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The relationship between the learning environment and medical students' professional identity formation: A cross-sectional study in Egypt

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Abstract

Background

Professional identity formation (PIF) is an important component of medical education. Following Egypt's 2017 transition to the 5 + 2 medical education model, this study assessed PIF and perceptions of the learning environment and examined their association among undergraduate medical students.

Methods

A cross-sectional study was conducted from June to September 2025 across Egyptian medical schools spanning public, private, and Al-Azhar sectors. Data were collected via convenience and snowball sampling using an online self-administered questionnaire. PIF was measured using the Developing Scale (DS) and learning environment perceptions using the Johns Hopkins Learning Environment Scale (JHLES). Multivariable linear regression models were used to identify factors associated with PIF scores.

Results

A total of 1,094 students (mean age 21.0 ± 1.7 years; 51.1% female) were included. The mean DS score was 67.1 (SD = 9.7), and the mean JHLES score was 86.1 (SD = 15.8). In multivariable regression, PIF scores were positively associated with community of peers (β = 0.58), inclusion and safety (β = 0.66), and academic climate (β = 0.21) (all $p < 0.05$), whereas meaningful engagement was inversely associated (β = -0.52, $p < 0.001$). Studying professionalism in the curriculum and extracurricular participation were also positively associated with PIF, while external pressure for medical school entry and senior academic year were associated with lower scores.

Conclusions

Peer community, inclusion and safety, and academic climate were positively associated with PIF, while meaningful engagement showed an inverse association. Longitudinal research is needed to clarify these relationships and their directionality.

Introduction

Professional identity formation (PIF) is increasingly recognized as a central goal of medical education, reflecting the development of how learners understand, enact, and experience themselves as members of the medical profession [1]. Rather than representing the acquisition of professional behaviors alone, PIF is a dynamic and longitudinal process through which students negotiate professional values, roles, and expectations alongside their pre-existing identities [2]. Professional identity therefore is recognized

to develop through the ongoing interactions between learners and the social contexts in which they learn and participate in medicine [3].

Contemporary conceptualizations have further emphasized that PIF involves both active participation in shaping one's professional identity and a sense of belonging within the profession. Sternszus et al. [4] recently reconceptualized PIF as a process of “being, becoming, and belonging,” highlighting that students’ PIF involves active engagement with, rather than passive assimilation of, professional norms. In this framework, learners enter medical education with pre-existing personal and professional identities, including their reasons for entering medicine, and subsequently encounter professional cultures, role expectations, and social norms [5–9]. The responses to these experiences may range from acceptance and adaptation to negotiation, resistance, or rejection [10], while the extent to which students can maintain a sense of authenticity may depend partly on whether their educational environments allow them to participate as active members of the learning community. Opportunities to exercise agency, develop relationships with peers and faculty, and experience inclusion may consequently be relevant to how students construct a sense of who they are becoming as physicians, as well as their belonging to the profession [6, 11].

Within medicine, the learning environment provides the social and educational context in which these processes occur. In a systematic scoping review of 204 studies, Sarraf-Yazdi et al. [12] synthesized influences on PIF into an integrated input-process-outcome model, identifying relational and practice cultures, the hidden curriculum, and broader institutional and societal factors as important inputs. Interactions with peers, patients, and faculty can provide opportunities for observation, feedback, reflection, and professional socialization, while institutional hierarchies, clinical experiences, and implicit norms may challenge students' existing understandings of what it means to be a physician [13, 14]. Formal educational structures may also shape these experiences by determining students' roles, opportunities for participation, assessment, and reflection. When these experiences are accompanied by appropriate support and opportunities for reflection, students may integrate emerging professional values with their existing identities [15–17]; however, in the absence of adequate support or psychological safety, they may instead contribute to unresolved identity dissonance, alienation, or disengagement [4, 12].

Empirical studies illustrate how these different aspects of the learning environment may influence professional identity development. Park and Hong [18], in a qualitative study among Korean medical students, found that an isolated and competitive learning culture hindered professional identity development, whereas informal interactions with patients and senior doctors supported students' understanding of becoming a physician. Similarly, Karnieli-Miller et al. [19] found that students' observations of attending physicians and residents shaped their understanding of professionalism, while Silveira et al. [20] found that negative role modeling and unreflective clinical practices created dissonance between students' desired and emerging professional identities. Phillips and Clarke [21] likewise showed that teachers' attitudes and behaviors communicated implicit professional values through the hidden curriculum, influencing how students understood the kind of physician they should

become. Quantitative evidence has also identified direct associations between perceived learning environment and PIF. Mukhalalati et al. [22] reported a positive relationship between the two among undergraduate health professional students, while Findyartini et al. [23] identified the curriculum, workplace-based learning, and external expectations as external factors affecting the PIF processes of Indonesian medical students.

