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Exploring health and allied science students' achievement emotions profiles: a person-centered analysis

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Abstract

Background While achievement emotions have gained prominence in education, research remains scarce in interprofessional education (IPE) contexts where students also experience complex combinations of emotions. This study uses a person-centered approach to explore health and allied science students' achievement emotions profiles in an IPE setting, capturing the full spectrum of emotional experiences, to identify clusters of achievement emotions in profiles, clarify between-profile differences, and establish the link between such profiles and student outcomes.

Methods We measured the participants' achievement emotions, team experience, and satisfaction with life using validated scales, as well as their team readiness and overall IPE performance. Data from 240 Chinese healthcare and allied science students enrolled in an interprofessional education simulation were analysed via a person-centred approach using K-means cluster analysis, multiple analysis of variance, and t-tests.

Results Three achievement emotion profiles emerged: positive (34%; high positive, low negative), low (28%; low positive, low negative), and mixed (38%; moderate positive, moderate negative). Students with positive profiles showed significantly higher team satisfaction, life satisfaction, and overall IPE performance compared to other clusters. Additional analyses revealed discipline differences, with Law (64%) and Nursing (45%) students showing the highest proportions of positive profiles. Gender analyses indicated that female students reported significantly higher positive emotions and lower negative emotions than male students.

Conclusions This study identified three achievement emotion profiles, with students showing positive emotion profiles demonstrating significantly better team satisfaction, life satisfaction, and IPE performance. Discipline and gender differences suggest that targeted interventions based on emotion profiles could potentially optimize student outcomes in collaborative healthcare education settings.

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Keywords Achievement emotions, Cluster analysis, Person-centred analysis, Interprofessional collaboration, Healthcare students

Introduction

While cognitive constructs have been widely recognized as common factors that explain student achievement, there has been a call to explore the effects of affective aspects to complement cognitive factors in explaining student achievement [1, 2]. Special attention is given to achievement emotions, defined as "emotions tied directly to achievement activities or outcomes"[3], as a non-cognitive construct and its impact on educational outcomes [1, 2, 4]. Previous studies untangled the relationships between achievement emotions (AE) with adaptive outcomes: problem-solving [5], learning persistence [6], engagement [7], motivation [8], satisfaction [9] and achievement [10, 11]. While AE has gained prominence in education and psychology, healthcare education researchers, particularly in interprofessional education (IPE), a context where holistic patient-centred care is promoted by allowing students to learn *with*, *about*, and *from* each other's expertise to improve health outcomes [12], have paid little attention to it. Understanding the impact of AE could provide healthcare educators and interprofessional education programme implementers with a better comprehension of a broad range of emotions experienced by interprofessional students and enable them to draw actionable plans for teaching and practice [1].

The control-value theory [3, 13] serves as a framework for understanding the nomological network of emotions in academic settings. Inherent to the theory is that students' appraisals of control (e.g., perceived causal influence over one's actions and outcomes) and values (e.g., perceived importance of one's actions and outcomes) are important to AE. Positive emotions such as joy and pride promote action repertoire [14], facilitating cognitive functioning. The control-value theory organizes achievement emotions along two dimensions: valence (positive vs. negative) and activation (activating vs. deactivating). While activating-positive emotions (joy, hope, pride) and activating-negative emotions (anger, anxiety, shame) directly influence motivational processes, deactivating emotions such as relief and contentment (positive) or hopelessness and boredom (negative) have different impacts on learning outcomes [15] (see Table 1). Negative emotions are detrimental to students' achievement, while positive emotions are associated with salubrious outcomes [16, 17]. Studies in medical education suggest that both positive and negative emotions are felt by students, such as joy in passing a test, pride in getting admitted to medical school, hopelessness from treating chronically ill patients, and anxiety for fear of malpractice suits [2, 18]. Further, in medical and healthcare education, studies have explored the relationships of AE with motivation, learning, and performance in the Western [1, 4, 19] and Eastern contexts [18, 20–22]. Other studies explored gender differences in AEs in the context of challenging subjects such as Mathematics, where girls reported significantly less enjoyment and pride than boys but a higher level of anxiety, hopelessness, and shame [23].

