, 2.153]	**1.226**	**3.409**	**1.973**	**[1.097, 10.597]**	**−1.345**	**0.260**	**0.165**	**[0.075, 0.899]**
FirstGen	**0.986**	**2.681**	**1.230**	**[1.091, 6.591]**	−1.114	0.328	0.321	[0.048, 2.229]	0.127	1.136	1.144	[0.158, 8.173]
SES	0.460	1.583	0.377	[0.993, 2.526]	−0.844	0.430	0.228	[0.152, 1.218]	0.384	1.469	0.818	[0.493, 4.377]
Family Interaction	**−1.010**	**0.364**	**0.138**	**[0.173, 0.766]**	0.884	2.420	2.229	[0.398, 14.720]	0.126	1.135	1.019	[0.195, 6.598]
Peer Interaction	**−0.752**	**0.471**	**0.061**	**[0.366, 0.608]**	−0.679	0.507	0.280	[0.172, 1.497]	**1.431**	**4.183**	**1.976**	**[1.657, 10.558]**
Faculty Interaction	**−1.082**	**0.339**	**0.111**	**[0.179, 0.642]**	−0.827	0.437	0.185	[0.191, 1.004]	**1.909**	**6.746**	**3.387**	**[2.521, 18.050]**
Institutional Support	**−1.532**	**0.216**	**0.061**	**[0.124, 0.377]**	0.512	1.668	1.202	[0.406, 6.851]	1.020	2.773	2.057	[0.648, 11.871]

Est. = logistic regression coefficient on the log-odds scale indicating the probability of being classified as a specific role identity profile versus the second-listed reference profile. OR = odds ratio, calculated as $e^{(Est.)}$. SE = standard error of the OR; CI (95%) = 95% confidence interval for the OR. Gender was coded as female = 0, male = 1. FirstGen = First-generation college status, coded as 0 = non-first-generation and 1 = first-generation. For each profile comparison, the second profile served as the reference category. Bold values indicate statistically significant associations. All covariates were entered simultaneously in the R3STEP analysis.

and burnout. One possibility is that such a pattern is related to experiences such as overcommitment, perfectionistic striving, or heightened self-evaluative sensitivity, but these mechanisms were not assessed in the present study and should therefore be regarded as tentative interpretations. This pattern is broadly consistent with research identifying engagement–burnout profiles in which high academic engagement coexists with emotional exhaustion (Tuominen-Soini and Salmela-Aro, 2014). Similarly, Klinkenberg et al. (2024) reported higher education student profiles characterized by strong engagement alongside elevated emotional strain. The Confusing group identified in the present study appears conceptually consistent with these "over-engaged but strained" patterns.

Importantly, the existence of this subgroup suggests that identity affirmation and psychological strain are not simple opposites. In this sample, relatively strong role orientation and adaptation coexisted with elevated role conflict and burnout among students in the Confusing profile. Thus, first-year students may experience both affirmation and tension in relation to the college student role.

4.2 Correlates of profile membership

Beyond identifying identity configurations, we also examined demographic and contextual correlates of profile membership. Among demographic factors, gender significantly differentiated the *Adaptive* and *Confusing* profiles. Male students were more likely to belong to the *Adaptive* profile rather than to the *Confusing* profile, a pattern consistent with prior research documenting gendered experiences in STEM environments (Seymour and Hunter, 2019). Female students may face additional stereotype-related pressures or heightened sensitivity to evaluative standards (Steele, 1997; Seymour and Hunter, 2019), although these mechanisms were not directly assessed in the present study.

Socioeconomic status was not significantly associated with profile membership; however, first-generation college status was associated with membership in a specific profile comparison. Specifically, first-generation students were more likely to be classified into the *Maladaptive* profile than the *Adaptive* profile. This finding aligns with research suggesting that limited access to cultural capital and fewer familial role models may complicate the process of role internalization and adjustment in higher education (Lile et al., 2018). With limited prior exposure to academic role norms, first-generation students may encounter greater uncertainty when navigating institutional expectations, potentially contributing to lower role affirmation and greater role-related strain.

In terms of the social variables, family interaction, faculty interaction, peer interaction, and institutional support were each associated with lower odds of membership in the Maladaptive rather than the Adaptive profile. Higher levels of these reported social interactions and perceived institutional support were therefore associated with a lower likelihood of belonging to the Maladaptive group relative to the Adaptive group. However, a more nuanced pattern emerged when distinguishing the *Confusing* and *Maladaptive* profiles. Higher levels of peer interaction and faculty interaction were associated with higher odds of membership in the *Confusing* profile relative to the *Maladaptive* profile. This pattern indicates that the Confusing group was not characterized by lower reported levels of faculty and peer interaction.