Despite international evidence establishing the significant influence of the educational environment on PIF, empirical research within Egypt remains remarkably limited, particularly following the country's major medical education reform. In 2017, Egyptian medical education transitioned from the traditional six-year program followed by a one-year internship to a five-plus-two (5 + 2) model, with the stated aim of aligning undergraduate education with the competency-based National Academic Reference Standards through integrated curricula and earlier clinical exposure [24]. However, emerging evidence suggests that challenges within the educational environment persist despite these structural changes. A recent nationwide cross-sectional evaluation of 7,264 fresh graduates from 27 Egyptian medical schools found moderate overall satisfaction with medical education, alongside persistent concerns regarding academic workload, frequent assessments, and adaptation to the educational program [25]. Other national evidence has similarly documented perceptions of a highly stressful learning environment, widespread reliance on passive memorization, and examinations perceived to emphasize rote recall [26]. Notably, passive learning environment perceptions have also been associated with greater reliance on surface learning [26], suggesting that the post-reform educational context may continue to shape how students approach learning and, potentially, their developing professional identities. Yet, despite these concerns, no study to our knowledge has specifically examined the post-reform learning environment in Egypt in relation to PIF. This represents an important gap, as the adoption of competency-based curricula does not necessarily ensure that students experience an educational environment that supports the development of a coherent professional identity. Accordingly, this study aimed to assess PIF among Egyptian medical students, examine their perceptions of the post-reform learning environment, and investigate the association between PIF and the learning environment.

Methods

Study design and period

A descriptive cross-sectional study with an analytical component was conducted from June to September 2025. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [27]; a completed STROBE checklist detailing our adherence to each reporting item is provided as Supplementary Material (Supplementary Material 1).

Population and setting

The study population included first through fifth years undergraduate medical students. Interns were excluded as their training and clinical learning environments differ substantially from undergraduate medical students. Students who didn't provide informed consent and those with incomplete responses were also excluded.

Medical education in Egypt is delivered through three higher education sectors: public universities (enrolling 70.1% of students), private universities (23.4%), and the Al-Azhar system (6.5%), which operates under a distinct curriculum framework with separate male and female faculties. To promote representation across sectors and facilitate comparisons by institutional background, participants were recruited from medical schools spanning all three sectors. Participating institutions also spanned all major regions of Egypt, which account for different proportions of the country's medical student population: (Lower Egypt (35.8%), Upper Egypt, (25.8%) urban governorates (37.4%), and frontier governorates (1%) [28].

Sample size

The sample size was calculated using the samplingbook package [29] in R [30]. The Developing Scale (DS) yields scores ranging from 15 to 105 for the overall professional identity formation score. To estimate the standard deviation, the range (90) was divided by 4, adhering to the range rule of thumb, resulting in a standard deviation of 22.5. Considering a 95% confidence level, a margin of error of 3, and a standard deviation of 22.5, a sample size of 217 was calculated. Assuming a design effect of 4, the targeted sample size was 868. A total of 1,125 students completed the questionnaire; after data cleaning, 31 responses were excluded due to incomplete data, yielding a final analytic sample of 1,094.

Sampling method and data collection approach

Data collection took place between June and September 2025 using a convenience and snowball sampling approach. Data collection was timed to coincide with the end of the academic year for all cohorts to assess their PIF and perceptions of the learning environment following completion of that year's curriculum, with the exception of fifth year students who were still undergoing exams during the data collection period.

Students participated in the study by answering the questionnaire online on the FormNX form hosting platform. The survey link was sent to the official academic channels and groups on Telegram and other social media platforms of the selected Egyptian medical schools. At least one author or data collection collaborator took charge of collecting data from each university, disseminating the questionnaire in the official groups of all academic years, guaranteeing extensive reach, and making it accessible to all students. In addition, the survey was shared within the authors' academic networks, and participants were encouraged to further disseminate it among their peers.

To enhance the representativeness of the sample, efforts were made to collect responses from each region and higher education sector in proportions broadly reflecting their estimated shares of the national medical student population, while also seeking a balanced distribution across academic years. Participation was voluntary and anonymous, with students able to complete the questionnaire freely. As a non-monetary incentive, participants were informed that they would be able to view their PIF score after submitting the form.

Study questionnaire

Data were collected using an English, self-administered, online questionnaire comprising three sections (Supplementary Material 2).

The first section gathered participant characteristics, including age (in years), academic year, sex, and university. It also asked whether medical professionalism was included in the curriculum, required clinical records (a clinical logbook, a clinical portfolio, both, or neither), the decision to enter medical school (personal choice, shared decision, or external pressure), first-generation status, and extracurricular participation.

The second section assessed participants' PIF using the Developing Scale (DS) [31]. The DS consists of 15 items rated on a 7-point Likert scale ranging from 1 (completely inapplicable) to 7 (greatly applicable). Items reflecting a lack of emotional control or prioritizing one's own needs over professional duties are reverse-coded, ensuring that higher total scores consistently indicate a higher degree of personal maturation, socialization, and acceptance of professional values. The instrument was developed based on Kegan’s model of human development [32] to evaluate the core features of PIF. The scale demonstrated acceptable internal consistency with an overall Cronbach’s alpha of 0.72 in the development study [31].

