BMC Medical Education

RESEARCH Open Access

The universal interprofessional education Q tool (U-IPEQ) for student learning– a pilot trial in the human anatomical dissection space

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Abstract

Introduction Interprofessional education (IPE) provides opportunities for health professional students from different disciplines to interact and foster effective collaborations in their future practices. Currently, various IPE evaluation tools are available for different healthcare settings, but many are limited to ceiling effects. Therefore, an universal IPE evaluation tool that describes students' unique perspectives within an IPE competency-based framework is necessary.

Methods Students' IPE readiness and perceptions were measured before and after an 8-week human anatomy dissection elective. This elective is offered annually to students from seven health professional programs, where students meet weekly for 3-hours to discuss scopes of practice, clinical case scenarios and perform anatomical dissections of human donors. The Likert-based Readiness for Interprofessional Learning scale (RIPLS) and Interprofessional Education and Perception scale (IEPS) were administered before and after the elective. To address the ceiling effects seen in Likert scores, a *Universal IPE Perceptions Q tool (U-IPEQ)*, informed by the Canadian Interprofessional Health Collaborative Interprofessional Competency Framework, was created. U-IPEQ has 40 statements across four domains and responses were collected after the elective, using Q-methodology.

Results A total of 24 from six disciplines and 15 students from seven disciplines completed the RIPLS and IEPS surveys before and after the elective, respectively. Twenty students from seven disciplines completed the U-IPEQ at the end of the elective. There were no statistically significant differences in the RIPLS and IEPS scores before and after the elective. However, the U-IPEQ revealed two distinct viewpoints: (1) *IPE Knowledge experts*; and (2) *IPE Skill experts*.

Conclusions The U-IPEQ was able to distinguish the differences in students' IPE learning priorities that were not obvious in the RIPLS and IEPS scores. Further refinement to U-IPEQ will be necessary to broaden its current applicability to other educational contexts.

Keywords Interprofessional learning, Interprofessional education, IPE, Anatomy dissection, Interprofessional collaboration, IPC, Health professional students

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Introduction

Interprofessional education (IPE) is increasingly acknowledged as a critical component of workforce preparation [1]. The World Health Organization (WHO) [2] describes IPE as a form of training where two or more professions learn about, from, and with each other to enable effective collaboration for improving health outcomes [3]. In healthcare, IPE is shaped by the collaborative practice between multiple disciplines to deliver high quality care to patients, families, caregivers, and communities [1, 4]. Therefore, the impact of successful collaboration in healthcare emphasizes the importance for academic institutions to prepare students for this responsibility by establishing effective IPE programs [4–7].

The Program for Interprofessional Practice, Education and Research (PIPER) at McMaster University is a collaborative department that develops, pilots, and evaluates IPE events for Faculty of Health Sciences (FHS) students [8]. Established in 2007, PIPER delivers IPE events to students in medicine (MD), nursing (RN), physiotherapy (PT), occupational therapy (OT), speech language pathology (SLP), midwifery (MW), physician assistant (PA), and child life (CL) programs. The IPE human anatomy dissection elective is a mastery levelled IPE opportunity, offered annually since 2009 [9]. Over the years, this elective was demonstrated to be effective at improving students' professional identity, anatomy competency, and willingness to collaborate with students from other disciplines [9–12].

IPE curriculums should encompass elements that will support learners' ability to communicate and work with interprofessional peers [2, 13]. There are numerous IPE evaluation tools available to measure learners' perceptions and skills development in interprofessional collaboration (IPC) after IPE [14–16]. However, existing tools are limited by its application for certain health care settings and populations, with reported ceiling effects [15]. Ceiling effects are common in Likert-based measurements, where the tool fails to detect score changes because individuals are already scoring near the maximum [15]. Therefore, novel mixed method approaches would allow educators to assess students' perspectives and fulfillment in IPE competencies [17]. The Canadian Interprofessional Health Collaborative (CIHC) is a network of health educators, organizations, professionals and students, aimed at identifying and disseminating the best practices and research in IPE [13, 18]. In 2010, the CIHC released an Interprofessional Competency Framework (IPCF), widely used to inform development of IPE and IPC practices. Knowledge advancement of IPE and IPC in recent years led to an updated version of the framework in 2024. The 2010 CIHC-IPCF was renamed to the 2024 CIHC Competency Framework for Advancing Collaboration (CFAC) [13]. Similarly, the CIHC-CFAC outlines six interdependent competency domains, describing the knowledge, skills and attitudes required for effective IPC [13]. As the CIHC-CFAC domains are comprehensive, they serve as excellent guides to inform the development of IPE evaluation tools for broad application.

In addition to broadening the applicability of evaluation tools, an adequate solution to overcome ceiling effects of Likert-based scales is also necessary [15]. An alternative to Likert-based scales is Q-methodology (Q) which explores subjective perspectives without ceiling effect limitations [19, 20]. Q collects data by asking participants to rank their level of agreement or disagreement between statements (Q-set) on a ranking grid [21]. This enables participants to convey their unique perspectives and opinions without being restricted by a linear, ranking scale [22, 23]. Past studies have shown that Q findings provide in-depth perspectives to supplement or in comparison to Likert-based outcomes [12, 23–25]. As perceptions and attitudes are complex, using Likert-based scales and Q can combine their distinct benefits to reveal participants' holistic viewpoints [22, 25]. Therefore, to inform the successful development and implementation of IPE programs, using both methodologies can yield meaningful feedback for future offerings [12, 25].

