












## Students' motivation and engagement in interprofessional education: the mediating role of peer relatedness

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### ABSTRACT

**Introduction:** Students' peer relatedness is vital to their academic achievement and engagement. However, little is known about the mechanisms that can explain such a link in health professions education, especially in interprofessional education (IPE), where interprofessional socialization is promoted. To address the research gap in understanding the social dynamics embedded within IPE and their impact on crucial motivational outcomes, this study examines how peer relatedness (belonging) mediates the link between motivation (both intrinsic and extrinsic) and engagement in IPE.

**Methods:** Data from 841 students enrolled in IPE from Medicine, Nursing, Social Work, Chinese Medicine, Pharmacy, Speech and Hearing Sciences, Clinical Psychology, and Food and Nutritional Science from a university in Hong Kong were used in this study. Intrinsic and extrinsic motivation were collected at baseline, while peer relatedness need satisfaction and engagement and disaffection in IPE were assessed after four weeks. We used a fully latent structural equation model to examine whether peer relatedness mediated the link between motivation and engagement in IPE.

**Results:** Our results indicate that intrinsic motivation at baseline significantly increases engagement and reduces disaffection four weeks later, while extrinsic motivation shows the opposite effect. Crucially, the adaptive role of motivation to engagement was significantly mediated by relatedness from IPE teams. Specifically, the effect of students' motivation on their engagement/disaffection in IPE can be partially explained by their relatedness within IPE teams.

**Conclusion:** This study underscores the importance of peer relatedness in IPE, highlighting its role in harnessing student motivation to foster student engagement. The findings contribute to a deeper understanding of the psychosocial mechanisms in IPE and highlight the value of collaborative learning environments in fulfilling students' need for relatedness, thereby fostering adaptive IPE learning outcomes. The implications and limitations of the study are also discussed.

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motivation; interprofessional education; engagement; peer relatedness; mediation

## Introduction

The interplay of peer relatedness in educational settings, particularly in Interprofessional Education (IPE), is a burgeoning research area within health professions education. Peer relatedness, which encompasses the formation of deep emotional connections and a strong sense of belonging among peers, is increasingly acknowledged as a pivotal factor in learning and motivational outcomes [1,2]. As

a basic psychological need [3,4], relatedness stems from an inherent desire for acceptance and connection and is linked to intrinsic motivation [5], achievement, and engagement [6], gaining substantial research attention. Despite the known importance of social interactions in learning environments [7], the link between motivation and peer relatedness and the engagement outcomes they predict remain insufficiently explored, especially in the context of IPE.

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Interprofessional Education cultivates team-based, patient-centered care that cuts across professional silos. Research has demonstrated its positive impacts on team effectiveness, patient safety, and cost reduction [8–10]. IPE also underscores the importance of relatedness in building trust and understanding among healthcare professionals. However, despite these advancements, the underlying mechanisms of these collaborative outcomes, particularly in terms of motivation and social processes, are not fully understood [11,12]. Hence, guided by the Self-Determination Theory (SDT) as a framework [4], this study aims to examine the role of peer relatedness in IPE, specifically exploring how it mediates the relationship between student motivation and engagement. By doing so, it seeks to contribute to the theoretical understanding and practical application of social-cognitive concepts in health professions education and collaborative learning environments [13].

### *Student motivation and engagement in IPE*

Motivation is a key driver of student engagement in education [4,14]. Specifically, while extrinsic motivation is detrimental to students' achievement [15], intrinsic motivation, which stems from inherent satisfaction of autonomy, competence, and relatedness, promotes greater engagement, effort, persistence, and performance [4]. This may be applicable to IPE, where students' motivation plays a crucial role in students' active participation and engagement in IPE learning activities [16–18]. For instance, intrinsically motivated students are more likely to engage in IPE activities and collaborate effectively with peers, through which their relatedness needs may be satisfied (e.g., Hadie et al.) [19].

### *The role of sense of relatedness in boosting engagement*

Relatedness refers to feelings of closeness, belongingness, and meaningful connections with others [1,4]. Empirical evidence shows that relatedness is linked to adaptive and optimal educational outcomes, including intrinsic motivation, achievement, and engagement [5,6]. For instance, in school settings, students who experience a greater sense of school belonging tend to be more motivated, engaged, and successful academically [1,2]. However, less is known about how peer relatedness specifically promotes engagement and optimal outcomes in IPE contexts.