Recent comprehensive evidence from a large-scale meta-analysis of 120 studies spanning 2000–2024 further demonstrates robust relationships between achievement emotions and learning outcomes [24]. Meta-analytic findings indicate that positive emotions showed moderate-to-large effects on both performance (r =.24) and motivation (r =.46), while negative emotions demonstrated comparable negative effects (r = −.25 and r = −.28, respectively). Importantly, their findings revealed significant cultural moderation, with achievement emotion effects being strongest among Asian student samples compared to North American samples, highlighting the importance of examining these relationships within specific cultural contexts.

In general, understanding Asian students' AE is urgently needed, given the seemingly academic trade-off between achievement and well-being among Asian learners. While they are known as top achievers in multiple international achievement tests such as the Programme for International Student Assessment (PISA) [25, 26], they also reported more negative emotions, such as anxiety and boredom. Specific to medical education, data involving 40,348 medical students revealed that anxiety is most prevalent among medical students from the Middle East and Asia (compared to other global regions) [27], with studies also showing that learning-related boredom significantly impacts medical students' self-regulated learning and increases burnout levels [28]. This finding may be explained by the highest stress load that medical education is known for [29, 30]. Despite these, we refrained from specifying the research hypothesis as our study participants involved diverse interprofessional expertise, including Chinese medicine, engineering, law, MBBS, nursing, pharmacy, social work, and speech and hearing. Considering the importance of AE, especially among students in interprofessional contexts such as in healthcare, a profound understanding of the link between AEs and outcomes is needed to inform theory and practice not only in medical education but also in overall healthcare education.

Table 1 A three-dimensional taxonomy of achievement emotions

Object focus	Positive		Negative	
	High arousal (activating)	Low arousal (deactivating)	High arousal (activating)	Low arousal (deactivating)
Activity	Enjoyment	Relaxation	Anger Frustration	Boredom
Outcome/prospective	Hope Joy	Relief	Anxiety	Hopelessness
Outcome/retrospective	Joy Pride Gratitude	Contentment Relief	Shame Anger	Sadness Disappointment

Positive Pleasant emotion, *Negative* Unpleasant emotion. Activating-positive emotions strengthens motivational processes, deactivating-negative emotions undermine motivation

One methodological innovation to understand students' emotions is to describe their AE profile using person-centred analysis. Considering the possibility that students might experience a combination of different AEs, describing them based on their single dominant emotion does not capture the wide spectrum of their emotions. For example, several students may be high in enjoyment because they find delight in working with others, average in anxiety as they also feel anxious about whether they will emerge as a winner in a class competition, and low in anger as they enjoy the class activity. Given such scenarios, therefore, it is important to recognise students' conglomeration of diverse AEs and to understand what AE profiles are adaptive (i.e., more beneficial) and less adaptive (i.e., less beneficial) to their achievement of educational outcomes. Methodologically, utilizing a person-centred approach is beneficial for developing interventions that are sensitive to the diverse needs of individuals with distinct AE profiles [31].

In summary, previous studies on emotions within healthcare education and interprofessional education contexts have been scarce. One possible reason is that emotions have been considered "non-cognitive" factors and were deemed less important in studies in healthcare education [32]. Although previous studies have investigated AEs and their connection with student achievement outcomes such as grades [15], strategy use [33], and engagement [15, 34], little is known about IPE students' AE and the mechanisms by which it affects outcomes. Further, to the best of our knowledge, no study has examined the AE profiles of healthcare students elsewhere, especially in Hong Kong, and their association with student achievement. Describing such profiles and understanding their relationship with cognitive outcomes (e.g., student achievement) and affective outcomes (e.g., team experience) can aid educators in the interprofessional healthcare field in identifying viable teaching strategies and interventions that also capture the affective aspect of students in facilitating their optimal learning.