The third section assessed perceptions of the educational climate using the Johns Hopkins Learning Environment Scale (JHLES) [33]. The JHLES is a 28-item instrument rated on a 5-point Likert scale (ranging from 1 = strongly disagree/not at all to 5 = strongly agree/tremendously), with negatively worded items reverse-coded so that higher scores consistently reflect a more positive perception of the learning environment. Grounded in social [34] and experiential [35] learning theory, the scale is divided into seven subscales: Community of Peers (6 items), Faculty Relationships (6 items), Academic Climate (5 items), Meaningful Engagement (4 items), Mentoring (2 items), Inclusion and Safety (3 items), and Physical Space (2 items). Its internal structure validity is supported by exploratory factor analysis, which yielded a seven-factor structure explaining 57% of the variance in the development study [33].

Statistical Analysis

Statistical analyses and data summaries were performed using R software [30] and jamovi [36], with tables prepared using the SummaryTables module in jamovi [37]. Categorical data were presented as

frequencies and percentages, whereas continuous data were presented as means and standard deviations (SD). Univariable and multivariable linear regression models were used to identify factors associated with professional identity formation scores. Within these models, unstandardized coefficients (B), standardized coefficients (β), and their 95% confidence intervals (CI) were calculated. A p-value < 0.05 was considered statistically significant.

Results

Participant demographics and characteristics

Among 1,094 medical students, the mean age was 21.0 years (SD = 1.7), and 51.1% were female. Most attended public universities (64.4%), were from Lower Egypt (40.7%), and were first-generation medical students (68.6%). Fifth-year students comprised the largest academic group (25.4%). Medical school entry was by shared decision for 46.3%, personal choice for 42.5%, and external pressure for 11.2%. Most had studied professionalism (82.6%), while 41.0% maintained a clinical portfolio and 46.7% participated in extracurricular activities (Table 1).

Table 1
Characteristics of the study sample of medical students in Egypt (N = 1,094)

Variable	Overall[1]
Age (years)	21.0 (1.7)
Academic year	
1st year	133 (12.2%)
2nd year	237 (21.7%)
3rd year	259 (23.7%)
4th year	187 (17.1%)
5th year	278 (25.4%)
Sex	
Female	559 (51.1%)
Male	535 (48.9%)
University category	
Public	704 (64.4%)
Private/Al-Ahleya	305 (27.9%)
Al-Azhar	85 (7.8%)
Region	
Lower Egypt	445 (40.7%)
Urban	341 (31.2%)
Upper Egypt	247 (22.6%)
Frontier	61 (5.6%)
Studied professionalism in the curriculum	
No	190 (17.4%)
Yes	904 (82.6%)
Required records during medical school	
Neither	285 (26.1%)
A clinical logbook	130 (11.9%)

[1]Mean (SD); n (%)

Variable	Overall[1]
A clinical portfolio	449 (41.0%)
Both	230 (21.0%)
Decision to enter medical school	
Personal choice	465 (42.5%)
Shared decision	506 (46.3%)
External pressure	123 (11.2%)
First-generation medical student	
No	343 (31.4%)
Yes	751 (68.6%)
Extracurricular activities participation	
No	583 (53.3%)
Yes	511 (46.7%)

[1]Mean (SD); n (%)

Overall DS and JHLES scores

The mean PIF score on the DS was 67.1 (SD = 9.7; 95% CI = 66.6, 67.7; mean POMP = 57.9%). The mean JHLES score was 86.1 (SD = 15.8; 95% CI = 85.2, 87.1; mean POMP score = 51.9%). Among JHLES subscales, physical space (mean POMP score = 57.3) and inclusion and safety (56.9) scored highest, whereas meaningful engagement (45.6) and mentoring (47.2) scored lowest (Table 2).

Table 2
Descriptive statistics of Johns Hopkins Learning Environment Scale and Developing Scale scores among medical students in Egypt (N = 1,094)

Scale Subscale	Mean (SD)	95% CI	Range	Mean POMP score
Learning environment (JHLES)	86.1 (15.8)	85.2, 87.1	34–133	51.9
Community of peers	19.2 (4.4)	18.9, 19.5	6–30	55.0
Faculty relationships	18.8 (4.7)	18.5, 19.1	6–30	53.2
Academic climate	14.7 (3.9)	14.4, 14.9	5–25	48.3
Meaningful engagement	11.3 (3.4)	11.1, 11.5	4–20	45.6
Mentoring	5.8 (2.0)	5.7, 5.9	2–10	47.2
Inclusion and safety	9.8 (2.7)	9.7, 10.0	3–15	56.9
Physical space	6.6 (1.7)	6.5, 6.7	2–10	57.3
Professional identity formation (DS)	67.1 (9.7)	66.6, 67.7	33–99	57.9

Abbreviations: CI = Confidence Interval, DS = Developing Scale, JHLES = Johns Hopkins Learning Environment Scale, POMP = Percentage of Maximum Possible

Responses to DS and JHLES items

On the DS, the highest endorsement was observed for awareness of one's position as a physician (66.1% applicable) and considering the long-term significance of current actions (65.1%), whereas intolerance toward sympathetic colleagues with differing mindsets was the most reported inapplicable item (54.3%) (Table 3). On the JHLES, positive perceptions were highest for encountering inspiring faculty role models (53.4% agree), ease of making friends (48.6%), and feeling a sense of community (47.4%). Conversely, dissatisfaction was most prominent regarding student involvement in curricular decisions (46.1% disagree) and faculty taking time to get to know students (39.3% disagree) (Table 4).