IPE fulfils relatedness needs by enabling students to form close bonds with peers from different healthcare backgrounds. However, the mechanisms linking peer relatedness through IPE to engagement outcomes are underexplored. Clarifying how relatedness

translates to adaptive IPE outcomes like behavioral engagement can extend SDT-based research in healthcare education and address the need for greater social science integration in IPE research, ultimately optimizing IPE programs to foster students' relatedness and engagement [9,20,21].

### *The dynamic link between motivation and relatedness*

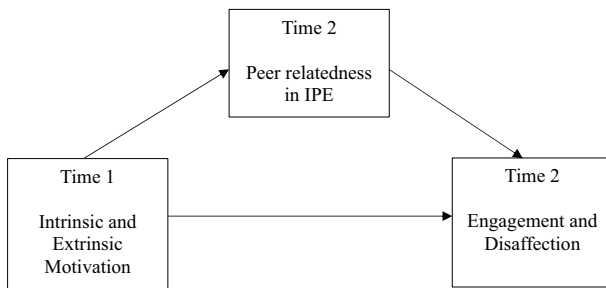
While SDT often suggests that a sense of relatedness is a driver of motivation, the potential reciprocal or bidirectional link between these two constructs is relatively unexplored, especially in the context of IPE. Specifically, students' baseline IPE motivation may shape their subsequent sense of relatedness with peers. Research shows that motivation creates interaction patterns fulfilling relatedness [22,23]. For instance, motivated students initiate more social connections [24]. In turn, relatedness gained through engaging in meaningful IPE interactions may also help satisfy students' belongingness needs, which can, in turn, reinforce and maintain their intrinsic motivation over time [1,25,26].

Relatedness may also influence perceptions of competence, affecting help-seeking motivation [27,28]. For example, Butler [27] found that students' perceptions of their competence, which can be influenced by their sense of relatedness, can affect their motivation to seek help. This finding suggests that the relationship between motivation and sense of relatedness can be complex and influenced by other factors, such as perceived competence.

Hence, the relationship between intrinsic motivation and relatedness in IPE is likely dynamic and bidirectional. Students with higher baseline intrinsic motivation may be more inclined to actively participate in IPE, through which positive social connections can fulfill their relatedness needs. Conversely, satisfying relatedness through genuinely engaging with interprofessional peers in learning activities may also promote and sustain students' intrinsic interest in collaborative education over time. While intrinsic motivation can facilitate IPE engagement from which relatedness is developed, satisfying relatedness through participation may also reciprocally reinforce intrinsic motivation.

### *Interprofessional education as a learning context*

Interprofessional Education and Collaborative Practice (IPECP) is considered one of Asia's largest interprofessional simulation programmes, with an annual average of 1,644 health and social care students being trained. The programme offers authentic experiential learning to develop interprofessional collaboration-related competencies among health and



**Figure 1.** The hypothesized model.

Examining how the role of intrinsic motivation on students' engagement and disaffection on IPE is mediated by their sense of relatedness with their peers

social care students. These efforts are in response to the call of various health organizations to promote team-based healthcare. At the core of the program, we developed a psychologically informed IPE model that immerses the students in a four-part series of activities referred to as preparation, readiness assurance, application, and enrichment (PRAE) using team-based learning [29,30] and case-based learning [31]. We provide further details of this four-part PRAE Model in Appendix A.

### The present study

Guided by SDT, this study aims to examine the links among motivation, engagement, and disaffection, and how peer relatedness mediates such links in an IPE context. We hypothesized that intrinsic motivation would positively predict engagement and negatively predict disaffection, whereas extrinsic motivation would negatively predict engagement and positively predict disaffection ( $H_1$ ). Furthermore, we expected these relationships to be partially mediated by peer relatedness need satisfaction developed through IPE activities ( $H_2$ ). Our hypothesized model is shown in Figure 1. This study aims to make a theoretical contribution by examining the impact of relatedness need satisfaction on IPE learning outcomes and expanding the nomological network of sense of relatedness in the context of IPE.