With the ongoing need for a universal IPE assessment measure, this study created a *Universal IPE Perceptions Q tool (U-IPEQ)*, informed by the core competencies outlined in the CIHC-IPCF [18]. This approach was to characterize participants' IPE perceptions after an IPE human anatomy dissection elective, in combination with traditional Likert-based scales. This would provide a greater in-depth understanding of their perceptions and attitudes toward IPE for improved collaboration.

Methodology

Study design

This was a program evaluation of the IPE human anatomy dissection elective at the FHS, McMaster University. Invited students were informed that their anonymous participation was optional and they were consenting to their data being used for analysis upon submission. Students were instructed to create their own codename in the surveys– this was to ensure their responses remained anonymous. This study was approved by the Hamilton Integrated Research Ethics Board #18020.

Course and participants

The IPE human anatomy dissection elective at McMaster University is offered to first year FHS students by PIPER in collaboration with the Education Program for Anatomy. IPE activities within FHS at McMaster University introduce interprofessional learning and collaboration at different levels: exposure, immersion, and mastery. The IPE human anatomy dissection elective is

the only mastery levelled IPE opportunity available and is delivered across 8 weeks in the winter term (January to March), limited to 30 to 35 students, yearly. Students from seven programs are invited: MD, MW, RN, OT, PA, PT and SLP (starting in 2018 with program initiation). The number of students from each discipline is limited to ensure multidisciplinary representation. A detailed description of this course has been published previously by Fernandez et al. (2014) [26] and Zheng et al. (2015) [27].

In 2023, students met weekly for 3-hours per session, for 8 weeks. During these 3-hour sessions, students delivered presentations on their scope of practice, discussed clinical case studies, and performed human anatomical dissections with their interprofessional peers. Students were assigned into interprofessional groups to complete the human anatomical dissections in the latter half of the session, guided by facilitators with previous anatomy knowledge and experience.

Data collection and surveys

Three assessments were administered in this IPE elective: Readiness for Interprofessional Learning Scale (RIPLS), Interprofessional Education Perception Scale (IEPS), and the U-IPEQ.

Readiness for interprofessional learning scale (RIPLS)

RIPLS is a self-evaluation tool designed to assess learners' attitudes and perceptions toward IPE [28–30]. This tool collects responses using a 5-point Likert scale and has 19 statements across four subscales: teamwork and collaboration; positive professional identity; negative professional identity; and roles and responsibilities [14, 28]. Total scores range from 19 to 95, with higher scores indicating greater IPE readiness. Greater details of the RIPLS have been reported before [14, 28, 30]. The RIPLS assessment was administered at the start and end of the IPE human anatomy dissection elective.

Interprofessional education and perception scale (IEPS)

The purpose of IEPS is to gauge learner's perceptions of their own profession and their relationship to other disciplines [31]. This tool collects responses using a 6-point Likert scale and has 12 statements across three subscales: competency and autonomy; perceived need for cooperation; and perception of actual cooperation [14, 32]. IEPS is widely used to evaluate the effectiveness of IPE interventions on improving IPE readiness and attitudes [33]. The IEPS assessment was administered at the start and end of the IPE human anatomy dissection elective.

IPE Q tool: creating the universal IPE perception Q tool (U-IPEQ)

Q is an approach that studies human subjectivity [20]. It utilizes both quantitative and contextual feedback to explore participants' perceptions towards a given experience or intervention. The latter is achieved by the process of Q-sorting, where participants are asked to rank their level of agreement and disagreement to a set of statements in a grid (Supplementary Figure S1) [20, 22]. Participants are also asked to contextualize their extreme responses (i.e., strongly agree/disagree) by providing a written statement justifying their selection [24]. Completed grids are referred to as "Q-sorts" and are collectively analyzed using a by-factor analysis [20]. This analysis identifies unique factors (i.e., groupings) representing similar perceptions and opinions based on participants' Q-sorts [19, 21]. Commonalities across factors are described by consensus statements and distinct viewpoints between factors are described by distinguishing statements. In addition, written feedback are qualitatively interpreted by the team to derive names for each factor [21, 24].

U-IPEQ was developed as part of this study to explore student perceptions towards the IPE experience of the elective. Prior to survey distribution, a Q-set– a list of statements of the topic was developed. As the aim of this study was to assess IPE experiences, we utilized multiple resources to inform Q-set development. This included students' feedback from previous cohorts of the IPE human anatomy dissection elective [9, 10, 26], IPE events, IPE literature [14–16, 34], and IPE tools (i.e., RIPLS and IEPS) [28, 31]. A total of 87 statements were initially derived and categorized into four relevant CIHC domains from the 2010 IPCF: Role Clarification (RC), Interprofessional Conflict Resolution (ICR), Team Functioning (TF), and Collaborative Leadership (CL) [13, 18]. CIHC domains pertaining to patient communication and clinical practices were omitted (i.e., Interprofessional communication and Patient/ Client/ Family/ Community-Centered Care) as they did not apply to the context of the IPE human anatomy dissection elective due to the absence of patient interactions [13, 18]. The 2010 CIHC-IPCF domains were used as U-IPEQ was developed (late 2022) and administered in March 2023, prior to the 2024 CIHC-CFAC release in April 2024.