The present study

This study was conducted during a 10-day cross-university "COVID-19 Infection Control and Management" Interprofessional Education (IPE) simulation course (see Fig. 1) to examine the students' achievement emotions (AEs) and their relationship with various outcomes such as satisfaction with team experience, satisfaction with life, readiness assurance, and overall IPE achievement. The IPE context served as a natural social setting where students experienced diverse emotional episodes

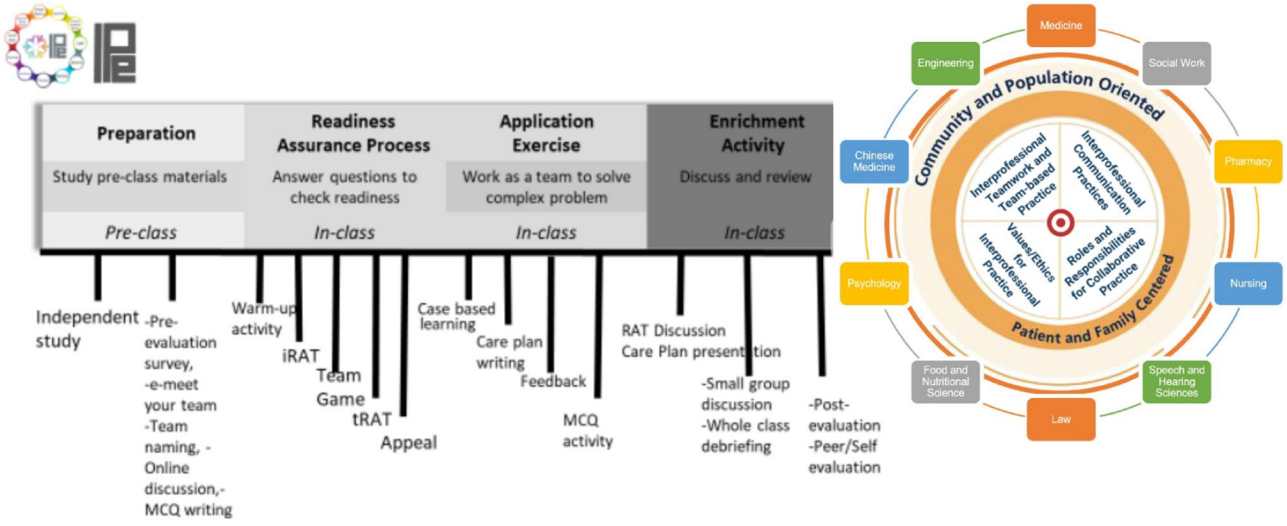

Fig. 1 Sequence of activities for IPE COVID-19 simulation

from their interactions with peers of varying educational, cultural, and linguistic backgrounds. To observe achievement emotions in this natural setting, we designed IPE activities that involved students with diverse educational backgrounds, serving as a test case for our research.

Given the reviewed literature and the context of the study, the aims of this research are threefold. *Firstly*, we aimed to provide an overview of several achievement emotions experienced by healthcare students in a cross-faculty interprofessional education. *Secondly*, we sought to identify distinct achievement emotion profiles among sample IPE students in Hong Kong and establish their association with both affective and cognitive outcomes. We intended to distinguish which profile is the most adaptive by examining between-cluster differences and their association with *affective* (satisfaction with team experience, satisfaction with life) and *cognitive* outcomes (readiness assurance test score and overall performance). *Finally*, we aimed to distinguish gender and discipline differences in achievement emotion profiles to design specific programme improvements.

Overall, this study is important theoretically, methodologically, and practically. Our data would add to the theoretical clarification of the application of control-value theory, particularly in extending the outcomes of emotions in the context of IPE. Methodologically, the use of cluster analysis [35] to examine the naturally occurring AE subgroups among healthcare Asian students is innovative, inviting other researchers to study the same involving non-Asian participants to establish potential cross-cultural generalizability of our findings. Finally, aside from the hope to stimulate a conversation among IPE educators on how to effectively design IPE to promote adaptive AEs, this study could provide beneficial insights to medical and interprofessional educators in understanding the potential linkages of students' achievement emotions on cognitive and affective outcomes.