## Methods

### Participants and procedures

Of the 883 undergraduate students (Time 1) who filled out the questionnaires, 841 (Time 2; 95.24% retention rate) provided complete data and were then utilized for the analyses. They were from eight disciplines at a government-subsidized university in Hong Kong: Chinese Medicine ( $n = 24_{T1}$ ;  $n = 24_{T2}$ ), Clinical Psychology ( $n = 19_{T1}$ ;  $n = 17_{T2}$ ), Food and Nutritional Sciences ( $n = 70_{T1}$ ;  $n = 59_{T2}$ ), Medicine ( $n = 197_{T1}$ ;  $n = 189_{T2}$ ), Nursing ( $n = 270_{T1}$ ;

$n = 260_{T2}$ ), Pharmacy ( $n = 73_{T1}$ ;  $n = 67_{T2}$ ), Social Work ( $n = 139_{T1}$ ;  $n = 135_{T2}$ ), and Speech and Hearing Sciences ( $n = 91_{T1}$ ;  $n = 90_{T2}$ ). Of the sample with complete data ( $n = 841$ ), 369 (43.9%) were second-year students, 260 (30.9%) were third-year students, and 212 (25.2%) were fourth-year students. There were 297 (35.3%) male and 544 (64.7%) female participants, with an average age of 21.91 ( $SD = 2.41$ ). They responded to the online questionnaires in Qualtrics across the two time points, within the four-week IPE PRAE simulation programme (Appendix A). Their participation in this study was entirely voluntary, and those who agreed to participate signed consent forms. Their participation or non-participation did not have any impact on their course assessment marks. This project obtained ethics approval from the Human Research Ethics Committee for Non-Clinical Faculties of the University of Hong Kong (EA210432).

## Measures

### Intrinsic and extrinsic motivation

Perceived Locus of Causality scale adapted to IPE (PLOC-IPE; 20 items) [32] was used to evaluate the reasons behind students' participation in the IPE, specifically the extent to which students believed their actions were caused by intrinsic or extrinsic reasons [33,34]. In this study, we used the four-item intrinsic motivation and the four-item extrinsic motivation subscales. Mean scores were calculated for each subscale. Sample items include 'Because IPE is interesting (intrinsic;  $\alpha = 0.89$ )' and 'Because I want my fellows to think of me as a good student (extrinsic  $\alpha = 0.67$ ) to which participants can respond using a scale ranging from 1 'completely disagree' to 6 'completely agree'. A previous study that utilized the PLOC-IPE among health professions students found good construct validity and reliability estimates ( $\alpha = 0.77$  to 0.93) for its subscales [32].

### Sense of relatedness

The relatedness scale [1] was adapted to the IPE context by adjusting its instructions (i.e., 'When I'm with my teammates in IPE' instead of 'When I'm with my classmates';  $\alpha = 0.72$ ). Participants can respond to each item using a scale ranging from 1, 'slightly characteristic or true of me', to 4, 'extremely characteristic or true of me'. Responses for all items were averaged. The adapted scale, composed of four items, has been found to have good psychometric properties ( $\alpha = 0.85$ ) in a previous study involving health professions education students [35].

### Behavioral engagement and disaffection

Two subscales of Engagement versus Disaffection with Learning Questionnaire (EDLQ) [36] were

used. They are behavioral engagement (5 items; ‘*I try hard to do well in IPE activities*,’  $\alpha = 0.89$ ) and behavioral disaffection (5 items; ‘*When I’m in IPE, I just act like I’m working*,’  $\alpha = 0.82$ ). Participants can respond to each item using the response scale ranging from 0, ‘not true at all’, to 3, ‘very true’. Mean scores for each subscale were calculated. Previous studies among health professions students also used this scale which yielded good validity and reliability [35,37].

Given the good validity, reliability, and utility of the abovementioned scales among health professions student samples, we utilized such scales in the present study.

### Data analysis

The analyses in the study were performed in R [38] using Rosseel’s lavaan package [39]. We used a fully latent structural equation model (SEM) to test the effect of intrinsic and extrinsic motivation (Time 1) on engagement and disaffection (Time 2) and the potential mediating role of relatedness need satisfaction from IPE (Time 2). As a first step, we tested the structural models of the instruments used. Relatedness need satisfaction was entered as a mediator between intrinsic and extrinsic motivation as predictors and engagement and disaffection as outcomes. To test the IPE relatedness mediating effect, we included four indirect effects in the model: the indirect effect of intrinsic motivation to (1) engagement and (2) disaffection, and the indirect effect of extrinsic motivation to (3) engagement and (4) disaffection. The indirect effects represent the pathways through which IPE-relatedness mediates motivation–engagement relationships.