The Q-set draft was circulated to the study committee and members of the interprofessional student committee (McMaster Interprofessional Student Collaboration consisting of four students from PT, OT and Bachelor of Health Sciences) for review. Reviewers were instructed to read statements for relevance, redundancy, and clarity. After multiple revisions, the final U-IPEQ consisted of 40 statements (Supplementary Table S1). This tool was administered at one timepoint, at the end of the elective.

The final Q-set was organized in a Q-sort table with 40 cells so that each statement could be ranked and ordered within the table to permit subsequent analysis. The Q-sort table approximates a normal distribution, such that the statement ranking assumes a forced normal distribution between strongly agree (+5) and strongly disagree (-5). Statements ranked under "0" (zero) reflect neither agreement or disagreement [12]. Each participant was provided with the 40 statements and a Q-sort table. Participants were instructed to read the statements carefully and rank them (based on the degree of agreement or disagreement) by assigning each statement to a single cell in the table. In cases where there were multiple cells for a given ranking (e.g., two statements could be ranked −5), participants were informed that the order in which they place two statements has no effect on the results of analysis. Finally, for the responses at either extreme (+5 and −5, termed critical statements), participants were asked to write a brief statement to contextualize or justify their response [24]. A representation of the Q-sort system is in Supplementary Figure S1.

Statistical analysis

All collected data were organized and analyzed on STATA 17.0 B/E. The threshold for statistical significance was $p<0.05$. Descriptive statistics were used to describe participants' characteristics, including frequencies, counts, percentages and proportions. Quantitative variables were reported as means with standard deviations or medians with interquartile ranges, where appropriate. Comparative tests were performed to compare pre and post RIPLS and IEPS scores (paired and non-paired) [35]. Non-parametric tests were used since the sample size was small ($n<30$) [36] and the RIPLS and IEPS data were non-normally distributed as confirmed by Shapiro-Wilk Test for Normality [35, 37]. Therefore, the Wilcoxon rank sum and signed rank tests were used [35–37]. Effect sizes were reported as Wilcoxon effect size (r) [38]. Effect size interpretations were interpreted as small ($r<0.3$), moderate ($0.3\leq r<0.5$) or large ($r\geq 0.5$) [38, 39]. All summative data were plotted into graphical displays.

Q-sorts from the participants were organized and loaded into STATA 17.0 B/E for by-person analysis using the "qfactor" command to identify unique factors [40]. Details on the "qfactor" analysis was published in the Stata Journal [40]. Each statement across factors were reported as weighted rank scores, ranging between −5 (strong disagreement) to +5 (strong agreement). The weighted rank scores of each statement across factors were identified as distinguishing statements (Cohen's effect size 0.8) if they were statistically significantly different. Consensus statements were those with no statistical significance in their weighted rank scores across factors. Within each factor, the mean weighted rank scores for each U-IPEQ domain were determined by averaging the weighted rank scores of the corresponding statements. The mean weighted rank scores were plotted onto a radar map. This was a novel approach to enhance the readability of the Q results between factors. See supplementary Table S5 and S6 for details of this process.

Results

Participant demographics

A total of 28 student-learners enrolled into this elective and one dropped out by the end. A total of 24 (85.7%) students from six disciplines (except SLP) and 15 (53.5%) students from all seven disciplines completed the RIPLS and IEPS surveys before and after the elective, respectively. The mean ages (and standard deviation [SD]) for the respondents pre and post elective were 24.67 (1.08) and 24.5 (0.83) years, respectively. Whereas 20 (71.4%) students with the mean age of 25.2 (4.85) years completed the U-IPEQ. These results are outlined in Supplementary Table S2.

RIPLS and IEPS scores

There were no statistically significant differences between the median pre and post scores for RIPLS and IEPS subscale or total scores. Total median (Q1, Q3) RIPLS scores were 87.5 (80.5, 91) and 88.0 (83, 90) and IEPS scores were 65.5 (60, 68.5) and 66.0 (62, 67) at pre and post elective, respectively ($p>0.05$). Effect sizes were very small (RIPLS $r=+0.04$; IEPS r=-0.09). Figures 1A-C are the graphical representation of these median scores. For the numerical data, please see Supplementary Table S3.

Paired RIPLS and IEPS scores

Of the 24 and 15 students who responded to RIPLS and IEPS at both timepoints, 11 students answered these surveys at both timepoints, mean age of 24.64 (SD = 1.21) years. Of the 11 students, 8 (72.7%) identified as cis-women and were from five disciplines: PA and MD (5, 45.4%); MW, RN and PT (6, 55.6%). Using their self-created ID codes and demographic characteristics, the RIPLS and IEPS surveys were matched to evaluate score changes. Similarly, there were no statistically significant changes between total RIPLS and IEPS scores after the elective. Total median RIPLS scores were 88 (81, 90) and 89 (86, 90), and IEPS scores were 61 (58, 69) and 66 (60, 67), pre and post elective, respectively ($p>0.05$). Effect sizes were small to moderate (RIPLS $r=+0.26$; IEPS $r=+0.46$). The data for paired analysis are available in Supplementary Table S4.