Table 3
Responses to Developing Scale items among medical students in Egypt (N = 1,094)

Item	Inapplicable	Neutral	Applicable
I cannot tolerate that colleagues who sympathize with my actions have a different mindset from me.	594 (54.3%)	243 (22.2%)	257 (23.5%)
I find it difficult to suppress my desires and act rationally.	507 (46.3%)	263 (24.0%)	324 (29.6%)
It is difficult for me to adjust and act according to the different values of each medical professional and the demands for physicians.	484 (44.2%)	300 (27.4%)	310 (28.3%)
I have never thought about the reasons or principles behind the required code of conduct.	434 (39.7%)	438 (40.0%)	222 (20.3%)
I am sometimes unable to do something I was not interested in despite understanding its necessity.	414 (37.8%)	199 (18.2%)	481 (44.0%)
The way I behave in medical settings is not my true self.	491 (44.9%)	261 (23.9%)	342 (31.3%)
I behave correctly as a physician on a daily basis.	248 (22.7%)	351 (32.1%)	495 (45.2%)
I am aware of my position as a physician.	160 (14.6%)	211 (19.3%)	723 (66.1%)
I have accepted the words of gratitude and the frustration and anger of patients as a personal evaluation of myself.	461 (42.1%)	246 (22.5%)	387 (35.4%)
I consider long-term significance and concerns when I think about what I should do now.	148 (13.5%)	234 (21.4%)	712 (65.1%)
I have used my own beliefs and ideals as a standard to evaluate my own actions as a physician.	237 (21.7%)	247 (22.6%)	610 (55.8%)
If I were able to play a role in improving society and organizations, I would be satisfied even if I did not receive individual recognition.	195 (17.8%)	218 (19.9%)	681 (62.2%)
I induce action in the people around me based on the principles I believe in to fulfill my role as a physician.	172 (15.7%)	325 (29.7%)	597 (54.6%)
I take on various roles in accordance with the demands of society.	172 (15.7%)	306 (28.0%)	616 (56.3%)
I feel that I need to change my current mindset and everyday behavior.	235 (21.5%)	243 (22.2%)	616 (56.3%)

Data are presented as n (%). The scale ranges from 1 (completely inapplicable) to 7 (greatly applicable), with 4 indicating neutral. For presentation, responses 1–3, 4, and 5–7 were grouped as Inapplicable, Neutral, and Applicable, respectively.

Table 4
Responses to Johns Hopkins Learning Environment Scale items among medical students in Egypt (N = 1,094)

Item	Disagree	Neutral	Agree
Community of peers			
How connected do you feel to other SOM students?[1]	306 (28.0%)	429 (39.2%)	359 (32.8%)
How supported do you feel in your personal and professional pursuits by other SOM students?[1]	326 (29.8%)	459 (42.0%)	309 (28.2%)
It's been easy to make friends at the SOM.	215 (19.7%)	347 (31.7%)	532 (48.6%)
I feel a sense of community at the SOM.	183 (16.7%)	392 (35.8%)	519 (47.4%)
To what extent have you felt a sense of belonging during your time as a student at the SOM?[1]	314 (28.7%)	403 (36.8%)	377 (34.5%)
I've encountered an abundance of positive, inspiring role models among fellow students at the SOM.	173 (15.8%)	419 (38.3%)	502 (45.9%)
Faculty relationships			
I feel that the SOM faculty I encounter are supportive of my professional goals.	218 (19.9%)	434 (39.7%)	442 (40.4%)
I feel that SOM faculty members have taken the time to get to know me.	430 (39.3%)	404 (36.9%)	260 (23.8%)
I feel that the SOM faculty I encounter genuinely care about my well-being.	355 (32.4%)	429 (39.2%)	310 (28.3%)
I've encountered an abundance of positive, inspiring faculty role models at the SOM.	159 (14.5%)	351 (32.1%)	584 (53.4%)
There are faculty members that I feel comfortable confiding in when important concerns come up.	257 (23.5%)	367 (33.5%)	470 (43.0%)
The faculty advisors in the Colleges Advisory Program are readily accessible and interested in students.	274 (25.0%)	447 (40.9%)	373 (34.1%)
Academic climate			
Our medical school's curriculum allows me to use my preferred learning style.	412 (37.7%)	348 (31.8%)	334 (30.5%)
I feel that course exams and assessments test my knowledge and abilities fairly.	389 (35.6%)	375 (34.3%)	330 (30.2%)
I understand the goals and objectives of the SOM curriculum.	221 (20.2%)	380 (34.7%)	493 (45.1%)