We used the maximum likelihood estimator with robust standard errors and a Satorra-Bentler scaled test statistic to test the model. Then, we resampled the model with 2000 bootstraps to test the indirect effects of the two mediators accurately [40]. The

models were assessed using various goodness-of-fit indices following the criteria proposed by Hu and Bentler [41]: Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Specifically, a desirable fit was indicated by CFI and TLI values greater than .90, an RMSEA value less than .08, and an SRMR value less than .08 [42].

### Results

The descriptive statistics and intercorrelations among the variables, represented by latent covariances, are shown in Table 1. Intrinsic motivation was positively associated with IPE relatedness ( $r = 0.14$ ,  $p < .01$ ) and engagement ( $r = 0.25$ ,  $p < .001$ ) while being negatively related to disaffection ( $r = -0.22$ ,  $p < .001$ ). Extrinsic motivation, on the other hand, showed a positive correlation with behavioral disaffection ( $r = 0.13$ ,  $p < .01$ ). IPE relatedness was positively associated with behavioral engagement ( $r = 0.29$ ,  $p < .001$ ) and negatively with behavioral disaffection ( $r = -0.34$ ,  $p < .001$ ).

Table 1 also shows the internal reliability estimates for each of the measurement scales used in this study, ranging from  $\alpha = 0.67$  to 0.89, while Table 2 shows the excellent fit indices of the structural validity of the measurement scales.

The SEM model (see Supplementary Figure S1) had an excellent fit to the data,  $SB\chi^2(196) = 564.186$ , CFI = 0.943, TLI = 0.933, RMSEA = 0.056, SRMR = 0.066, suggesting that the proposed model adequately represents the observed data. The results of the direct effects (see Figure 2 and Table 3) indicate that intrinsic motivation at Time 1 positively predicted IPE relatedness at Time 2 ( $\beta = 0.17$ ,  $p < .01$ ) and engagement at Time 2 ( $\beta = 0.23$ ,  $p < .001$ ) and negatively predicted disaffection at Time 2 ( $\beta = -0.23$ ,  $p < .001$ ). Time 1 extrinsic motivation, on the other hand, had no statistically significant

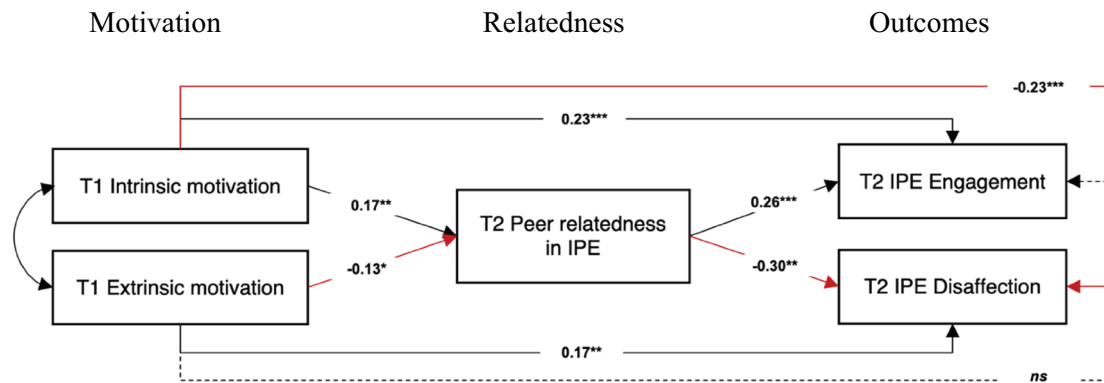
**Table 1.** Latent covariance among study variables.

	1	2	3	4	5
(1) Intrinsic motivation	(0.89)				
(2) Extrinsic motivation	0.26***	(0.67)			
(3) IPE Relatedness	0.14**	-0.09	(0.72)		
(4) Behavioral engagement	0.25***	-0.03	0.29***	(0.89)	
(5) Behavioral disaffection	-0.22***	0.13**	-0.34***	-0.42***	(0.82)
Mean	3.71	3.63	1.93	2.14	1.11
SD	0.97	0.86	0.38	0.46	0.54
Skewness/Kurtosis	-0.73/0.74	-0.27/0.39	0.70/3.45	-0.39/2.27	0.27/1.25

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ ; Coefficients in parentheses are reliability estimates.