Q-methodology (Q)

Twenty respondents were loaded into two factor groups, representing two major viewpoints of the learners. These two viewpoints were termed: Factor 1: *IPE Knowledge*

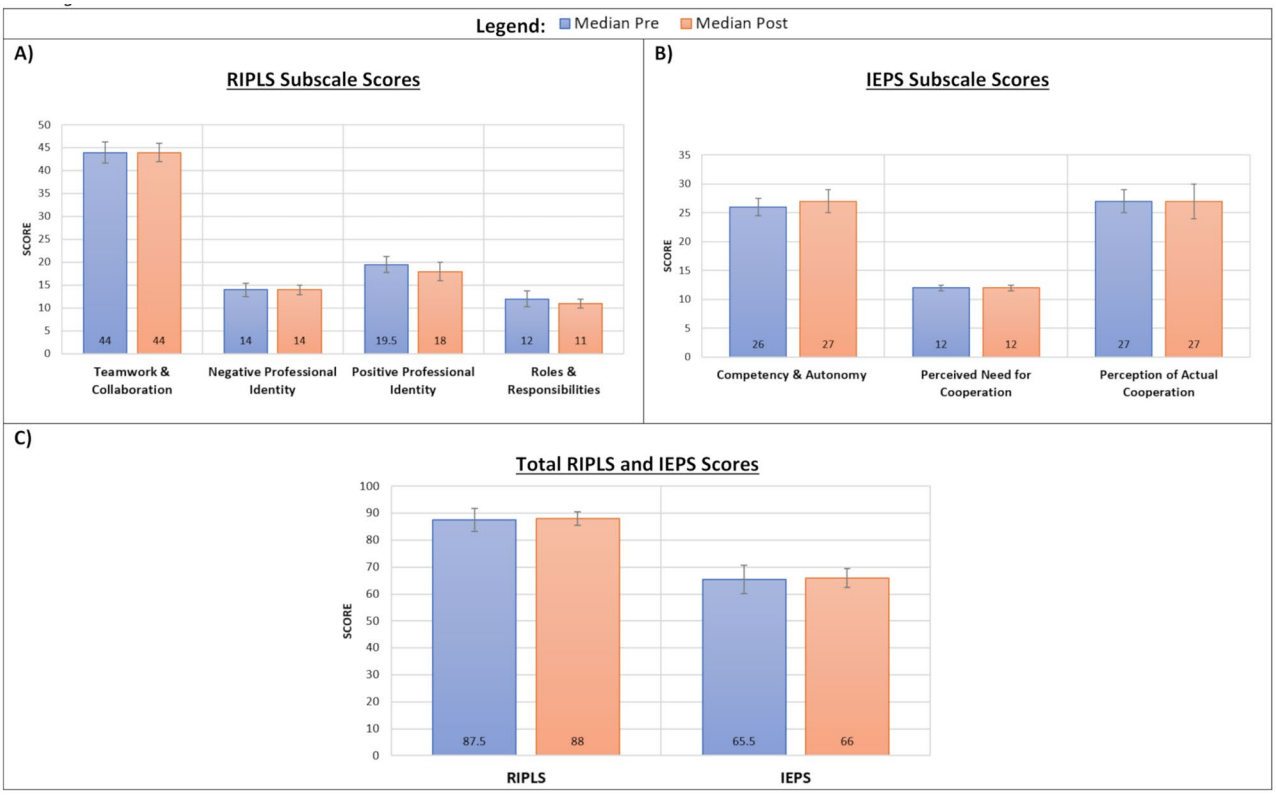

Fig. 1 The median subscale scores for RIPLS and IEPS are shown in **A** and **B**, respectively. Subscale scores at the two timepoints (pre vs. post elective) were not statistically significantly different. Total median scores of the RIPLS and IEPS are presented in **C**. Sample sizes at pre and post elective were 24 and 15, respectively. Error bars for medians represent their interquartile range (Q3-Q1). Numerical values are available in Supplementary Tables S3 and S4. *Abbreviations: IEPS = interdisciplinary education perception scale; RIPLS = readiness interprofessional learning scale*

experts and Factor 2: *IPE Skill experts*. There were no statistically significant differences in their age or genders (Supplementary Table S2B). The factor names were based on the distinguishing statements identified from each domain and their contextual feedback. The mean weighted rank scores for each statement within the four subdomains of each factor were averaged and plotted onto a radar map (Fig. 2). Of the 40 statements, 15 statements met consensus between the two factors (ICR = 5; CL = 3; RC = 5; TF = 2). For details on the distinguishing and consensus statements, please see Table 1.

Factor 1: IPE knowledge experts

There were 11 learners (55%) in this factor group, aged 24.7 (3.9) years, 8 (72.7%) identified as cis-women and were from PA, PT, RN, MW, OT, MD and SLP disciplines. These learners felt the elective provided them with ample opportunities to interact with their interprofessional peers to broaden their understanding of their own and other disciplines in the context of patient care. These are notable by their positively ranked statements such as: "*38. I learned the importance of trusting the expertise of other learners*" and "*27. I gained insight into how other professionals would approach a specific concern or condition*." These distinguished statements were justified with contextual feedback that emphasized the importance of relying on other interprofessional peers to solve clinical problems and to work as a team for overall patient care (Table 2).