Item	Disagree	Neutral	Agree
Community of peers			
To what extent do you trust that the institution has fulfilled your needs as a medical student?[1]	387 (35.4%)	454 (41.5%)	253 (23.1%)
The workload during medical school is manageable.	391 (35.7%)	408 (37.3%)	295 (27.0%)
Meaningful engagement			
The SOM engages students as meaningful participants.	302 (27.6%)	468 (42.8%)	324 (29.6%)
The SOM is flexible and responsive to my needs as a student.	409 (37.4%)	371 (33.9%)	314 (28.7%)
I feel that I have a say in decision making about courses and curricular changes.	504 (46.1%)	346 (31.6%)	244 (22.3%)
The SOM encourages scholarship and innovation.	351 (32.1%)	453 (41.4%)	290 (26.5%)
Mentoring			
I've found a mentor in a research field that interests me.	419 (38.3%)	408 (37.3%)	267 (24.4%)
I've found a mentor in a clinical specialty or discipline that I am passionate about.	344 (31.4%)	402 (36.7%)	348 (31.8%)
Inclusion and safety			
I am concerned that students are mistreated at the SOM.	341 (31.2%)	377 (34.5%)	376 (34.4%)
I sense there is discrimination based on gender, race, ethnicity, or sexual identity at the SOM.	601 (54.9%)	265 (24.2%)	228 (20.8%)
I feel concerned at times for my personal safety at the SOM.	484 (44.2%)	324 (29.6%)	286 (26.1%)
Physical space			
The preclinical SOM building has a significant effect on my perception of the learning environment.	203 (18.6%)	444 (40.6%)	447 (40.9%)
The work spaces where clinical teaching occurs contributes positively to my sense of the SOM learning environment.	186 (17.0%)	422 (38.6%)	486 (44.4%)

[1]For these items, the original response options “Not at all” and “A little” are combined as Disagree, “A fair amount” as Neutral, and “A lot” and “Tremendously” as Agree.

Abbreviation: SOM = School of Medicine

Item	Disagree	Neutral	Agree
Community of peers			

Data are presented as n (%). For presentation, the original response options “Strongly disagree” and “Disagree” were grouped as Disagree, “Neutral” was retained, and “Agree” and “Strongly agree” were grouped as Agree.

Factors associated with professional identity formation

Multivariable linear regression analysis identified several variables significantly associated with PIF scores among the medical students (Table 5).

Male students exhibited lower PIF scores compared to female students (B = -1.48; 95% CI = -2.51, -0.45). Senior students in their 4th year (B = -3.02; 95% CI = -5.00, -1.03) and 5th year (B = -3.66; 95% CI = -5.62, -1.69) had significantly lower PIF scores compared to 1st-year students. Students in Al-Azhar universities had lower scores than those in public universities (B = -3.91; 95% CI = -6.00, -1.81), whereas students from Upper Egypt had higher scores than those from Lower Egypt (B = 1.94; 95% CI = 0.52, 3.35).

Regarding educational background, studying professionalism in the curriculum (B = 2.31; 95% CI = 0.95, 3.67) and participating in extracurricular activities (B = 1.32; 95% CI = 0.29, 2.36) were associated with higher PIF scores. Conversely, students whose entry was a shared decision (B = -2.36; 95% CI = -3.43, -1.28) or driven by external pressure (B = -4.11; 95% CI = -5.82, -2.40) had significantly lower PIF scores compared to personal choice. Maintaining a clinical logbook was also associated with lower PIF scores compared to neither (B = -2.58; 95% CI = -4.35, -0.82).

Among learning environment domains, community of peers (B = 0.58; 95% CI = 0.45, 0.72), inclusion and safety (B = 0.66; 95% CI = 0.46, 0.86), and academic climate (B = 0.21; 95% CI = 0.02, 0.40) were positively associated with PIF scores. In contrast, meaningful engagement was inversely associated with PIF scores (B = -0.52; 95% CI = -0.75, -0.29).

Table 5
Linear regression analysis of professional identity formation scores among medical students in Egypt (N = 1,094)

Variable	Professional identity formation (DS)[1]	Univariable regression			Multivariable regression[3]		
		B (95% CI)	β (95% CI)[2]	p-value	B (95% CI)	β (95% CI)[2]	p-value
Academic year							
1st year	70.7 (10.5)	—	—		—	—	
2nd year	68.2 (9.5)	-2.54 (-4.57, -0.51)	-0.262 (-0.472, -0.052)	**0.014**	-1.64 (-3.47, 0.19)	-0.169 (-0.358, 0.019)	0.078
3rd year	67.2 (10.4)	-3.51 (-5.51, -1.51)	-0.362 (-0.569, -0.156)	**< 0.001**	-1.70 (-3.56, 0.15)	-0.176 (-0.368, 0.016)	0.072
4th year	66.0 (8.3)	-4.69 (-6.82, -2.57)	-0.485 (-0.704, -0.265)	**< 0.001**	-3.02 (-5.00, -1.03)	-0.312 (-0.517, -0.107)	**0.003**
5th year	65.3 (9.1)	-5.39 (-7.37, -3.42)	-0.557 (-0.761, -0.353)	**< 0.001**	-3.66 (-5.62, -1.69)	-0.378 (-0.580, -0.175)	**< 0.001**
Sex							
Female	68.2 (9.7)	—	—		—	—	
Male	66.1 (9.6)	-2.14 (-3.28, -1.00)	-0.221 (-0.339, -0.103)	**< 0.001**	-1.48 (-2.51, -0.45)	-0.153 (-0.259, -0.046)	**0.005**
University category							
Public	66.8 (9.6)	—	—		—	—	
Private/Al-Ahleya	69.3 (9.5)	2.50 (1.22, 3.79)	0.259 (0.126, 0.391)	**< 0.001**	1.32 (-0.08, 2.71)	0.136 (-0.008, 0.280)	0.064
Al-Azhar	62.7 (9.6)	-4.03 (-6.18, -1.88)	-0.416 (-0.638, -0.194)	**< 0.001**	-3.91 (-6.00, -1.81)	-0.403 (-0.620, -0.187)	**< 0.001**
Region							
Lower Egypt	66.4 (9.8)	—	—		—	—	
Urban	67.2 (10.0)	0.76 (-0.60, 2.12)	0.079 (-0.062, 0.219)	0.27	1.37 (-0.01, 2.74)	0.141 (-0.001, 0.283)	0.052