**Table 2.** Fit indices of the structural validity of the measurement scales.

Measure	Structural model	CFI	TLI	RMSEA	90% Confidence Interval	SRMR
Intrinsic and extrinsic motivation (PLOC-IPE)	2-factor	0.958	0.931	0.08	0.072–0.108	0.076
Sense of relatedness	1-factor	0.993	0.955	0.106	0.040–0.192	0.018
Behavioral engagement and disaffection	2-factor	0.949	0.931	0.064	0.080–0.112	0.064



**Figure 2.** The mediating role of sense of relatedness from IPE peers on the link between motivation and engagement. Black lines = significant positive effects; red lines = significant negative effects; dashed lines are non-significant effects. \* =  $p < .05$ , \*\* =  $p < .01$ , \*\*\* =  $p < .001$ . T1 = time 1, T2 = Time 2. All variables are latent variables but are not shown for parsimony.

**Table 3.** The direct, indirect, and total effects of the structural equation model examining the mediating role of IPE relatedness between motivation and engagement.

				Std. est.	SE	p	95% Confidence Interval		
							Lower	Upper	
<i>Direct effects</i>									
Intrinsic Motivation	→	Engagement		0.234	0.015	0.000	—	—	
Extrinsic Motivation	→	Engagement		-0.063	0.025	0.144	—	—	
Intrinsic Motivation	→	Disaffection		-0.225	0.011	0.000	—	—	
Extrinsic Motivation	→	Disaffection		0.165	0.018	0.002	—	—	
Intrinsic Motivation	→	IPE Relatedness		0.170	0.007	0.001	—	—	
Extrinsic Motivation	→	IPE Relatedness		-0.132	0.010	0.011	—	—	
IPE Relatedness	→	Engagement		0.255	0.195	0.000	—	—	
IPE Relatedness	→	Disaffection		-0.295	0.170	0.003	—	—	
<i>Indirect effects</i>									
Intrinsic Motivation	→	IPE Relatedness	→	Engagement	0.043	0.005	0.001	0.006	0.025
Extrinsic Motivation	→	IPE Relatedness	→	Engagement	-0.034	0.007	0.007	-0.033	-0.005
Intrinsic Motivation	→	IPE Relatedness	→	Disaffection	-0.050	0.003	0.000	-0.017	-0.005
Extrinsic Motivation	→	IPE Relatedness	→	Disaffection	0.039	0.005	0.009	0.003	0.023
<i>Total effects</i>									
Intrinsic Motivation	→	IPE Relatedness	→	Engagement	0.278	0.015	0.000	0.070	0.130
Extrinsic Motivation	→	IPE Relatedness	→	Engagement	-0.097	0.025	0.029	-0.104	-0.006
Intrinsic Motivation	→	IPE Relatedness	→	Disaffection	-0.275	0.012	0.000	-0.084	-0.035
Extrinsic Motivation	→	IPE Relatedness	→	Disaffection	0.204	0.020	0.000	0.031	0.108

effect on engagement. However, it positively predicted disaffection at Time 2 ( $\beta = 0.17, p < .001$ ) and negatively predicted IPE relatedness at Time 2 ( $\beta = -0.13, p < .05$ ). Still, on direct effects, relatedness to IPE teammates positively predicted engagement ( $\beta = 0.26, p < .001$ ) and negatively predicted disaffection ( $\beta = -0.30, p < .01$ ).

For the indirect effects (see Table 3), the resampled model with 5000 non-parametric bootstraps shows that the indirect effects of intrinsic motivation on engagement ( $\beta = 0.04, p < .01, 95\% \text{ CI } [0.006, 0.025]$ ) and disaffection ( $\beta = -0.050, p < .001, 95\% \text{ CI } [-0.017, -0.005]$ ) through IPE relatedness as mediator were statistically significant. The indirect effects of extrinsic motivation on engagement ( $\beta = -0.034, p < .01, 95\% \text{ CI } [-0.033, -0.005]$ ) and disaffection ( $\beta = 0.039, p < .01, 95\% \text{ CI } [0.003, 0.023]$ ) were also statistically significant. These indirect effects demonstrate partial mediating effects.