Methods

Participants and procedures

Among the 323 undergraduate students from two universities in Hong Kong enrolled in an IPE simulation course, 263 students consented and responded to the survey (81% response rate) for this cross-sectional quantitative study. After excluding the participants with more than 5% item-level missing data via listwise deletion [36], the final analytical sample is 240. The final sample included 225 health and social care students and 15 allied non-health students from two government-subsidized higher educational institutions in Hong Kong.

Among the 225 health and social care students, 44.9% were males and 55.1% were females, while among the 15 allied non-health students, 33.3% were males and 66.7% were females. Health and social care students include: nursing ($n = 78$, year 3), medicine ($n = 97$, year 5), pharmacy ($n = 23$, year 4), social work ($n = 16$, year 3), Chinese medicine ($n = 8$, year 5) and speech and hearing sciences ($n = 3$, year 4). On the other hand, allied non-health students include: law ($n = 14$, year 3) and engineering ($n = 1$, year 3).

The procedures of this study complied in accordance to the ethical principles for conducting research involving human participants consistent with the 1964 Helsinki Declaration and its later amendments. Further, before conducting this study, we sought the approval of the Human Research Ethics Committee of the designated university (approval number EA210433). Invitation to participate in this study was given to students who signed an online informed consent form to indicate their voluntary participation. We explained to them that their participation would not affect their marks in the course. Students' participation was voluntary and anonymous.

The online survey was administered during the last day of the ten-day IPE simulation on *COVID-19 Infection Control and Management*. In this study, healthcare, social care, and allied non-health students refer to the disciplines involved in the management of the COVID-19 pandemic. Law students were involved in managing the legal disputes covered by the COVID-19 case, while engineering students were especially important in managing engineering-related structural concerns related to the spread of infection.

Measures

We used the Achievement Emotions Questionnaire-Short Version [15] (AEQ-S) to measure the achievement emotions of the participants. We used the IPE-adapted version, which was also previously validated among interprofessional health and allied science students [37]. The items in the AEQ-SIPE referred to emotional experiences, such as class-related and learning-related emotion items that specifically referred to their IPE class. In the current sample, the scale measures enjoyment (4 items, e.g., '*I enjoy being in IPE*"; α =.96), hope (4 items, e.g., "*I am confident when I go to IPE*"; α =.92), pride (4 items, e.g., *I am proud of myself*"; α =.92), anger (4 items, e.g., "*I am angry*"; α =.93), anxiety (4 items, e.g., "*Even before class, I worry whether I will be able to understand the material*"; α =.90), shame (4 items, e.g., "*I get embarrassed*"; α =.96), hopelessness (4 items, e.g., "*I feel hopeless*"; α =.97), and boredom (4 items, e.g., "*I get bored in IPE*"; α =.95) in the context of IPE. Participants were asked to indicate their agreement with each item using a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). Scores could range from 4 to 20 for each subscale, Scores could range from 4 to 20 for each subscale, with higher scores in each subscale indicating higher levels of the emotion measured.

For the outcome variables, we used the following measures below.

We measured the participants' satisfaction with team experience with the Team Experience Questionnaire [38] (TEQ). This scale was used to estimate students' perception of satisfaction with team experiences in IPE (5 items, e.g., *I have found working as part of an IPE team in my classes to be a valuable experience*, α = 0.95), and it has been validated earlier in the healthcare context [39]. Participants can respond to each of the items using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Scores on this scale could range from 5 to 25, with higher scores indicating excellent team experience. This scale was also used to partly measure the potential affective effect of achievement emotions felt during IPE participation.

We also measured participants' satisfaction with life using the validated Satisfaction with Life scale [40, 41]. This scale has five items that measure a respondent's perceived satisfaction after IPE experience (e.g., "*In most ways my life is close to my ideal*," α = 0.95). This scale is answerable from 1 (strongly disagree) to 5 (strongly agree). Scores for this scale could range from 5 to 20, with higher scores indicating higher satisfaction with life. Along with the TEQ, this scale was also used to evaluate the potential affective effect of achievement emotions among the participants.