One possible interpretation is that higher reported interaction with faculty and peers may involve greater exposure to high standards, competitive norms, and upward social comparison. Peer dynamics can shape learning attitudes, behavioral norms, and value orientations through subtle social influence processes (Bu et al., 2023). In high-achievement environments, proximity to high-performing peers may generate "discouragement effects," whereby students compare themselves unfavorably and experience increased psychological pressure (Wu and Zhang, 2023). Similarly, faculty interaction may sometimes be accompanied by heightened perceived expectations. However, competition, upward comparison, and perceived expectations were not measured in the present study, so these explanations remain tentative. Alternative explanations are also possible. For example, students experiencing greater role-related strain may seek more interaction with faculty or peers, or unmeasured academic demands may be associated with both social interaction and role identity profiles. Given the cross-sectional design, the direction and mechanisms of these associations cannot be determined from the present data.

4.3 Theoretical and practical implications

The present findings extend research on role identity in higher education in several important ways. First, they offer empirical support for understanding college student role identity among STEM freshmen as multidimensional and internally differentiated. The identification of a subgroup characterized by both high affirmation and high strain shows that higher scores on the affirming role identity dimensions can coexist with higher role conflict and burnout. Instead, identity strength and emotional burden can coexist. Second, the results highlight the value of a person-centered framework. By examining patterns of co-occurring experiences, this approach reveals configurations of identity that would likely remain hidden in variable-centered analyses. The *Confusing* profile is especially instructive because elevated strain within this group coexisted with strong role affirmation in an academically demanding context. Third, the distinct associations between social interactions and profile membership raise questions about how reported social experiences relate to different role identity patterns. Faculty and peer interactions are often considered important sources of support in students' academic adjustment. However, whether these interactions contribute to role affirmation or strain, occur in response to them, or reflect other unmeasured contextual factors remains unclear. This pattern underscores the importance of examining the mechanisms and direction of the associations between social interactions and identity configurations.

From a practical standpoint, the findings suggest that institutional support may need to account for identity heterogeneity rather than assume a single pattern of adjustment. Students in the *Maladaptive* profile may benefit from foundational transition support. Structured orientation programs, mentorship initiatives, and targeted assistance for first-generation students are possible approaches that future research could evaluate in relation to clearer role expectations and institutional integration. For students in the Confusing profile, support efforts could attend to role-related strain while recognizing their high levels of role affirmation. Approaches focused on expectation management and workload demands may also warrant examination. Because the present study was cross-sectional, the effectiveness of these approaches cannot be inferred from the current findings. Recognizing that high role affirmation can coexist with significant strain may nevertheless be useful for identifying different support needs during the first year of STEM study.

4.4 Limitations and future directions

Several limitations should be acknowledged. First, the cross-sectional design does not allow conclusions about temporal ordering or causality. The direction of the associations between social interactions and identity profiles remains unclear. Students experiencing role-related strain may seek additional interaction,

social interactions may be associated with subsequent role-related experiences, or unmeasured academic demands may be associated with both. Longitudinal research, particularly studies employing latent transition analysis (LTA), would allow researchers to examine profile stability over time and identify factors associated with transitions between profiles. Repeated assessments of both social interactions and role identity would also help clarify their temporal ordering.

Second, the *Confusing* profile comprised a relatively small proportion of the sample. Although theoretically meaningful, its robustness across institutional and cultural contexts should be tested in larger, more diverse cohorts. The same profile may also reflect different underlying experiences across demographic groups. Future research with larger samples and direct measures of self-doubt, perceived parental pressure, and related experiences could examine whether similar configurations arise through different pathways.

Third, although the sample consisted of STEM freshmen, role identity was assessed with the College Student Role Identity Scale, which focuses on students' role as college students rather than their identification with a STEM discipline or profession. The profiles should therefore be interpreted as patterns of college student role identity among first-year STEM students. Because exploration and commitment were not directly assessed, the identified profiles should not be classified as Marcia's identity statuses. Future studies could include STEM-specific identity measures, as well as direct assessments of exploration and commitment, to examine how these patterns relate to disciplinary or professional identification.

Finally, all constructs were assessed through self-report measures, which may introduce shared method variance or social desirability bias. Future research could incorporate multiple data sources, such as faculty evaluations, academic records (e.g., GPA), or indicators of counseling service use, to strengthen validity. Qualitative interviews or mixed-method designs may further clarify how students interpret faculty and peer interactions and how these interpretations are associated with the simultaneous experience of affirmation and strain.

5 Conclusion

This study examined patterns of college student role identity among first-year STEM students using a person-centered approach and identified three distinct identity configurations, namely *Adaptive*, *Maladaptive*, and *Confusing*, highlighting substantial heterogeneity in how students experience affirmation and strain during the transition to university. By demonstrating that high role affirmation can coexist with elevated conflict and burnout, the findings illustrate the multidimensional nature of college student role identity and underscore the complexity of early adaptation in demanding STEM contexts. Moreover, demographic factors and social interactions were differentially associated with profile membership, suggesting that role identity may be situated not only within individual characteristics but also within relational and institutional environments. These findings highlight variation in the role-related experiences of first-year STEM students and provide a basis for future longitudinal research on how such patterns may change over time.

Data availability statement

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

Ethics statement

The studies involving humans were approved by Institutional Review Board of East China Normal University. 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

TD: Conceptualization, Writing – original draft, Data curation. CJ: Writing – original draft, Formal analysis, Methodology. YJ: Writing – review & editing, Writing – original draft, Investigation, Conceptualization, Supervision.

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