The results show that students' baseline motivation for IPE holds statistically significant implications for engagement and disaffection on IPE. More importantly, the

findings also show that the effect of motivation on engagement in IPE is partially explained by the sense of relatedness that students experience among IPE teammates.

### Discussion

The present study aimed to examine the links among motivation, engagement, and disaffection, and how peer relatedness mediates such links in an IPE context. We hypothesized that intrinsic motivation would positively predict engagement and negatively predict disaffection, whereas extrinsic motivation would negatively predict engagement and positively predict disaffection ( $H_1$ ). We also hypothesized that these relationships would be partially mediated by peer relatedness need satisfaction developed through IPE activities ( $H_2$ ).

Our results show that students' high intrinsic motivation at Time 1 predicted their high sense of relatedness with their IPE teammates and

engagement at Time 2. Specifically, intrinsic motivation at Time 1 positively predicted IPE relatedness and engagement at Time 2 while concurrently showing a negative association with disaffection at Time 2. In contrast, extrinsic motivation at Time 1, although not significantly influencing engagement, was linked to decreased IPE relatedness and increased disaffection at Time 2, providing partial support to hypothesis 1. Consistent with hypothesis 2, the indirect effects further corroborated the partial mediating role of IPE relatedness. This finding suggests that while students' initial motivation for IPE has implications for both their engagement and disaffection in IPE activities, the sense of relatedness they experience with peers plays a pivotal role in determining these outcomes. In essence, while intrinsic motivation fosters engagement and reduces disaffection, the sense of relatedness with peers facilitates these effects, underscoring the intertwined nature of motivation and social connections in shaping students' experiences in interprofessional educational settings.

Intrinsic motivation positively influenced engagement in IPE. This finding aligns with prior studies asserting that students who are internally motivated often find activities to be inherently meaningful, leading to greater investment in the learning process [9,43]. This is further supported by the SDT, which emphasizes the importance of autonomy and relatedness in fostering intrinsic motivation [5,26]. Moreover, when students perceive activities as intrinsically rewarding, the sense of belonging and camaraderie with teammates seems to be enhanced, reducing the likelihood of disaffection. [2,6]

Conversely, while extrinsic motivation might drive students to participate initially, it appeared to be less effective in fostering sustained engagement and was associated with increased disaffection over time. Over-reliance on extrinsic factors, such as rewards or fear of punishment, can sometimes undermine the genuine internal drive for learning and lead to higher levels of disaffection [4,44]. This is consistent with Butler's [27] findings on help-seeking behaviors, where perceived reasons for classroom help-avoidance were linked to extrinsic motivations.

Peer relatedness emerged as a key mechanism for translating intrinsic motivation into higher IPE engagement. When intrinsically motivated students experience greater belongingness among interprofessional peers, relatedness needs are fulfilled [1,25]. In turn, this acceptance and value within IPE teams enhanced active engagement and participation in collaborative activities [5,45].

Our findings extend this principle to IPE, highlighting the power of peer relatedness, specifically in translating students' intrinsic motivation into heightened behavioral engagement in collaborative IPE activities. The intrinsically motivated students likely

felt a greater sense of belongingness with their interprofessional peers, fulfilling their relatedness needs. In turn, this greater relatedness satisfaction from feeling accepted and valued within their IPE teams boosted their active participation and engagement in the collaborative components of the program [5,45].

Therefore, peer relatedness appears to be a key mechanism allowing students' intrinsic motivation for the interprofessional learning experience to be translated into adaptive engagement outcomes. Satisfying belongingness needs through positive interprofessional peer interactions and relationships may be pivotal in unlocking the motivational potential of IPE programs [46]. As Deci and Ryan [45] contend, relatedness is central to converting motive to action. This underscores the importance of intentionally designing IPE initiatives to foster relatedness through activities facilitating meaningful interprofessional connections [47,48]. Doing so can optimize engagement in collaborative learning among intrinsically motivated students.

From a pedagogical standpoint, the importance of IPE in health professions has been increasingly recognized [48,49]. However, from our current data, fostering an environment where relatedness can flourish is equally crucial. This assertion is consistent with the findings of Coster et al. [50] and Eccott et al. [51], emphasizing the importance of crafting opportunities where students can genuinely connect in IPE settings.