Further, we also used the Team Readiness assurance test (tRAT) [42]. Readiness assurance is a concept from team-based learning that evaluates students' preparation out of class to contribute meaningfully to team activities. This six-item multiple-choice test was constructed based on the pre-reading materials and vetted by all the participating teachers from the two involved universities in the IPE "COVID-19 Infection Control and Management" simulation module. As each correctly answered item was scored as two points, the scores for this test could range from 0 to 12 points. Students in each IPE team answered the tRAT as a team.

Lastly, we measured the overall IPE performance of the participants. IPE performance refers to the individual students' composite score in the IPE class, which includes weighted scores for attendance, team scores on application exercise and readiness assurance test (standardized by the participating teachers in IPE), and additional points for the 'best team care plans', and most creative team names (winners for both awards were voted by the participating teachers). Scores range from 0 to 100, with higher scores indicating higher overall IPE performance.

Statistical analysis

All data from the 240 participants were included in the analyses. We used the Statistical Package for the Social Sciences (SPSS) version 28 [43] for all statistical analyses. Hierarchical cluster analysis using Ward's method and squared Euclidean distances was utilised to extract the number of clusters suggested by the data [44]. Based on the control-value theory taxonomy (Table 1), the AEQ-SIPE measured three activating-positive emotions (enjoyment, hope, pride) and five emotions, including activating-negative (anger, anxiety, shame) and deactivating-negative emotions (hopelessness, boredom). For parsimony of interpretation and cluster analysis, we collapsed the three positive activating emotions into a composite 'positive AE' score and the five negative emotions into a composite 'negative AE' score by averaging their respective subscale means. The dendrogram suggested three clusters fit the data best. Furthermore, the three-cluster solution was interpretable and had a good distribution of cases across clusters. Next, a K-means cluster procedure with a three-cluster solution was run to construct the final solution [45, 46]. We used one-way multiple analysis of variance (MANOVA) to compare the three clusters across dependent variables simultaneously and used follow-up univariate ANOVAs. We utilised Scheffe post-hoc to compare the clusters and disciplines on outcomes and *t*-test to examine gender differences. Multiple comparison corrections were applied within specific analyses (Scheffe post-hoc tests), balancing the control of Type I error with the exploratory nature of this person-centered analysis. A p-value of < 0.05 was considered statistically significant.

Results

Achievement emotion clusters among Chinese interprofessional students

Three achievement emotion profiles emerged (see Fig. 2): a positive achievement emotions group (i.e., high positive, low negative; $n = 81$; 34%), a low achievement emotions group (i.e., low positive, low negative; $n = 67$; 28%), and a neutral achievement emotions group (i.e., average positive, average negative; $n = 92$; 38%).

Further, results in Table 2 revealed that there is a large proportion of Law students with a positive achievement emotions profile (64%), a larger proportion of Nursing students with a positive achievement emotions profile (45%), and a large proportion of MBBS students with a negative achievement emotions profile (40%).

Differences among clusters of achievement emotion profiles

One-way MANOVA was used to examine whether differences in these outcomes can be adequately explained by students' AE profiles (see Table 3). The main effect of membership was significant (Pillai's trace = 0.179, F (12, 466) = 3.817, $p < .001$, partial $\eta^2 = 0.09$). We ran follow-up univariate ANOVAs on each dependent variable (i.e., satisfaction with team experiences, satisfaction with life,