Factor 2: IPE skill experts

There were 9 learners (45%) in this factor group, aged 25.8 (6.3) years, 8 (88.8%) identified as cis-women and were from four disciplines: PA, PT, OT and MD. These students felt they were able to develop their communication and leadership skills in an interprofessional setting to be effective team members. Their positively ranked statements were: "*32. I learned how to work with different professions to solve challenges/achieve a client's goal*" and "*35. I learned how to communicate my role in the healthcare context*."

Discussion

We developed the U-IPEQ, using the 2010 CIHC-IPCF as a foundation, and piloted this tool as part of the 2023 IPE human anatomy dissection elective at McMaster University. RIPLS and IEPS scores at pre and post-elective did not show any statistically significant differences, with

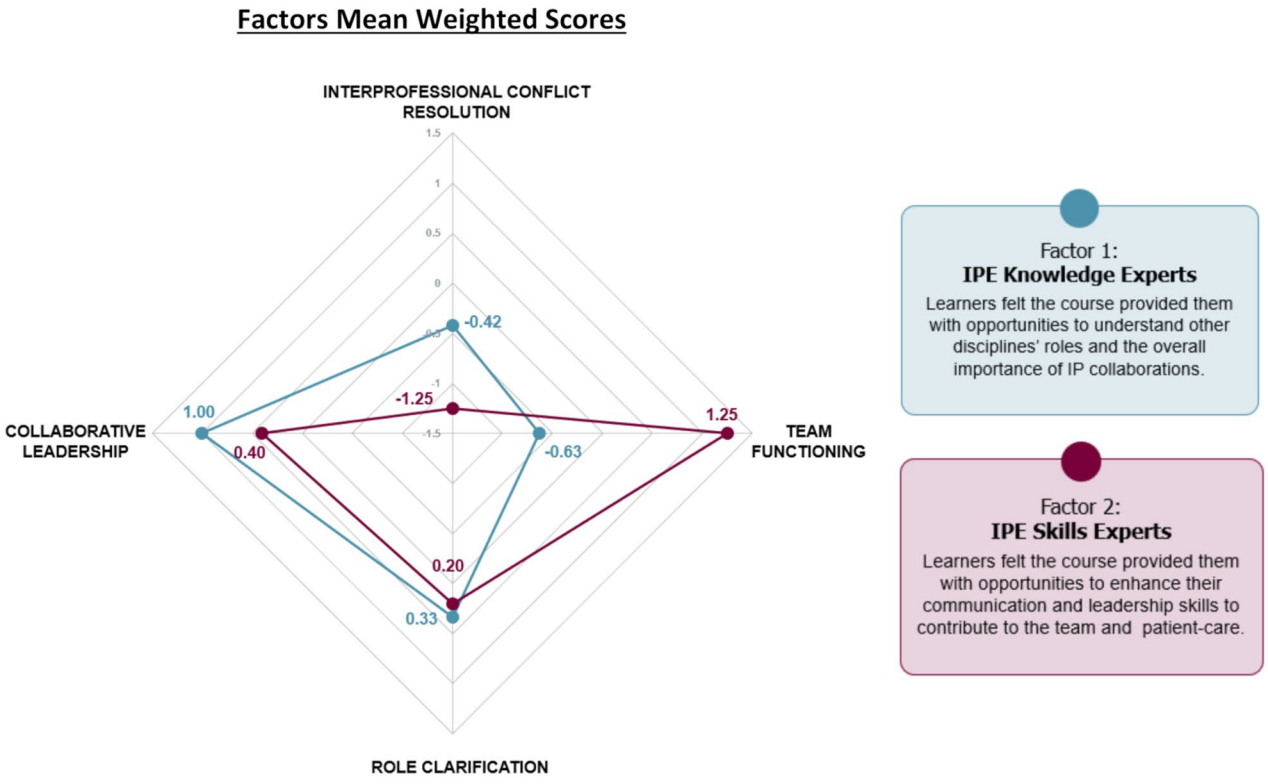

Fig. 2 Visual radar map of learners' perceptions toward IPE for each factor, under the domains identified from the CIHC-IPCF [18]. The plotted value for each domain is the mean weighted rank scores of the corresponding statements, derived from the computed data from the 'qfactor' analysis on STATA17.0 B/E. The magnitude of weighted rank scores indicates the factor's strength of their level of disagreement or agreement for each domain. Learners' contextual feedback (Table 2) helped describe their perceptions for each named factor. Additional data is available in Supplementary Table S5 and S6

small to moderate effect sizes. However, our U-IPEQ identified two distinct perspectives and attitudes toward IPE and IPC. Factor 1, referred to as *IPE Knowledge Experts* prioritized understanding and learning about other disciplines' roles and the overall importance of IPC. In contrast, Factor 2, *IPE Skills Experts*, prioritized opportunities to enhance communication and leadership skills for improved team function and patient care. By using U-IPEQ, we were able to gain insight into the participants' IPE and IPC perceptions which were not observed from the Likert-based scales alone. This is informative to improve future renditions of this elective, ensuring its content and delivery address the participants' needs.