### *Limitations and directions for future research*

Our study has limitations. Self-report measures might introduce biases, suggesting the need for more objective measures like behavioral observations in future research. The sample of students from a single university hinders generalizability, underscoring the importance of broader IPE samples in future studies. In addition, the current study did not include students' level of expertise which can be considered in future studies. More measurement points in future longitudinal studies can offer detailed insights into engagement trajectories. Qualitative data, such as interviews, can also enrich our understanding of students' IPE experiences. Cross-cultural and experimental studies manipulating relatedness in IPE programs can further validate the causal relationships implied by our findings.

### **Conclusion**

This study highlights the complex interplay among intrinsic motivation, extrinsic motivation, and peer relatedness in shaping students' engagement and disaffection in IPE. Our findings indicate that intrinsically motivated students tend to experience a stronger sense of relatedness with their peers, which, in turn, increases their likelihood of remaining actively

engaged in IPE activities. Conversely, extrinsic motivation does not predict engagement and may even lead to increased disaffection over time. This finding suggests that students' motivation for collaborative and interprofessional learning environments can influence their sense of relatedness in teams, ultimately impacting their engagement outcomes.

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## Disclosure statement

No potential conflict of interest was reported by the author(s).

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## Data availability statement

The data that support the findings of this study can be requested from the first author upon reasonable request.

## Ethical approval

The ethics and procedures of this study were approved by the Human Research Ethics Committee for Non-clinical Faculties of the University of Hong Kong with approval number EA210432.

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## Appendix A

### The intervention

IPE PRAE (preparation, readiness assurance, application, enrichment) is informed by self-determination theory [4] in programme development designed to foster students' collaboration-related behaviors. Inherent to this psychologically informed model is the integration of diverse learning activities (Figure A1) to meet students' three basic psychological needs: autonomy (students represent their expertise the best that they can), competence (students reflect on their disciplinary prior knowledge in answering MCQs and in managing the patient), and relatedness (students interact with other students) to facilitate autonomous motivation leading to the achievement of target learning outcomes. IPE PRAE was implemented in an existing cross-institutional IPE programme [35] involving two collaborating higher educational institutions (HEIs) in Hong Kong, and it is embedded within specified courses in both HEIs where students enrolled in such courses are immersed in the IPE PRAE programme.

To optimize the engagement and cohesion of all eight disciplines involved in the teams, we strategically structured the ten days into four weeks. This approach allowed ample time for each discipline to complete its diverse tasks while fostering the development of strong team cohesiveness. This ten-day period is also the most feasible duration that accounts for the overall course structures and timeline of all eight disciplines. The schedule included Part 1 (3 days to complete tasks, Week 1), Part 2 (2 days to complete tasks, Weeks 2), Part 3 (4 days to complete tasks, Week 3), and Part 4 (1 day, Week 4).

### Part 1: Preparation (P)

The IPE curriculum adopted a flipped classroom pedagogical design [52], in which the position of homework and classwork was swapped, allowing learners to engage in knowledge construction aided by instructional technology. We infused diverse learning activities to promote a sense of community, sense of relatedness, and social presence (e.g., developing trust and team cohesiveness early in teams to enable learners to transition from forming to performing [53]). Using the Open edX Learning Management System (<https://openedx.org/>), students worked in small interprofessional teams composed of around seven to ten interdisciplinary members to co-achieve the following pre-class activities online: e-meet your team, name your team, make sense of the pre-class study material using Perusall annotation board [54], write multiple-choice questions based on the pre-class materials, and write reflections on the important lessons learned from working together as a team.

### Part 2: Readiness Assurance (R)

The readiness assurance aimed to strengthen the development of teamwork and collaboration [55]. In line with cognitive presence, this warm-up activity