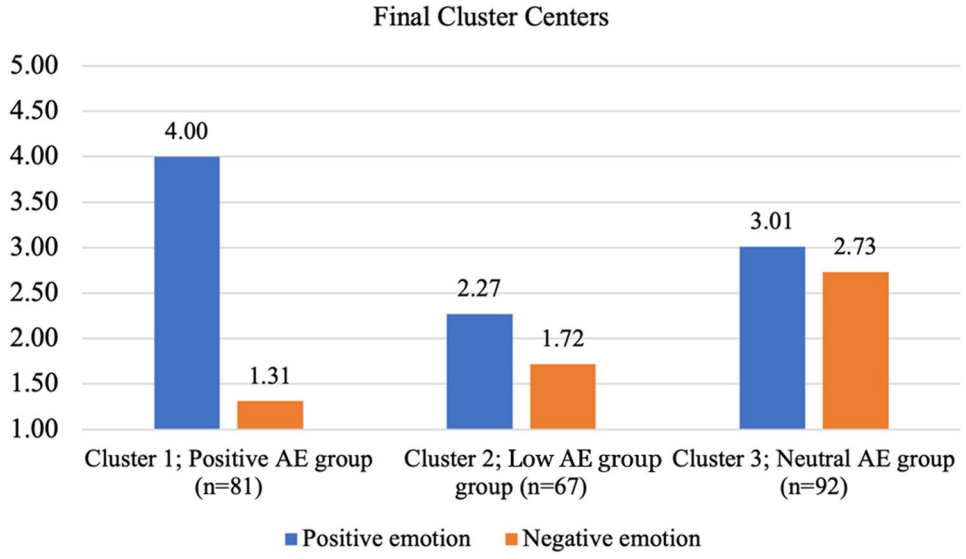

Fig. 2 The extracted achievement emotion clusters: *Cluster 1*: positive achievement emotion group (i.e., high positive, low negative); *Cluster 2*: low achievement emotion group (i.e., low positive, low negative); and *Cluster 3*: neutral achievement emotion group (i.e., average positive, average negative). X-axis represents three different achievement emotion clusters. Y-axis represents mean scores for achievement emotions

Table 2 Composition of extracted achievement emotion clusters

Discipline	Cluster 1: Positive achievement emotion group (34%)	Cluster 2: Low achievement emotion group (28%)	Cluster 3: Neutral achievement emotion group (38%)	Total
1. Chinese Medicine	1 (13%)	0	7 (88%)	8 (100%)
2. Engineering	0	0	1 (100%)	1 (100%)
3. Law	9 (64%)	2 (14%)	3 (21%)	14 (100%)
4. MBBS	26 (27%)	39 (40%)	32 (33%)	97 (100%)
5. Nursing	35 (45%)	14 (18%)	29 (37%)	78 (100%)
6. Pharmacy	5 (22%)	6 (26%)	12 (52%)	23 (100%)
7. Social work	4 (25%)	4 (25%)	8 (50%)	16 (100%)
8. Speech and hearing	1 (33%)	2 (67%)	0	3 (100%)
Total	81 (34%)	67 (28%)	92 (38%)	240 (100%)

Table 3 Mean scores on outcome variables across the three achievement emotion profiles

Outcomes	Cluster 1 (*n*=81, 34.00%)		Cluster 2 (*n*=67, 28.00%)		Cluster 3 (*n*=92, 38.00%))		*F*	*P*	η^2	Scheffe post hoc comparison
	M	*SD*	*M*	*SD*	*M*	*SD*				
1. Satisfaction with team experience	**4.00**	.08	2.89	.09	3.26	.07	45.27	<.001	.045	1>2,3
2. Satisfaction with Life	**5.23**	.12	3.95	.14	4.26	.11	25.93	<.001	.083	1>2,3
3. Readiness Assurance Test scores	6.01	.34	5.29	.38	5.70	.32	.960	.384 (ns)	.019	ns
4. Overall achievement	**89.19**	1.20	85.25	1.32	85.48	1.13	3.300	.039	.064	1>2,3

Bolded values are the statistically significant highest mean scores. "*ns*" Not significant. *Cluster 1* Positive achievement emotions group, *Cluster 2* Low achievement emotions group, *Cluster 3* Neutral achievement emotions group

readiness assurance test scores, overall IPE achievement) and the Scheffe post hoc mean comparisons thereafter indicated that interprofessional students in Cluster 1 (high positive, low negative) reported higher scores than Clusters 2 and 3 in terms of satisfaction with team experience, satisfaction with life, and overall IPE achievement, but not in terms of team readiness assurance test.

Gender and discipline differences among identified clusters

Independent-sample t-tests/ANOVAs were conducted to test the differences in positive and negative emotions between males and females, as well as among disciplines. Due to unequal sample sizes across disciplines, with some having fewer than five participants, formal statistical testing of profile proportions was not conducted.