Various IPE measurement tools are currently available, and are designed to measure different IPE competencies [41], across different contexts [15, 29]. However, Likert-scale tools are limited by ceiling effects, possibly explaining the lack of change in the RIPLS and IEPS scores before and after this elective [14, 15, 42]. Ceiling effects are most observed when a scale does not have sufficient range to produce meaningful differences at the upper or lower ends of possible scores [41]. Leading to underestimation of score changes or biased positive results [42], further limiting the tool's ability to identify whether there is growth or effectiveness of the intervention [43, 44]. Since this elective welcomes self-selection for participation, these participants likely already had greater appreciation for IPE and IPC at baseline. Relatively high pre-elective scores were also observed in past cohorts [9]. Thus, recent IPE studies have incorporated elements of mixed methods design to complement Likert-based outcomes and strengthen findings [11, 12, 17, 45, 46]. Mixed methods include using focus group meetings, open-text responses, interviews and Q [10, 12, 17, 45, 46]. Although uncommonly used, Q is a viable method to explore perceptions and attitudes that may have been lost in Likert-based scales, even in the same cohort [22]. Therefore, our approach to combine numeric Likert-based scales with Q was to provide a wholistic overview of participants' IPE and IPC perspectives [22, 25]. Despite participants' RIPLS and IEPLS did not show change, we can appreciate their relatively high scores indicate interest for IPE and IPC. To build on this point, U-IPEQ allowed for an in-depth exploration of the participants' interest in IPE and IPC, which revealed the two distinct viewpoints in the same cohort.

Table 1 Participant rotated (orthogonal varimax) factor loadings and statement weighted scores for each factor group. The weighted scores range from −5 (strongly disagree) to +5 (strongly agree). Bolded and highlighted rows indicate consensus (15 total) for that statement amongst the two factor groups. The remaining are distinguishing statements, where the factors' weighted scores were statistically significantly different. Differences in the factors' viewpoints may be based on the magnitude and/ or direction of their weighted scores. For example, *IPE knowledge experts* (Factor 1) were neutral while *IPE skills experts* (Factor 2) strongly agreed to statement #1.

Domain*	Statement	Factor	
		1†	2‡
ICR	1. I learned how to effectively explain concepts to people with different educational backgrounds.	0	+3
ICR	2. I learned to adapt my communication skills to relay information to patients clearly.	-2	0
ICR	**3. I learned to value working as a team as opposed to trying to be the one that saves the day.**	**+2**	**+1**
ICR	4. I better understand interprofessional collaboration and the challenges that may arise.	+3	0
ICR	5. I am more aware of the importance of supporting an interprofessional team.	+4	+1
ICR	**6. I am more aware of the importance of being open and communicative with others.**	**+1**	**+1**
ICR	**7. I feel that learners from different educational backgrounds were not able to work well together.**	**-4**	**-5**
ICR	8. I was able to learn how to mitigate conflict at this event.	-5	-1
ICR	**9. I feel that it was difficult to reach a consensus decision with my peers.**	**-3**	**-4**
ICR	10. I feel that everyone had equal opportunity to participate.	+1	-2
ICR	**11. I feel that my professional values did not align with my group.**	**-2**	**-4**
ICR	12. I feel that my profession was undermined at this event.	0	-5
CL	**13. I learned the importance of listening to my clients.**	**0**	**-3**
CL	**14. I learned to be more flexible and adapt my plans when working with a team.**	**0**	**0**
CL	15. I learned to seek appropriate resources from others to facilitate patient care.	-1	+4
CL	**16. I learned how to collaborate with other professions to facilitate patient care.**	**+2**	**+2**
CL	17. This program created a friendly and safe environment for learning and making mistakes.	+4	-1
RC	18. I felt that I made assumptions when I was communicating with my peers.	-4	-1
RC	19. I learned to empathize with patient's perspective and how they may feel getting different forms of information from many different healthcare professionals.	-2	+2
RC	20. I learned how different aspects of patient perspectives and preferences would impact healthcare experience.	-4	+4
RC	21. I learned how to communicate my role in the healthcare context.	+4	-2
RC	**22. I learned that I may not know the answer to everything my client asks, and that is okay.**	**+1**	**-1**
RC	**23. I considered other perspectives to understand the topic being discussed.**	**0**	**+1**
RC	**24. I learned about my limitations and how to adapt to new environments.**	**0**	**0**
RC	25. I felt the information taught and learned was very important to my role as a student.	+3	0
RC	26. I felt comfortable in engaging with others.	+3	-3
RC	27. I gained insight into how other professionals would approach a specific concern or condition.	+5	0
RC	**28. I learned many of the professionals thought about things I would not have thought about in my profession.**	**+2**	**+2**
RC	29. I feel the insights of others helped me understand my own role.	+2	-3
RC	30. I clarified misconceptions I had about other professions.	-1	+3
RC	**31. I don't think it's vital to learn about everyone's scope of practice and how they contribute to patient care.**	**-5**	**-4**
RC	32. I learned how to work with different professions to solve challenges/achieve a client's goal	+1	+5
TF	33. I learned the importance of developing empathy in my communication with my peers	-3	+4
TF	34. I learned the importance of waiting for your turn to speak and contributing to the group.	-2	+2
TF	35. I learned the importance of active listening to other health care professionals and working with them to solve problems.	-1	+5
TF	**36. This event has allowed me to build meaningful connections with my peers.**	**+1**	**+1**
TF	37. I learned how to be mindful of cultural differences.	-3	-1
TF	38. I learned the importance of trusting the expertise of other learners.	+5	-2
TF	**39. I learned the importance of applying closed loop communication.**	**-1**	**-2**
TF	40. I learned strategies to help me engage in shared-decision making with those in a different educational background from me.	-1	+3

*Domain names are based on the 2010 Canadian Interprofessional Health Collaborative Interprofessional Education Competency Framework (CIHC-IPCF) as the U-IPEQ was trialed in 2023 before the updated 2024 Competency Framework. †Factor 1 = *IPE Knowledge experts;* ‡Factor 2 = *IPE Skills experts*. *Abbreviations: ICR = Interprofessional Conflict resolution; CL = Collaborative Leadership; RC = Role Clarification; TF = Team Functioning*.