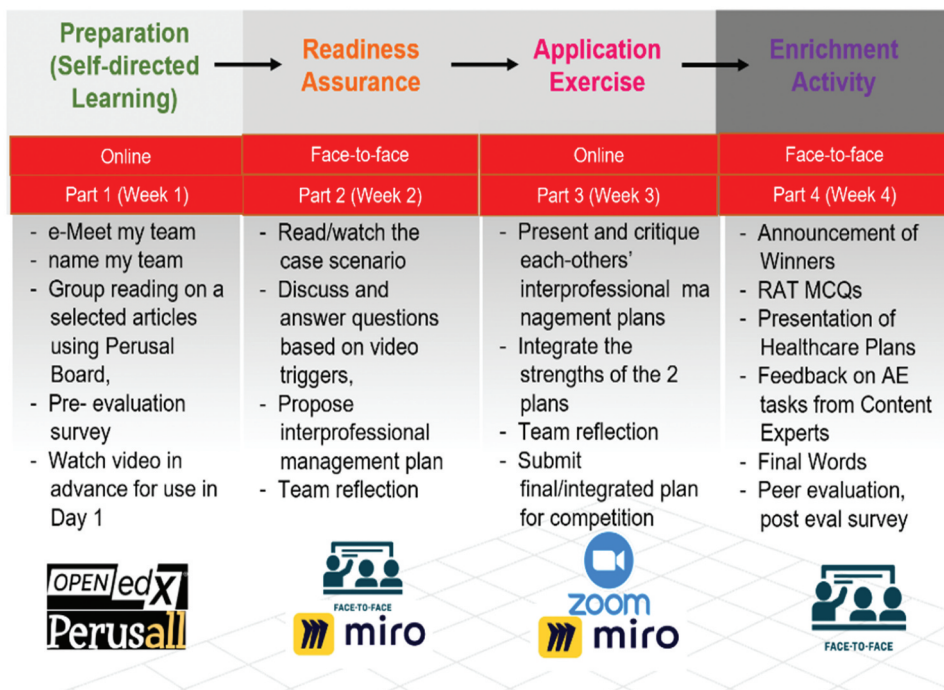


Figure A1. The IPE PRAE model implemented at the University of Hong Kong.

was designed to enable the diverse expertise in teams to get mentally prepared to manage the patient adequately in Part 3. Readiness assurance was applied through a set of multiple-choice questions (MCQs) written by the multi-disciplinary context experts based on the pre-class study materials. The MCQs were designed to foster interprofessional discussion and respectful communication. The small team discussions using Zoom videoconferencing software are facilitated by both faculty and student facilitators (i.e., near-peer teachers).

Given the importance of contextual triggers to enable the team members to work together, the programme utilized both faculty and student facilitators of in-person team discussions. The faculty facilitators (i.e., teachers) have experience in interprofessional team-based teaching, while student facilitators, called near-peer-teachers, have previously completed the Peer Teaching Certificate Programme offered at the designated university (redacted for peer-review purposes). A part of the near-peer-teachers' teaching induction included serving as discussion facilitators during the interprofessional education programme.

### **Part 3: Application Exercise (AE)**

Informed by Kolb's experiential learning theory [56] which underscores the dialectical relationship between knowing and doing, an application exercise followed readiness assurance. The application exercise was implemented by having small teams watch video-triggered clinical cases with supplementary written accounts. Among many objectives in promoting important and relevant skills such as teamwork and collaboration, respectful communication, conflict resolution, and decision-making, the primary goal of the team was to manage the patient through interprofessional healthcare management planning. This part develops not only the students' need for relatedness but also their need

for autonomy and competence as we explicitly encouraged them to represent their expertise within their teams in the best way they could. We applied the constructive controversy framework [57], in which two teams were placed into a breakout room to present and challenge each other's completed care plan, seek to understand the reasoning of the other team, reflect on potential conceptual change, and eventually yield integrated solutions. Furthermore, the teams were required to provide a written justification for their care plans, explaining why their care plan deserved recognition as the best in interprofessional care, an award that will be given during the interactive session in Part 4.

### **Part 4: Enrichment Activity (EA)**

The interactive session was the culminating activity where the teams and content experts (IPE teachers) met in a large lecture theatre for a plenary debriefing. The enrichment activity was a gamified part of the design where we used game-based elements to make learning fun and engaging [58]. The Application Exercise (AE) from Part 3 was the reference by the content experts in providing feedback to the teams through a large session debriefing. Additionally, when the content experts rationalized the team's responses to multiple-choice questions in the AE, teams were randomly selected to elucidate on the collaborative processes they encountered that led to their consensus on their chosen team answers. The highlight of the EA was the announcement and presentation of the winning teams' interprofessional healthcare management plans where content experts also provided feedback regarding the teams' care plans. These interactions and evaluations aimed to promote critical reflection and sharing of successful approaches among participating teams.