Instead, descriptive proportions are presented to illustrate distribution patterns. There was a significant difference in positive achievement emotion between male ($M = 2.89$, $SD = 0.82$) and female ($M = 3.08$, $SD = 0.68$) students; t (238) = 2.011, $p = .05$; and in negative achievement emotion between male ($M = 2.06$, $SD = 0.87$) and female ($M = 1.89$, $SD = 0.70$) students; t (238) = 1.613, $p = .013$. Females reported higher scores in positive achievement emotions and significantly lower in negative achievement emotions. To attend to sampling bias, we combined students from Chinese Medicine, Engineering, Law, Pharmacy, Social work, and Speech and Hearing Sciences. There was a statistically significant difference in positive achievement emotions among disciplines, F (2, 237) = 6.637, $p = .002$; Wilk's $\Lambda = 0.937$, partial $\eta^2 = 0.06$; but no significant effect on negative emotions (F (6, 232) = 1.550 $p < .163$; partial $\eta^2 = 0.03$). Scheffe post hoc mean comparisons indicated that Nursing students were significantly higher in positive emotions than medicine students and the combined disciplines.

Discussion

An important finding of this study relates to the cluster solution, which emerged from our data set, in which three AE cluster solutions parsimoniously describe the variance in students' positive and negative emotions. The *positive* AE cluster in this IPE context is characterized by its relatively highest scores on both affective behavioural and cognitive measures. Compared with *low* AE and *neutral* AE clusters, the *positive* AE cluster stood out advantageously with the highest level of satisfaction with IPE team experiences and satisfaction with life, and scored highest in overall IPE achievement. Both the *low* and *neutral* AE clusters, which accounted for the biggest proportion of the sample when combined ($n = 159$ or 66%), are characterized by having lower satisfaction with team experience, lower satisfaction with life, and lower scores on overall IPE achievement compared with the positive AE cluster. These findings suggest that having low AE, let alone neutral AE, is non-beneficial to students' satisfaction and achievement in IPE settings. However, in terms of cognitive tests (i.e., readiness assurance test), even if a positive AE cluster emerged as the highest scorer, there was no significant difference when compared with scores of low AE and neutral AE clusters. This may reflect the collaborative nature of this assessment, where team dynamics and collective preparation may have moderated individual emotional influences on performance.

Another noteworthy finding of this study relates to the cluster membership of the three extracted clusters. Results indicated that a substantially larger proportion of Nursing and Law students belonged to the positive AE cluster (45% and 64%, respectively), while a larger proportion of MBBS students belonged to a negative AE cluster (39%). Our finding that Nursing students had high positive AE is aligned with previous studies that investigated AEs among Nursing students in Korea [20, 21]. Peer support was found to significantly mediate the relationship between achievement emotions and learning satisfaction among graduate nursing students, suggesting that the interprofessional nature of our study may have particularly benefited nursing students' emotional experiences[20], although further research is needed to verify such a mechanism in the IPE context.

On the other hand, although no previous study has examined the AE of law students, our present finding that law students had high positive AE might be due to the novelty of the interprofessional experience to them, and that IPE might be viewed as a welcome escape from the nature of their usual legal courses. As for the finding that most MBBS students in the sample had low AE, the previous report indicates that the global prevalence rate of anxiety, one of the eight AEs examined in this investigation, among medical students was 33.8%, and anxiety was most prevalent among medical students from Asia and the Middle East [25, 27]. This is also consistent with research showing that medical students commonly experience learning-related boredom and anxiety, which impair self-regulated learning and increase burnout [28]. This pattern may reflect the demanding nature of medical curricula and the high-pressure academic environment characteristic of medical education. Such findings, at least in part, may have provided corroborating evidence about the negative emotions medical students experienced while completing their degree. Overall, these findings stimulate further reflection on the curricular structures of different programmes to understand what potential factors (e.g., nature of the course, etc.) may account for the higher positive AE among Nursing and Law students.