Variable	Professional identity formation (DS)[1]	Univariable regression			Multivariable regression[3]		
		B (95% CI)	β (95% CI)[2]	p-value	B (95% CI)	β (95% CI)[2]	p-value
Upper Egypt	67.1 (9.0)	0.71 (-0.79, 2.21)	0.073 (-0.081, 0.228)	0.35	1.94 (0.52, 3.35)	0.200 (0.053, 0.346)	**0.008**
Frontier	72.0 (8.3)	5.53 (2.95, 8.10)	0.571 (0.305, 0.837)	**< 0.001**	0.92 (-1.57, 3.42)	0.095 (-0.163, 0.353)	0.47
Studied professionalism in the curriculum							
No	64.7 (9.1)	—	—		—	—	
Yes	67.7 (9.7)	3.01 (1.50, 4.52)	0.311 (0.155, 0.467)	**< 0.001**	2.31 (0.95, 3.67)	0.238 (0.098, 0.379)	**< 0.001**
Required records during medical school							
Neither	67.2 (10.0)	—	—		—	—	
A clinical logbook	63.7 (8.8)	-3.52 (-5.51, -1.52)	-0.363 (-0.569, -0.157)	**< 0.001**	-2.58 (-4.35, -0.82)	-0.267 (-0.449, -0.084)	**0.004**
A clinical portfolio	67.5 (9.3)	0.33 (-1.10, 1.75)	0.034 (-0.114, 0.181)	0.65	-1.11 (-2.40, 0.18)	-0.115 (-0.248, 0.018)	0.091
Both	68.3 (10.0)	1.10 (-0.57, 2.77)	0.113 (-0.059, 0.286)	0.20	0.69 (-0.84, 2.22)	0.071 (-0.087, 0.229)	0.38
Decision to enter medical school							
Personal choice	69.5 (9.4)	—	—		—	—	
Shared decision	66.1 (9.3)	-3.35 (-4.54, -2.16)	-0.346 (-0.469, -0.223)	**< 0.001**	-2.36 (-3.43, -1.28)	-0.243 (-0.354, -0.132)	**< 0.001**
External pressure	62.5 (9.9)	-6.95 (-8.82, -5.07)	-0.718 (-0.911, -0.524)	**< 0.001**	-4.11 (-5.82, -2.40)	-0.424 (-0.601, -0.248)	**< 0.001**
First-generation medical student							

Variable	Professional identity formation (DS)[1]	Univariable regression			Multivariable regression[3]		
		B (95% CI)	β (95% CI)[2]	p-value	B (95% CI)	β (95% CI)[2]	p-value
No	67.5 (10.0)	—	—		—	—	
Yes	67.0 (9.5)	-0.47 (-1.70, 0.77)	-0.048 (-0.176, 0.080)	0.46	-0.17 (-1.26, 0.92)	-0.018 (-0.130, 0.095)	0.76
Extracurricular activities participation							
No	65.9 (9.8)	—	—		—	—	
Yes	68.6 (9.4)	2.67 (1.53, 3.82)	0.276 (0.158, 0.394)	**< 0.001**	1.32 (0.29, 2.36)	0.137 (0.030, 0.244)	**0.012**
Community of peers		0.70 (0.58, 0.82)	0.320 (0.263, 0.376)	**< 0.001**	0.58 (0.45, 0.72)	0.268 (0.204, 0.331)	**< 0.001**
Faculty relationships		0.48 (0.36, 0.60)	0.234 (0.176, 0.291)	**< 0.001**	0.15 (-0.01, 0.32)	0.075 (-0.006, 0.156)	0.069
Academic climate		0.51 (0.36, 0.65)	0.206 (0.148, 0.264)	**< 0.001**	0.21 (0.02, 0.40)	0.086 (0.010, 0.162)	**0.027**
Meaningful engagement		0.26 (0.09, 0.42)	0.091 (0.032, 0.150)	**0.003**	-0.52 (-0.75, -0.29)	-0.185 (-0.267, -0.102)	**< 0.001**
Mentoring		0.58 (0.29, 0.87)	0.117 (0.058, 0.176)	**< 0.001**	-0.05 (-0.37, 0.27)	-0.010 (-0.075, 0.055)	0.77
Inclusion and safety		0.88 (0.67, 1.08)	0.245 (0.188, 0.303)	**< 0.001**	0.66 (0.46, 0.86)	0.185 (0.130, 0.240)	**< 0.001**
Physical space		0.88 (0.55, 1.21)	0.156 (0.097, 0.214)	**< 0.001**	0.24 (-0.09, 0.57)	0.042 (-0.017, 0.101)	0.16