Table 2 Participants were invited to provide open text comments to explain their strong disagreement (-5) or strong agreement (+5) towards certain statements. The contextual feedback was informative for naming and understanding the attitudes for each factor. This table lists a few statements with strong agreement (+5) in each factor, and the justification provided by participants

	Domain	Statement	Contextual justifications
Factor 1: *IPE Knowledge Experts*			
Strongly Agree (+5)	RC	27. I gained insight into how other professionals would approach a specific concern or condition.	*"…I feel like I am finally understanding what the other health professions do."*
	TF	38. I learned the importance of trusting the expertise of other learners.	*"…But I quickly learned just how much knowledge all the other professions have in their various areas of expertise."* *"I have a greater understanding of the role of other professions and can recognize when they might be better suited to deal with a patient situation."*
Factor 2: *IPE Skill Experts*			
Strongly Agree (+5)	RC	32. I learned how to work with different professions to solve challenges/achieve a client's goal	*"…I learned so much from them and it really was great to learn about how we could continue to work together in the future as colleagues."*
	TF	35. I learned the importance of active listening to other health care professionals and working with them to solve problems.	*"It is important to listen to others because everyone has different experiences and expertise they can bring forward."*

Abbreviation: IPE = interprofessional education; RC = Role Clarification; TF = Team functioning

Participants in this study were either described as *IPE Knowledge Experts* and *IPE Skills Experts*, motivated by different learning needs. Factorial analysis revealed that one subset of learners (*IPE Skills Experts*) highly rated statements that valued practical expertise and/or application of IPE knowledge. In contrast, statements implying theoretical knowledge gain and/or appreciation were valued by another subset of learners (*IPE Knowledge Experts*). These findings indicate potential differences in learners' learning approaches and strategies in IPE, which could include varying levels of self-directed and collaborative learning [47, 48]. These approaches are not unusual as students in higher education focus on gaining theoretical knowledge or practical knowledge [47, 48]. Additionally, it is possible that these two distinct viewpoints, *IPE Knowledge* versus *IPE Skills experts*, are from the differences in previous interprofessional experiences [49, 50]. By the start of this annual elective in January, students from several programs would have received some form of clinical exposure (i.e., shadowing health professionals, observing interprofessional care with patients) or clinical placement. Variation of these clinical experiences may also be a contributing factor to our participants' perception towards IPE. However, details of these experiences were not collected at the time of the survey, preventing us from confirming this hypothesis.

From our Q results, we demonstrate unique viewpoints of learners in this elective. However, we also appreciate commonalities between the factors, as there were 15 consensus statements across the four subdomains. This is particularly evident in the overlap of the two viewpoints in "*Role clarification*" (Fig. 2). Consensus demonstrates this elective's capability to provide students with opportunities to improve role clarity to meet interprofessional competencies for IPC. This extends our understanding of the value of IPE in anatomy, as our past reports have alluded to the benefits of this approach [9, 27]. Similarly, past IPE interventions also reported improved students' knowledge of their interprofessional peers' scopes of practice and skills development for IPC [4–7, 50, 51]. This observation is also seen in IPE within anatomical education, where interprofessional communication and collaboration significantly improved, while developing appreciation for their interprofessional peers [6, 51].

We developed the U-IPEQ, informed by the core IPE competencies in the 2010 CIHC-IPCF [18], current literature, past IPE experiences and students' feedback. To our knowledge, this would be the first universal measure designed to identify the gaps and fulfillment of CIHC core competencies. Although U-IPEQ was developed using the 2010 CIHC-IPCF [18], the 2010 version served as the foundation for the 2024 CIHC-CFAC update. The 2024 CIHC-CFAC was a refresh of the 2010 version, meant to confirm and ensure the domains' relevancy for IPE and IPC. The six outlined domains did not conceptually change but were renamed to be more descriptive [13, 18]. The basis of U-IPEQ is still unique and relevant, as past IPE work did not incorporate IPE competency-based frameworks into their Q development [10, 12]. Emerging synthesis reviews highlight the need for further research to identify and uniformly assess IPE competencies in outcome tools [17, 29]. Outcome tools vary by their measured IPE competencies and application, but by integrating the CIHC-IPCF into U-IPEQ, we optimized its potential for universal use. This pilot demonstrated U-IPEQ's capability to provide additional information to supplement our understanding of the Likert-based outcomes. Furthermore, these findings provide insight to students' learning interests and needs. As this elective is a mastery-levelled opportunity, different activities were implemented [49, 50, 52–54]. Such as interprofessional lectures, peer-guided learning, and case scenarios,