Another important finding of direct practical implications to future IPE intervention relates to gender and discipline differences in achievement emotion outcomes. Consistent with previous findings [23], our results indicated that females had significantly higher levels than males in positive achievement emotions. The reverse is true for the negative achievement emotions, where females registered significantly lower scores than males. This is interesting as it contrasts with much of the literature on academic stress and test anxiety [47, 48], where females typically report higher negative achievement emotions levels, such as anxiety. This unexpected pattern in our IPE context may reflect the collaborative, supportive nature of interprofessional learning environments, which could be particularly beneficial for female students' emotional experiences. Our findings also align with broader achievement emotions research. A comprehensive meta-analysis of 120 studies demonstrated that

positive emotions consistently enhance both academic performance and motivation, while negative emotions show comparable detrimental effects [24]. Their finding that achievement emotion effects were strongest among Asian samples supports our focus on Chinese interprofessional students and suggests cultural context may amplify the importance of achievement emotions in academic settings.

These are important findings that challenge medical and interprofessional educators to consider how to influence students' appraisal of achievement activities and design learning environments that foster positive emotions appropriate for different student clusters. Overall, the study findings lend support to the contention that achievement emotions are worthy of exploring in the context of healthcare education and that these findings also add to the ongoing line of research concerning the role and importance of achievement emotions in medical and interprofessional education [1].

While the present study has notable strengths, we also submit to the limitations of this study. *First*, the number of participants from eight disciplines varied greatly, limiting between-cluster comparison. *Second*, we situated our study in a single area in IPE only, and results may not be extended to other siloed educational activities. Students' emotions likely vary relative to the courses they are in. *Third*, this study is cross-sectional, which does not allow the examination of AE profile trajectories over time. *Lastly*, the timing of data collection on the final day of the IPE course may have created potential reverse causality, where students' achievement emotions could have been influenced by their perceived course performance rather than emotions driving performance outcomes. Additionally, the specific topic (COVID-19 Infection Control and Management simulation course) may have had a priming effect on the AEs that students reported during data collection. Future studies may be conducted to address these limitations, including the examination of the mechanisms by which negative and positive emotions relate to students' use of cognitive and metacognitive strategies [3] and motivational processes.

Conclusion

Notwithstanding these limitations, the findings provided evidence about students' emotions and their link to students' cognitive and affective outcomes. Previous studies indicated that healthcare students' achievement emotions contributed to their educational outcomes [1, 4, 19]. Similarly, our study indicates that Chinese interprofessional students who experienced high positive emotions and low negative emotions in IPE contexts are likely to achieve desired academic outcomes. In terms of practice, medical educators and interprofessional education programme implementers may introduce interventions that are responsive to the needs of students with distinct emotional characteristics to optimize students' success in the academic context. Despite the dominance of cognitive factors in explaining student outcomes, our findings support the increasing evidence of how affective factors, such as AEs, can impact student achievement in the healthcare education context. We hope that our findings stimulate further discussion, which may result in the identification of malleable areas for intervention in interprofessional healthcare curricula to promote adaptive AEs in classroom practices.

Abbreviations

IPE	Interprofessional education
AE	Achievement emotions
PISA	Programme for International Student Assessment
MBBS	Bachelor of Medicine, Bachelor of Surgery
AEQ	Achievement emotions questionnaire
TEQ	Team experience questionnaire
tRAT	Team readiness assurance test
MANOVA	Multiple analysis of variance

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Authors' contributions

FAG proposed and conceptualized the study, curated and interpreted the data, performed quantitative data analysis, co-supervised the project within which the study was conducted, acquired the funding, and was a significant contributor to the writing and editing of the manuscript. JIWTD and XS curated the data, helped in performing quantitative data analysis, and were significant contributors to the writing and editing of the manuscript. PYN, BZ, AKCW, FWTC, KMKC, & LC contributed in writing the original draft of the manuscript. SSCC, DMC, JKPC, AYMC, ECHD, QH, LYWH, JJ, WNL, FCYL, QW, KKT, & DV contributed to the review and editing of the manuscript. GLT co-supervised the project and provided administrative supervision and coordination.

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Data availability

The data that support the results of this study is available from the corresponding author, FAG, upon reasonable request.

Declarations

Ethics approval and consent to participate

The ethics and procedures of this study were reviewed and approved by the Human Research Ethics Committee of the University of Hong Kong with approval number EA210433. Informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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