Variable	Professional identity formation (DS)[1]	Univariable regression			Multivariable regression[3]		
		B (95% CI)	β (95% CI)[2]	p-value	B (95% CI)	β (95% CI)[2]	p-value

[1]Mean (SD)

[2]The outcome and continuous predictors were standardized; categorical predictors were not.

[3]R^2 = 0.275; Adjusted R^2 = 0.258; F(25, 1068) = 16.23, p < 0.001; Residual SD = 8.34

Abbreviations: B = Unstandardized Coefficient, CI = Confidence Interval, DS = Developing Scale, JHLES = Johns Hopkins Learning Environment Scale, β = Standardized Coefficient

Discussion

In this cross-sectional study of medical students in Egypt, PIF was significantly associated with several learning environment domains and student and educational characteristics. Together, these findings are consistent with contemporary conceptualizations of PIF as a process shaped by both individual factors and the learning environment [4, 5].

Students in this study demonstrated a moderate level of PIF, with a mean DS score of 67.1 out of 105 (POMP 57.9%). This score was somewhat higher than those reported in studies utilizing the same scale among medical students in Iran (60.5) [38] and Indonesia (approximately 64) [23], and among Chinese medical interns (64.2) [39]. These findings place the level of PIF observed in our sample within the range reported in other medical student populations, although direct comparisons should be interpreted cautiously given differences in study populations, sampling methods, and educational contexts.

In this light, the medical students in this study reported a moderate overall perception of their learning environment, with a mean JHLES score of 86.1 out of 140 (POMP 51.9%). This was slightly higher than scores reported at King Saud University in Saudi Arabia (81.0) [40] and across six medical colleges in Pakistan (81.75) [41], but substantially lower than the score of 107 reported in the original U.S. validation study [33]. The findings are also consistent with recent national evaluations of medical education in Egypt. In a nationwide assessment of the post-reform system involving 7,264 recent graduates from 27 medical schools, Hosny et al. [25] reported an overall satisfaction score of 2.94 out of 5, with particularly low ratings for the physical and psychosocial learning environment (2.71) and for providing constructive feedback (2.94). Similarly, Omar et al. [26] found that Egyptian medical students experienced the post-reform educational climate as predominantly characterized by passive learning and memorization (80.6% of the maximum score) and competitiveness and stress (77.1%), whereas centrality of learning and mutual respect received substantially lower scores (59.0%). Within this broader context, meaningful engagement was inversely associated with PIF scores in our multivariable analysis. This finding contrasts with previous research reporting positive relationships between professional identity and learning engagement among medical students. Li et al. [42], using network analysis, identified

professional identity and learning engagement as positively connected among medical students, while Lu et al. [43] reported a positive correlation between the two constructs. Similarly, Adema et al. [44] described meaningful engagement in clinical experiences and interactions with patients, peers, and physicians as contributing to professional identity development. However, these studies examined engagement with learning or clinical experiences, whereas the JHLES meaningful engagement domain primarily captures students' perceptions of institutional responsiveness and participation in educational decision-making. In our sample, only 22.3% agreed that they had a say in decisions regarding courses and curricular changes, and 28.7% agreed that the school was flexible and responsive to their needs. Thus, the inverse association should not be interpreted as evidence that engagement itself is detrimental to PIF. It may instead reflect the distinct nature of institutional engagement captured by this JHLES domain. Nevertheless, longitudinal and qualitative studies are needed to clarify this unexpected association.

In this study, the community of peers, inclusion and safety, and academic climate domains of the JHLES were positively associated with PIF scores, consistent with recent conceptual frameworks highlighting that students' professional identities are shaped, at least partly, by the social and educational environments in which they learn [4, 12]. Our findings are also consistent with the empirical findings of Bullock et al. [6], who, using grounded theory with medical students, found that identity safety involved feeling a sense of belonging and being able to participate authentically within the learning environment. Similarly, Yakes et al. [45], in a qualitative study of preclerkship medical students, found that learning communities supported PIF through connections with peers and faculty, psychological safety, and meaningful relationships. More recently, House and Kelly [46] reported that medical students participating in clerkship process groups described peer connection and psychological safety as important to their professional development. Together, these findings suggest that PIF may be shaped not only by formal curricular experiences but also by the quality of students' social relationships, sense of inclusion, and broader academic environment. However, these findings should be interpreted cautiously, as the studies primarily used qualitative or mixed-methods approaches, and the cross-sectional design of our study does not establish a causal relationship.