to address learners' diverse IPE learning needs [52, 55]. These unique viewpoints provided an in-depth reflection of students' experiences with these activities. Collectively, the results are informative for tailoring and developing future IPE opportunities that would meet the national competencies and students' learning needs [4, 51, 56]. Future IPE offerings should continue to incorporate multiple learning approaches and refine them based on students' feedback. Prior IPE experiences through clinical exposures or placements should also be explored for its influence on students' learning priorities as they progress through their programs [50, 56]. Our future work will include: (1) revising the U-IPEQ to align with the 2024 CIHC-CFAC domains; (2) developing statements for the remaining domains in the CIHC-CFAC (i.e., Team Communication and Relationship-focused services, formerly known as Interprofessional communication and patient/client/ family/ community-centered care); and (3) assessing U-IPEQ's psychometric properties by including greater sample sizes and evaluations across multiple IPE events [13]. Greater IPE exposure and experiences before licensure may facilitate learners' IPE knowledge and skills, encouraging them to engage in IPE to benefit their future patients [55, 56]. Thus, opportunities to build practical and theoretical knowledge are important considerations for IPE educators.

This study has limitations. The U-IPEQ was informed by the 2010 CIHC-IPCF, which may not comprehensively reflect the updated 2024 version. Therefore, before U-IPEQ is distributed again, U-IPEQ will be revised to ensure alignment withall the domains outlined in the 2024 CIHC-CFAC. Another limitation is U-IPEQ was distributed only after the elective, preventing us from performing pre and post comparisons. However, Q was able to capture two distinct viewpoints compared to RIPLS and IEPS alone, providing comprehensive understanding of students' perspectives. Finally, the number of responses for each outcome measure and timepoints (pre/post-elective) were small. Since enrolment into this elective is limited, the subsequent sampling size was limited. In addition, there was also limited input from certain disciplines, such as students from SLP. Furthermore, since participation in these surveys was voluntary, participation bias may be possible. For these reasons, these findings may have limited applicability to other cohorts with different compositions of disciplines and IPE events.

Conclusion

Piloted in an IPE human anatomy dissection elective, U-IPEQ revealed two distinct viewpoints of students' perspectives on IPE and IPC. RIPLS and IEPS scores before and after this elective showed no statistically significant differences. U-IPEQ provided additional context to the students' perspectives, building a wholistic overview of their IPE experiences and values. *IPE knowledge experts and IPE skills experts* were the two contrasting viewpoints, highlighting the differences in students' IPE learning priorities. These findings are informative and could be incorporated into future IPE curricula. Future refinement of U-IPEQ needs to include all IPE competency domains and the updated domains of the CIHC-CFAC to broaden its current applicability to other educational contexts.

Abbreviations

CFAC	Competency framework for advancing collaboration
CIHC	Canadian Interprofessional Health Collaborative
CL	Collaborative leadership
CLS	Child life specialty
ICR	Interprofessional conflict resolution
IEPS	Interprofessional Education Perception scale
IPCF	Interprofessional competency framework
IPE	Interprofessional education
MD	Medicine
MW	Midwifery
OT	Occupational therapy
PA	Physician assistant
PIPER	Program for Interprofessional Practice, Education and Research (at McMaster University)
PT	Physiotherapy
Q	Q–methodology
RC	Role clarification
RIPLS	Readiness for Interprofessional Learning scale
RN	Nursing
SD	Standard deviation
SLP	Speech language pathology
TF	Team functioning
U	IPEQ–Universal interprofessional education perceptions Q tool
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-025-07440-z.

Supplementary Material 1

Acknowledgements

We would like to express our deepest gratitude to the individuals who generously donated their bodies to advance scientific research and education, making this dissection elective possible. Their selfless contributions are invaluable and have enriched the learning and development of future healthcare professionals. Without their generous donations, this research would not have been possible. We extend our sincerest appreciation to the families and loved ones of our donors. In addition, we would like to thank Jasmine Rockarts and Joshua Mitchell for their contributions to the delivery and data collection of this study.

Author contributions

SQ and YM were involved in all stages of this research study, including conceptualization, literature search, data extraction and analysis, data summarization, reviewed, revised and finalized the manuscript. NAD assisted in the data analysis, reviewed, revised and finalized the manuscript. AP and BD facilitated data collection, reviewed, revised and finalized the manuscript. SW and BW participated in study conceptualization, reviewed, revised and finalized the manuscript. All authors reviewed the final manuscript.

Funding

This research was supported by the Education Program in Anatomy and the Program for Interprofessional Practice, Education and Research, McMaster University.

Data availability
The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials. Additional data that support the findings of this study are available from the corresponding author, SQ, upon reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Hamilton Integrated Research Ethics Board (HIREB #18020). All methods and analyses were conducted in alignment with relevant institutional and legislative requirements. Students enrolled in this elective were invited to participate via e-mail. The purposes of the survey collection were explained and by submitting their responses, they consented to having their data included for analysis. Students were aware that participation was non-mandatory, anonymous and did not impact their enrollment or grades. Students created their own codenames, only known to them, protecting their identities and remaining anonymous. All study data are password protected and accessible to team members by 2-factor authentication and verification (McMaster University approved credentials).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Clinical trial number
Not applicable.

Received: 30 October 2024 / Accepted: 30 May 2025
Published online: 01 July 2025

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