Regarding educational background, studying professionalism within the curriculum was positively associated with PIF scores. This finding is consistent with the view that professionalism education provides an important cognitive foundation for professional identity development. Indeed, Cruess et al. [47] argue that PIF should be an explicit educational objective and that curricula should provide students with knowledge about professionalism while creating opportunities for active engagement in developing their professional identities. Similarly, Forouzadeh et al. [48] described professionalism education as an essential component of developing professional identity, while Kalet et al. [49] demonstrated the feasibility of incorporating PIF and professionalism-related measures within a theory-based professionalism curriculum for early medical students. Interestingly, we found that maintaining a clinical logbook was associated with lower PIF scores compared with maintaining neither a logbook nor portfolio. This finding contrasts with literature describing logbooks and portfolios as potential tools for reflection and professional identity development [15, 50]. However, their educational value may depend

substantially on how they are implemented. Campbell et al. [51] reported that dental students found written clinical logbooks suboptimal for deep reflection, with end-of-session documentation described as rushed, stressful, and lacking meaningful reflection. A similar pattern may occur in some Egyptian medical schools, where, based on the authors' experience, clinical logbooks may be completed retrospectively and under time pressure toward the end of the semester, with entries sometimes reproduced from peers rather than reflecting students' own clinical experiences. If so, such practices may limit the reflective and developmental functions of the logbook and could help explain why logbook use was not associated with higher PIF in our sample. However, this interpretation is based on contextual observation rather than directly measured data and should therefore be considered hypothesis-generating. Differences in academic year, clinical setting, and institutional requirements may also contribute to the observed association.

Among the personal factors examined, compared with students who reported choosing medicine personally, those whose decision was shared with others had lower PIF scores, while those who reported entering medicine because of external pressure had still lower scores. This finding is consistent with those of Liang and Fan [52], who found higher professional identity among students who had actively chosen their medical major compared with those who had not. Similarly, Faihs et al. [53], reported a positive association between professional identity and motivation for medical school among first-year medical students in Germany. Taken together, these findings suggest that entering medicine through a personally endorsed choice may provide a motivational context more conducive to developing a professional identity. Conversely, when entry is substantially shaped by external expectations, students may have less opportunity to initially integrate medicine with their own values and sense of self. However, because our measure captured the reported basis for choosing medicine rather than autonomy or motivation directly, and because of the cross-sectional design, this interpretation remains tentative.

Limitations

This study has several limitations. The cross-sectional design precludes causal inference, and longitudinal studies are needed to clarify the direction and stability of the observed associations. Convenience and snowball sampling, primarily through social media and academic groups, may have underrepresented students less active on these platforms despite efforts to balance the sample across regions and university sectors. A response rate could not be calculated because the number of students who received the survey link was unknown, preventing assessment of non-response bias. Self-reported data may also be subject to social desirability bias, particularly for professional attitudes and behaviors. Although the DS and JHLES are validated instruments, they have not been formally validated in Egypt, and cultural or language differences may have affected responses. Their quantitative nature also limits insight into unexpected findings, such as the inverse associations with meaningful engagement and clinical logbook use, which warrant qualitative investigation. Finally, unmeasured factors, including personality traits and institution-specific differences, may have contributed to the observed associations.

Conclusions

Egyptian medical students reported moderate PIF, with scores associated with both learning environment domains and individual and educational characteristics. Peer community, inclusion and safety, academic climate, professionalism education, and extracurricular participation were associated with higher PIF, whereas meaningful engagement, external pressure to enter medicine, and senior academic years were associated with lower scores. Given the cross-sectional design, these findings do not establish causality. Longitudinal and qualitative research is needed to clarify these associations and better understand PIF in post-reform medical education.

Declarations

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No funding or sponsorship was received from any companies, groups, individuals, organizations, or any other entities.

Competing Interests

The authors declare that they have no conflict of interest.

Data Availability

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

Ethical approval

Ethical approval was obtained from the Institutional Research Board (IRB) of Mansoura University's Faculty of Medicine (approval code: R.25.04.3156), and the study was conducted according to the principles of the Helsinki Declaration. All participants were invited to voluntarily and anonymously complete an online survey, provided electronic informed consent, and were free to respond at their convenience.

Author contributions

Yusof Mohamed Omar and Nour Edin Darwish contributed equally to this work. Yusof Mohamed Omar and Nour Edin Darwish: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing; Mohamed Ashraf Elsaadany, Renad Akram, and Abdelrahman Yasser Kilany: Data curation, Investigation, Writing – original draft; Omar Johar: Writing – original draft, Writing – review & editing; Egypt Medical Education Collaborative: Data curation, Investigation; Abdel-Hady El-Gilany: Supervision, Methodology, Writing – review & editing. All authors reviewed and approved the final manuscript.

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Clinical trial number

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Consent for publication

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Consent for participation

All participants were invited to voluntarily and anonymously complete an online survey, provided electronic informed consent, and were free to respond at their convenience.

Declaration of generative AI use

Generative AI tools were used in a very limited capacity to assist with language and grammar refinement. All AI-generated outputs were reviewed and revised by the authors, who remain fully responsible for the final manuscript.

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